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Non-opportunistic intestinal parasitic infections among HIV-infected individuals at Wolaita Sodo Hospital, South Ethiopia

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ABSTRACT

Objective: To determine the prevalence of non-opportunistic intestinal helminthic and protozoal infections among HIV-infected individuals and to determine socio-demographic determinants of intestinal parasitosis.

Methods: A cross-sectional study was conducted on HIV-infected individuals attending anti-retroviral therapy clinic of Wolaita Sodo Hospital. Stool in wet mount preparation and formal-ether concentration technique were used to diagnose intestinal parasitic infection. Socio-demographic variables were collected by using questionnaire. *Chi*-square test was used to test the associations between intestinal parasitosis and socio-demographic variables.

Results: The overall prevalence of non-opportunistic intestinal parasitic infection was 32.4% out of which 11.0% was protozoal infection and 21.4% was helminthic infection. The most common intestinal parasite detected was *Ascaris lumbricoides* with 12.7% prevalence followed by *Giardia lamblia* with 7.5% prevalence. The prevalence of *Strongyloides stercoralis*, hookworm species, *Entamoeba histolytica/Entamoeba dispar*, *Schistosoma mansoni* and *Taenia* species was 2.9%, 1.2%, 3.5%, 1.7% and 2.3% respectively. There was no significant difference in prevalence of intestinal parasite infection with regard to age, sex, residence area, job type and religion of participants but there was a significant association between the educational status and intestinal parasitic infection. The prevalence of intestinal parasitic infection was higher among illiterate participants.

Conclusions: *Ascaris lumbricoides* was the most common intestinal parasite detected in HIV-infected individuals. *Giardia lamblia* was the most common protozoal parasite observed. Prevalence of intestinal helminthic infection was higher than protozoal infection. Intestinal parasitosis was significantly associated with an educational status of individuals.

1. Introduction

The intestinal parasites are the protozoan or helminth living within intestine of human and these parasites are more common in tropics and subtropics than elsewhere in the world[1]. The progressive reduction in immunological defense is due to HIV infection predisposing infected individuals, a number of opportunistic intestinal pathogens[2].

Type and prevalence of intestinal parasitic infections vary with the geographical area[3]. Opportunistic and non-opportunistic intestinal parasites frequently encountered in HIV-infected individuals are *Cryptosporidium* species, *Isospora belli*, Microsporidia species, *Giardia intestinalis*, *Entamoeba* species, *Cyclospora*, hookworm, *Taenia* species and *Ascaris lumbricoides*[4].

Different factors such as climatic conditions, poor sanitation, unsafe drinking water and lack of toilet facilities are the main contributors to the high prevalence of intestinal parasitic infection in the tropical and subtropical countries. Especially, fecal contamination of food and drinking water is the main factor to spread intestinal parasites in developing countries[5,6].

The HIV pandemic is a major public health problem for the

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The study protocol was performed according to the Helsinki declaration and approved by Ethical Clearance Committee of College of Health Sciences and Medicine of Wolaita Sodo University. Informed oral consent was obtained from each of the study participants.

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world. An estimated 33 million adults and children are living with the virus globally of which an estimated 22 million adults and children are living with the virus in sub-Saharan African region[7]. Since the beginning of the HIV epidemic in the world, opportunistic infections have been recognized as an important cause for clinical complications among which opportunistic parasitic infections do have a great impact on health of HIV-infected individuals[8].

HIV infection is currently one of the biggest and most deadly infectious diseases. It is believed that there are 1.8 million HIV/AIDS related deaths per year globally. Patients with HIV/AIDS are at higher risk for many diseases. An infection of the gastrointestinal tract is a big problem in HIV/AIDS patients[9-12].

Non-opportunistic intestinal parasites like hookworms, *Opisthorchis viverrini* and *Ascaris lumbricoides* were commonly observed in HIV-infected patients regardless of their immunity level. The attention should be given to the importance of tropical non-opportunistic intestinal parasitic infection, HIV-infected individuals[13]. Gastrointestinal infections are responsible for different clinical manifestations in HIV infection, such as diarrhea which occurs in 30%–60% and 90% of HIV/AIDS patients in developed and developing countries respectively[14]. High prevalence of intestinal parasitic infection was observed among HIV/AIDS patients with diarrhea and low $CD4^+$ T-lymphocyte count[15].

