Knowledge and Practices on Consumption of Free-Range Chicken Viscera in Selected Rural Communities of Kwazulu-Natal, South Africa, with Focus on Zoonotic Transmission of *Toxoplasma Gondii* and *Toxocara* Spp.

Adejumoke Oluwatosin Omonijo (earnesthope@yahoo.com)
Federal University Oye-Ekiti https://orcid.org/0000-0001-9290-029X

Samsom Mukaratirwa
University of Kwazulu-Natal

Research Article

Keywords: Toxoplasma gondii, Toxocara spp, Knowledge, Free-range chickens, Chicken viscera, KwaZulu-Natal, South Africa.

Posted Date: January 31st, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1246622/v1

Abstract

Free-range chickens (FRC) are a host to a variety of pathogens of zoonotic and economic importance which includes *Toxoplasma gondii* and *Toxocara* spp among others. Humans acquire infections via the ingestion of infective stages of *T. gondii* and *Toxocara* spp with raw or undercooked food. This study aimed to assess knowledge and practices on the household consumption of FRC meat and viscera by rural communities in KwaZulu-Natal (KZN), South Africa as risk factors in the transmission of zoonotic pathogens. A descriptive cross-sectional study was conducted among twenty (20) randomly selected households in each selected community on the northern coast (Gingindlovu and Ozwathini) and southern coast (uMzinto and Shongweni) of KZN province. An adult from each household was interviewed on FRC consumption practices using a semi-structured questionnaire. Data were analyzed using statistical package for social sciences (SPSS) version 25.0. Descriptive, and Chi-square statistics were used to assess knowledge and practices related to FRC consumption and zoonoses transmission. Knowledge of zoonosis transmission was estimated at (31.3%, 25/80) in the four localities and a significant association was found between the educational level of respondents and study locations ($p<0.05$). Knowledge was highest among respondents with a high school education (13.75%, 11/80) and lowest (1.3%, 1/80) among respondents with no formal education. Overall, over three-quarters (76.3%, 61/80) of respondents reported chicken viscera consumption although majority (96.7%, 59/80) preferred eating them 'well-cooked'. This result underscores the need to intensify awareness on health risk associated with the consumption of raw/undercooked viscera from free-range chickens.

Introduction

Free-range chickens are major agents in parasite transmission due to their exposure to infective stages of parasites existing in contaminated environment (De Vries et al. 2018). Commonly reported parasites from chickens include but not limited to; *Toxoplasma gondii* and *Toxocara* spp (Zibaei et al. 2017; dos Santos Silva et al. 2020). *Toxoplasma gondii* is an apicomplexan parasite that causes toxoplasmosis in animals and humans globally (Dubey 2020). The main definitive hosts are felids while birds and a wide range of animals serve as the intermediate hosts (Gaulin et al. 2020). Although *Toxocara canis* and *T. cati* are helminth parasites of canids and felids, they also are responsible for human toxocariasis worldwide (Yoshida et al. 2016).

Although free-range chickens (FRC) contribute significantly to animal protein, reports on their role in transmitting zoonotic pathogens is scanty (Rodrigues et al. 2019). Free-range chickens are infected during scavenging when they ingest the infective stage of parasites from the contaminated environment (Sasse et al. 2020). Humans acquire infection indirectly via the consumption of raw or undercooked infected chicken viscera or meat containing tissue cysts (*T. gondii*) or larvae (*T. canis* and *T. cati*) (Fan et al. 2015; Gaulin et al. 2020). Once ingested by humans, the parasites migrate through the viscera and are deposited in various organs where they cause varying degrees of diseases ranging from fever, headache, sore throat, arthralgia, myalgia, and blindness depending on the affected organs, infection intensity and duration, host age and immunity status of the infected host (Holland and Hamilton 2013; Fan et al. 2015; Gaulin et al. 2020).

Consumption of poultry meat viscera is a dietary habit that is common in different communities worldwide and dependent on socio-cultural practices and culinary habits where it can either be eaten raw or undercooked (Broglia and Kapel 2011). The practice of eating raw or undercooked meat or viscera is associated with zoonosis transmission (Trevisan et al. 2019), for instance, cases of toxocariasis transmission have been reported after ingesting raw chicken liver (Nagakura et al. 1989; Morimatsu et al. 2006; Campos-da-Silva et al. 2015). Similarly, human toxoplasmosis outbreak have been reported among individuals who consumed raw or undercooked meat (Dawson, 2005; Choi et al. 2006).

In South Africa, the greater population lives in rural areas and rear chickens following a free-range system (Mwale and Masika 2009; Mukaratirwa and Khumalo 2010a; Malatji et al. 2016). In KwaZulu-Natal (KZN) province of South Africa, the majority of the population are rural farmers and rear FRC for consumption, marketing and socio-cultural purposes (Naidoo 2005). The farming practice, allows the chickens to scavenge freely in the environment during daytime and use trees for shelter at night or confined to rustic chicken runs (Naidoo 2005).

The tendency of FRC to pick up *T. gondii and Toxocara* spp infective oocysts and eggs respectively in the environment increases with the abundance and availability of stray dogs and cats' which are definitive hosts of the parasites, particularly in KwaZulu-Natal (KZN) province where stray dogs and feral cats have been reported to be abundant (Tannent et al. 2010; Mukaratirwa and Singh 2010b) thereby leading to persistent environmental contamination with these parasites.

Moreover, change in globalization has led to the adoption of a variety of culinary and consumption patterns regarding raw or undercooked food as delicacies (Broglia and Kapel 2011). Besides, due to the high poverty level in rural areas of KZN there is a high level of household food insecurity thereby leading to alternative foods and various ways of food preparation (Tarwireyi and Fanadzo 2013). Understanding the consumption pattern of the much available free-range chicken meat or viscera is imperative in these communities as a basis for guaranteeing food security as well as identifying risks related to food-borne diseases such as toxoplasmosis and toxocariasis.

Considering the poor socio-economic status and food insecurity of the rural communities in KZN province of South Africa, it is imperative to determine household consumption patterns of free-range chicken viscera and preparation practices that may be favouring zoonotic transmission in the study area. Hence, this study was designed to address this aim with the hope of using the information to create awareness on the health risks associated with the consumption of raw or undercooked FRC meat or viscera.

