Clinical Epidemiology and Global Health 15 (2022) 101032

Contents lists available at ScienceDirect

Clinical Epidemiology and Global Health

journal homepage: www.elsevier.com/locate/cegh

Prevalence of intestinal parasitic infections and associated factors among pregnant women attending antenatal care at Yirgalem General Hospital, Sidama, Ethiopia

Aregahegn Dona Buchala [*], Siyoum Tesfaw Mengistu, Azmach Dache Mue, Amelo Bolka Gujo

Department of Social and Population Health, Yirgalem Hospital Medical College, Yirgalem, Sidama, Ethiopia

ARTICLE INFO

Keywords:
Intestinal parasite
Pregnant women
Ethiopia

ABSTRACT

Background: In poor countries like Ethiopia, the burden of intestinal parasitic infections (IPIs) is high. Thus, this study was aimed to assess the prevalence of IPIs and associated factors among pregnant women attending antenatal care clinics at Yirgalem General Hospital, Sidama, Ethiopia.

Methods: A cross-sectional study was conducted among systematically selected 400 pregnant women. Trained data collectors administered the questionnaire. The stool samples were collected and analyzed. SPSS version-25 was used for data analysis. Descriptive statistics, bivariable and multivariable logistic regression analysis were done. Adjusted odds ratio (AOR) with 95% confidence interval (CI) was used to measure the presence and strength of association. A p-value $\leq$0.05 was considered to declare statistical significance.

Results: The prevalence IPI was 35.8% (95% CI: 31.1, 40.5%). Increased odds of IPIs observed among pregnant women who lived in the rural area, ate unwashed fruits/vegetables, drank water from the unprotected source, drank untreated water, not washed hands by soap, and had a history of previous IPI.

Conclusion: Prevalence of IPIs was high. Thus, strengthening health education on the appropriate handling of foods, keeping personal and environmental hygiene, and protecting the source of drinking is crucial. Further, therapeutic and prophylactic intervention according to the World Health Organization deworming protocol is also important to tackle this problem.

1. Background

An intestinal parasitic infection (IPI) is a condition in which a parasite infects the gastrointestinal tract of humans. It constitutes a global health burden of causing clinical morbidity in 450 million people; many of these are reproductive age women.[1] Globally, the three most common soil-transmitted helminths are *Ascaris lumbricoides* (*A. lumbricoides*), *Trichuris trichiura* (*T. trichiura*) and *hookworms*. These are responsible for the majority of the disease burden due to neglected tropical diseases.[2]

World Health Organization (WHO) estimated 800-1 billion cases of *Ascariasis*, 700–900 million *hookworm* infections, half-billion *Trichuriasis*, 200 million *giardiasis,* and 500 million *E. histolytica* globally. In Sub-Saharan African countries, up to 250 million people are infected with at least one IPI.[1]

Pregnancy is a physiological state and often associated with decreased immunity that increases the probability of being susceptible to various infections. So, IPI is a double burden for pregnant women in affecting their health and their offspring.[3]

Pregnant women are the segments of a community affected by parasitic infections that directly or indirectly lead to a spectrum of adverse maternal and fetal effects. They often experience a more severe infection than their counterparts due to a transient depression of cell-mediated immunity that interferes with resistance to various infectious diseases.[4] Additionally, the study showed that immunological interactions between protozoan and helminths infection could intensify the impact of parasitic infection when they co-exist.[5]

The parasitic infection could occur at any stage of the three trimesters during pregnancy. However, an infection that occurs in the first trimester is associated with more severe fetal and placental consequences than those occurring later in pregnancy. Furthermore, the infection becomes more severe in women who are pregnant for the first

* Corresponding author.
E-mail addresses: aregahegndona@gmail.com (A.D. Buchala), siyoumtesfaw@gmail.com (S.T. Mengistu), dacheazm@gmail.com (A.D. Mue), amelobolka@gmail.com (A.B. Gujo).

https://doi.org/10.1016/j.cegh.2022.101032
Received 31 January 2022; Received in revised form 13 March 2022; Accepted 21 March 2022
Available online 30 March 2022

time.[6]

IPIs are a major concern, mostly in developing countries, particularly in sub-Saharan Africa (SSA). The main reason mentioned for the high burden of this problem in developing countries is low literacy rate, lack of safe drinking water, poor hygiene, malnutrition, and hot and humid tropical climate.[7]

Ethiopia as one of the SSA countries has the highest prevalence of IPIs due to unsafe and inadequate provision of water, unhygienic living conditions, lack of proper utilization of latrine, and habit of walking barefoot. As a result, IPIs have been recorded as a major public health problem and the second most predominant cause of outpatient morbidity in the country.[8,9] Different reports revealed that in Ethiopia the prevalence of IPIs ranged from 14.3% to 70.6% from 2013 to 2016.[10,11]

So, identifying different factors precipitating IPIs among pregnant women is critical to improving their health condition including their newborns. Hence, this study was aimed to assess the prevalence of IPIs and associated factors among pregnant women attending antenatal care (ANC) clinic at Yirgalem General Hospital, Sidama, Ethiopia in 2021.

