

Awareness and Risk Behaviors of Toxoplasmosis among Hail Population, Kingdom of Saudi Arabia

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Abstract: Background: Toxoplasmosis is a worldwide disease that severely affects the fetuses and immunocompromised patients and results in many critical and life threatening conditions. Awareness about toxoplasmosis and its transmission not only helps in reducing its prevalence, but also in decreasing the undesired outcomes of congenital toxoplasmosis. Aim of the work: this study aimed to evaluate the level of awareness as well as the behavioral risk factors towards toxoplasmosis in Hail region. Such data are needed for initiating health education activities and aid in the control measures against toxoplasmosis. Subjects and methods: A cross sectional study was conducted during the study year 2016-2017 in Hail city, which is located in north of Saudi Arabia. A total randomly selected sample of 800 participants agreed to participate in the current study. Data were collected through individual interviews to fill a structured questionnaire followed by analysis and expression as percentage distribution. Results: Generally, the current study revealed some conflicting results, that although a high percentage of our participants (79.25%) knew about the toxoplasmosis, unfortunately few percentage of them (25.1%) knew the correct causative agent and only 22.13%, 22.62%, 17.75% and 24% had knowledge about vulnerable group susceptibility, treatment availability and modality of the disease respectively. Most of the respondents got their information from the internet (55.5%). The highest level of knowledge was about the role of cats in transmission of toxoplasmosis (50.25%) while the results detected low level of knowledge about other methods of transmission. Unfortunately, many participants in the current work seemed confused about the symptoms of *T. gondii* infection and surprisingly, 25.37% of the participants mentioned the Sneezing or coughing from infected person to be one of the mode of transmission of toxoplasmosis which is not correct. The high percentage of the participants (39.12%) recognized the relation of toxoplasmosis to Congenital anomalies followed by those who mentioned abortion (38.62%). However knowledge about generalized lymphadenopathy produced the greatest number of wrong answers (98.1%). It is conflicting that although participants' low knowledge regarding the preventive behaviors, good number of them practices the correct preventive measures to avoid infection. Most of our respondents didn't raise cats (64.7%), do not consume undercooked meat (85.25%). Moreover, high percentage of them used to wash their hands before eating or handling meat (75.75%), well cook their meat (88.25 %) and wash their vegetables (78.88 %). Unfortunately, 69.85 % of the participants used to benefit from cat feces as fertilizer and, 69.5% of them didn't change the cats' litter boxes frequently and 28.9% of them used to drink tank water. Conclusion: Hail population has low level of knowledge as well as they are lacking the necessary preventive behavior to Toxoplasma infection and hence, they are vulnerable to toxoplasmosis infection. Likewise, this study reflects the necessity to educate Hail people about the knowledge and hygienic measures which are essential to avoid infection. This is better done through adopting health education program to educate people in groups like in schools, hospitals and other work areas.

Keywords: Toxoplasmosis, Knowledge, Behavioral practice, Hail

1. Introduction

Toxoplasmosis is a zoonotic disease caused by the protozoan parasite *Toxoplasma gondii* (*T.gondii*). The parasite is found in humans worldwide, under a variety of climatic and socio-economic conditions. Over the last three decades, *T. gondii* infection has emerged as one of the most common opportunistic and may be fatal infections associated with immunosuppressive states as in HIV infected patients (Carruthers 2002). Approximately 30% – 65% of the world's population is estimated to have chronic *Toxoplasma* infection (Montoya & Liesenfeld 2004).

Toxoplasma gondii infection in humans is acquired in various ways. Undercooked meat or pork poses the biggest risk to humans infection (Dubey & Jones 2008). Ingestion of sporulated oocysts from cat's litter or soil, contaminated unwashed vegetables and fruits, gardening without using gloves or contaminated water is the main transmission mechanism (Dubey & Jones 2008). Congenital transmission occurs when a primary maternal infection is passed transplacentally to the fetus

(Jacquemard 2000). Dubey and Jones (2008) reported that blood transfusion, organ transplant or laboratory accidents also pose possible infection risks.

The majorities of toxoplasmosis cases in immunocompetent people are asymptomatic (Tenter, Heckeroth & Weiss 2000) or produce only mild symptoms, in the form of fever and slight generalized lymphadenopathy. It may result in life-long infection with parasites located inside tissue cysts. In pregnant women, *Toxoplasma* is an important cause of abortion and stillbirth after primary infection. Reactivation of latent infection leads to severe and life-threatening fatal disease in immunocompromised individuals (Sell, Sander & Klingerebiel 2005; Sorrentino 2005). Toxoplasmosis is the most prevalent disorder affecting the brain in HIV-patients, causing toxoplasmic meningo-encephalitis (Luft & Remington 1992). Manifestations of congenital toxoplasmosis are various, including hydrocephalus, microcephaly, intracranial calcifications, chorioretinitis, strabismus, blindness, hepatosplenomegally, jaundice, and anemia (McAuley et, 1994; Swisher et al 1994).

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Anti-parasitic antibiotic therapy is the currently available treatment for *Toxoplasma* (Paquet&Yudin, 2013). The effective therapy was well known as pyrimethamine, sulfadiazine and folic acid (Montoya & Remington, 2008). The pregnant women usually given spiramycin antibiotic if the infection occurs during the first 18 weeks of gestation, while pregnant women who acquired this parasitic infection after 18 weeks of gestation and onwards are treated like other patients.

In the meantime, developments of vaccines are still being studied (Verma& Khanna, 2013). So preventive measures as good hygiene and avoiding risk behaviors to cut the life cycle and transmission of the disease are the main methods for prevention of toxoplasmosis (Amina et al, 2013; Ogunmodede, 2005).