The progressive decline and ultimate destruction of immune system functions, which occur due to HIV/AIDS, can result in morbidity and ultimately death due to opportunistic bacterial, viral, fungi and parasitic infections. The outcome of intestinal parasitic infection in HIV/AIDS is dependent on absolute $CD4^+$ T-lymphocyte count in which being lower counts are associated with more severe disease, more atypical disease, and a high risk of disseminated disease[16,17].

In Ethiopia, intestinal parasites are widely occurring due to the low level of environmental sanitation and improper disposal of human excreta. The epidemiological distribution and prevalence of various types of intestinal parasites differ from region to region in Ethiopia because of environmental, social and geographical factors[18,19].

In this area, no study was conducted to determine the types and prevalence of non-opportunistic intestinal parasitic infections among HIV infected individuals as well as the socio-demographic determinants of intestinal parasitosis was not assessed so that this research work was conducted in consideration these gaps.

The aims of this study were to determine the prevalence of intestinal helminthic and protozoal infection among HIV-infected individuals and to determine the associations between intestinal parasitic infections and socio-demographic variables.

2. Materials and methods

2.1. Study area and design

Wolaita Sodo is a town in South-Central Ethiopia and is administrative center of Wolaita zone of south nations, nationalities and peoples region which is 380 km away from Addis Ababa Wolaita Sodo and has an altitude between 1 600 and 2 100 m above sea level (6°54' N, 37°45' E/6.900°N, 37.750°E). Sodo possesses a well moderated subtropical highland climate. The area has annual rain fall of 1 212 mm and 20 °C mean monthly temperature.

An institution based cross-sectional study was conducted to determine the prevalence of intestinal parasitic infections among HIV infected individuals and to assess an association between sociodemographic variables and intestinal parasitosis.

2.2. Sampling technique

The study participants were clients attending anti-retroviral therapy (ART) clinic of Wolaita Sodo University. Firstly, the participants were asked for being voluntary to participate in this study, secondly, the verbal consent was obtained and finally, all those who were voluntary were included in the study.

2.3. Sample collection and processing

Total of 173 HIV-infected individuals were participated in this study. Firstly, participants provided questionnaire information which assessed the socio-demographic conditions of individuals like age, sex, residence area, educational status and job types, then participants provided stool sample for laboratory examination to diagnose intestinal parasitic infection. Firstly, wet mount preparation was made from fresh specimen and examined microscopically for ova, trophozoite, cyst and larva of parasites. Then, a portion of the same stool specimen was used for formal-ether concentration technique as follow: 10% formalin was mixed with stool sample by using applicator stick which was filtered into the centrifuge tube on which ethyl acetate was added and mixed; then, the preparation was centrifuged at 3 200 r/min for 3 min and the drop of sediment obtained after centrifugation was examined with 10× and 40× objective for ova, cyst and larva of parasites and finally, the type of intestinal parasite identified was recorded on prepared record format in laboratory. Inclusion criteria: HIV-positive patients were treated with ART and pre-ART.

2.4. Data analysis

All data from questionnaire and laboratory investigations were checked for completeness and cleaned for any inconsistencies. Then, data were analyzed by using SPSS version 20. The descriptive statistics was used to determine the frequencies of different variables. The association between intestinal parasitosis and socio-demographic variables was tested by using *Chi*-square test. For all statistical tests, $P \leqslant 0.05$ was considered as statistically significant.

2.5. Ethical considerations

Ethical approval was obtained from ethical clearance committee of College of Health Sciences and Medicine of Wolaita Sodo University. Informed oral consent was obtained from each participant of the study. Intestinal parasitic infected individuals got appropriate management from clinicians.

2.6. Data quality assurance

Standard operating procedures were followed in all laboratory techniques during data collection. The expiry date of all laboratory equipments and reagents was checked before using them.

3. Result

3.1. Socio-demographic characteristics

Out of total participants of the study, 81 (46.8%) were male and 92 (53.2%) were female. Regarding the religion, 57.2% were protestant, 30.6% were orthodox and 4.6% were catholic. Most of the studied participants were from urban area (86.1%) and the remaining 13.9% were from rural area. Regarding the educational status, majorities (46.2%) completed secondary education and most participants (72.3%) were private workers as shown in Table 1.