2. Method and materials

2.1. Study setting and period

This study was conducted in Yirgalem General Hospital which is located in Sidama National Regional State (SNRS), Southern Ethiopia. YGH is one of the oldest hospitals in Ethiopia and is located about 320 km South of Addis Ababa and 45 km from Hawassa, a capital city of the region. It was established in 1958 by a non-governmental organization. Currently, it is serving around 5.2 million population including the Southern and Oromia Region. It has functional 177 beds and total of 332 workers. It has 196 nurses, 6 health officers, 13 specialists, and 31 general practitioners. The study was conducted from 16 January to 15 February 2021.

2.2. Study design and population

A facility-based cross-sectional study was conducted among pregnant women who were attending ANC clinic at YGH. All pregnant women who were visiting the ANC clinic during the study period were included in this study. Those who were critically sick and unable to give a response during the data collection period were excluded.

2.3. Sample size determination and sampling procedures

The sample size was determined by using the single population proportion formula with the following assumptions: considering 38.7% of IPI taken from the previous study,[12] 95% confidence interval (CI), 5% margin of error, and 10% non-response rate, the final sample size calculated was 400 participants. A sample size for the second objective (associated factors) was calculated by considering some of potential variables from previous literature. However, all these samples were less than that of the first objective. As a result, the maximum sample of the first objective (400) was used for this study. A sampling frame was prepared from the ANC records that contain pregnant women's ANC follow-up information. Based on computerized ANC records of the clients, the simple random sampling technique was applied by using a computer generated numbers to select the pregnant women.

2.4. Data collection tools, procedures and quality assurance

Data were collected by using interviewer-administered, structured, and pretested questionnaires developed by reviewing related literature and conceptualizing with the study objective. The questionnaire contains socio-demographic factors, obstetrics and medical-related factors, behavioral and sanitation-related issues. It was developed in English and translated into the local language (Sidaamu Afoo) and back to English by language experts to check its consistency. Three midwives and three laboratory technicians participated in the data collection activities. One public health officer and a senior laboratory technologist supervised the data collection process.

The discussion was held with the pertinent experts to assess the appropriateness of the questionnaire. For assessing the reliability of the questionnaire, we distributed the questionnaires to the pregnant women (5% of the sample) and conducted a re-test after one week. All the necessary modifications were done based on the result of the pre-test. The internal consistency reliability of Cronbach's alpha was 0.82.

To ensure data quality, data collectors and supervisors were trained for one day. The training was given on the general objective of the study, the contents of the tool, and how to approach the study participants. The entire data collection process was strictly supervised by the supervisors and investigator. Every day, the filled questionnaires were reviewed and checked for completeness, and the necessary feedback was offered to data collectors.

After informing how to bring the stool specimen, a clean stool specimen container was given with an applicator stick to each study participant. About 2 g of stool specimens were collected from each pregnant woman. All specimens were processed by using formal ether fecal concentration techniques.[13,14] The direct microscopy method was applied to identify intestinal parasites. The stool sample was well mixed and filtered using a funnel with gauze then centrifuged for 1 min at 2000 revolution per minute, then the supernatant was discarded. Seven Milliliter normal saline was added, mixed with a wooden stick, 3 ML ether was added and mixed well then centrifuged for 5 min at 2000 revolution per minute. Finally, the supernatant was discarded and the whole sediment was examined for parasites.

2.5. Data processing and analysis

After cleaning and checking its completeness, data were coded and entered into Epi data version-3.1 software and finally exported to Statistical software for social science (SPSS) version 25 for analysis. Descriptive analysis was done for each predictor variable. A cross-tabulation was performed to see the distribution of predictor variables in relation to the outcome variable. Bivariable logistic regression analysis was done for each independent variable with the outcome variable, and variables with a p-value of ≤ 0.25 were considered as candidates for multivariable logistic regression analysis to control possible confounders. AOR with 95% CI was calculated to determine the presence and strength of association among predictors and outcome variables. A P-value of ≤ 0.05 was used to consider statistically significant variables. Finally, the results were described by texts, figures, and tables.

2.6. Ethics approval

Ethical clearance was obtained from the Research Ethics Review Committee of Yirgalem Hospital Medical College (Ref. No YHMC/RERC/079/21). An official letter was taken from the Yirgalem General Hospital after thoroughly discussing the ultimate purpose of the study.

2.7. Informed consent

Informed written consent was taken from the study participants prior to study initiation. Counseling was provided to the study subjects regarding personal hygiene and sanitation. Also, the positive cases for the IPIs were consulted and linked with a hospital for the treatment.

