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Full Length Research Paper

The effects of *in utero* exposure to antiretroviral therapy (ART) on the language abilities of HIV exposed uninfected infants

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This study investigates the possible effects of *in-utero* antiretroviral therapy (ART) exposure on early language development in HIV exposed uninfected infants. 27 mother-infant pairs consented to the study. Early language development was assessed using the Rossetti Infant Toddler Language Scale. Descriptive statistics were used to describe the caregiver and infant characteristics, as well as the language and communication abilities of infants exposed to *in-utero* ART. T-test statistics compared the early linguistic development of infants conceived while taking efavirenz and infants that were conceived on a nevirapine or protease-inhibitor (PI lopinavir/ritonavir) containing regimen. Similarly, t-tests or ANOVA statistics assessed maternal and infant characteristics associated with total language development. Results obtained in the study revealed no significant differences between the overall language abilities of infants exposed to regimen containing nevirapine or a PI versus regimen that contained efavirenz. The comparison of mean total Rossetti Infant-Toddler Language scores by infant age and maternal and infant characteristics revealed no significant association between variables except for hospitalization. Results obtained suggest that overall language development may not be significantly affected by *in utero* ART exposure however, further research is warranted to assess whether these infants are at an increased risk of late language emergence.

Key words: HIV, *in-utero* antiretroviral therapy exposure, early language development, Rossetti Infant Toddler Language Scale, HIV, HIV exposed uninfected children.

INTRODUCTION

It is estimated that of the 1.1 million babies that are born in South Africa every calendar year, 300,000 are born to HIV positive mothers (National Consolidated Guidelines

for the Prevention of Mother-to-Child Transmission, 2015). According to the 2010 South African National Antenatal Survey, 30.2% of pregnant women in South

Africa were HIV-positive (Goga et al., 2014). However, maternal antiretroviral therapy (ART) in pregnancy is beneficial and substantially reduces known risks to the mother and her infant (National Consolidated Guidelines for the Prevention of Mother-to-Child Transmission, 2015). In 2010, the first national population-based survey of the effect of the South African prevention of mother-to-child HIV transmission (PMTCT) programme on early HIV transmission from mother to child reported an overall transmission rate of 3.5%. When the survey was repeated in 2011, the transmission rate was found to be 2.7% (Goga et al., 2014). Therefore, the overall transmission rate of 3.5% in 2010 and 2.7% in 2011 represent strong progress which would support the efficacy of prevention of mother-to-child HIV transmission (PMTCT) programmes in reducing mother-to-child HIV transmission (MTCT). The success of this programme is further evidenced in a reduction in maternal and under five mortality in South Africa (National Consolidated Guidelines for the Prevention of Mother-to-Child Transmission, 2015). In South Africa, the current PMTCT treatment approach was implemented in 2013 and includes initiating ART for all pregnant women, regardless of CD4 count, with a fixed drug combination consisting of efavirenz, emtricitabine and tenofovir. Previously, nevirapine was the preferred non-nucleoside reverse transcriptase inhibitor that was recommended for pregnant women, until April 2012 when it was replaced by efavirenz due to maternal deaths linked to nevirapine toxicity (Pillay and Black, 2012). Efavirenz (EFV) was previously contra-indicated for the use in pregnancy because of teratogenicity concerns linked to four retrospective case reports of neural tube defects in human infants following first trimester exposure to EFV and animal studies showing neural tube defects following first trimester exposure to efavirenz (De Santis et al., 2002; Ford et al., 2011). However, neural tube defects are a relatively common birth defect (with rates as high as 6.1 per 1000 live births), complicating interpretation of these retrospective case reports (De Santis et al., 2002). Rates of any defect among infants exposed to efavirenz in the first trimester are 2.4% (95% CI: 1.5%, 3.6%) which is similar to that of the general population with 3% for the United States and 5.3% in South Africa (Christianson et al., 2006). Owing to the risk to benefit ratio and toxicities of alternative ART options to use in pregnancy, efavirenz is now part of the first line regimen for pregnant women in South Africa (National Consolidated Guidelines for the Prevention of Mother-to-Child Transmission, 2015).

There remains uncertainty about the increased risk for birth defects, particularly those that are not present morphologically at birth, and long-term developmental

delay following *in-utero* ART exposure (Pillay and Black, 2012). Understanding the potential toxicities of ART following *in utero* exposure allows one to modify the choice of ART and to detect the effects in individual infants early in order to mitigate long-term effects. Language development begins from birth or even sooner (Rossetti, 2001). For the purpose of this study, language is defined as an individual's ability to understand spoken language and to express themselves using either verbal or non-verbal means of communication (Rossetti, 2001). Similarly, communication is defined as the manner in which an individual conveys and receives a message via verbal and nonverbal modes (Rossetti, 2001; Saxton, 2010). The adequate formation of complex neural pathways within the language centres of the foetal brain during intra-uterine development form the foundation for future language emergence (Saxton, 2010; Owens et al., 2015; Slater, 2007). The adverse effects of *in utero* ART exposure have not been sufficiently explored in the area of language development. This study investigated the language development of HIV-exposed, but uninfected infants in South Africa that were exposed to either efavirenz or nevirapine containing ART regimens *in utero*.

MATERIALS AND METHODS

Study design and participants

Data are presented from a prospective cohort of infants, nested within a larger cohort study of HIV positive, reproductive-aged women on ART followed for pregnancy incidence over 12 months or through six weeks postpartum if conception occurred (Schwartz et al., 2012). Of the 850 women from the original cohort, there were 170 pregnancies among 161 women, including 95 who conceived on nevirapine (NVP) (59.0%), 55 who conceived on EFV (34.2%), and 11 who conceived on a protease inhibitor (6.8%). Pregnancy outcomes were as follows: Lived birth (n=85), voluntary termination of pregnancy (n=44), spontaneous abortion (n=28), ectopic pregnancy and termination (n=5), stillbirth (n=2) and unknown (n=6). Of the 85 known live births, 50 qualified for the study and 27 mother-infant pairs (54.0%) consented for the study.