Table 1
Socio-demographic characteristics of HIV-infected individuals attending ART clinic of Wolaita Sodo Hospital, South Ethiopia.

Variables		Number	Percentage
Sex	Male	81	46.8
	Female	92	53.2
Age	10–14	6	3.5
	15–19	3	1.7
	20–24	38	22.0
	25–29	53	30.6
	30–34	36	20.8
	35	37	21.4
Religion	Protestant	100	57.8
	Orthodox	53	30.6
	Catholic	8	4.6
	Others	12	6.9
Residence	Urban	149	86.1
	Rural	24	13.9
Educational status	Illiterate	15	8.7
	Primary education	62	35.8
	Secondary education	80	46.2
	College/university	15	8.7
Job types	Government	9	5.2
	Private	125	72.3
	Others	39	22.5

3.2. Prevalence of intestinal parasitic infection among HIV infected individuals

The overall prevalence of non-opportunistic intestinal parasitic infection was 32.4% out of which 11.0% was protozoal infection and 21.4% was helminthic infection. Seven different species of intestinal parasites were detected in this study (Figure 1). The most common intestinal parasite detected was *Ascaris lumbricoides* (*A. lumbricoides*) with prevalence of 12.7% followed by *Giardia lamblia* (*G. lamblia*) with the prevalence of 7.5%. The prevalence of *Entamoeba histolytica* (*E. histolytica*)/*Entamoeba dispar* (*E. dispar*) and *Schistosoma mansoni* (*S. mansoni*) infection was 3.5% and 1.7% respectively. Hookworm was least prevalent intestinal parasite (1.2%) (Figure 1). The co-infection of *S. mansoni* and *Strongyloides stercoralis* (*S. stercoralis*) was detected in 0.6% of study participants.

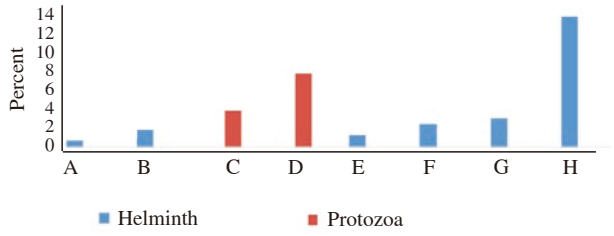

Figure 1. Prevalence of intestinal helminth and protozoa infections among HIV-infected individuals attending ART clinic of Wolaita Sodo Hospital, South Ethiopia.
A: *S. mansoni* + *S. stercoralis*; B: *S. mansoni*; C: *E. histolytica*; D: *G. lamblia*; E: *Hookworm*; F: *Taenia* specias; G: *S. stercoralis*; H: *A. lumbericoides*.

3.3. Association between intestinal parasitic infections and socio-demographic variables

Intestinal parasitic infection was not significantly associated with sex of participants, $P = 0.12$. Similarly socio-demographic factors like age, residence area, job types and religion were not associated with intestinal parasitosis (Table 2). Educational status was significantly associated with intestinal parasitic infection, $P = 0.03$.

Table 2
The association between intestinal parasitic infections and socio-demographic factors in Wolaita Sodo Hospital, South Ethiopia.

Variables		Positive number	Percent	Negative number	Percent	*P* value
Sex	Male	31	38.3	50	61.7	0.12
	Female	25	27.2	67	72.8	
Age	10–14	3	50.0	3	50.0	0.85
	15–19	1	33.3	2	66.7	
	20–24	11	28.9	27	71.1	
	25–29	15	28.3	38	71.7	
	30–34	12	33.3	24	66.7	
	> 35	14	37.8	23	62.2	
Residence	Urban	47	31.5	102	68.5	0.56
	Rural	9	37.5	15	62.5	
Job	Government	3	33.3	6	66.7	0.41
	Private	37	29.6	88	70.4	
	Others	16	41.0	23	59.0	
Educational status	Illiterate	9	60.0	6	40.0	0.03
	Primary education	21	33.9	41	66.1	
	Secondary education	19	23.8	61	76.2	
	College/university	7	43.8	9	56.2	
Religion	Protestant	32	32.0	68	68.0	0.10
	Orthodox	13	24.5	40	75.5	
	Catholic	4	50.0	4	50.0	
	Others	7	58.3	5	41.7	