Methodology

Study design and sample

A cross-sectional study was conducted in four rural communities in KwaZulu-Natal province to assess knowledge and practices of consumption of free-range chicken viscera with a focus on *T. gondii and Toxocara* spp transmission from March to July 2019. Localities where the study was conducted, and their population sizes are as follows; Gingindlovu (GI) (1,109) and Ozwathini (OZ) (1,979) in the northern coast and uMzinto (MZ) (16,205) and Shongweni (SH) (427,613) in the southern coast of KZN (Fig. 1) (http://www.durban.gov.za/). These localities have sugar cane farming as their main livelihood followed by livestock farming which include rearing of free-range chickens. The study population comprised 80 randomly selected participants and each participant represented a household. Twenty participants were randomly selected from each of the localities. The sample size was calculated using the following equation with 95% confidence level and 11% error margin.

$n=1.96^2\ pq/L^2$,

where:

n=sample size,

p=expected prevalence (0.5),

q=1-p, and

L=limits of error on the prevalence and the expected prevalence was set at 11%.

Study procedure

After briefing the community leaders regarding the objectives of the study, 20 household representatives were randomly selected from each locality and consent was obtained regarding their willingness to participate in the study. Questionnaires were translated into isiZulu, which is the local language of all the localities, and were administered to selected participants following an interview-guided approach. Prior to administration, a pilot study was done to validate the tool. The questionnaire administration process took approximately 20 minutes for each participant. Upon completion of questionnaires, participants were enlightened on the dangers associated with zoonosis transmission and prevention methods.

Data collected from the interview included socio-demographic information, knowledge, and practice of participants related to zoonosis transmission. Questions were asked specifically on habits on consumption of chicken viscera, type of the viscera eaten, and the preferred method of preparation and designated members of the family who eat each type of viscera. The demographic information collected included age, gender, household size, educational qualifications, and occupation of respondents. Information on ownership of free-range chickens (FRC) including the number of FRC owned per household were also collected. Information on ownership of pets, type of pets, and the number owned was also collected.

Study design and sample

A cross-sectional study was conducted in four rural communities in KwaZulu-Natal province to assess knowledge and practices of consumption of free-range chicken viscera with a focus on *T. gondii and Toxocara* spp transmission from March to July 2019. Localities where the study was conducted, and their population sizes are as follows; Gingindlovu (GI) (1,109) and Ozwathini (OZ) (1,979) in the northern coast and uMzinto (MZ) (16,205) and Shongweni (SH) (427,613) in the southern coast of KZN (Fig. 1) (http://www.durban.gov.za/). These localities have sugar cane farming as their main livelihood followed by livestock farming which include rearing of free-range chickens. The study population comprised 80 randomly selected participants and each participant represented a household. Twenty participants were randomly selected from each of the localities. The sample size was calculated using the following equation with 95% confidence level and 11% error margin.

$n=1.96^2\ pq/L^2$,

where:

n=sample size,

p=expected prevalence (0.5),

q=1-p, and

L=limits of error on the prevalence and the expected prevalence was set at 11%.

Study procedure

After briefing the community leaders regarding the objectives of the study, 20 household representatives were randomly selected from each locality and consent was obtained regarding their willingness to participate in the study. Questionnaires were translated into isiZulu, which is the local language of all the localities, and were administered to selected participants following an interview-guided approach. Prior to administration, a pilot study was done to validate the tool. The questionnaire administration process took approximately 20 minutes for each participant. Upon completion of questionnaires, participants were enlightened on the dangers associated with zoonosis transmission and prevention methods.

Data collected from the interview included socio-demographic information, knowledge, and practice of participants related to zoonosis transmission. Questions were asked specifically on habits on consumption of chicken viscera, type of the viscera eaten, and the preferred method of preparation and

designated members of the family who eat each type of viscera. The demographic information collected included age, gender, household size, educational qualifications, and occupation of respondents. Information on ownership of free-range chickens (FRC) including the number of FRC owned per household were also collected. Information on ownership of pets, type of pets, and the number owned was also collected.

Statistical analysis

Data were processed and analyzed using statistical package for social sciences (SPSS) version 25.0. Descriptive and Chi-square statistics were used to assess knowledge and practices related to the consumption of FRC viscera and risks of transmission of *T. gondii* and *Toxocara* spp in KwaZulu-Natal. A p-value < 0.05 was considered as statistically significant.

Statistical analysis

Data were processed and analyzed using statistical package for social sciences (SPSS) version 25.0. Descriptive and Chi-square statistics were used to assess knowledge and practices related to the consumption of FRC viscera and risks of transmission of *T. gondii* and *Toxocara* spp in KwaZulu-Natal. A p-value < 0.05 was considered as statistically significant.

Results

Socio-demographic profile of participants

Table 1 shows the demographic characteristics of participants in all four study localities. Participants interviewed in the four localities ranged from the category of father, mother, and household member greater than 18 years (GI-5%, 55%, and 40%; OZ-5%, 80%, and 15%; MZ-10% 50%, and 40%; SH-25%, 60%, and 15%). Overall, the mean age of the respondents was 47.11±18.02) (Table 1). Ozwathini (OZ) had the highest mean age (53.3±16.82), followed by SH (50.25±17.12, GI (43±18.98) and MZ (41.9±17.80). A significant difference was observed between the educational level of study respondents among study locations (p<0.05). Most respondents (47.5%, 38/80) had a high school education while only (20%, 16/80) had completed tertiary education. The percentage of respondents who had tertiary education was highest in OZ (40%, 8/20), followed by GI (30%, 6/20), and SH (10%, 2/20) while none of the respondents in MZ had tertiary education.

The percentage of respondents that were unemployed was highest (90%, 18/20) in OZ, (85%, 17/20) in GI and SH, followed by (70%, 14/20) in MZ. Overall, household size ranged from 1-16 with a mean of (6.40±3.26). Household size ranged from 2-11 with a mean of 7.05±2.65, 2-14 (6.65±3.79), 2-13 (5.70±2.89) and 1-16 (6.20±3.67) in GI, MZ, OZ, and SH respectively (Table 1). Availability of playground for children was also observed to be significantly different among study locations (p<0.05), with only (5%, 1/20) in GI and MZ and (15%, 3/20) in SH having reported to have reserved playground for children in the household respectively while none was reported in OZ (Table 1). Overall, three-quarters (75%, 60/80) of the households utilized household vicinity as playgrounds while only (2.5%, 2/80) had reserved playgrounds for children (Table 1).

Table 1 Socio-demographic characteristics of study respondents from four localities of KwaZulu-Natal province of South Africa (GI = Gingindlovu; OZ = Ozwathini; MZ = uMzinto; SH = Shongweni).