Data collection and analyses

Mother-infant pairs were invited for the language development sub-study from July to September 2011. Women in the parent cohort were recruited between August 2009 and January 2011 from one of four ART clinics within the inner city of Johannesburg. The adult ART regimen at the time included stavudine, lamivudine, and nevirapine or efavirenz as first line option with lopinovir/ritonavir, zidovudine and didanosine for people who had failed first line therapy. Individual drug substitutions for toxicity could be provided. HIV-infected mothers with a CD4 count ≤ 200 cells/ μ L were qualified for ART initiation until April 2010, at which time the guidelines

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were extended to initiate people with tuberculosis or pregnant women with a CD4 count ≤ 350 cells/ μ L (Evian, 2007). Women who conceived and delivered a live infant were contacted by a field worker they were familiar with and invited to participate with their infant in the infant language development sub-study. Infants were eligible if they were HIV negative, medically stable, alert and responsive, and between 7 to 18 months of age. The age range was chosen as this age is considered critical for language development. Infants were characterised as being exposed to either efavirenz, nevirapine or lopinavir/ritonavir (Pillay and Black, 2012). The researcher completing the questionnaire and evaluating the infant was kept blinded to the exposure group of the infant.

Mothers were interviewed using a questionnaire that was adapted from the caregiver tool from the Preschool Language Scales 4th Edition (PLS-4) (2009) (Zimmerman et al., 2011). The questionnaire was utilized to determine the mother's and child's demographic information, pregnancy, labour and delivery experience, areas of expressive and receptive language, as well as areas of cognition and attachment. During the interview the researcher observed and recorded the infant's behaviour and the interaction between the caregiver and the infant.

The infants' language development was assessed using the Rossetti Infant-Toddler Language Scale (Rossetti, 2006) as it is suitable to assesses the language skills of children from birth through three years of age. The Rossetti scale evaluates preverbal and verbal areas of communication and interaction by direct observation and caregiver report. Areas that were assessed included: Interaction-attachment, pragmatics, gesture, play, language comprehension, and language expression (Rossetti, 2006). The examiner, a speech-language pathologist and audiologist, established both a baseline and a ceiling for the infant's developmental age by observing, eliciting, or using a caregiver's report of various behaviours listed in each of the six developmental areas. Scores were awarded as follows; 0 = behaviour absent; 1 = behaviour observed; 2 = behaviour could be elicited by the researcher or the mother; 3 = behaviour occurred spontaneously at any given time during the assessment session. Mothers were instructed to neither intervene in testing nor prompt the child unless the researcher requested her assistance.

Data were analysed using Stata 14 (College Station, Texas). Descriptive statistics were used to describe the caregiver and infant characteristics, as well as the language and communication abilities of infants exposed to *in-utero* ART. T-test statistics compared the early linguistic development of infants conceived while taking efavirenz and infants that were conceived on a nevirapine or protease-inhibitor (PI, lopinavir/ritonavir) containing regimen. Similarly, t-tests or ANOVA statistics assessed maternal and infant characteristics associated with total language development scores or protease-inhibitor (lopinavir/ritonavir).

This study was approved by the University of the Witwatersrand Human research Ethics Committee; study protocol number (M110350). All mothers with eligible infants were verbally informed about the scope of the study and invited to participate in the study. Mothers provided written informed consent for themselves and their infants to participate in the study. Any infants identified with psychosocial concerns or neurodevelopmental delay were referred for further management.

RESULTS

Participant characteristics

Among the 27 infants included, 16 mothers were taking a NVP-based regimen during pregnancy (59.3%), 10 mothers were taking an EFV-based regimen (33.3%) and

mothers on a protease inhibitor-based regimen (7.4%) at the time they conceived. The mean age of the children examined was 8.3 months (SD 1.7, range 8-12). Table 1 depicts the maternal and infant characteristics of participants.

Language abilities of all infants exposed to ART *in utero*

The language abilities of all infants exposed to ART *in utero* are depicted in Table 2. The evaluation of language abilities for interaction and attachment resulted in a mean score of 10.42 (SD 3.36). For pragmatics, which refers to the use of language in social contexts and the ways in which language is produced and comprehended through language, the mean score was 6.57 (SD 3.05). The mean interaction attachment and pragmatics scores fall within the average range. On evaluating play and language comprehension, the mean scores were 13.63 (SD 5.29) and 17.7 (SD 6.67) respectively. When considering the possible range of scores on the play sub-scale, results obtained indicated mild delay in this area while in the area of language comprehension results indicated average performance. Language expression scored 11.19 (SD 5.60) shows a moderate delay for the expected age range.