4. Discussion

The overall prevalence of non-opportunistic intestinal parasitic infection was 32.4% in the study which is comparable to previous

study in other part of Ethiopia and the prevalence of intestinal parasitosis in ALERT hospital was 35%[20]. The prevalence of intestinal protozoal infection of HIV-infected individuals in our study was 11.0% and it was 14.6% in a study done in Hawassa University Referral Hospital, in the same region with this study[21]. The incidence of intestinal helminthic infection was 21.4% which was higher than protozoal infection. An intestinal helminth infection like *A. lumbricoides*, hookworm, *Trichuris trichuria*, and *S. mansoni* is commonly observed in previous studies conducted in Ethiopia but for protozoan parasite types, only two species (*E. histolytica* and *G. lamblia*) were commonly reported in country[22,23].

The prevalence of *A. lumbricoides* infection was 12.7% and it was the most common intestinal parasite detected among HIV-infected individuals. *A. lumbricoides* is generally the most common intestinal parasite observed in Ethiopia from different reports[23]. This might be due to the favorable environmental condition for survival of ova of *A. lumbricoides* in country. However, our finding is lower than a report from Jimma, Ethiopia in which the prevalence of ascariasis was 21.67% which may be due to the difference in geographical areas[24].

S. stercoralis was the second common helminth found with 2.9% positivity rate. *S. stercoralis* was significantly more prevalent among HIV-infected individuals than HIV negatives[25]. In immunosuppressed patients like HIV/AIDS patients, autoinfection of *S. stercoralis* is speeded up in which large number of larvae are released and cause the dissemination of infection. The clinical syndrome of disseminated strongyloidiasis are gastrointestinal symptoms and respiratory symptoms such as dyspnea, hemoptysis, coughing, or manifestations of asthma and extensive pneumonia as well as secondary infections[3].

Hookworm was the least prevalent helminthic parasite observed among HIV-infected individuals with 1.2% prevalence which might be due to the reason that majority of participants were from urban area that have the habit of wearing shoes which is a preventive practice to control hookworm transmission and this finding is consistent with a report from North Ethiopia (1.1%) by Alemu *et al*[26]. *S. mansoni* was detected in 1.7% of the study subjects which is close to a previous report from Ethiopia (0.8%)[27]. *S. mansoni* was also observed in co-infection with 0.6% prevalence of *S. stercoralis*. The incidence of coinfection was low in our study which may be due to the regular follow up of health status of HIV-infected individuals at ART clinic of the hospital.

G. lamblia was the most common protozoan parasite detected in this study with prevalence of 7.5%, which is close to a report from Eastern Ethiopia (8.1%)[27]. Previous studies have also indicated the association between *G. lamblia* and HIV-infection, and HIV causes depressed humoral immunity of an individual which has a significant contributory role in the susceptibility of *G. lamblia* infection[28]. *E. histolytica*/*E. dispar* infection prevalence was 3.5%. *E. histolytica*/*E. dispar* infection was also indicated as common intestinal parasitic infection among HIV/AIDS infected patients in a previous report from Ethiopia[27].

The prevalence of intestinal parasitic infection was 38.3% in male and 27.2% in female and this difference was not statistically significant, $P > 0.05$. This indicated that intestinal parasitosis was not significantly associated with sex of study participants. Regarding intestinal parasitic infection among age groups, there was no statistically significant difference in parasitic infection among age groups. Our report is concordant with a study conducted at Northeast Ethiopia, in which socio-demographic characteristics like sex and age group did not show significant association with intestinal parasitic infection[29].

There was no statistically significant difference in intestinal parasitic infection with regard to the residence area of participants, even though a figure was higher in rural than urban (37.5 % *vs*. 31.5%). The impressive improvement in environmental sanitation like latrine usage in rural areas of Ethiopia is due to the implantation of rural health extension polices in recent years which may contribute to a comparable distribution of intestinal parasitosis among rural and urban areas observed in this study[30]. Similarity, intestinal parasitic infection was not associated with the job types of study participants. Intestinal parasitic infection was significantly associated with the educational status in which it was higher among illiterate participants than others so that educational status was the only socio-demographic factors associated with intestinal parasitosis.