	Localities										
	GI (n = 20)		OZ (n = 20)		MZ (n = 20)		SH (n = 20)		Total (n = 80)		
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	*p*-Value
Age groups (years)											
<21	1	5	1	5	-	-	1	5	3	3.75	0.733
21-30	7	35	6	30	3	15	2	10	18	22.50	
31-40	1	5	4	20	1	5	2	10	8	10.00	
41-50	5	25	4	20	5	25	5	25	19	23.75	
51-60	2	10	2	10	4	20	4	20	12	15.00	
61+	4	20	3	15	7	35	6	30	20	25.00	
Educational level											
None	2	10	2	10	1	5	1	5	6	7.50	0.020
Primary	1	5	3	15	8	40	8	40	20	25.00	
High School	11	55	7	35	11	55	9	45	38	47.50	
Tertiary	6	30	8	40	-	-	2	10	16	20.00	
Occupational status											
Employed	-	-	4	20	1	5	2	10	7	8.75	0.310
Unemployed	17	85	14	70	18	90	17	85	66	82.50	
Self employed	3	15	2	10	1	5	1	5	7	8.75	
Respondents' categories											
Father	1	5	2	10	1	5	5	25	9	11.25	0.088
Mother	11	55	10	50	16	80	12	60	49	61.25	
Family members ≥ 18 years	8	40	8	40	3	15	3	15	22	27.50	
Household size											
1-5	6	30	10	50	8	40	11	55	35	43.75	0.340
6-10	13	65	8	40	8	40	7	35	36	45.00	
11-15	1	5	2	10	4	20	1	5	8	10.00	
16-20	-	-	-	-	-	-	1	5	1	1.25	
Playground for children											
Reserved	1	5	-	-	1	5	3	15	2	2.50	0.000
Vicinity of house	19	95	19	95	5	25	17	85	60	75.00	
Both	-	-	-	-	11	55	-	-	11	13.75	
Not applicable	-	-	1	14	3	43	3	43	7	8.75	

Knowledge on health risks associated with the consumption of free-range chicken viscera

Overall, knowledge of zoonotic disease transmission associated with consumption of FRC viscera in the study localities was estimated at 31.3%. Knowledge was the same (35%, 7/20) in MZ and SH followed by GI (30%, 6/20) and OZ (25%, 5/20) (Table 2). The proportion of respondents having knowledge on zoonoses transmission through consumption of raw/undercooked chicken viscera was high in the age group 41-50 years and highest in GI (20%, 4/20) followed by SH (15%, 3/20) and OZ (10%, 2/20). However, in MZ, knowledge was highest in the age group ≥61 (20%, 4/20).

Based on education level, knowledge on zoonosis transmission was highest among respondents with high school education (13.8%, 11/80), followed by tertiary education (8.8%, 7/80), primary education (7.5%, 6/80) and (1.3%, 1/80) among respondents with no formal education (Table 2). The knowledge of zoonosis due to consuming undercooked/raw FRC was the same (35%, 7/20) in MZ and OZ, followed by (30%, 6/20), and (25%, 5/20) in GI and OZ respectively (Table 2). Regarding occupation, knowledge was highest among the unemployed, (26.3%, 21/80), followed by (3.8%, 3/80) and (2.5%, 2/80) among the employed and self-employed participants respectively. Furthermore, based on the household size, knowledge of zoonosis was highest (13.8%, 11/80) in household size 1-5 and 6-10, and decreased in household size 11-15 (2.5%, 2/80) and 16-20 (1.3%, 1/80) (Table 2).

Table 2
Responses on knowledge of zoonoses transmission from free range chickens in four localities in the KwaZulu-Natal province of South Africa (GI = Gingindlovu; OZ = Ozwathini; MZ = uMzinto; SH = Shongweni).

Variable	Localities							
	GI (n=20)		OZ (n=20)		MZ (n=20)		SH (n=20)	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Age								
<21	-	1 (100)	-	1 (100)	-	-	-	1 (100)
21-30	2 (29)	5 (71)	1 (17)	5 (83)	1 (33)	2 (67)	2 (100)	-
31-40	-	1 (100)	1 (25)	3 (75)	-	1 (100)	-	-
41-50	4 (80)	1 (20)	2 (50)	2 (50)	-	5 (100)	3 (60)	2 (40)
51-60	-	2 (100)	1 (50)	1 (50)	2 (50)	2 (50)	-	4 (100)
61+	-	4 (100)	-	3 (100)	4 (57)	3 (43)	2 (33)	4 (67)
Total	6 (30)	14 (70)	5 (25)	15 (75)	7 (35)	13 (65)	7 (35)	13 (65)
X^2, *p*-Value	(X^2 = 9.388, p = 0.095)		(X^2 = 3.556, p = 0.615)		(X^2 = 5.139, p = 0.273)		(X^2 = 8.864, p = 0.115)	
Educational level								
None	-	2 (100)	-	2 (100)	-	1 (100)	1 (100)	-
Primary	-	1 (100)	-	3 (100)	4 (50)	4 (50)	2 (25)	6 (75)
High school	2 (18)	9 (82)	3 (43)	4 (57)	`3 (27)	8 (73)	3 (33)	6 (67)
Tertiary	4 (67)	2 (33)	2 (25)	6 (75)	-	-	1 (50)	1 (50)
	6 (30)	14 (70)	5 (25)	15 (75)	7 (35)	13 (65)	7 (35)	13 (65)
X^2, *p*-Value	(X^2 = 5.859, p = 0.119)		(X^2 = 2.857, p = 0.414)		(X^2 = 1.618, p = 0.445)		(X^2 = 2.418, p = 0.490)	
Occupation								
Employed	-	-	1 (25)	3 (75)	-	1 (100)	1 (50)	1 (50)
Unemployed	4 (24)	13 (76)	4 (29)	10 (71)	7 (39)	11 (61)	6 (35)	11 (65)
Self employed	2 (67)	1 (33)	-	2 (100)	-	1 (100)	-	1 (100)
Total	6 (30)	14 (70)	5 (25)	15 (75)	7 (35)	13 (65)	7 (35)	13 (65)
X^2, *p*-Value	(X^2 = 2.260, p = 0.133)		(X^2 = 0.762, p = 0683)		(X^2 = 1.197, p = 0.550)		(X^2 = 0.737, p = 0.692)	
Participant's ID								
Father	-	1 (100)	-	2 (100)	-	1 (100)	1 (20)	4 (80)
Mother	3 (27)	8 (73)	3 (30)	7 (70)	6 (38)	10 (62)	4 (33)	8 (67)
Children >18yrs	3 (38)	5 (62)	2 (25)	6 (75)	1 (33)	2 (67)	2 (67)	1 (33)
Total	6 (30)	14 (70)	5 (25)	15 (75)	7 (35)	13 (65)	7 (35)	13 (65)
X^2, *p*-Value	(X^2 = 0.682, p = 0.711)		(X^2 = 0.800, p = 0.670)		(X^2 = 0.586, p = 0.746)		(X^2 = 1.832, p = 0.400)	
Household Size								
1-5	1 (17)	5 (83)	3 (30)	7 (70)	2 (25)	6 (75)	5 (45)	6 (55)
6-10	4 (31)	9 (69)	2 (25)	6 (75)	4 (50)	4 (50)	1 (14)	6 (86)
11-15	1 (100)	-	-	2 (100)	1 (25)	3 (75)	-	1 (100)
16-20	-	-	-	-	-	-	1 (100)	-
Total	6 (30)	14 (70)	5 (25)	15 (75)	7 (35)	13 (65)	7 (35)	13 (65)
X^2, *p*-Value	(X^2 = 2.845, p = 0.241)		(X^2 = 0.800, p = 0.670)		(X^2 = 1.319, p = 0.517)		(X^2 = 4.244, p = 0.236)	