Generally, studies about the awareness of toxoplasmosis are deficient in Gulf countries. Most of the studies carried out in the kingdom concentrated on the pregnant women as target populations to detect the prevalence and levels of awareness. The highest prevalence of the disease was reported in Jeddah 61.4% (Tonkal, 2008), followed by Al Hassa of 51.4% (Al-Mohammed et al., 2010), and then Makkah 35.6% (Al-Harthi et al., 2006).

Awareness about toxoplasmosis and its transmission not only helps in reducing its prevalence, but also in decreasing the undesired outcomes of congenital toxoplasmosis. To the best of our knowledge, questionnaire base study on awareness of toxoplasmosis has never been conducted among Hail population. Therefore, this study aimed to evaluate the level of awareness as well as the behavioral risk factors towards toxoplasmosis in Hail region. Such data are needed for initiating health education activities and aid in the control measures against toxoplasmosis. Dissemination of appropriate knowledge to prevent infection is necessary especially for those most vulnerable namely pregnant women. This study would definitely provide the provisional insight on toxoplasmosis in Hail community and enabling the informed decision making by disease control authorities.

2. Material & Methods

1-Setting

The current study was conducted in Hail city, which is located in north of Saudi Arabia, and found at distance of 690 km from Riyadh, the capital city of Saudi Arabia during the year 2016-2017 .

2- Sampling:

A total of 800 participants agreed to participate in the current study. Samples were randomly chosen by Multistage sampling technique from urban and rural districts (Moore & McCabe, 1998).

3-Data Collection

Data were collected through individual interviews to fill A structured questionnaire including information regarding:

1-Socio-demographics: Age, residence, educational and occupational status ... etc

2-General knowledge about toxoplasmosis regarding source of information, mode of transmission, symptoms of congenital and acquired toxoplasmosis and Behavioral practice of the participants regarding the preventive measures that should be considered as recommended by Centers for Disease Control and Prevention and others (Lopez et al., 2000; Kravetz et al., 2005; Jones et al., 2001). The question formats included mixture of yes/no (closed ended) and open ended questions.

Finally participants were asked regarding symptoms and signs of both acquired and congenital toxoplasmosis as well as the treatment and preventive measures. At the end of the interview participants were inquired about their sources of information.

Pilot Testing

Initial questionnaire was compiled in English, which was translated into Arabic and then tested on a small sample of Saudi persons. From the results of the pilot testing toxoplasmosis is known among Saudi individuals as "cats disease", .So, the previous term was used all through the interview.

Data analysis

All data collected were analyzed and expressed as percentage distribution.

Ethical Considerations

Full orientation of the approached participants about the study purposes was carried out with the emphasis on their right of not to participate. An individual verbal consent to participate and fill the questionnaire was taken from each participant and data confidentiality was maintained all though.

3. Results

Socio-demographic profile

A total of 800 participants were included in the current work 51.37% of them were under the age of 35 years (table: 1) 32.5 % were highly educated, 25.25% were secondary school Certified, 18.5% were preparatory school, 11.12% were primary school while 12.63% were illiterate (table: 2). Working people were 38.75%, non-working were 15.5% while students were 45.75% (Table: 3). Correspondents who are living in houses were 66.75% while those living in rented flats were 33.25% (Table: 4). Married participants constituted 49.75 % whereas non married were 50.25% (Table:5).

General knowledge about toxoplasmosis

In general, a high percentage of the correspondents heard or read about toxoplasmosis (79.25), while only 34.75% knew the right causative agent for toxoplasmosis being a protozoa and 22.13% had information about the vulnerable group (females) susceptibility of toxoplasmosis. However 19.25% of them have read, heard, or seen some information regarding toxoplasmosis. Also, The knowledge about treatment availability, treatment modalities and prevention of toxoplasmosis were illustrated as 22.62%, 17.75% and 24% respectively (Table:6). The participants revealed that the source of their information was television (16.75 %), newspaper (10.25 %), school or university (17.5 %), internet (55.5%), friends and relatives (25.4%), while only (1.5%) got their information from social worker (Table: 7)

Knowledge about about the mode of transmission of toxoplasmosis

Table (8 demonstrated that about half (50.25%) of the participants knew that *Toxoplasma* is transmitted through contact with infected cats. However much lower level of knowledge about other mode of transmission were detected as (14%, 11%, 10.25, %, 9.12 %) for consumption of undercooked meat, unwashed vegetables or fruits, receiving blood transfusion and organ transplantation respectively. Unfortunately, 25.37 % of participants thought, incorrectly, that sneezing of coughing of infected person can transmit the infection.

knowledge about the symptoms of acquired toxoplasmosis.

Table (9)in the current work, demonstrated the participant's knowledge about the symptoms of toxoplasmosis. It was presented as 22.75% for lymphadenopathy, 13 % for fever, 11.12 % for headache and 13.5% for muscle pain. Paradoxically thought wrongly that constipation, diarrhea, eczema and gastric ulcer are symptoms of the of toxoplasmosis in percentages of 22.63%, 17%, 4.0% and 5.1% respectively.

Knowledge about the symptoms of congenital toxoplasmosis

38.82%, 39.12%, 10.12%, 9.5% of participants knew that abortion, congenital anomalies, hydrocephalus and eye affection are among clinical manifestations of toxoplasmosis . However knowledge about hepatsplenomegaly and generalized lymphadenopathy was lower; 4.0%, 1.9% respectively. However 11% and 9.8% thought wrongly that cleft lip and spina pifida are included among symptoms of congenital toxoplasmosis.(Table:10).