Figure 1 compares language abilities of infants exposed *in utero* during the first trimester to EFV versus NVP or a PI. Results obtained for interaction attachment revealed a mean score of 8.3 (SD 2.7) in children exposed to EFV *in utero* and a mean score of 12.0 (SD 0.0) in children exposed to NVP/Protease Inhibitors *in utero* ($p=0.169$). Infants exposed to EFV *in utero* obtained a mean of 4.6 (SD 2.3) in the area of pragmatics, while children exposed to NVP/PI *in utero* obtained a mean of 8.0 (SD 0.5) in the area of pragmatics ($p=0.168$). A mean score in the area of interaction attachment and pragmatics could only be obtained for seven ($n=7$) of the 27 infants as these questions could only be administered to infants 9 months and older. In the area of play, infants exposed to EFV *in utero* obtained a mean score of 14.2 (SD 1.8) and infants exposed to NVP/PI *in utero* obtained a mean score of 13.3 (5.2) ($p=0.689$). In the area of language comprehension, infants exposed to EFV *in utero* obtained a mean score of 16.6 (SD 2.3) and infants exposed to NVP/PI obtained a mean of 18.3 (SD 15.0) ($p=0.537$). Finally, infants exposed to EFV *in utero* obtained a mean score of 10.44 (SD 1.63) and infants exposed to NVP/PI obtained a mean of 11.56 (SD 1.4) in the area of language expression ($p=0.636$).

The total mean score combined for 6 to 8 month old infants exposed to EFV *in utero* was 47.50, while 6 to 8 month old infants exposed to NVP/PI obtained a mean of 40.79 ($p=0.324$). The total language scores combined for infants 9 to 12 months exposed to EFV *in utero* obtained a mean of 41.67 versus infants exposed to NVP/PI *in*

Table 1. Maternal and infant characteristics of participants.

Characteristic	Value
Maternal characteristics (n=27)	
Age at child's birth, median years (IQR)	31 [28-34]
Number of children, median (IQR)	2 [1-3]
CD4 count prior to delivery, median (IQR)	343 [185-535]
Viral load at time of pregnancy, n (%)	
Virally suppressed	17 (68)
Detectable	8 (32)
ART regimen at time of pregnancy (NNRTI/PI drug), n(%)	
Nevirapine	16 (59)
Efavirenz	9 (33)
PI	2 (7)
Infant characteristics	
Sex, n (%)	
Female	15 (56)
Male	12 (44)
Birth weight, median grams (IQR)	2800 [2400-3200]
Age at time of language development assessment, n (%)	
6-9 months	20 (7%)
9-12 months	7 (26)
Completed 6 week ART prophylaxis regimen after birth, n (%)	25 (93)
Hospitalized after birth, n (%)	4 (15)

IQR = Interquartile range; NNRTI = Non-nucleoside reverse transcriptase inhibitor; PI = Protease inhibitor.

Table 2. Descriptive statistics of the language abilities of all the infants exposed to ART *in utero* using the Rossetti infant-toddler language scale (n=27).

Task	Range of potential score	Mean	SD	Severity rating
Interaction attachment*	0-12	10.42	3.36	Average
Pragmatics*	0-9	6.57	3.05	Average
Play	0-18	13.63	5.29	Mild
Language comprehension	0-36	17.7	6.67	Average
Language expression	0-21	11.19	5.60	Moderate

Language abilities of infants exposed to first trimester EFV compared to infants exposed to first trimester NVP/PI *in utero*.

in utero which obtained a mean of 71.50 (p=0.123).

Overall, results obtained for infants exposed to NVP/PI *in utero* revealed a slightly larger magnitude of effect than results obtained for infants exposed to EFV *in utero* in the language areas of interaction attachment, pragmatics, language comprehension and language expression, however results were not significantly different across groups. Results obtained in the area of play, revealed a slightly larger magnitude of effect in infants exposed to EFV *in utero* as compared to infants exposed to NVP/PI *in utero*, however again these results were not statistically significantly different across both groups.

Infants that were assessed at 6 to 9 months that had

reportedly been hospitalized after birth obtained a mean total language development score of 24.5 (SD 34.6) and infants that had been assessed at 9 to 12 months that had reportedly been hospitalized after birth, obtained a mean total language development score of 29.5 (SD 33.2) (Table 3). In comparison, infants that had not been hospitalized after birth that were assessed at 6 to 9 months obtained a mean total language development score of 44.8 (SD 9.6) and infants assessed at 9 to 12 months obtained a mean score of 70.4 (SD 8.0). There were statistically significant differences between the means of these two groups which suggests that infants that had been hospitalized after birth were at a

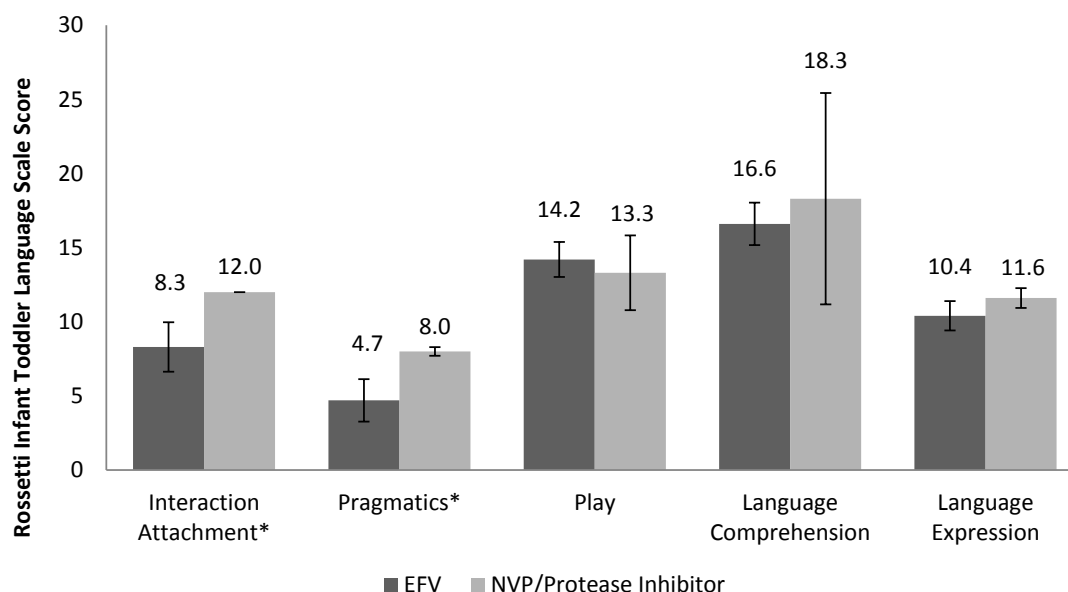


Figure 1. Rossetti infant toddler language scale of infants exposed to first trimester efavirenz and nevirapine or protease inhibitor (lopinavir/ritonavir) *in utero*.