3. Result

3.1. Socio-demographic characteristics of the study participants

Totally, 400 pregnant women were participated in this study, yielding a response rate of 100%. About 61.2% of them were below the age of 25 years. Regarding religion, 64.3% were Protestants. Nearly three-fourths (73.3%) of them were Sidama in ethnicity. Concerning the education status, 168 (42%) of them not attended formal education. In terms of occupation, 51.6% of them were housewives. More than half, 228 (57%) of respondents were urban dwellers. About three-fourths (74.5%) have four or fewer family members (Table 1).

3.2. *The prevalence of intestinal parasite infection*

Stool examination identified six species of intestine parasites. Out of the study participants, 142 (35.8%; 95% CI: 31.1–40.5%) were infected with at least one parasite. The *Giardia lamblia* was the most prevalent 49 (12.2%) followed by *A. lumbricoides,* 40 (10%). However, the E. *vermicularis* was the least observed parasite, 7 (1.7%). All were the single infection. Moreover, above half (59.1%) of the IPIs were occurred in the third trimester of the pregnancy (Fig. 1).

3.3. *Behavioral and sanitation related characteristics of the study participants*

More than one third (37%) of them had no latrine. Hand washing after the toilet was practiced by 245 (61%) participants. Nearly half (49.5%) of them did not use soap to wash their hands. About 164 (41%) of them reported that their Source of drinking water was from the unprotected source. A large proportion of participants (61%) used untreated water for drinking. Out of them, 241 (60.25%) consumed unwashed fruits and vegetables (Table 2).

3.4. *Obstetrics and medical **related** characteristics of **the study participants***

In this study, more than half (52.5%) of the respondents were at the gestational age of the third trimester. About 240 (60%) of them had less than ≤2 children. More than one-third (35%) of them had history of IPI in the previous pregnancy. Only 44 (11.0%) had a history of deworming in the last 6 months prior to the study (Table 3).

Table 1
Socio-demographic characteristics of the pregnant women attending ANC clinic at Yirgalem General Hospital, Sidama, Ethiopia, 2021.

Variables (n = 400)	Category	Frequency	Percent (%)
Age of the mother	≤25 years	245	61.2
	>25 years	155	38.8
Ethnicity	Sidama	293	73.3
	Amara	47	11.8
	Oromo	28	7.0
	Others*	32	8.0
Religion	Protestant	257	64.3
	Orthodox	94	23.5
	Muslim	49	12.2
Educational status	Not attended formal education	168	42
	Primary school & above	232	58
Educational status (husband)	Not attended formal education	70	17.5
	Primary school & above	330	82.5
Women's occupation	Housewife	207	51.7
	Merchant	73	18.3
	Government/NGO employee	120	30
Monthly income	≤3000 Eth Birr (≤75.35 US$)	228	57.0
	>3000 Eth Birr (>75.35 US$)	172	43.0
Size of household	≤4	298	74.5
	>4	102	25.5
Place of residence	Rural	172	43.0
	Urban	228	57.0

Other*: Gurage, Silte, Wolaita; Eth Birr: Ethiopian Birr; n: sample size; US$: United States Dollar.

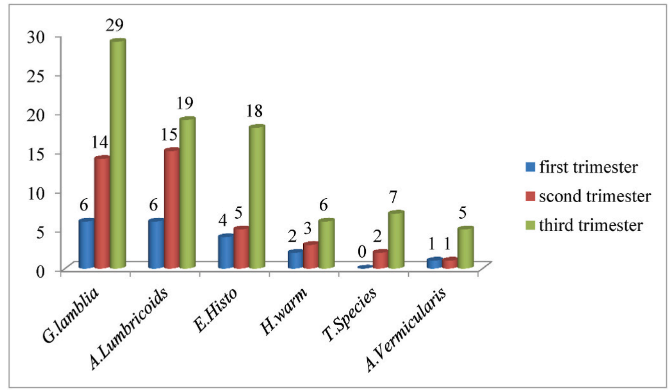

Fig. 1. Distribution of intestinal parasitic infections by gestational age at Yirgalem General Hospital, Sidama, Ethiopia, 2021.

Table 2
Sanitation and behavioural related characteristics of the pregnant women attending ANC clinic at Yirgalem General Hospital, Sidama, Ethiopia, 2021.