Results of the risk behaviors

The majority of the correspondents (85.25%) indicated they don't eat raw meat and practice good hygienic measures such as washing their hands (75.75%), well cooking their meat (88.25%) and washing the vegetables

and fruits before eating (78.88%). However lower percentages of them stated that they use gloves when handling raw meat (35.38%) and (35.25%) of them owned cats. (Table:11). Fortunately, majority of cat raiser (71.27 %) used to keep their cats indoor. Much lower percentages of them (30.49%) actually gave vaccination to their cats, 26.95 % had special place for raising cats at home, 29.43 % were using litter pits for cats' feces , while 21.63 % of them had habits of using gloves during cleaning of domestic cat's litter. Unfortunately, 69.85 % of the participants, incorrectly, used to benefit from cat feces as fertilizer (Table:12). Additional risk behavior among cats' raiser was the changing of cats' letterboxes. It was noted that only 18.8% were changing cats' letterbox frequently as 1-3 times per day, 11.7% practiced it 1-3 times per week while 69.5% of them had evident low frequency as 1-3 times per month (Table: 13). One more risk behavior which is the source of drinking water was demonstrated in (table:14).The highest percentage of the correspondents fortunately used bottled water (53.1%) followed by those used reservoir water (28.9%). However 14.3% of them used well water and 3.7% used other sources.

Table 1: Percentage distribution of age as one of the sociodemographic profile among the participants in Hail region, Saudi Arabia (2016-2017)

Age distribution		Age in years
%	No	
27.25%	218	15-< 25
24.12%	193	25-< 35
22.75%	182	35-< 45
7.25%	58	45-< 55
18.63%	149	> 55
100%	800	Total

Figure (1): Percentage distribution of age

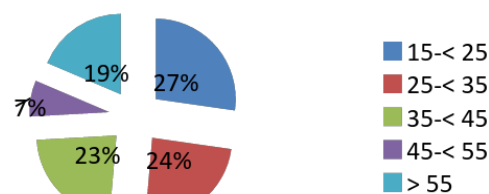


Table 2: Percentage distribution of educational level as one of the sociodemographic profile among the participants in Hail region, Saudi Arabia(2016-2017)

Educational distribution		Education level
%	No	
12.63%	101	Illiterate
11.12%	89	Primary school
18.5%	148	Preparatory school
25.25%	202	Secondary school
32.5%	260	High education
100%	800	Total

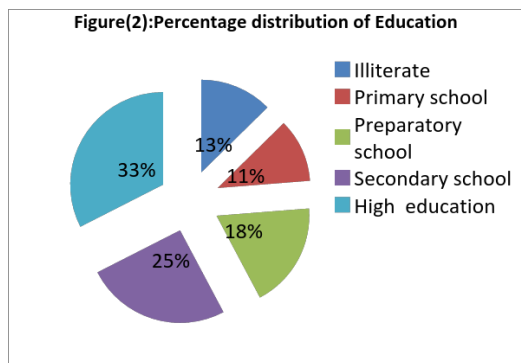


Table 3: Percentage distribution of occupation as one of the sociodemographic profile among the participants in Hail region, Saudi Arabia(2016-2017)

Occupational status		Occupation
%	No	
45.75%	366	Students
38.75%	310	Working
15.5%	124	Not working
100%	800	Total

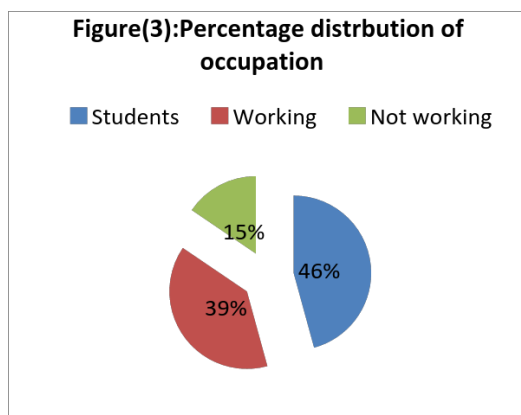


Table 4: Percentage distribution of residency as one of the sociodemographic profile among the participants in Hail region, Saudi Arabia (2016-2017)

Residency distribution		Residency
%	No	
66.75%	534	House
33.25%	266	Flat
100%	800	Total

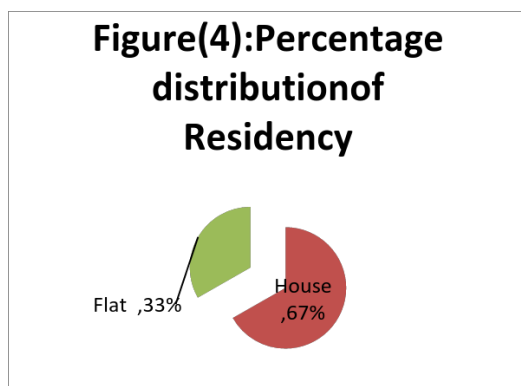


Table 5: Percentage distribution of marital status as one of the sociodemographic profile among the participants in Hail region, Saudi Arabia (2016-2017)

Marital status distribution		Marital status
%	No	
49.75%	398	Married
50.25%	402	Non married
100%	800	Total

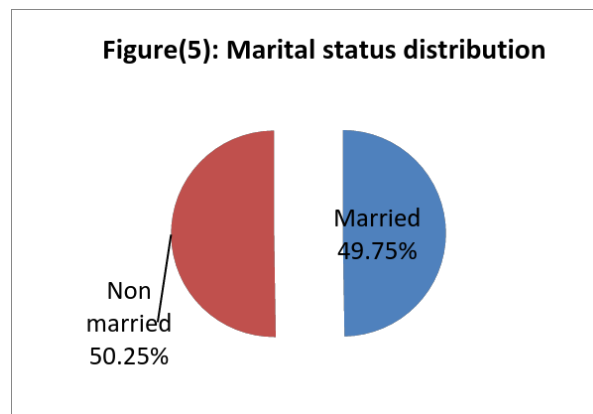


Table 6: Awareness (knowledge) about toxoplasmosis among the participants in Hail Region, Saudi Arabia (2016-2017)