Ownership of free-range chicken and pets in study localities

Overall, 65% (52/80) of the interviewed households in the study population owned free-range chickens ranging from 1-51 (17.2±1.4). Twenty percent (16/80) of the households had FRC greater than 20, while (10%, 8/80) of the study population have ≤5. FRC ownership was highest in MZ (80%, 16/20), followed by OZ (70%, 14/20), SH (60%, 12/20), and GI (50%, 10/20) (Table 3). With respect to pet ownership, 30% (24/80) of the households that were surveyed owned either of dogs, cats, or both in the proportion of 23.8%, 1.3%, and 5% respectively. Generally, the proportion of households owning cats was low, with only 10% (2/80) in GI and SH, and 1.25% (1/80) in MZ while there was nothing recorded in OZ. Also, 20% (16/80) of the household owning pets allow them to roam and (24%, 19/80) of the respondents reported pets deworming (Table 3).

Table 3
Ownership of free-range chicken and pets in four localities in the KwaZulu-Natal province of South Africa (GI = Gingindlovu; OZ = Ozwathini; MZ = uMzinto; SH = Shongweni)

Variable	**Localities**										
	GI (n=20)		OZ (n=20)		MZ (n=20)		SH (n=20)		Total (n=80)		
	Freq	(%)	Freq	(%)	Freq	(%)	Freq	(%)	Freq	(%)	*p*-Value
Ownership of free-range chickens											
Yes	10	50	14	70	16	80	12	60	52	65.00	0.222
No	10	50	6	30	4	20	8	40	28	35.00	
Number of free-range chickens in the household											
1 – 5	1	5	4	20	1	5	11	55	8	10.00	0.416
6 – 10	1	5	5	25	2	10	7	35	10	12.50	
11 – 15	2	10	2	10	7	35	1	5	14	17.50	
16 – 20	1	5	-	-	1	5	1	5	4	5.00	
20+	5	25	3	15	5	25	-	-	16	20.00	
Presence of pet animal (dog or cats)											
Yes	7	35	1	5	6	30	10	50	24	30.00	0.019
No	13	65	19	95	14	70	10	50	56	70.00	
Number of dogs											
1-5	5	25	1	5	5	25	9	45	20	25.00	0.946
6-10	1	33	-	-	1	33	1	33	3	3.75	
Number of cats											
1-5	2	40	-	-	1	20	2	40	5	6.25	-
Mode of rearing of pet											
Allowed to roam	3	15	1	5	5	25	7	35	16	20.00	0.043
Not Allowed to roam	4	20	-	-	1	5	3	15	8	10.00	
Not applicable	13	23	19	34	14	25	10	18	56	70.00	

Chicken viscera consumption

Overall, 76.3% (61/80) of respondents reported consumption of chicken viscera (Table 4). The proportion of respondents consuming chicken viscera was highest in SH (90%, 18/20), followed by OZ (80%, 16/20), MZ (75%, 15/20), and GI (60%, 12/20). No significant association was found between household size and chicken viscera consumption ($p>0.05$).

A three-way Cross-Tabulation and Chi-square statistic for respondents' categories (father, mother, or household members ≥ 18 years), the types of chicken viscera that were being consumed, and consumption preference showed a significant association in all the study locations ($p<0.05$) with the majority of the respondents (96.7%, 59/80) reporting their consumption preference as 'well-cooked' (Table 4). The proportion of respondents consuming the combination of all chicken viscera i.e., gizzard, heart, liver, lungs, kidney, and intestines was higher than the other chicken viscera combinations, however, the difference was not significant ($p>0.05$) (Table 5).

Table 4 **Responses from participants on type and consumption preference of viscera from free range in four localities in KwaZulu-Natal province of South Africa.**

Respondents Category	Viscera type consumed and preferred manner of consumption in Gingindlovu (n = 12)										
	1, 3	1, 2, 3	1, 3, 4, 6	1, 2, 3, 6	1, 2, 3, 4, 5	1, 3, 4, 5, 6	1, 2, 3, 5, 6	1, 2, 3, 4, 5, 6	Consumption preference		*p*-Value
									Well cooked	Under cooked	
Father	-	-	-	-	-	-	-	1	1	-	0.001
Mother	-	-	-	-	-	1	2	4	7	-	
Family members ≥ 18 years	-	-	-	-	-	-	2	2	3	1	
Total	**-**	**-**	**-**	**-**	**-**	**1**	**4**	**7**	**11**	**1**	
Respondents Category	Viscera type consumed and preferred manner of consumption in Ozwathini (n = 16)										
Father	-	7-	-	-	-	-	-	1	1	-	0.006
Mother	-	1	-	1	-	-	3	2	7	-	
Family members ≥ 18 years	1	-	1	-	-	1	2	3	8	-	
Total	1	1	1	1	-	1	5	6	16	-	
Respondents Category	Viscera type consumed and preferred manner of consumption in uMzinto (n = 15)										
Father	-	-	-	-	-	-	-	1	1		0.000
Mother	-	-	-	-	7	-	-	5	11	1	
Family members ≥ 18 years	-	-	-	-	2	-	-	-	2	-	
Total	-	-	-	-	9	-	-	6	14	1	
Respondents Category	Viscera type consumed and preferred manner of consumption in Shongweni (n = 18)										
Father	-	1	-	-	1	-	-	2	4	-	0.000
Mother	-	-	-	3	3	-	-	5	11	-	
Family members ≥ 18 years	-	-	-	-	1	-	-	2	3	-	
Total	-	1	-	3	5	-	-	9	18	-	
Overall Total	1	2	1	4	14	2	9	28	59	2	
p-Value	0.000										

Chicken viscera types are denoted as follows; 1 = Gizzard, 2 = Heart, 3 = Liver, Lungs = 4, Kidney = 5, Intestines = 6

Table 5
Categories of household members consuming each type of chicken viscera in four localities as per respondent responses.