Variables (n = 400)	Categories	Frequency	Percent (%)
Had toilet facility	Yes	251	62.75
	No	149	37.25
Practice open field defecation	Yes	139	34.75
	No	261	65.25
Washed hand after toilet	Yes	245	61.25
	No	122	38.75
Used soap to wash hands	Yes	202	50.5
	No	198	49.5
Source of drinking water	Protected	236	69.0
	Unprotected	164	41.0
Treated drinking water	Yes	156	39.0
	No	244	61.0
Eat unwashed fruits and vegetables	Yes	241	60.25
	No	159	39.75

4. Factors associated with IPIs

In the present study, both bivariable and multivariable logistic regression analyses were done to identify the predictors of IPIs among pregnant women. Twelve independent variables that were associated with IPIs in bivariable analyses at P ≤ 0.20 were entered into multivariable logistic regression model. In multivariable logistic regression analysis, place of residence (p = 0.003), source of drinking water (p < 0.0001), using untreated drinking water (p = 0.0001), not using a soap for handwashing (p = 0.005), eating unwashed fruits and vegetables (p

Table 3
Obstetrics and medical related characteristics of the pregnant women attending ANC clinic at Yirgalem General Hospital, Sidama, Ethiopia, 2021.

Variables (n = 400)	Category	Frequency	Percent (%)
Number of children	≤2	240	60
	>2	160	40
Birth interval	≤2 years	192	48
	>2 years	208	52
Gestational age	First trimester	72	18.0
	Second trimester	118	29.5
	Third trimester	210	52.5
History of IP in the previous pregnancy	Yes	140	35.0
	No	260	65.0
Dewormed in the last 6 months	Yes	44	11.0
	No	356	89.0

= 0.008), and having a history of IPIs during previous pregnancy ($p < 0.0001$) showed significant association with IPIs (Table 4).

Accordingly, increased odds of IPIs were observed in pregnant women who live in the rural areas (AOR: 3.71, 95% CI: 1.56, 8.83), used drinking water from unprotected sources (AOR: 7.91, 95% CI: 4.37, 14.32), used untreated drinking water (AOR: 3.55, 95% CI: 1.89, 6.68), not used soap for handwashing (AOR: 2.69, 95% CI: 1.36, 5.34), eat unwashed fruits and vegetables (AOR: 2.41, 95% CI: 1.26, 4.60), and had a history of IPIs during previous pregnancy (AOR: 5.83, 95% CI: 3.16, 10.76) when compared to their counterparts (Table 4).

Table 4
Bivariable and multivariable logistic regression analysis of the factors associated with IPIs among pregnant women attending ANC in Yirgalem General Hospital, Sidama, Ethiopia, 2021.

Variable (n = 400)	Category	IPIs		COR (95% CI)	AOR (95% CI)
		Yes (%)	No (%)		
Age of pregnant women	≤25 years	81 (56.6)	164 (63.8)	1.35(0.89, 2.05)	1.54(0.85, 2.77)
	>25 years	62 (43.4)	93 (36.2)	1	1
Education level	Not attended formal education	79 (55.2)	89 (34.6)	2.33(1.53, 3.54)	1.93(0.86, 4.36)
	Elementary school and above	64 (44.8)	168 (65.4)	1	1
Occupation	Housewife	100 (70)	107 (41.6)	3.22 (01.94,5.35)	1.36(0.61, 3.04)
	Merchant	16 (11.2)	57 (22.2)	0.97(0.48, 1.95)	0.99(0.39, 2.56)
	Government/ NGO employee	27 (18.8)	93 (36.2)		1
Gestational age	1st trimester	19 (13.3)	53 (20.6)	1	1
	2nd trimester	40 (28)	78 (30.4)	1.43(0.75, 2.73)	1.02(0.45, 2.34)
	3rd trimester	84 (58.7)	126 (49)	1.86(1.03, 3.36)	1.56(0.73, 3.34)
Knowledge on IPIs	Yes	74 (51.7)	205 (79.8)	1	1
	No	69 (48.3)	52 (20.2)	3.68(2.35, 5.75)	1.16(0.51, 2.64)
Previous history of IPIs	Yes	84 (58.7)	56 (21.8)	5.11(3.27, 7.98)	5.83 (3.16,10.76)
	No	59 (41.3)	201 (78.2)	1	1
Source of drinking water	Protected	43[15]	193 (75)	1	1
	Unprotected	100 (70)	64 (25)	7.01 (4.45,11.06)	7.91 (4.37,14.32)
Treated drinking water	Yes	31 (21.7)	125 (48.6)	1	1
	No	112 (78.3)	132 (51.4)	3.42(2.14, 5.46)	3.55(1.89, 6.68)
Practice open field defecation	Yes	103 (72)	36 (14)	2.38(1.43, 3.96)	1.93(0.86, 4.36)
	No	40 (28)	221 (86)	1	1
Used soap for hand washing	Yes	40[16]	162 (63)	1	1
	No	103 (72)	95 (37)	4.39(2.82, 6.85)	2.69(1.36, 5.34)
Eat unwashed fruits and vegetables	Yes	102 (71.3)	139 (54)	2.11 (1.36,3.27)	2.41(1.26, 4.60)
	No	41 (28.7)	118 (46)		1
Place of residence	Rural	93 (65)	79 (30.7)	4.19 (2.71,6.47)	3.71(1.56, 8.83)
	Urban	50 (35)	178 (69.3)	1	1

ANC = Antenatal Care, AOR = Adjusted Odds Ratio, CI= Confidence Interval, COR= Crude Odds Ratio, IPIs = Intestinal Parasitic Infections, NGO= Non-governmental Organization.