Total	participants lacking knowledge		participants having knowledge		Knowledge about
	%	No.	%	No.	
800 (100%)	20.75%	166	79.25%	634	Definition of toxoplasmosis (hearing or reading about it)
800 (100%)	65.25%	522	34.75%	278	The correct causative agent (protozon)
800 (100%)	77.87%	623	22.13%	177	Vulnerable group susceptibility
800 (100%)	77.38%	619	22.62%	181	Treatment availability
800 (100%)	82.25%	658	17.75%	142	Treatment modalities
800(100%)	76%	608	24%	192	Prevention of toxoplasmosis

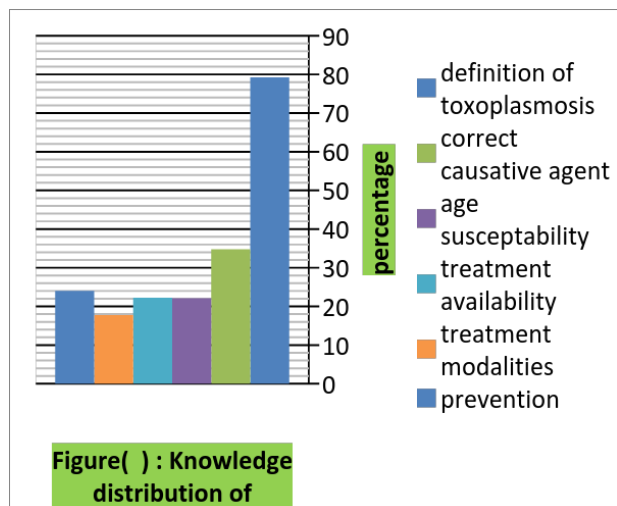


Table 7: Source of information about toxoplasmosis in the participants in Hail Region, Saudi Arabia(2016-2017)

Total 800(100%)	Participants having knowledge		Source of knowledge about Toxoplasmosis
800(100%)	%	No.	
800(100%)	16.75%	134	Television
800(100%)	10.25%	82	Newspaper
800(100%)	17.5%	140	University or school
800(100%)	55.5%	444	Internet
800(100%)	1.5%	12	Health worker
800(100%)	25.4%	203	Friends and relatives
800(100%)	2.2%	18	Books

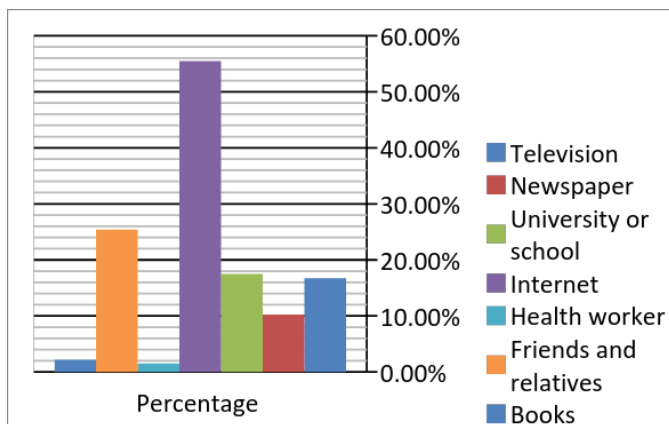


Table 8: Awareness (knowledge) about the mode of transmission of toxoplasmosis among the participants in Hail Region, Saudi Arabia(2016-2017)

Total	Participants gave the answer No		Participants gave the answer Yes		knowledge about
	%	No.	%	No.	
800 (100%)	47.75%	398	50.25%	402	Contact with cat
800(100%)	74.63%	597	25.37%	203	Sneezing or coughing from

				infected person
86%	688	14%	112	Consumption of raw meat (Salami, Pastrami, luncheon, sausages, burgers, minced meats)
89%	712	11%	88	Consumption of unwashed vegetable
89.75%	718	10.25%	82	Blood Transfusion
90.88%	727	9.12%	73	Organ transplant

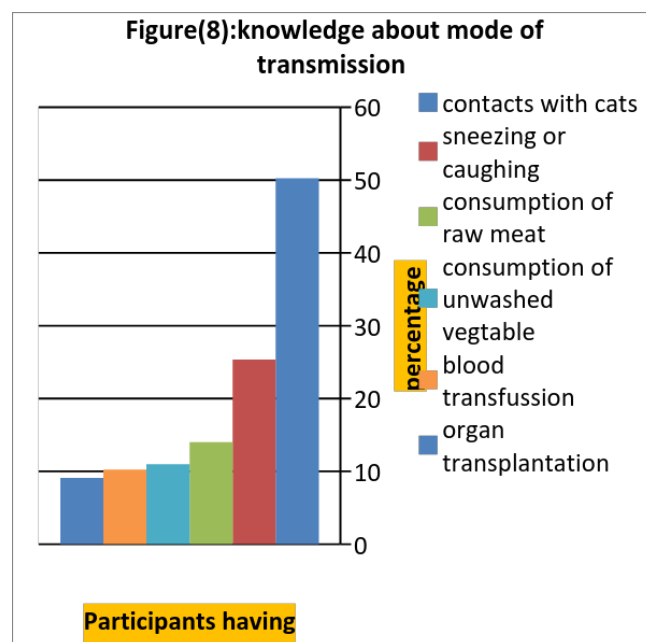


Table 9: Awareness (knowledge) about the clinical manifestations of acquired toxoplasmosis among the participants in Hail Region, Saudi Arabia(2016-2017)