Table 3. Mean total infant Rossetti Infant-Toddler Language Scores by infant age and maternal and infant characteristics.

Characteristic	Infant assessed at 6 to <9 months (n=20); Potential range 0-75.		Infant assessed at ≥9 to 12 months (n=7); Potential range 0-96	
	Mean (sd)	p-Value	Mean (sd)	p-Value
Maternal				
Age		0.228		0.746
<30 years	38.7 (18.0)		54.7 (42.1)	
≥30 years	46.2 (8.0)		61.8 (6.1)	
ART regimen at time of pregnancy (NNRTI/PI drug)		0.224		0.123
Nevirapine	38.7 (15.9)		71.5 (8.8)	
Efavirenz	47.5 (5.0)		41.7 (31.6)	
Protease Inhibitor	53.5 (6.4)		--	
Infant				
Sex		0.569		0.746
Female	41.3 (15.3)		54.7 (42.1)	
Male	45 (11.2)		61.8 (6.1)	
Hospitalized after birth		0.041		0.031
Yes	24.5 (34.6)		29.5 (33.2)	
No	44.8 (9.6)		70.4 (8.0)	

disadvantage in comparison to their non-hospitalized peers.

DISCUSSION

Results obtained in this study revealed no significant differences between the overall language abilities of

infants exposed to regimen containing NVP or a PI versus regimen that contained EFV. The results obtained for infants exposed to NVP/PI *in utero* revealed a slightly larger magnitude of effect than results obtained for infants exposed to EFV *in utero* in the language areas of interaction attachment, pragmatics and language comprehension, however results were not significantly different across groups. Results obtained in the area of

play and language expression, revealed a slightly larger magnitude of effect in infants exposed to EFV *in utero* as compared to infants exposed to NVP/PI *in utero*, however again these results were not statistically significantly different across both groups. Hence results obtained in this study suggest that further research is warranted in a larger study population to assess whether infants exposed to ART *in utero* are at an increased risk of late language emergence as compared to the general South African population. The results lend plausibility to the hypothesis that language development may be impacted by *in utero* ART exposure. A study conducted by Rice et al. (2012a) investigated the association between *in utero* ART exposure with late language emergence in HIV-uninfected, exposed children and found that infants born to mothers with HIV infection and *in utero* ART exposure are at a higher risk of late language emergence than the general population (Rice et al., 2012b).

A subsequent study found that children who were exposed to any ART *in utero* did not have lower mental and psychomotor Developmental Index and Psychomotor Developmental Index scores than unexposed children (Smith et al., 2008). The comparison of mean total Rossetti Infant-Toddler Language scores by infant age and maternal and infant characteristics revealed no significant association between variables except for hospitalization. Results suggest that infants that had been hospitalized after birth were at a disadvantage and at higher risk for late language emergence in comparison to their non-hospitalized peers. This finding is supported by a study conducted by Prothe (2012) which highlights the increased risk of late language emergence in hospitalized infants.

This study had some limitations but these were managed as explained. The sample sizes for the two groups were small and limited the ability to compare differences across groups and to control confounding factors. Nevertheless, there is a lack of data on language development among HIV and ART exposed infants in Africa and this study provides initial data towards understanding language development in this context. The Rossetti Infant Toddler Language Scale is a criterion-referenced scale is not normed on the South African population. However, the use of the Rossetti was efficient in terms of costs and time, and could be performed and completed on infants who had come to the clinic for other routine medical check-ups. Furthermore, the results were interpreted with caution. Though the caregiver questionnaire served to provide supplementary information about the child's language abilities, more information could have been collated using probing questions about parenting capacity and environmental factors. Lastly, the assessment of language development was cross sectional; it is important to also generate information about the sustained effects of ART exposure on child language development over time. Whether language abilities among HIV exposed, uninfected infants improve,

plateau or regress over time is unknown.

Despite the aforementioned limitations, given the dearth of data on the relationship between ART and language development, the study results provide important exploratory analyses that could be further researched in a larger study population. More studies are required to further substantiate which independent variables (from the child's developmental needs, parenting capacity and family and environmental factors) influence the language abilities of HIV-negative infants born to mothers with HIV infection who were receiving ART preconception.