5. Discussion

Intestinal parasitic infections remain an overall public health burden of the world; specifically, it continued as a more challenging problem among countries with limited resources because of poverty, low literacy rate, lack of safe drinking water, poor hygiene, and malnutrition.[2,7]

Women of the child-bearing age group are more affected due to pregnancy-related physiologic conditions. Infections with parasites worsen the burden in pregnancy and cause serious adverse effects for both the mother and her unborn baby.[4,5]

The global effects of these parasites in pregnancy encompass compromised nutritional status and perhaps health for both the mother and the unborn baby. Thus, these infections contribute to malnutrition and iron deficiency anemia, which causes poor pregnancy outcomes. These adverse consequences yield a dual burden for pregnant women.[1,6]

Also, *hookworm* infection during pregnancy could be transmitted to neonates, probably through ingestion of hookworm third-stage larvae in the milk.[6]

In Ethiopia, IPIs remain unresolved health problems due to low socioeconomic status, poor sanitation and hygienic conditions, low literacy rate, lack of safe and protected drinking water, and weak waste disposal and drainage system.[8,9]

Strengthening early detection of IPIs for better prevention, evaluation, management, and assessing its occurrence and contributing factors is a fundamental step to establishing preventive and control strategies, particularly in resource-limited settings. Furthermore, taking these actions could help minimize the burden of parasitic infections and related negative consequences.[5,7]

Thus, this study assessed the prevalence of IPIs and its predictors among pregnant women. Accordingly, the overall prevalence of the IPIs among the study participants was found to be 35.8%: 95% CI: 31.1, 40.5). The finding of this study was in line with what was found in Gondar Hospital (31.3%),[17] Felege Hiwot Referral Hospital (31.5%),[18] Gojjam (37.3%),[19] Wondo Genet (38.7%),[12] Northern Ghana (31.7%)[20] and Southeastern Iran (34.2%).[21] The probable reason for this likeness might be due to similarities of the diagnostic methods used, and study designs and sampling techniques applied. Additionally, the distribution of these parasites is common in poor settings, so this might be a reason for similarities of the results.

The result of this study was high when compared with findings of previous studies done in Northern Ethiopia (21.1%),[22] East Wollega (24.7%),[23] Kitale Hospital, Kenya (13.8%),[24] Iran (16.3%)[25] and Kasoa Polyclinic, Ghana (14.3%).[26] However, the finding of this study was lower than previous results done in the Gilgel Gibe dam area (41%),[5] Lalo Kiltie, Oromia (43.8%)[27] and Mecha district (70.6%).[10] The difference might be due to dissimilarities of sanitation and hygiene practice as well as variation of socio-economic status of the study participants. In current study, about 60.25% the participants ate unwashed fruits and vegetables, 89% were not dewormed, and 61% of them used untreated water. Furthermore, about 43% of the participants were from a rural setting where sanitation and hygiene related activities are poorly practiced. As a result, their chance of being infected by intestinal parasite was so high.

However, this result was lower when compared with the previous findings from Colombia (41%),[28] Nepal (42%),[16] Nigeria (43.4%)[29] and Venezuela (73.9%).[15] The reason for this dissimilarity could be the difference in the geographical location, study period, diagnostic method applied, socio-economic status of the study participants, and difference in operation of various health-related interventional strategies.

Regarding the specific types of parasites, *G. lamblia* was most frequently identified (12.2%). This finding is agreed with a study done in Felege Hiwot Referral Hospital (13.3%)[18] and Southeastern Iran (10.6%),[21] but higher than the findings from Wondo Genet (5.4%),[12] Gondar Hospital (6.3%)[17] and Kasoa Polyclinic, Ghana (2.3%).[26] This might be due to similarity in infection prevention and controlling strategies of the country as well as habits of protecting environmental and persona hygiene in the community.

In this study, the prevalence of *A. lumbricoides* was 10.0%. This was supported by previous study done in Lalo Kiltie, Oromia (7.3%)[27] and Nepal (11%).[16] But lower when compared with previous findings from Wondo Genet (24.9%),[12] and Mecha district, Oromia (32.7%).[10] However, it was higher than previous results from Felege Hiwot Referral Hospital (2.9%),[18] Gondar Hospital (1.37%),[17] Northwest Ethiopia (2.9%),[11] Kasoa Polyclinic, Ghana (4.3%)[26] and Kenya (6.5%).[24] The most probable reasons for this variation could be due to improvement of health service delivery systems, difference of socio-economic status of respondents within and between countries, as well as variation of study periods and study designs applied.