Total	Participants gave the answer No		Participants gave the answer Yes		Knowledge
	%	No.	%	No.	
800(100%)	77.25%	618	22.75%	182	Lymphadenopathy
	87%	696	13%	104	Fever
	88.88%	711	11.12%	89	Headache
	94.1%	753	5.9%	47	Eye affection
	86.5%	692	13.5%	108	Muscular pain
	83%	664	17%	136	Diarrhea
	77.37%	619	22.63%	181	Constipation
	96%	768	4.0%	32	Eczema
	94.9%	759	5.1%	41	Gastric ulcer

Figure(9): knowledge about clinical pictures of acquired toxoplasmosis

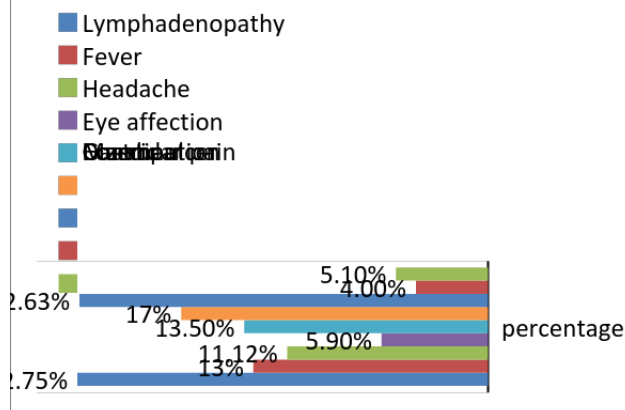


Table 10: Awareness (knowledge) about the clinical manifestations of congenital toxoplasmosis among the participants in Hail Region, Saudi Arabia(2016-2017)

Total	Participants gave the answer No		Participants gave the answer Yes		Knowledge about
	%	No.	%	No.	
800 (100%)	61.38%	491	38.62%	309	Abortion
	60.88%	487	39.12%	313	Congenital Anomalies
	89.88%	719	10.12%	81	Hydrocephalus
	90.5%	724	9.5%	76	Eye affection
	96%	768	4.0%	32	Hepatosplenomegally
	91.1%	729	8.9%	71	Jaundice
	98.1%	785	1.9%	15	Generalized lymphadenopathy
	89%	712	11%	88	Harelip
	90.2%	721	9.8%	79	Spina pifida

Figure(10):knowledge about clinical picture of congenital toxoplasmosis

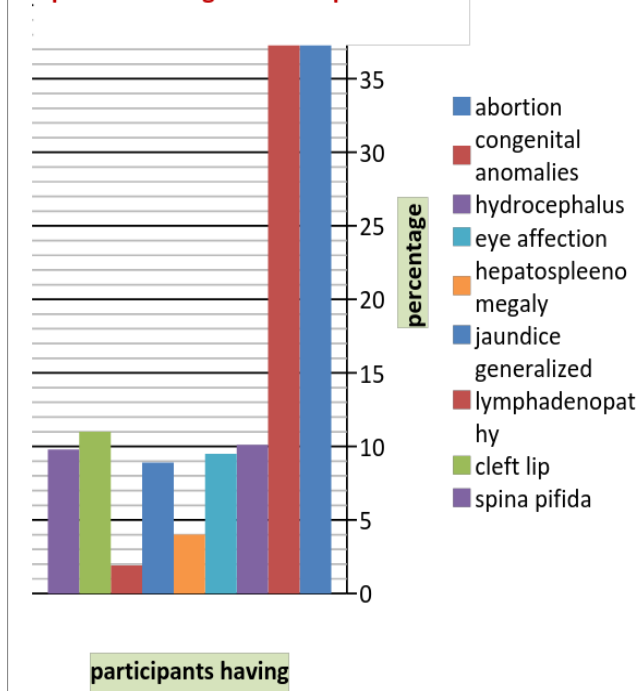


Table 11: Behavioral own practice (risk behaviors) towards the preventive measures against toxoplasmosis among the participants in Hail Region, Saudi Arabia (2016-2017)

	participants with -ve practice		participants with +ve practice		practice towards preventive measures
	%	No	%	No	
TOTAL: 800 (100%)	24.25%	194	75.75%	606	Washing hands before eating and after handling raw meat
	64.62%	517	35.38%	283	Using gloves during handling of meat or vegetables or during gardning
	11.75%	94	88.25%	706	Well cooking meat
	21.12%	169	78.88%	631	Washing fruits and vegetables
	85.25%	682	14.75%	118	Eating raw meat (Salami, Pastrami, luncheon, sausages, burgers, minced meats)
	64.75%	518	35.25%	282	Raising cats

figure(10);Behavioral preventive practice of the participants

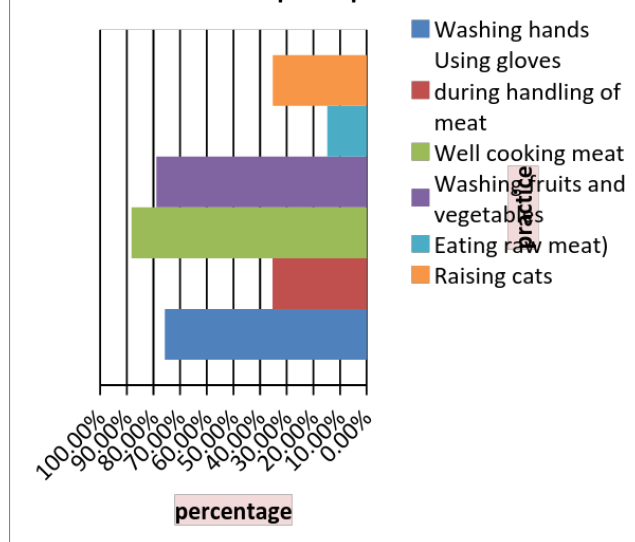


Table 12: Behavioral practice (risk behaviors) towards cats to avoid transmission of infection from cats among cats' owners in Hail Region, Saudi Arabia (2016-2017)