Chicken viscera	Gingindlovu (N = 20)							
	1	2	3	1 and 2	1 and 3	2 and 3	1, 2, and 3	4
Gizzard	3 (15)	-	-	-	1 (5)	3 (15)	5 (25)	8 (40)
Heart	2 (10)	-	-	-	1 (5)	3 (15)	5 (25)	9 (45)
Liver	3 (15)	-	-	-	1 (5)	3 (15)	5 (25)	8 (40)
Lungs	1 (5)	-	1 (5)	-	-	3 (15)	4 (20)	11 (55)
Kidney	1 (5)	1 (5)	-	-	1 (5)	3 (15)	6 (30)	8 (40)
Intestines	2 (10)	-	-	-	1 (5)	3 (15)	6 (30)	8 (40)
Chicken viscera	Ozwathini (N = 20)							
Gizzard	3 (15)	-	1 (5)	-	-	-	4 (20)	12 (60)
Heart	1 (5)	-	1 (5)	-	-	-	6 (30)	12 (60)
Liver	3 (15)	-	1 (5)	-	-	-	4 (20)	12 (60)
Lungs	1 (5)	-	-	-	-	-	11 (55)	8 (40)
Kidney	1 (5)	-	-	1 (5)	-	-	8 (40)	10 (50)
Intestines	2 (10)	-	-	-	-	-	6 (30)	12 (60)
Chicken viscera	uMzinto (N = 20)							
Gizzard	1 (5)	-	-	-	-	7 (35)	5 (25)	7 (35)
Heart	1 (5)	-	-	-	-	7 (35)	5 (25)	7 (35)
Liver	1 (5)	-	-	-	-	7 (35)	5 (25)	7 (35)
Lungs	2 (10)	-	-	-	-	7 (35)	5 (25)	6 (30)
Kidney	2 (10)	-	-	-	-	7 (35)	5 (25)	6 (30)
Intestines	1 (5)	-	3 (15)	-	-	5 (25)	9 (45)	2 (10)
Chicken viscera	Shongweni (N = 20)							
Gizzard	5 (25)	1 (5)	-	1 (5)	1 (5)	5 (25)	2 (10)	5 (25)
Heart	6 (30)	1 (5)	-	1 (5)	-	5 (25)	3 (15)	4 (20)
Liver	6 (30)	1 (5)	-	1 (5)	-	5 (25)	2 (10)	5 (25)
Lungs	3 (15)	-	1 (5)	1 (5)	1 (5)	6 (30)	4 (20)	4 (20)
Kidney	3 (15)	-	1 (5)	1 (5)	-	6 (30)	5 (25)	4 (20)
Intestines	2 (10)	-	2 (10)	1 (5)	1 (5)	4 (20)	6 (30)	4 (20)

Categories keys; 1 = Father, 2 = Mother, 3 = Family members ≥ 18 years, 4 = None of the categories

Discussion

Toxoplasmosis and toxocariasis are global zoonotic diseases of public health importance that can be acquired either, directly via accidental ingestion of infective oocysts and egg with larvae respectively or indirectly through ingestion of raw or undercooked vegetables, meat or viscera infected with cysts/larvae from the intermediate host (Campos-da-Silva et al. 2015; Zibaei et al. 2017; Luna et al. 2018; Belluco et al. 2018; Omonijo et al. 2020; dos Santos Silva et al. 2020). The socio-demographic parameters obtained in this study revealed resource-limited settings and is in agreement with report from a study by Tarwireyi and Fanadzo (2013). Other studies have reported the vulnerability of resource-poor communities who keep FRC to zoonotic diseases such as toxoplasmosis and toxocariasis (Neghina 2010; Santarém et al. 2011; Mirza and Rathore 2019).

Our study showed that a quarter of the respondents in the study areas had only completed primary education. This is consistent with reports from other rural regions of South Africa where the low levels of education have been reported (Mwale and Masika, 2009; Spaull 2015). Similarly, the high unemployment rate observed in this study agrees with an earlier report from the Eastern Cape province of South Africa (Mwale and Masika 2009) and previous studies have shown that limited employment and socio-demographic factors influence the food and meat gathering practices of people in a way that predisposes them to parasitic infections (Simeone 2008; Drescher et al. 2012; Goyette et al. 2014).

This study showed that knowledge of zoonotic disease transmission was highest in the southern localities (MZ and SH) than in the northern (GI and OZ) of KZN respectively. Also, this study showed that the overall percentage of zoonosis transmission awareness was comparable to 30.1% recorded from cattle

farmers in Senegal (Tebug et al. 2015), but higher than the awareness level of 19.1% of zoonotic risk associated with livestock in Ibadan Nigeria (Awosanya and Akande 2015). However, it was lower than 69% and 79.74% that was reported in Cambodia and Punjab respectively (Osbjer et al. 2015; Singh et al. 2019). Studies have shown that zoonosis transmission rates and associated risk factors may differ among localities within regions as observed in the USA (Congdon and Lloyd 2011; Ishaku et al. 2018).

Moreover, the significant association of playgrounds with study locations observed in this study may be of importance in zoonosis transmission especially among children, considering that most of them utilized household vicinity as playground. The exposure of these playgrounds to stray definitive hosts could result in environmental contamination with oocysts or eggs which are picked up by free-range chickens during foraging thereby making environmental contact an important route of infection for humans and animals (Campos-da-Silva et al. 2015; Yan et al. 2016; Gaulin et al. 2020).