Entamoeba histolytica was also one of the identified parasites with a prevalence of 6.7%. This finding which was in agreement with the result of 7.8% at Felege Hiwot Referral Hospital,[18] and 5% at Kasoa Polyclinic, Ghana.[26] On other hand, it was higher than previous findings from Wondo Genet (3.4%)[12] and Northwest Ethiopia (2.9%).[11] But less than the result reported from the Gondar Hospital (11.23%).[30] A likely explanation for high prevalence of *E. histolytica* in present study is that *amebiasis* is mainly caused by using contaminated water. In our study area majority of the participants reported that they used untreated water from unprotected sources. So, this could increase their probability of acquiring different parasitic infections.

Regarding *hookworm*, its prevalence was found to be 2.7%. The finding was comparable with the previous studies done in Felege Hiwot Referral Hospital (1.3%)[18] and Kenya (3.9%).[24] However, this finding was lower when related with other studies done in Gondar Hospital (4.7%),[17] Wondo Genet (11.2%),[12] Mecha district, Oromia (14.2%),[10] West Gojjam (18.8%)[19] and Kasoa Polyclinic (10.3%).[26] A possible clarification for this difference might be that our study considered pregnant women who came for ANC visits that might decrease the probability of getting infections, but the previous studies applied a community-based approach and included pregnant women living in a rural setting where IPIs are more common.

This study showed that rural-urban differences of residence influenced the magnitude of the IPIs. Pregnant women from rural areas of residence were 3.71 times more likely to be infected by intestinal parasites when compared to those in the urban areas. This finding was comparable with the previous studies done in the Ethiopia,[10,31] and Iran.[21] The possible reason for this could be the fact that rural areas have less access to primary healthcare interventions.

Increased odds of IPIs were observed among pregnant women who consumed unwashed fruits and vegetables. Accordingly, those pregnant women who consumed unwashed fruits and vegetables were 2.41 times more likely to be infected by intestinal parasites when compared with those who ate washed fruits and vegetables. This finding was supported by previous studies conducted in Ethiopia.[10,19,22,23,15] The most likely explanation for this might be raw vegetables acts as a vehicle for transporting intestinal parasites.

Similarly, the odds of being infected by intestinal parasites were 2.69 times higher among those who did not use soap to wash their hands. This result was in line with previous findings done in different settings.[5,22] This might be due to the reason that proper handwashing with soap breaks the chain of transmission for intestinal parasites. As this study revealed, utilization of the soap for handwashing purposes was poor in our study setting, so this might increase the probability of getting parasitic infections.

Those pregnant women who used untreated drinking water were 3.55 times more likely to be infected by intestinal parasites when compared with those who used treated water. This finding was also in line with previous results Gojjam,[19] and Kasoa Polyclinic, Ghana.[26] This might be due to that treating drinking water and handling it properly could prevent from acquiring different water-borne diseases including intestinal parasites.

Those pregnant women who used drinking water from unprotected sources were 7.91 times more likely to be infected by intestinal parasites when compared with those who used from protected sources. This finding was supported by previous studies done in Hossana[31] and Iran.[21] The likely explanation for this could be that if the sources of water are not protected well, the chance of being exposed to different microorganisms could be high among users. So, using this could increase the probability of being infected by microorganisms like intestinal parasites.

Also, those pregnant women who had a history of IPI in the previous pregnancy were 5.83 times more likely to be infected by intestinal parasites than their counterparts. This result was supported by previous studies in Northwest Ethiopia[11] and Kasoa Polyclinic, Ghana.[26] The reason might be due to a lack of routine deworming programs or poor drug adherence during a deworming time that increased the rate of having intestinal parasites.

5.1. Limitation of the study

Due to limited resources, the examination of the fecal samples was done by the wet mount and concentration method only. As a result, this could decrease the sensitivity of identifying the infections. This study was hospital-based, so it could not represent the general population. It also lacks the qualitative part that explores women's perceptions about the causes of IPI and its prevention methods. This study was also prone to the Hawthorne effect. The Hawthorne effect is when there is a change in the subject's normal behaviours, attributed to the knowledge that their behavior is being watched or studied. Although knowledge of participation in a study is thought to have the potential to induce a Hawthorne effect, using hidden observation can help to prevent this effect.[32]

6. Conclusion

This study showed a high prevalence of IPIs among pregnant women in the study setting. *Giardia lamblia, A. lumbricoides*, and *E. histolytica* were the most predominant parasites. Dwelling in the rural areas, eating unwashed fruits and vegetables, drinking water from unprotected sources, using untreated drinking water, not washing hands with soap, and having a history of IPI in the previous pregnancy were predictors positively associated with IPIs. These findings propose a necessity for interventional actions like establishing proper waste disposal and drainage systems, protecting the cleanness of the water sources, and encouraging communities to treat drinking water and regularly wash their hands with soap. Similarly, paying more attention to advising pregnant women concerning personal hygiene, proper handling of the food and keeping the environmental hygiene is crucial. Further, therapeutic and prophylactic intervention according to the WHO deworming protocol is necessary.