In conclusion, the early identification of possible risks to early language development including the identification of possible language delays is vital, as communication difficulties can have devastating effects on the quality of an individual's personal, vocational and cultural environment. The largest part of brain development occurs within the first three years of a child's life (Smith et al., 2008), hence these early years of a child's neurodevelopment are critical for the acquisition of language. Early identification of abnormal early language development is vital for intervention to be maximized. It is essential therefore for healthcare professionals to be aware of possible threats to the speech and language development of this already at-risk population.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Full Length Research Paper

Water handling and low cost treatment practice of peoples living with human immunodeficiency virus (HIV) in Arba Minch Town, Southern Ethiopia, 2016

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Worldwide, 780 million people do not have access to improved drinking water supplies and 88% of deaths from diarrheal diseases are attributable to unsafe water, inadequate sanitation, and insufficient hygiene. Access to safe water and practice of low cost home based treatments are generally at lower level in people living with human immunodeficiency virus (HIV) in Ethiopia. The aim of this study was to assess the water handling and treatment practice of peoples living with HIV in Southern Ethiopia. A cross sectional descriptive study was carried out among 414 study participants in February 2016 at Arba Minch town, Southern Ethiopia. The study participants were selected randomly from all the associations found in Arba Minch town who have HIV/acquired immunodeficiency syndromes (AIDS) infected people with proportional allocation to sample size. Data was collected using structured questionnaire and prepared checklists by trained data collectors. After checking for the completeness and consistency, the data were entered into Epi Info Version 7 software. Finally, descriptive analysis was done using SPSS Version 21 software, and the results were presented and discussed. The majority of clients 403 (97.6%) reported their drinking water source is tap water. Most households 382 (92.5%) had covered their stored water. Most of the respondents practiced pouring method to withdraw water from the stored container. The water status served for the clients showed that 84.5% (349) of households have improved water status. Majority (83.9%) of the households had access to water within a distance of up to 200 m or less. The majority (82.4%) of households had access to water within a time of 30 min or less. About 56% of the households treated drinking water at home. The water handling practice of the participants is not as recommended, and much effort is needed to alleviate this problem.

Key words: Water handling, water treatment, human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS).

INTRODUCTION

Worldwide, 780 million people do not have access to improved drinking water supplies and an estimated 2.5

billion people, half of the developing world, lack access to adequate sanitation. Every year, diarrheal diseases kill

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801,000 young children, more children than acquired immunodeficiency syndrome (AIDS), malaria, and measles combined, making diarrheal disease the second leading cause of death among children under five. Eighty-eight percent of deaths from diarrheal diseases are attributable to unsafe water, inadequate sanitation, and insufficient hygiene (Center for Disease Control (CDC), 2013).

Africa is one of the two major regions with the least improvement in accomplishing the Millennium Development Goals on sanitation by 2015. Sub-Saharan Africa has a startling 30% coverage with only a 4% increase from 1990. This is a serious concern because of the associated massive health burden as many people who lack basic sanitation engage in unsanitary activities like open defecation, solid waste disposal and wastewater disposal. Africa as a whole, especially sub-Saharan Africa despite efforts and approaches to extend and sustain water, sanitation and hygiene (WASH) systems and services has led to different health complications leading to death within the region. 115 people in Africa die every hour from diseases linked to poor sanitation, poor hygiene and contaminated water (United Nations Department of Economic and Social Affairs (UNDESA), 2014).

Water should be stored in clean, covered containers and kept in a cool dark place. Wide-necked containers such as a bucket fitted with a tight fitting lid are the best as they are easy to clean between uses. Contamination can also occur as the water is taken out of the storage container. Hands and utensils may come into contact with the water so it is important to encourage users to wash their hands with soap before handling drinking water; and to fit a tap to the storage container so that water can be poured directly into a cup or bowl (World Health Organization (WHO), 2016).

Good access to safe water and sanitation is indispensable for people living with human immunodeficiency virus (HIV)/AIDS and for the provision of home-based care to AIDS patients. Water is needed for bathing patients and washing soiled clothing and linen. Safe drinking water is necessary for taking medicines. Nearby latrines are necessary for weak patients. Finally, water is needed to keep the house environment and latrine clean in order to reduce the risk of opportunistic infections. Water and sanitation provision increases the sense of dignity of both patients and caregivers. In addition, safe drinking water is needed for taking medicines and to make food easier to eat for the patients suffering from mouth ulcers or thrush and for excellent hygiene to prevent opportunistic infections. Despite these changing needs, however, access to water, sanitation and hygiene may in fact become more difficult for households caring for Peoples Living with HIV (PLHIV) due to declining physical health, worsening economic status and/or stigma (USAID, 2007).

In resource-limited settings, household-based water

treatment and storage methods are recommended for PLHIV and their households. Contaminated water, lack of sanitation, and poor hygienic practices in homes of PLHIV increase the risk of diarrhea, which can result in increased viral load, decreased CD4 counts, and reduced absorption of nutrients and Anti-Retrovirals (ARVs). Ninety percent of people living with HIV are affected by diarrhea, the major cause of morbidity and mortality especially sub-Saharan Africa, where access to safe water and adequate sanitation is most limited (Boschi-Pinto et al., 2008; Lule et al., 2005; Thom and Forrest, 2006; World Health Organization (WHO), 2008).

Current WHO guidelines for drinking-water quality support efforts to ensure safe collection, treatment and storage of drinking water. These safe water interventions should be implemented not only where supplies are absent but also where community supplies are known to be contaminated or are causing waterborne diseases. Point-of-use water, personal hygiene, and sanitation interventions have been found to be cost beneficial (Hutton and Haller, 2004; Obimbo et al., 2004; WHO, 2004, 2008). Household water treatment (treatment that happens at the point of water collection or use, rather than at a large, centralized location) improves water quality and reduces diarrheal disease in developing countries (Center for Disease Control (CDC), 2013).

In Ethiopia up to 60% of the disease burden is attributable to poor sanitation where 15% of total deaths are from diarrhea, mainly among the large population of children under five. In each year, about 250,000 children die accordingly (Federal Democratic Republic of Ethiopia Ministry Of Health, 2005).

A study conducted among rural communities of Dire Dawa Ethiopia revealed that majority of the respondents were found to collect water from springs and wells each accounting for 140 (36.5%), while 104 (27%) will collect water from tap. Fifty seven percent of participants fetch water for more than 60 min. In addition to this, 90 (70.3%) of the households were not aware of the need to protect the water sources before use and 38 (29.7%) of the respondents protected the water sources before use (Amenu et al., 2013).