Total	participants having -ve attitude		participants having +ve attitude		Practice
	%	No	%	No	
282 (100%)	69.51%	196	30.49%	86	Vaccination of cats
282 (100%)	28.73%	81	71.27%	201	Keeping cats indoor

282 (100%)	73.5%	216	26.95%	76	Having special place at home
282 (100%)	70.57%	199	29.43%	83	Using of letterbox (sandpit)
282 (100%)	78.37%	221	21.63%	61	Using gloves during cleaning of domestic cat's litter or gardening
282 (100%)	30.15%	85	69.85%	197	Using cat feces as fertilizer

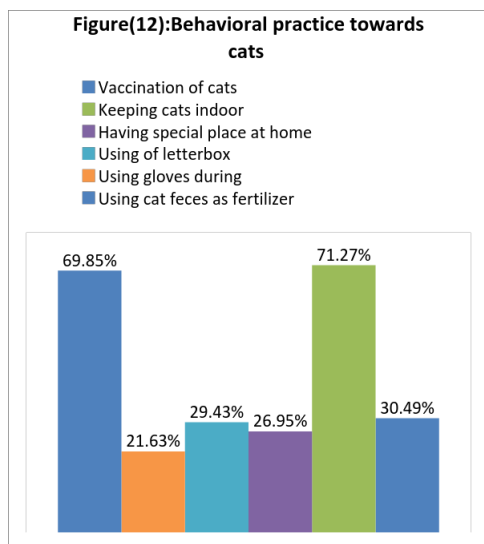


Table 13: Behavioral Practice (risk behaviors) for changing cats' letterbox among cats' owners in Hail Region, Saudi Arabia(2016-2017)

participants having +ve practice		practice of changing letterbox
%	No	
18.8%	53	1-3 times per day
11.7%	33	1-3 times per week
69.5%	196	1-3 times per month
(100%)	282	Total

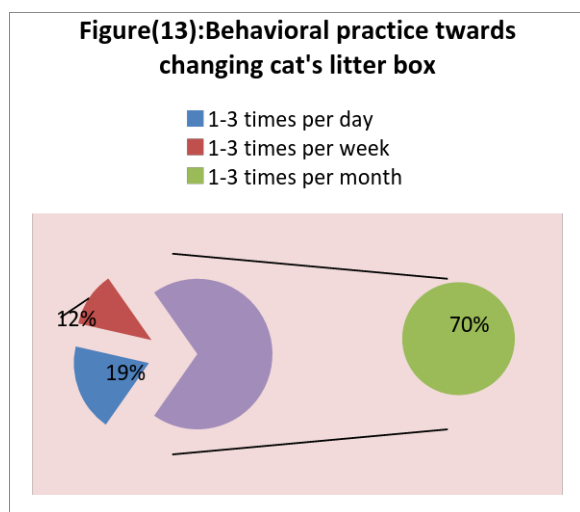
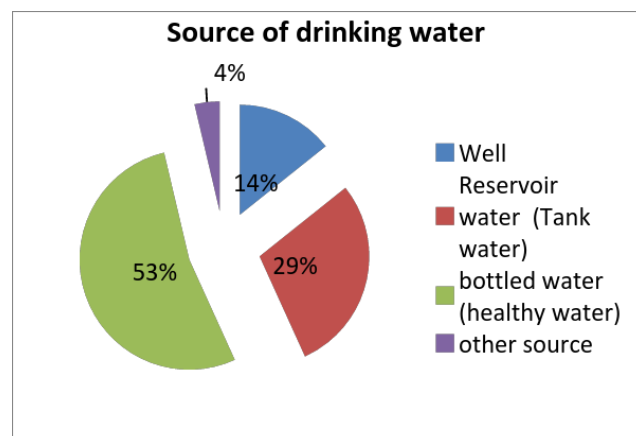


Table 14: Drinking water source as a behavioral Practice (risk behaviors) of the participants in Hail Region, Saudi Arabia (2016-2017)

Total	Participants	Participants	Practice
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800 (100%)	gave the answer No		gave the answer Yes		Well
	%	No	%	No	
800 (100%)	85.7%	686	14.3%	114	Well
800 (100%)	71.1%	569	28.9%	231	Reservoir water (Tank water)
800 (100%)	46.9%	375	53.1%	425	bottled water (healthy water)
800 (100%)	78.4%	773	3.7%	30	other source



4. Discussion

Toxoplasmosis is considered as the most prevalent parasitic zoonotic disease worldwide (Tenter et al, 2000).*Toxoplasma gondii* can cause severe morbidity and mortality specially in immunocompromised patients. Moreover, in pregnant females it may lead to serious morbidity or even death to the fetus (Pappas et al, 2009)

The results of the current study revealed that Hail population, Saudi Arabia, are substantially vulnerable to toxoplasmosis infection as they are lacking awareness as well as most of the necessary preventive behavior to protect themselves from toxoplasmosis. This is conflicting as 32.5% of the sample were students and 45.75% of them were highly educated. Sociodemographic profile specially low family income and little formal schooling among people are well known as contributing factors to increase the risk for infection (Costa et al., 2012).