Furthermore, this study revealed that ownership of free-range chickens in the study locations was 65% (52/80), this is higher than the 57.7% (41/71) reported in Ethiopia (Sambo et al. 2015), but lower than the 93.5% and 84% poultry (duck and chicken) ownership observed in Eastern Cape province of South Africa and Cambodia respectively (Mwale and Masika 2009; Osbjer et al. 2015). Also, the average flock size (17.2±1.4) observed in this study is higher than (16±2.1), reported in Eastern Cape province of South Africa (Mwale and Masika 2009), but lower than (22.03±2.85) in Limpopo province and (28.40±2.57) earlier reported in KwaZulu-Natal province respectively (Malatji et al. 2016).

Moreover, the co-existence of dogs, cats, and free-range chickens observed in this study may provide insight into the roles of these animals in transmitting toxoplasmosis and toxocariasis in KZN where the occurrence of *T. gondii* have been reported in cows (Thekisoe et al. 2020) and *T. canis* and *Toxocara* spp reported in dogs (Mukaratirwa and Singh 2010), and household dust (Mejia et al. 2020) respectively. *T*oxocara *canis* and *T. cati* are major parasites of canids and felids but can also infect a wide range of paratenic hosts and humans where they cause toxocariasis (Omonijo et al. 2020).

Furthermore, this study showed that 20%) (16/80) of the household owning pets allow them to roam. This may be attributed to low education level of owners thus, negatively influencing veterinary seeking practice for their pets. This is consistent with other studies who reported the positive influence of post-secondary education in seeking veterinary services (Pereira et al. 2016). This study underscores the need to intensify awareness on standard pet care practice and risk of disease transmission among animals and from animals to humans.

Regarding consumption patterns, the majority (76.3%, 61/80) of respondents reported the practice of consumption of FRC viscera in the households. The reason for the high demand for chicken viscera in the study area is however unknown. Studies have identified the role of poor socio-demographic parameters as well as globalization as important factors in meat consumption pattern (Tambi 2001; Simeone 2008; Goyette et al. 2014; Robertson et al. 2014). Additionally, viscera of chicken and other avian animals have been reported to be rich in essential nutrients that are highly valuable to humans (Schönfeldt and Gibson 2008).

Despite a high trend in the consumption of chicken viscera, this study does not find any significant association between the consumption of free-range chicken viscera and symptoms of zoonosis (p>0.05). This may be attributed to the respondents' preference for 'well-cooked' viscera. Also, a study reported the important role of mothers in the provision and preparation of healthy meals for their households (Reid et al., 2015) which might be the case in our study. Although the association between household size and consumption pattern was not significant in this study, a previous study showed the inverse relationship between household size and certain food consumption patterns (Abdulai et al. 1999). Considering the high rate of chicken viscera consumption practiced by communities in this study, although most preferred "well-cooked", it is important to intensify awareness on health associated with the consumption of raw/undercooked viscera from free-range chickens.

Declarations

Acknowledgements The authors would like to thank the University of KwaZulu-Natal and the National Research Foundation who awarded A.O.O. a bursary for her PhD studies.

Authors' contributions All authors contributed to the study conception and design Adejumoke O. Omonijo and Samson Mukaratirwa conceived and designed the study. Adejumoke O. Omonijo wrote the article and Samson Mukaratirwa reviewed the article. Both authors read and approved the final manuscript.

Data availability The data used to support the findings of this study are available from the corresponding author upon request.

Ethics approval The study was conducted under the Human and Social Sciences Research Ethics committee of the University of KwaZulu-Natal protocol reference number HSS/1655/018D.

Consent to participate • We confirm the confidentiality of each participant's answer, and the data will be treated with complete confidentiality, and only for research and statistical purposes only.

• We confirm that their participation in the study was voluntary, with no financial compensation.

• We confirm the participants' right to not answer any question they do not want to, and their right to withdraw from the study at any time they wish without giving reasons without any negative consequences being applied to them.

• Written consent was obtained from each participant before their participation in the study.

Consent for publication The corresponding author confirms that the manuscript has been read and approved for submission by all the co-authors.

Conflict of interest The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Financial support This study is based on the research supported wholly by University of KwaZulu-Natal Research Productivity funds allocated to Samson Mukaratirwa.