Not much attention is given to water safety, handling and treatment practices of peoples living with HIV especially in developing countries like Ethiopia. Therefore, this study aimed to assess the water handling and home based treatment practices of PLHIV.

METHODOLOGY

Study area and study period

The study was conducted in Arba Minch town. Arba Minch is the capital city of Gamo Gofa Zone, located in approximately 505 km to the South of Addis Ababa and 275 km away from the Regional capital, Awassa. In Arba Minch town, there are two associations for HIV infected people with different numbers of members. The study was conducted in February 2016 at Arba Minch town, Southern

Ethiopia.

Study design

A descriptive community based, cross-sectional study design was implemented.

Population

The source population for the study were all HIV infected people who are member of the associations in Arba Minch town. Those HIV infected people who were randomly selected were the study population. All HIV infected people who are member of the associations and permanent residents were included in the study, and participants who were mentally incompetent, critical ill, and less than 15 years of age during data collection period were excluded.

Sample size

A sample size of 414 was calculated using single proportion population formula of Epi Info Version 7 to assess the water handling practice of PLHIV. The assumptions were considering 95% confidence level ($Z=1.96$), 5% margin of error, 42.9% proportion of water, sanitation and hygiene (WASH) practice (14), and to minimize errors arising from the likelihood of non-compliance 10% of the sample size was added.

Sampling procedures

All associations found in Arba Minch town who have HIV/AIDS infected people members were taken. Then samples were allocated proportional to size from each association in the town. Simple random sampling technique was employed using random table to select the study subjects.

Data collection methods

A structured questionnaire and observational checklist was developed to collect information on the households' socio-economic, environmental conditions and behavioral aspects. The questionnaires were first prepared in English and then translated to Amharic (local language) and again back to English to ensure its consistency.

The trained data collectors interviewed the selected study participants. Moreover, an observational checklist was filled by direct observation to collect complementary information on the characteristics of the home water handling practices. During data collection, if the participant was not available at the time of the first visit, the data collectors had made another visit to that household, the next day.

Six diploma environmental health professionals were recruited as data collectors who have a long experience in data collection was involved in the data collection process. Four days training was given to the data collectors and supervisors prior to the start of the data collection process by the principal investigator(s).

A training manual was also prepared to facilitate the training process. The training was mainly focused on interviewing techniques, and emphasis was also given for questions that need careful attention and observation. Classroom lectures, mock interviews and field practice were included in the training.

Two trained masters of public health professional supervised the survey. The supervisors were responsible for supervising the data collectors; check for the completed questionnaire; and correct any

mistake or problem encountered. The principal investigators coordinated the overall data collection process.

Data quality

To ensure reliable information, the questionnaire, check lists and interview guides were developed after reviewing relevant literatures of the subject to include all the possible variables that will address the objective of the study. All tools were first prepared in English and then translated to Amharic and back translated to English to maintain the consistency of the contents of the instrument.

A pretest was done in 5% of the total sample size. Vague terms, phrases and questions identified during the pretest were modified and changed. Missing responses like "No response" and "Others" were added, and skipping patterns were also corrected.

The completed data collection tools were checked every day during data collection for completeness, clarity and consistency by the supervisors/principal investigator. Any mistake detected was corrected the next day. Five percent of the respondents were re-interviewed by the supervisors/principal investigators to check for the consistency of data collection and corrections were made at the spot.

Data management and analysis

Data was coded, stored in a proper area, and kept confidential. Then it was entered into a prepared Epi info template. The data was exported to SPSS version 21 for cleaning and analysis. The data was cleaned by running simple frequency and cross tabulation to check for completeness and consistency, and sorting to identify outliers.

Descriptive measurements (Frequencies, proportions and measures of central tendency) were done to assess the socio-demographic characteristics and the water handling practices of the study participants.

Ethical considerations

Ethical clearance was obtained from the Institutional Review Board of Arba Minch University. Permission was asked from the organizations and Arba Minch city administration office. The questions from the questionnaire were approved and deemed not to affect the morale and personality of study subjects. Informed written consent was obtained from each study subject after explanation and any involvement was done after his or her complete consent. Confidentiality was ensured from all data collectors and principal investigator's side via the use of code numbers and keeping questionnaires in a safe secure location. Data collectors interviewed people privately; separately from others to keep the privacy of the clients.

RESULTS AND DISCUSSION

Socio demographic characteristics

This study was conducted among 413 study participants yielding a response rate of 97.6%. The mean (\pm standard deviation [SD]) age of respondents was 37.14 \pm 7.74 years. About 71% of the participants were females. Of the total 413 participants, 116 (28.1%) were in the age group of 36 to 40 years (Table 1).

Table 1. Frequency of distribution among PLHIV by socio-demographic characteristics, Arba Minch town, Southern Ethiopia, 2016.

Socio-demographic characteristics		Frequency	Percent
Sex	Male	121	29.3
	Female	292	70.7
Marital status	Married	235	56.9
	Single	35	8.5
	Widowed	74	17.9
	Divorced	62	15
	Separated	7	1.7
Age category	20-25	22	5.3
	26-30	89	21.5
	31-35	87	21.1
	36-40	116	28.1
	41-45	56	13.6
	45+	43	10.4
Occupation	House wife	88	21.3
	Farmer	76	18.4
	Merchant	18	4.4
	Private	18	4.4
	Daily labourer	54	13.1
	Jobless	140	33.9
	Other	19	4.6
Educational status	No schooling	125	30.3
	Elementary	170	41.2
	High school	95	23
	Diploma and above	23	5.6
Wealth index	Lowest (poorest)	84	20.3
	Second (poor)	81	19.6
	Third (middle)	117	28.3
	Fourth (high)	79	19.1
	Fifth (highest)	52	12.6

Regarding the marital status of the study participants, 235 (56.9%) respondents were married. The majority of the respondents 237 (57.4%) belong to the Gamo ethnic group followed by Welayta (13.8%), Amhara (12.1%) and others (Gofa, Oromo, Tigre, Konso and Kembata).