Data availability

The finding of this study was generated from the data collected and analyzed based on stated methods and materials. The original data supporting these findings are uploaded as supplementary information.

Authors' contributions

ADB contributed in conception, design, analysis, interpretation of the result and preparing the original manuscript. STM involved in conception and design. ADM revised the manuscript. ABG involved in design, analysis, interpretation of the results and revision of the original document. All authors read and gave a final approval of the version to be published.

Funding

The authors received no specific funding for this work.

Declaration of competing interest

The authors have declared that no competing interests exist.

Acknowledgements

We would like to thank Yirgalem Hospital Medical College, Department of Social and Population Health for its support to conduct this study. We would like to extend our heartfelt thanks to the study participants, data collectors, supervisors and Yirgalem General Hospital staffs.

Abbreviations

ANC	Antenatal Care
AOR	Adjusted Odds Ratio
COR	Crude Odds Ratio
IPIs	Intestinal Parasitic Infections
SPSS	Statistical Package for Social Science Students
WHO	World Health Organization

References

1 World Healt Organization. *Guideline: Preventive Chemotherapy to Control Soil-Transmitted Helminth Infections in At-Risk Population Groups*. Geneva: World Health Organization; 2017. Licence: CC BY-NC-SA 3.0 IGO.
2 Freeman MC, Akogun O, Belizario V, et al. Challenges and opportunities for control and elimination of soil-transmitted helminth infection beyond 2020. *PLoS Neglected Trop Dis*. 2019;13(4), e0007201.
3 Tsoka-Gwegweni JM, Ntombela N. A double load to carry: parasites and pregnancy. *South Afr J Infect Dis*. 2014;29(2):52–55.
4 Dotters-Katz S, Jeffrey K, Philips HR. Parasitic infections in pregnancy. *Obstet Gynecol Surv*. August 2011;66(8):515–525. https://doi.org/10.1097/OGX.0b013e3182385fde.
5 Getachew M, Tafess K, Zeynudin A, Yewhalaw D. Prevalence of 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(1):1–7.
6 Montresor A, Mupfasoni D, Mikhailov A, Mwinzi P, Lucianez A, et al. The global progress of soil-transmitted helminthiases control in 2020 and World Health Organization targets for 2030. *PLoS Neglected Trop Dis*. 2020;14(8), e0008505. https://doi.org/10.1371/journal.pntd.0008505.
7 Dutta S, Chatterjee S, Sinha D, Pal B, Basu M, et al. Correlates of anaemia and worm infestation among rural pregnant women: a cross sectional study from Bengal. *Natl J Community Med*. 2013;4(4). pISSN 0976 3325|eISSN 2229 6816.
8 Alebie G, Erko B, Aemero M, Petros B. Epidemiological study on Schistosoma mansoni infection in Sanja area, Amhara region, Ethiopia. *Parasites Vectors*. 2014;7(1):1–10.
9 Abera A, Nibret E. Prevalence of gastrointestinal helminthic infections and associated risk factors among schoolchildren in Tilili town, northwest Ethiopia. *Asian Pac J Trop Med*. 2014;7(7):525–530.
10 Feleke BE, Jember TH. Prevalence of helminthic infections and determinant factors among pregnant women in Mecha district, Northwest Ethiopia: a cross sectional study. *BMC Infect Dis*. 2018;18(1):1–6.
11 Alem M, Enawgaw B, Gelaw A, Kena T, Seid M, et al. *Prevalence of Anemia and Associated Risk Factors Among Pregnant Women Attending Antenatal Care in Azezo Health Center Gondar Town, Northwest Ethiopia*. 2013.
12 Bolka A, Gebremedhin S. Prevalence of intestinal parasitic infection and its association with anemia among pregnant women in Wondo Genet district, Southern Ethiopia: a cross-sectional study. *BMC Infect Dis*. 2019;19(483).
13 Khanna V, Tilak K, Rasheed S, Mukhopadhyay C. Identification and preservation of intestinal parasites using methylene blue-glycerol mount: a new approach to stool microscopy. *J Parasitol Res*. 2014. https://doi.org/10.1155/2014/672018. ID 672018.
14 Garcia LS, Arrowood M, Kokoskin E, Paltridge GP, Pillai DR, et al. Laboratory diagnosis of parasites from the gastrointestinal tract. *Clin Microbiol Rev*. 2017. https://doi.org/10.1128/CMR.00025-17.