Non-opportunistic intestinal helimenthic and protozoal infection was observed as common health problem among HIV-infected individuals in the study area. *A. lumbricoides* was the most common helminth and *G. lamblia* was the most common protozoa parasite observed. The prevalence of intestinal helimenthic infection was higher than that of protozoal infection. Intestinal parasitic infection was significantly associated with an educational status of participants whereas it has no correlation with sex and age of individuals. Due attention should be given to the laboratory screening and management of intestinal parasitic infection among HIV-infected individuals.

Conflict of interest statement

We declare that we have no conflict of interest.

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References

[1] Abate A, Kibret B, Bekalu E, Abate S, Teklu T, Yalew A, et al. Cross-sectional study on the prevalence of intestinal parasites and associated

risk factors in Teda Health Centre, Northwest Ethiopia. *ISRN Parasitology* 2013; **2013**: 757451.

[2] Stensvold CR, Nielsen SD, Badsberg JH, Engberg J, Friis-Møller N, Nielsen SS, et al. The prevalence and clinical significance of intestinal parasites in HIV-infected patients in Denmark. *Scand J Infect Dis* 2011; **43**(2): 129-35.

[3] Cimerman S, Cimerman B, Lewi DS. Enteric parasites and AIDS. *Sao Paulo Med J/Rev Paul Med* 1999; **117**(6): 266-73.

[4] Jaiswal S, Sharma S, Bhat SR, Pokhrel T, Chaudhary N, Sharma I. Distribution of intestinal parasite in people living with HIV/AIDS of different care centre of Pokhara Valley, Nepal. *Scholars J Appl Med Sci* 2014; **2**(6G): 3366-9.

[5] Mahfouz AA, el-Morshedy H, Farghaly A, Khalil A. Ecological determinants of intestinal parasitic infections among pre-school children in an urban squatter settlement of Egypt. *J Trop Pediatr* 1997; **43**: 341-4.

[6] Kumie A, Ali A. An overview of environmental health status in Ethiopia with particular emphasis to its organization, drinking water and sanitation: a literature survey. *Ethiop J Health Dev* 2005; **19**: 89-103.

[7] Campos LN, Guimarães MD, Carmo RA, Melo AP, Oliveira HN, Elkington K, et al. HIV, syphilis, and hepatitis B and C prevalence among patients with mental illness: a review of the literature. *Cad Saude Publica* 2008; **24**: s607-20.

[8] Kaur G, Sharma V. Correlation between CD4 counts and parasitic intestinal infection among diarrheal and non-diarrheal human immunodeficiency virus positive Indian patients. *Int J Med Sci* 2015; **2**(8): 1-6.

[9] Berenji F, Sarvghad MR, Fata A, Hosseininejad Z, Saremi E, Ganjbakhsh M, et al. A study of the prevalence of intestinal parasitic infection in HIV positive individuals in Mashhad, Northeast Iran. *Jundishapur J Microbiol* 2010; **3**(2): 61-5.

[10] Nissapatorn V, Sawangjaroen N. Parasitic infections in HIV infected individuals: diagnostic & therapeutic challenges. *Indian J Med Res* 2011; **134**(6): 878-97.

[11] World Health Organization. AIDS epidemic update. Geneva: World Health Organization; 2002. [Online] Available from: http://www.who.int/hiv/facts/en/epiupdate_en.pdf?ua=1 [Accessed on 5th December, 2015]

[12] Basnet A, Sherchan JB, Rijal B, Sharma S, Khadga P. Detection of coccidian parasites and their clinical manifestation, treatment and prophylaxis in HIV infected patients in Tribhavan University Teaching Hospital. *Sci World* 2010; **8**(8): 51-5.

[13] Wiwanitkit V. Intestinal parasitic infections in Thai HIV-infected patients with different immunity status. *BMC Gastroenterol* 2001; **1**: 3.

[14] Dalela G, Vijay A. Prevalence of intestinal parasitic infection among HIV infected patients at SRG Hospital, Jhalawar, India. *Int J Curr Microbiol Appl Sci* 2015; **4**(8): 817-24.