Concerning the occupational status of the study participants, most 140 (33.9%) were jobless followed by housewives 88 (21.3%), farmers 76 (18.4%) and daily laborers 54 (13.1%). About 170 (41.2%) respondents had attended formal education from elementary, 125 (30.3%) were illiterate. The income distribution of the study participants was assessed using various parameters of

the respondents and their households. Then, wealth index was calculated using factor analysis in five categories. Accordingly, the poorest/lowest, second, third/middle, fourth/high and richest/highest quintile accounted for 20.3, 19.6, 28.3, 19.1 and 12.6%, respectively.

Status of water supply

The majority of clients 403 (97.6%) reported their drinking water source is tap water. Only a small number of clients

Table 2. Principal water source and Location of source of drinking water of Study Participants in Arba Minch Town, 2016.

Characteristic	Frequency	Percent
Principal source of water for drinking and cooking		
Tap water	403	97.6
Protected spring/well	5	1.2
River	5	1.2
Location of source of drinking water		
Inside the house	98	23.7
In the compound	165	40
Outside the compound private	91	22
Outside the compound shared	59	14.3

(1.2%) get their water from a protected well/spring or river. According to this study, 40% of the drinking water source is located within their compound (Table 2).

Water and sanitation to people were affected and living with HIV/AIDS were some of the shortcomings reported in South Africa (Potgieter et al., 2007). In India, economic constraints, lack of individual household toilets, lack of fuel for boiling water, and water scarcity were problems for PLHIV (Seremet et al., 2010). Studies conducted in Zambia and Malawi revealed that PLHIV used different sources and travel long distance to fetch drinking water; only 54 and 53% of clients fetch water from improved sources and walk at least 40 and 25.33 min, respectively (Kangamba et al., 2006; Lockwood et al., 2006). Another study conducted in Botswana on access to safe water for HIV/AIDS patients showed that people use several sources of water and the unreliability leads to use of poor quality water and poor hygiene (Ngwenya and Kgathi, 2006).

Similarly, study done in Ethiopia indicated that the majority of clients 211 (71.8%) reported their drinking water source location as outside their yards in the neighborhood. Only a small number of clients, that is, 0.7% (2), 1% (30), and 0.7% (2) households get their water from protected well, spring and unprotected spring, respectively (Yallew et al., 2012). In other research conducted in Ethiopia, it was reported that one third of the respondents were discriminated in the water source and forced to go far distance to fetch water for their families (Tibebu et al., 2007).

Water storage practice

A good number of participants responded that they stored their drinking water in containers. The majority 386 (93.5%) had used plastic containers, followed by tin containers (6.5%). The data collectors observed whether the household water container was covered or not. Accordingly, the observation revealed that most

households 382 (92.5%) had covered their stored water and the rest 31 (7.5%) had not covered. The major type of primary vessel volumes in the households was 20 L (95%). Other households reported tanker, 5 and 2.5 L as primary vessel containers. The type of neck of the primary vessels were narrow, covered, necked, and opened accounting 40.2, 35.1, 23 and 1.7%, respectively.

Most of the respondents practiced pouring method to withdraw water from the stored container, while 129 (31.2%) practiced dipping and 123 (29.8%) using both dipping and pouring methods (Figure 1). In general water status served for the clients showed that 84.5% (349) of households have improved and 14.5% (64) of the clients have unimproved water status.

Although storing of water in covered containers and the use of proper procedures to pour water ensures the water is not re-contaminated, different studies in different areas documented malpractices. A study conducted in Zambia reported that only 55% used vessels having a narrow neck for storage and 12% reported dipping from the container (Kangamba et al., 2006). A similar study in Malawi also showed that 26.7% used narrow neck while the majority (83.3%) reported dipping a coup into the storage (Lockwood et al., 2006). But a study done in Ethiopia indicated that majority of the clients (80.3%) practiced pouring method to withdraw water from the stored container while (7.1%) practiced dipping (Yallew et al., 2012).

Water collection and consumption

The containers differ in sizes but range from 20 L buckets to 40 L containers. Mostly, 20 L jerry cans are used for fetching water 391 (94.7%). With respect to distance of water source from dwelling, majority (83.9%) of the households had access to water within a distance of up to 200 m or less. In addition, the majority (82.4%) of households had access to water within a time of 30 min or less. Fifty seven percent of participants fetch water for

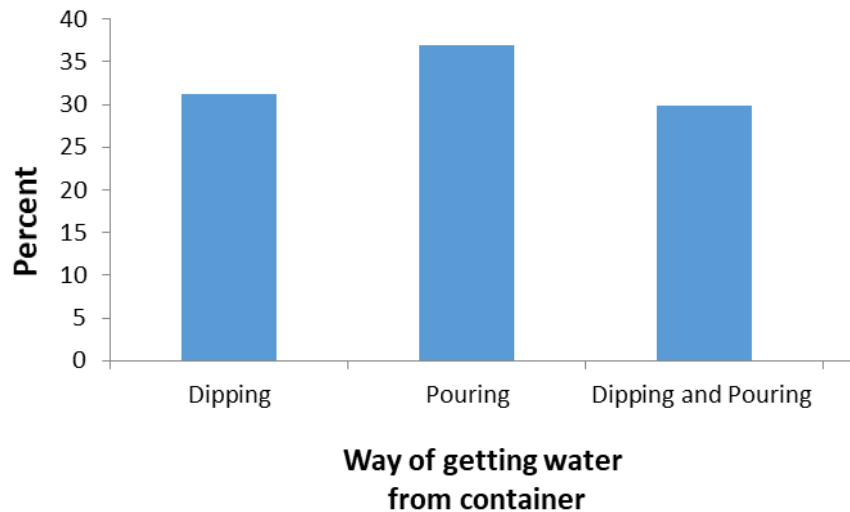


Figure 1. Methods of getting water from container of the study participants in Arba Minch Town, 2016.