Generally, the current study revealed some conflicting results, that although a high percentage of our participants (79.25%) knew about the toxoplasmosis. Unfortunately few percentage of them (25.1%) knew the correct causative agent and only 22.13%, 22.62%, 17.75% and 24% had knowledge about vulnerable group susceptibility, treatment availability and modality of the disease respectively. These results are not in agreement with the study done by Al-Harthi et al in Makkah - Saudi Arabia, which revealed that only around 10% of the participants were aware of the toxoplasmosis (El-Harthi et al;2006). Additional conflict was in Jeddah study where 33% of the participants (students) knew about the disease (Ebtesam et al; 2015) and in Al-Ahsaa where 40.3% of the pregnant

women only had positive information about the disease (Amin et al, 2013). Moreover, in Brazil, their results demonstrated that only 35% of their participants knew about toxoplasmosis (Varella et al, 2009). However this conflicting results may be due to the differences in the sample participants, the questionnaire clearance as it is mentioned the term (cat disease in our questionnaire). Globally, 58% of Japanese women were aware of *Toxoplasma gondii*, while 48% in the US (Jones et al. 2003) and 98% in France (Cordier et al. 2012a) had good knowledge about toxoplasmosis. Differences in the percentages were possibly due to different incidences of toxoplasmosis in each country that creates a good knowledge to the diseases, for example it is very common in France Guerina et al. 1994; Villena et al. 2010; Yamada et al. 2011).

In the current work, Hail population were found to get their information about toxoplasmosis mainly from the internet (55.5%) , followed by friends and relatives (25.4%) and the least sources were the books (2.2%) and health workers (1.5%) Similarly Amin et al.; 2013 showed that the major source of information about the disease among Saudi women in Al Hassa was the internet while those received their information from health team was 16.5 (Amin et al.; 2013). The sources of information also differed from previous similar studies. In Iran studies, most of the participants chose books as the source of information (55.8%) and very few chose newspapers (2.3%) (Ebrahimi et al, 2015). In USA, newspapers may have been more important (Ogunmodede et al;2005) while books in another study was considered the most important (71%) (Jones et al. 2003), whereas medical professionals were mentioned as a necessary source of information (Jones et al. 2003).

In the present work, the highest level of knowledge was about the role of cats in transmission of toxoplasmosis (50.25%) while the participants showed low level of knowledge about other methods of transmission. Similar results were reported among American pregnant women (Jones et al., 2001) and even among obstetricians and gynecologists (Jones et al., 2003). It should be noted that it is inaccurate to say that cats are the main source of infection like what happened in case of the current study where more than half of the patients mentioned cats as the main source of infection while they were unaware that toxoplasmosis infection can be caused by other causes like ingestion of contaminated food. On the contrary, in a study done in Asian countries, only 19.4% of respondents correctly identified contact with cat feces as the main mode of transmission of toxoplasmosis (Andiappan et al;2014).

Unfortunately, many participants in the current work seemed confused about the symptoms of *T. gondii* infection and what parts of the body would be most severely affected. Similar results were also obtained in studies worldwide (Jones et al., 2003; Andiappan et al;2014). Surprisingly, 25.37% of the participants in the present work mentioned the Sneezing or coughing from infected person to be one of the mode of transmission of toxoplasmosis which is not correct. This again raise the

importance of health education about the mode of transmission of the diseases.

Despite usage of the term “mode of transmission by contact with cat feces” and reports of environmental contamination caused by the feces of infected cats, one of the main risks of infection is through the handling of cat litter boxes.

Awareness (knowledge) about the clinical manifestations of congenital toxoplasmosis among the participants showed that, the high percentage of the participants (39.12%) recognized the relation of toxoplasmosis to Congenital anomalies followed by those who mentioned that abortion is an important manifestation of *Toxoplasma* infection during pregnancy (38.62%). However question relating to the *Toxoplasma*-induced generalized lymphadenopathy produced the greatest number of wrong answers (98.1%). On the other hands, (55%) of participants in Iran study gave wrong answers about abortion as a clinical manifestation of congenital toxoplasmosis and only 7.4% of Brazilians identified the possibility of abortion or miscarriage (Lehmann et al, 2014)

In the absence of an effective vaccine in humans, following the best preventive practice might be the best way to approach the problem of toxoplasmosis, and must be done by limiting exposure to oocysts or tissue cysts. Recommendations for accomplishing this include practicing good hygiene (e.g. hand washing after soil contact, washing fruits and vegetables that are eaten raw), freezing meat at 18C for 24 hours and/or cooking meat until an internal temperature of 66 8C is reached (Stacey et al; 2012)

In the present work, it is conflicting that although participants' low knowledge regarding the preventive behaviors, majority of them practice the correct preventive measures to avoid infection. This study as well other confirmed that disease specific knowledge was not necessarily associated with preventive behavior, regarding toxoplasmosis and conversely, a lack of knowledge was not always associated with engaging in risk behavior (Lehmann et al, 2014). This may be due to that habits of Hail populations and others help them to avoid many of its risk behaviors. Most of our respondents didn't raise cats (64.7%), do not consume undercooked meat (85.25%). Moreover, high percentage of them used to wash their hands before eating or handling meat (75.75%), well cook their meat (88.25 %) and wash their vegetables (78.88 %). These findings are close to those of Amin et al. (2013) which revealed that 98.2% of their participants did not contact with cats, 82.6% did not eat undercooked and raw meat, but only about 50% of them did not wash their hands after dealing with raw meats and vegetables and 9.1% of them were gardening without gloves. However and to the contrary of our study, only 3.9% of their participants owned domestic cats, this is expected as their samples was females whose always advised to avoid contact with cats for protection of their babies from congenital toxoplasmosis. (Amin et al., 3013).

Moreover, Several studies have addressed the contribution of various risk factors to toxoplasmosis. These studies have found that the most significant risk factor to be undercooked meat consumption (Baril et al., 1999; Bobic et al., 1998; Bobic et al., 1996; Kravetz & Federman, 2005). One study estimated that up to 63% of the seroconversions during pregnancy was secondary to undercooked meat consumption (Jones et al., 2001), soil contact via gardening, eating raw or unwashed vegetables and fruits (Bobic et al., 1998; Bobic et al., 1996), contact with cat's litter and infrequent washing of kitchen knives used to cut raw meat (Bobic et al., 1998; Bobic et al., 1996; Kravetz & Federman, 2005). Centers for Diseases Control and Prevention (CDC) recommended the adoption of individual measures for primary prevention of toxoplasmosis during, based the preventive behavior directed to food hygiene (Lopez et al., 2000).