[15] Singh DD, Singh V. Prevalence of intestinal parasitic infections in HIV infected patients presenting with diarrhea and their association with $CD4^+$ counts. *Int J Appl Sci Biotechnol* 2015; **3**(1): 96-100.

[16] Patel SD, Javadekar TB, Kinariwala DM. Enteric opportunistic parasitic infections among HIV-seropositive patients at tertiary care teaching hospital. *Natl J Med Res* 2015; **5**(3); 190-3.

[17] Vasundhara, Khan HM, Sharma H, Singh S. Prevalence of intestinal parasitic infections in hiv-positive patients. *Int J Curr Microbiol Appl Sci* 2015; **4**(5): 269-73.

[18] Haftu D, Deyessa N, Agedew E. Prevalence and determinant factors of intestinal parasites among school children in Arba Minch town, Southern Ethiopia. *Am J Health Res* 2014; **2**(5): 247-54.

[19] Nkenfou CN, Nana CT, Payne VK. Intestinal parasitic infections in HIV infected and non-infected patients in a low HIV prevalence region, West-Cameroon. *PLoS One* 2013; **8**(2): e57914.

[20] Taye B, Desta K, Ejigu S, Dori GU. The magnitude and risk factors of intestinal parasitic infection in relation to human immunodeficiency virus infection and immune status, at ALERT Hospital, Addis Ababa, Ethiopia. *Parasitol Int* 2014; **63**(3): 550-6.

[21] Fekadu S, Taye K, Teshome W, Asnake S. Prevalence of parasitic infections in HIV-positive patients in southern Ethiopia: a cross-sectional study. *J Infect Dev Ctries* 2013; **7**(11): 868-72.

[22] Getachew M, Tafess K, Zeynudin A, Yewhalaw D. Prevalence soil transmitted helminthiasis and malaria co-infection among pregnant women and risk factors in Gilgel Gibe dam Area, Southwest Ethiopia. *BMC Res Notes* 2013; **6**: 263.

[23] King JD, Endeshaw T, Escher E, Alemtaye G, Melaku S, Gelaye W, et al. Intestinal parasite prevalence in an area of ethiopia after implementing the SAFE strategy, enhanced outreach services, and health extension program. *PLoS Negl Trop Dis* 2013; **7**(6): e2223.

[24] Zeynudin A, Hemalatha K, Kannan S. Prevalence of opportunistic intestinal parasitic infection among HIV infected patients who are taking antiretroviral treatment at Jimma Health Center, Jimma, Ethiopia. *Eur Rev Med Pharmacol Sci* 2013; **17**: 513-6.

[25] Feitosa G, Bandeira AC, Sampaio DP, Badaró R, Brites C. High prevalence of giardiasis and stronglyloidiasis among HIV-infected patients in Bahia, Brazil. *Braz J Infect Dis* 2001; **5**(6): 339-44.

[26] Alemu A, Shiferaw Y, Getnet G, Yalew A, Addis Z. Opportunistic and other intestinal parasites among HIV/AIDS patients attending Gambi higher clinic in Bahir Dar city, North West Ethiopia. *Asian Pac J Trop Med* 2011; **4**(8): 661-5.

[27] Teklemariam Z, Abate D, Mitiku H, Dessie Y. Prevalence of intestinal parasitic infection among HIV positive persons who are naive and on antiretroviral treatment in Hiwot Fana Specialized University Hospital, Eastern Ethiopia. *ISRN AIDS* 2013; **2013**: 324329.

[28] Robinson RD, Lindon JF, Neva FA. Interaction between HTLV-I and *S. stercoralis* infection resulting lower IGE levels in Jamaica. *W Ind Med J* 1990; **39**: 35-7.

[29] Missaye A, Dagnew M, Alemu A, Alemu A. Prevalence of intestinal parasites and associated risk factors among HIV/AIDS patients with pre-ART and on-ART attending dessie hospital ART clinic, Northeast Ethiopia. *AIDS Res Ther* 2013; **10**: 7.

[30] United Nations Children's Emergency Fund. UNICEF sanitation priority country factsheet 2014. New York: United Nations Children's Emergency Fund; 2014. [Online] Available from: http://www.unicef.org/ethiopia/Ethiopia_Fact_Sheet_Jan_2014._final.pdf [Accessed on 5th December, 2015]