more than 60 min according to a study done on Eastern Ethiopia (Amenu et al., 2013). The variation might be due to difference in geographical location and time of study. A study carried out in Malawi on assessment of water, sanitation, and hygiene in the context of Home-Based Care for Peoples Living with HIV indicated that long distances to water sources in the rural areas created barriers to accessing water for households affected by HIV (Lockwood et al., 2006).

In the majority of households 328 (79.7%), an adult woman usually collected drinking water from water sources followed by both adults 35 (8.5%), adult men 28 (6.8%) and under 18 years females 21 (5.1%).

Regarding consumption of water, the majority of households (93.7%) had used less than 20 L per capita per day and of which 55.8% households had used less than 15 L per capita per day. This is in contrary to a case study conducted in Botswana, which revealed that home based care HIV/AIDS patients used additionally 20 to 80 L of water for care from the normal water supply, and also the water consumption was increased from 40 l to 100 L (Ngwenya and Kgathi, 2006). This variation could be attributed due to economic problems and/or insufficient amount of water availability in the household (Yallew et al., 2012).

Home based water treatment

More than one-third (67.6%) of the respondents think that the water they drink is safe directly from its source, however, 104 (25%) participants responded "I do not know". Only 7.4% (30) of respondents do not think that the water they drink is safe directly from its source. Moreover, 233 (56.4%) households treated drinking water

at home, but the rest 176 (42.6%) did not treat water at home. A study from Northern Ethiopia showed that only 12% households treated water at home and 82.7% of them believed that the water they used was always clean and safe (Sharma et al., 2013).

Among the households who treated their drinking water within 24 h at home, about 98.5% mostly used a water guard. Filtration, settlement, solar disinfection and boiling were also the other water treatment methods used by the households at home (Figure 2). Some studies showed that the use of household treatment or at point of use thereby reduces the risk of diarrheal disease by 30 to 40% (Lule et al., 2005; Wanyiri et al., 2013). Sharma et al. (2013) reported only 7.8, 3, and 1.5% households practiced simple sedimentation, boiling and filtration methods, respectively to treat water at home before consuming water (Sharma et al., 2013). Studies done in Zambia and Malawi revealed that respondents used chlorine and boiling to treat their drinking water in the previous 24 h (Kangamba et al., 2006; Lockwood et al., 2006). A study done in Gondar city also showed that people living with HIV practice treating water in home using chlorination, boiling and filtration (Yallew et al., 2012).

Conclusion

This study found that handling practices of drinking water at the household level among PLHIV is not good. The use of low cost household level water treatment system technologies available is also one of the problems, accordingly, this study showed that people living with HIV/AIDS practice some form of home treatment to make water safe. People living with HIV and AIDS recognized

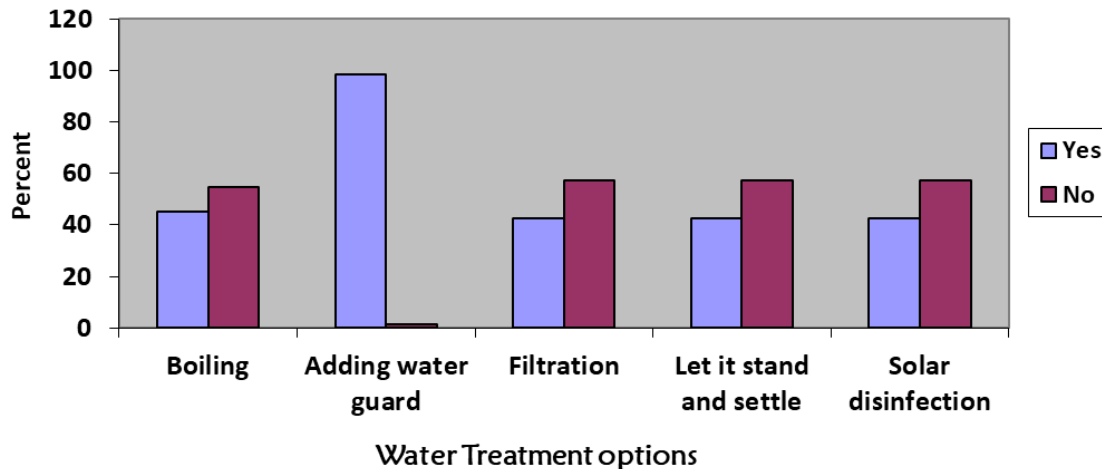


Figure 2. Home based water treatment practice of PLHIV in Arba Minch town, Southern Ethiopia, 2016.

the need for safe water, safe handling practices better than most of the population. This needs integrated efforts of stakeholders who work in the area. The associations helping this people, and the governmental offices should provide safe water and water handling skills.

This study is not free of limitations as it is a descriptive type of study. There was no control group in the study and thus the contributing factors are not assessed.

CONFLICT OF INTERESTS

The authors have declared no conflict of interests.

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