Washing fruits and vegetables with water and soap before eating is also an important preventive measure for transmission of toxoplasmosis since the raw fruits and vegetables may be contaminated with the mature oocysts from the cats' feces contaminating the soil. (Alvarados et al, 2011). Cooking meat and poultry is very important as they contain viable true cysts of *Toxoplasma gondii* that are killed easily by boiling (Stacey et al; 2012)

It should be known that cats are the main sources of environmental contamination, because, when infected, they release large quantities of the infective oocysts which are estimated to be more than 100 million oocysts by a single cat, allowing for the continuity of the parasite biological cycle (Tenter et al; 2000; Jones et al, 2009). These oocysts require at least 24 hours to sporulate and become infectious (Dos Santos et al, 2010; Almeida et al, 2011).

Once again, following good behavioral practice, is usually recommended for prevention of toxoplasmosis. These include keeping cats indoors, feeding them commercially prepared diets, and cleaning their litter boxes daily, because it takes at least one day for the organisms to sporulate and become infectious after being shed (Stacey et al; 2012). Other ways include wearing gloves when gardening or being in contact with soil or sand, followed by thorough hand-washing. In addition, pregnant women should avoid changing cat litter if possible. (Stacey et al; 2012). In the present work, 35.25% of the respondents owned domestic cats. Opposite to the current study, Only 3.9% of participant mentioned that they had domestic cats in Al- Ahsaa. This big differences may be due to different population sample as in their study, they chose the pregnant females particularly. Regarding cats' vaccination, 30.49% of our cases were aware and actually gave vaccination to their cats while it is higher in the study done in USA (Jeffrey, et al., 2003). The majority of our participants (71.27 %) fortunately, used to keep their cats indoor while 26.95 % of them had special place for cats at home. In addition, 29.43 % of them were using litters, while 21.63 % of them were using gloves during cleaning of domestic cat's litter or gardening. Unfortunately, 69.85 % of the participants used to benefit from cat feces as fertilizer. To the opposite of our work,

gardening without gloves was stated by only 9.1% of Al-ahsaa women, while 6.7% mentioned using gloves while gardening but without washing their hands (Amin et al., 2013). In USA and as expected, the participants surveyed indicated that 93% routinely wash their hands after gardening, 88% owned litter boxes for cats, 80% routinely washed their hands after changing cat litter. (Jeffrey, et al., 2003). Contacting with cat and changing cat's litter is one of the most likely method for transmission among cat's raisers. One more risk behavior was addressed in the current study about changing cats' letterbox among cats' owners. Unfortunately, 69.5% of our cases didn't change the cats' litter boxes frequently but they used to do it 1-3 times per month which is well known very dangerous scientifically (Stacey et al; 2012). Opposite to this behavior, cat raisers should get rid of the cats pits daily or better more as the non-infective immature oocysts shedded from cats 'feces need about 24 hours in optimum conditions to mature and be ready for infection. So keeping cat's feces more than 24 hours always allows the process of maturation and consequently infection of the cat's owner.

Drinking water is another risk for transmission of infection. The current study reveals that more than 50% of the participants drink healthy water while, 28.9% of them used to drink tank water. Drinking tank water have been documented to have an influence on *T. gondi* transmission in different parts of the world as reported by Remington et al. (2001) and Montoya & Liesenfeld (2004). Oocysts can remain viable for long periods of time in water and can resist freezing and moderately high water temperatures. (Remington et al., 2001; Montoya & Liesenfeld., 2004; Dumetre et sl., 2008)

5. Conclusion

The current study proved that Hail population has low level of knowledge as well as they are lacking the necessary preventive behavior to *Toxoplasma* infection and hence, they are vulnerable to toxoplasmosis infection. However, most of the preventive behaviors that are applied could be explained by the economic, and cultural habits in the region. Likewise, this study reflects the necessity to educate Hail people about the hygienic measures which are essential to avoid the infection. These measures include the personal hygiene, applying safe water supply, eating healthy and clean food, checking the cats regularly and changing their litter box daily. Furthermore, the physicians should be at the first line to educate people specially women who are pregnant or plan to be pregnant in order to reduce the risk of congenital toxoplasmosis.

6. Recommendation

1. Although this study, included 800 participants, this sample is not considered enough to represent the whole Hail community, so in the future, it should extend to cover more areas of Hail region specially the remote villages.

2. Constructing a new project to study the comparative relationship between sociodemographic data, knowledge and risk behaviors.
3. Constructing a further study to assess the effect of risk behaviors through blood analysis to detect seropositivity against *Toxoplasma gondii* as well as to get the prevalence of the disease in the region.
4. An appropriate health education program has to be adopted so as to educate people in groups like in schools, hospitals and other work areas.
5. Veterinarians should educate their canine-owning clients of the importance of vaccinating against toxoplasmosis.

7. Limitation of the Study

To our knowledge, this is the first study that explores toxoplasmosis-related knowledge and risk behaviors among Hail population, Saudi Arabia. Most of the study limitations are due to the shortage of the time of the study. Nevertheless, the results of the current study should be cautiously interpreted in the lights of the following limitations:

1. The study population might have been increased to be more accurately representative of all Hail region Saudi Arabia.
2. Comparative relationship between sociodemographic data, knowledge and risk behaviors might have been better to fulfilled.
3. The effect of risk and preventive behavior was not assessed through blood analysis to detect antibodies against *Toxoplasma gondii*.

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