References

1. Abdulai, A., Jain, D.K. and Sharma, A.K. 1999. Household food demand analysis in India. Journal of Agricultural Economics, 50: 316-327.
2. Awosanya, E.J. and Akande, H. 2015. Animal health care seeking behavior of pets or livestock owners and knowledge and awareness on zoonoses in a university community. Veterinary World, 8: 841.
3. Belluco, S., Simonato, G., Mancin, M., Pietrobelli, M. and Ricci, A. 2018. *Toxoplasma gondii* infection and food consumption: a systematic review and meta-analysis of case-controlled studies. Critical Reviews in Food Science and Nutrition, 58(18): 3085-3096.
4. Broglia, A. and Kapel, C. 2011. Changing dietary habits in a changing world: emerging drivers for the transmission of foodborne parasitic zoonoses. Veterinary Parasitology 182, 2-13.
5. Campos-Da-Silva, D.R., Da Paz, J.S., Fortunato, V.R., Beltrame, M.A., Valli, L.C. and Pereira, F.E. 2015. Natural infection of free-range chickens with the ascarid nematode *Toxocara* sp. Parasitology Research, 114: 4289-4293.
6. Choi, W.Y., Nam, H.W., Kwak, N.H., Huh, W., Kim, Y.R., Kang, M.W., Cho, S.Y. and Dubey, J.P. 1997. Foodborne outbreaks of human toxoplasmosis. Journal of Infectious Diseases, 175(5): 1280–1282.
7. Congdon, P. and Lloyd, P. 2011. *Toxocara* infection in the United States: the relevance of poverty, geography and demography as risk factors, and implications for estimating county prevalence. International Journal of Public Health, 56: 15-24.
8. Dawson, D. 2005. Foodborne protozoan parasites. International Journal of Food Microbiology, 103(2): 207–227.
9. De Vries, S.P, Vurayai, M., Holmes, M., Gupta, S., Bateman, M., Goldfarb, D., Maskell, D.J., Matsheka, M.I. and Grant, A.J. 2018. Phylogenetic analyses and antimicrobial resistance profiles of Campylobacter spp. from diarrhoeal patients and chickens in Botswana. PLoS One, 13(3): e0194481.
10. dos Santos Silva, A.C., de Barros, L.D., Barros, V.M.C., de Alcântara, A.M., Andrade, M.R., Garcia, J.L., Mota, R.A. and Porto, W.J.N. 2020. Occurrence of Atypical and new genotypes of *Toxoplasma gondii* in free-range chickens intended for human consumption in Brazil. Acta Parasitologica, 65(3): 774-778.
11. Duarte, P.O., Oshiro, L.M., Zimmermann, N.P., Csordas, B.G., Dourado, D.M., Barros, J.C. and Andreotti, R. 2020. Serological and molecular detection of *Neospora caninum* and *Toxoplasma gondii* in human umbilical cord blood and placental tissue samples. Scientific reports, 10(1): 1-8.
12. Dubey, J.P., 2020. The history and life cycle of *Toxoplasma gondii*. In *Toxoplasma gondii* (1-19): Elsevier.
13. Drescher, L.S., De Jonge, J., Goddard, E. and Herzfeld, T. 2012. Consumer's stated trust in the food industry and meat purchases. Agriculture and Human Values, 29: 507-517.
14. Fan, C.K., Holland, C.V., Loxton, K. and Barghouth, U. 2015. Cerebral Toxocariasis: Silent Progression to Neurodegenerative Disorders? Clinical Microbiology Reviews, 28: 663.
15. Gaulin, C., Ramsay, D., Thivierge, K., Tataryn, J., Courville, A., Martin, C., Cunningham, P., Désilets, J., Morin, D. and Dion, R. 2020. Acute toxoplasmosis among Canadian deer hunters associated with consumption of undercooked deer meat hunted in the United States. Emerging infectious diseases, 26(2): 199-205.
16. Goyette, S., Cao Z., Libman, M., Ndao, M. and Ward, B.J. 2014. Seroprevalence of parasitic zoonoses and their relationship with social factors among the Canadian Inuit in Arctic regions. *Diagnostic Microbiology* and *Infectious Disease,* 78: 404-410.
17. Holland, C.V. and Hamilton, C.M. 2013. The significance of cerebral toxocariasis: a model system for exploring the link between brain involvement, behaviour and the immune response. Journal of Experimental Biology, 216: 78-83.
18. http://www.durban.gov.za/Resource_Centre/reports/Framework_Planning/Documents/Shongweni_LAP_Regional_Economic_Assessment_June_2010_Dra
19. Ishaku, B., Abdullahi, M., Nalong, D., Jonah, R. and Mayowa, O. 2018. Seroprevalence and risk factors for *Toxoplasma gondii* in pigs, sheep and goats at slaughter in Jos Municipal Abbatoir, Nigeria. *Veterinary Sciences*: *Research* and Reviews, 4(2): 55-61.
20. Luna, J., Cicero, C.E., Rateau, G., Quattrocchi, G., Marin, B., Bruno, E., Dalmay, F., Druet- Cabanac, M., Nicoletti, A. and Preux, P.-M., 2018. Updated evidence of the association between toxocariasis and epilepsy: Systematic review and meta-analysis. PLOS Neglected Tropical Diseases,12: e0006665.
21. Malatji, D.P., Tsotetsi, A.M., Van Marle-Köster, E. and Muchadeyi, F.C. 2016. A description of village chicken production systems and prevalence of gastrointestinal parasites: Case studies in Limpopo and KwaZulu-Natal provinces of South Africa. Onderstepoort Journal of Veterinary Research, 83: 1-8.
22. Mirza, A. and Rathore, M., 2019. Toxocariasis, Hydatid Disease of the Lung, Strongyloidiasis, and Pulmonary Paragonimiasis. Kendig's Disorders of the Respiratory Tract in Children. 535-546, Elsevier Inc.
23. Morimatsu, Y., Akao, N., Akiyoshi, H., Kawazu, T., Okabe, Y. and Aizawa, H. 2006. A familial case of visceral larva migrans after ingestion of raw chicken livers: appearance of specific antibody in bronchoalveolar lavage fluid of the patients. American Journal of Tropical Medicine and Hygiene. 75, 303–306.
24. Mukaratirwa, S. and Khumalo, M. 2010a. Prevalence of helminth parasites in free-range chickens from selected rural communities in KwaZulu-Natal province of South Africa. Journal of the South African Veterinary Association, 81(2): 97-101.
25. Mukaratirwa, S. and Singh, V. 2010b. Prevalence of gastrointestinal parasites of stray dogs impounded by the Society for the Prevention of Cruelty to Animals (SPCA), Durban and Coast, South Africa. Journal of the South African Veterinary Association, 81, 123-125.