15 Rodriguez-Morales AJ, Barbella RA, Case C, Arria M, Ravelo M, et al. Intestinal parasitic infections among pregnant women in Venezuela. *Infect Dis Obstet Gynecol*. 2006:23125, 2006.
16 Yadav BK, Prakash S, Yadav K. Characterization of intestinal parasitosis in pregant women at ram janaki hospital. *Janakpurdham. Tribhuvan Univ J Microbiol*. 2020;7:91–103.
17 Kumera G, Gedle D, Alebel A, Feyera F, Eshetie S. Undernutrition and its association with socio-demographic, anemia and intestinal parasitic infection among pregnant women attending antenatal care at the University of Gondar Hospital, Northwest Ethiopia. *Matern Health Neonatol Perinatol*. 2018;4:18.
18 Derso A, Nibret E, Munshea A. Prevalence of intestinal parasitic infections and associated risk factors among pregnant women attending antenatal care center at Felege Hiwot Referral Hospital, northwest Ethiopia. *BMC Infect Dis*. 2016;16(1):530.
19 Hailu T, Abera B, Mulu W, Kassa S, Genanew A, et al. Prevalence and factors associated with intestinal parasitic infections among pregnant women in West Gojjam zone, northwest Ethiopia. *J Parasitol Res*. 2020, 8855362, 2020.
20 Ahenkorah B, Nsiah K, Baffoe P, Ofosu W, Gyasi C, et al. Parasitic infections among pregnant women at first antenatal care visit in northern Ghana: a study of prevalence and associated factors. *PLoS One*. 2020;15(7), e0236514.
21 Abbaszadeh AMJ, Barkhori MM, Rezaeian M, Mohebali M, Baigi V, et al. Prevalence and associated risk factors of human intestinal parasitic infections: a population-based study in the southeast of Kerman province, southeastern Iran. *BMC Infect Dis*. 2020;20(1):12.
22 Shiferaw MB, Zegeye AM, Mengistu AD. Helminth infections and practice of prevention and control measures among pregnant women attending antenatal care at Anbesame health center, Northwest Ethiopia. *BMC Res Notes*. 2017;10(1):274.
23 Mengist HM, Zewdie O, Belew A. Intestinal helminthic infection and anemia among pregnant women attending ante-natal care (ANC) in East Wollega, Oromia, Ethiopia. *BMC Res Notes*. 2017;10(1):440.
24 Wekesa AW, Mulambalah CS, Muleke CI, Odhiambo R. Intestinal helminth infections in pregnant women attending antenatal clinic at kitale district hospital, Kenya. *J Parasitol Res*. 2014, 823923, 2014.
25 Obiezue NR, Okoye IC, Ivoke N, Okorie JN. Gastrointestinal helminth infection in pregnancy: disease incidence and hematological alterations. *Iran J Public Health*. 2013;42(5):497–503.
26 Abaka-Yawson A, Sosu SQ, Kwadzokpui PK, Afari S, Adusei S, et al. Prevalence and determinants of intestinal parasitic infections among pregnant women receiving antenatal care in Kasoa polyclinic, Ghana. *J Environ Public Health*. 2020, 9315025, 2020.
27 Yesuf DA, Abdissa LT, Gerbi EA, Tola EK. Prevalence of intestinal parasitic infection and associated factors among pregnant women attending antenatal care at public health facilities in Lalo Kile district, Oromia, Western Ethiopia. *BMC Res Notes*. 2019;12(1):735.
28 Aranzales AFE, Radon K, Froeschl G, Pinzon Rondon AM, Delius M. Prevalence and risk factors for intestinal parasitic infections in pregnant women residing in three districts of Bogota, Colombia. *BMC Publ Health*. 2018;18(1):1071.
29 Adeolu AJ, Okonko IO, Nwanze JN. Prevalence of intestinal nematode infection among pregnant women attending antenatal clinic at the University College Hospital, Ibadan, Nigeria. *Adv Appl Sci Res*. 2011;2(4):1–13.
30 Kumera G, Haile K, Abebe N, Marie T, Eshete T. Anemia and its association with coffee consumption and hookworm infection among pregnant women attending antenatal care at Debre Markos Referral Hospital, Northwest Ethiopia. *PLoS One*. 2018;13(11), e0206880.
31 Tesfaye DJ, Beshir WG, Dejene T, Tewelde T. Prevalence of intestinal helminthiases and associated factors among pregnant women attending antenatal clinic of nigist Eleni mohammed memorial hospital, Hossana, Southern Ethiopia. *OALib*. 2015;2(7):1–11.
32 Oswald D, Sherratt F, Smith S. Handling the Hawthorne effect: the challenges surrounding a participant observer. *Review of Social Studies*. 2014;1(1):53–73.