26. Mwale, M. and Masika, P. 2009. Ethno-veterinary control of parasites, management and role of village chickens in rural households of Centane district in the Eastern Cape, South Africa. Tropical Animal Health and Production 41, 1685-1693.
27. Nagakura, K., Tachibana, H., Kaneda, Y. and Kato, Y. 1989. Toxocariasis possibly caused by ingesting raw chicken. Journal of Infectious Diseases 160:735–736.
28. Naidoo, M., 2005. Local poultry production systems in Northern Kwazulu Natal, South Africa. Tropicultura 23, 42.
29. Neghina, R. 2010. Trichinellosis, a Romanian never-ending story. An overview of traditions, culinary customs, and public health conditions. Foodborne Pathogens and Disease, 7(9): 999-1003.
30. Omonijo, A.O., Kalinda, C. and Mukaratirwa, S. 2020. A systematic review and meta-analysis of canine, feline and human *Toxocara* infections in sub-Saharan Africa. Journal of Helminthology, 94: e96, https://doi.org/10.1017/S0022149X19000889
31. Osbjer, K., Boqvist, S., Sokerya, S., Kannarath, C., San, S., Davun, H. and Magnusson, U. 2015. Household practices related to disease transmission between animals and humans in rural Cambodia. BMC Public Health, 15 (1): 476.
32. Pereira, A., Martins, Â., Brancal, H., Vilhena, H., Silva, P., Pimenta, P., Diz-Lopes, D., Neves, N., Coimbra, M., Alves, A.C. and Cardoso, L., 2016. Parasitic zoonoses associated with dogs and cats: a survey of Portuguese pet owners' awareness and deworming practices. Parasites and Vectors 9, 245.
33. Reid, M., Worsley, A. and Mavondo, F., 2015. The obesogenic household: Factors influencing dietary gatekeeper satisfaction with family diet. Psychology and Marketing, 32(5): 544-557.
34. Robertson, L.J., Sprong, H., Ortega, Y.R., Van der giessen, J.W. and Fayer, R. 2014. Impacts of globalisation on foodborne parasites. Trends in Parasitology, 30: 37-52.
35. Rodrigues, F.T., Moreira, F.A., Coutinho, T., Dubey, J. P., Cardoso, L. and Lopes, A.P. 2019. Antibodies to *Toxoplasma gondii* in slaughtered free-range and broiler chickens. Veterinary Parasitology, 271: 51-53.
36. Sambo, E., Bettridge, J., Dessie, T., Amare, A., Habte, T., Wigley, P. and Christley, R.M. 2015. Participatory evaluation of chicken health and production constraints in Ethiopia. Preventive Veterinary Medicine, 118: 117-127.
37. Santarém, V.A., Rubinsky-elefant, G. and Ferreira, M.U. 2011. Soil-transmitted helminthic zoonoses in humans and associated risk factors. Journal of *Soil* Contamination IntechOpen.
38. Sasse, J.P., Silva, A.C.D.S., Carneiro, P.G., Nino, B.D.S.L., Vieira, F.E.G., Barros, L.D.D. and Garcia, J.L. 2020. *Neospora caninum* in free-range chickens (*Gallus gallus domesticus*) from southern Brazil. Revista brasileira de parasitologia veterinaria 29(4): e013620 | https://doi.org/10.1590/S1984-29612020107.
39. Schönfeldt, H. and Gibson, N. 2008. Changes in the nutrient quality of meat in an obesity context. Meat Science, 80: 20-27.
40. Simeone, T. 2008. The Arctic: Northern Aboriginal peoples. In Library of Parliament INFOSERIES. Parliamentary Information and Research Service Publication PRB 08-10E.
41. Singh, B., Kaur, R., Gill, G., Gill, J., Soni, R. and Aulakh, R. 2019. Knowledge, attitude and practices relating to zoonotic diseases among livestock farmers in Punjab, India. Acta Tropica, 189: 15-21.
42. Spaull, N. 2015. Schooling in South Africa: How low-quality education becomes a poverty trap. *South African Child Gauge,* 12: 34-41.
43. Tambi, N.E. 2001. Analysis of household attitudes toward the purchase of livestock products and fish in Cameroon. *Journal of Agricultural Economics,* 26: 135-147.
44. Tannent, J.K., Downs, C.T., Wald, D.M. and Watson, H.K. 2010. Public perceptions of feral cats within an urban conservancy on a campus of the University of KwaZulu-Natal. African Journal of Wildlife Research, 40: 16-27.
45. Tarwireyi, L. and Fanadzo, M. 2013. Production of indigenous chickens for household food security in rural KwaZulu-Natal, South Africa: A situation analysis. African Journal of Wildlife Research, 8: 5832-5840.
46. Tebug, S.F., Kamga-Waladjo, A.R., Ema, P.J.N., Muyeneza, C., Kane, O., Seck, A., Ly, M.T. and Lo, M. 2015. Cattle farmer awareness and behavior regarding prevention of zoonotic disease transmission in Senegal. *Journal* of Agromedicine, 20(2): 217-224.
47. Thekisoe, O.M., Mofokeng, L.S., Smit, N.J. and Taioe, O.M. 2020. Parasites of veterinary importance from domestic animals in uMkhanyakude district of KwaZulu-Natal province. Journal of the South African *Vet*erinary Association, 91(1): 1-11.
48. Trevisan, C., Torgerson, P.R. and Robertson, L.J. 2019. Foodborne parasites in Europe: Present status and future trends. Trends in Parasitology, 35(9): 695-703
49. Yan, C., Liang, L.-J., Zheng K.-Y. and Zhu, X.Q. 2016. Impact of environmental factors on the emergence, transmission and distribution of *Toxoplasma gondii*. Parasites and Vectors, 9(1): 1-7.
50. Yoshida, A., Hombu, A., Wang, Z. and Maruyama, H. 2016. Larva migrans syndrome caused by *Toxocara* and *Ascaris* roundworm infections in Japanese patients. European Journal of Clinical Microbiology and Infectious Diseases, 35(9): 1521-1529.
51. Zibaei, M., Sadjjadi, S., Maraghi, S., 2017. The occurrence of *Toxocara* species in naturally infected broiler chickens revealed by molecular approaches. Journal of Helminthology, 91: 633-636.

Figures

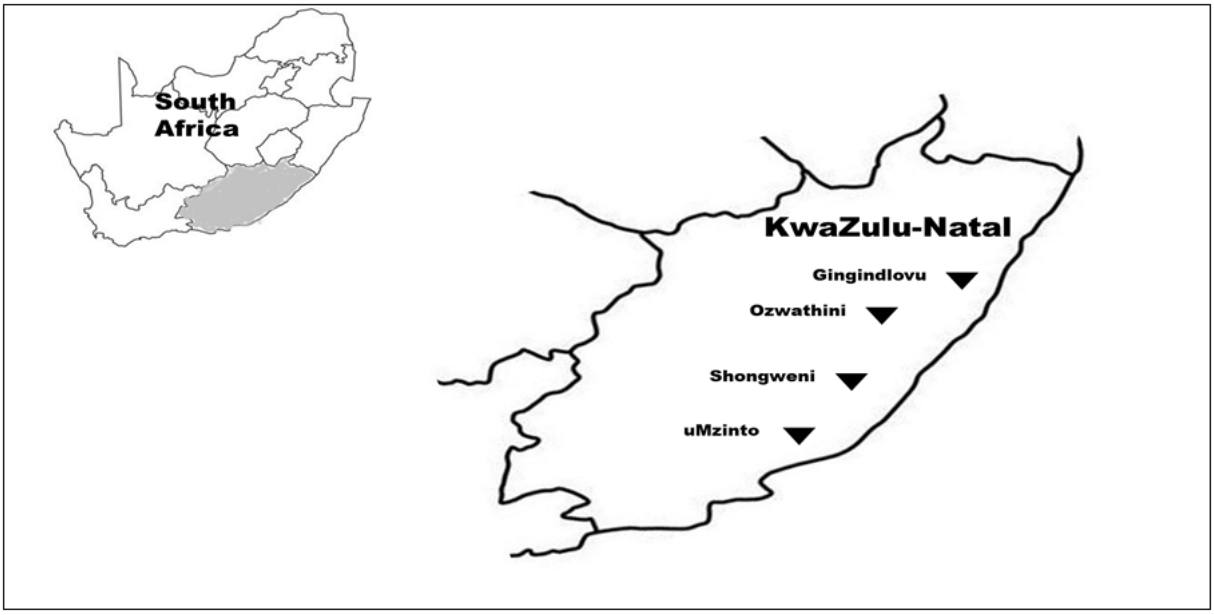

Figure 1

Map showing the study location sites in KwaZulu-Natal South Africa