Evaluation of an educational handout on knowledge about toxoplasmosis

Avaliação de um folheto educativo abordando o conhecimento sobre toxoplasmose

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ABSTRACT

Aims: The study sought to determine the factors associated with prior knowledge about toxoplasmosis, and to assess what participants learned after reading an educational handout. **Methods:** Participants were recruited at two sites in California: a public meeting about water quality in Morro Bay; and at the Women Infants and Children's Nutrition Program office or La Leche League meetings in Yolo County. Demographic differences between sites were compared using Fisher's exact test, and change in knowledge before and after reading the handout using Mantel-Haenszel methodology. **Results:** Non-Hispanic white participants were more likely than those of Hispanic ethnicity (62% vs. 20%, respectively) to have prior knowledge about toxoplasmosis. The most common source of information was newspapers (36%). Only 16% had obtained information from medical professionals. After reading the handout, 85% of participants identified *Toxoplasma gondii* as a parasite and 98% identified cats as the source of oocysts. Ninety-eight percent of participants who read the handout were aware they could acquire infection from cat faeces, 94% from meat, 78% from soil or *in utero,* and 69% from unwashed vegetables. Fewer (59%) recognized all sources. C**onclusions:** Knowledge about *Toxoplasma gondii* increased in all areas evaluated, but gaps remained, particularly with regard to environmental sources of *Toxoplasma gondii* infection and clinical manifestations of disease. In addition to care in handling cat faeces/litter and avoidance of undercooked meat, healthcare providers counseling pregnant women should emphasize the importance of wearing gloves when gardening, hand washing after handling soil or meat, and rinsing fresh vegetables thoroughly before consumption.

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INTRODUCTION

Toxoplasma gondii (*T. gondii*) is recognized as one of the most successful parasites worldwide and infects humans and animals from the Arctic to the tropics.[1-3] The chief concern for human disease focuses on immunocompromised persons and pregnant women, who can transmit the parasite to their developing foetus.[4] Congenital toxoplasmosis can cause spontaneous abortion, stillbirth or serious illness for the neonate.[5] Manifestations in the neonate may include intracranial calcifications, retinochoroiditis, microcephaly, and hydrocephalus.[5,6] Symptoms in the infant may appear months after birth and include psychomotor or mental retardation, visual impairment, deafness, hepatosplenomegaly, anaemia, thrombocytopenia, and convulsions.[5,6]

Most efforts at prevention of congenital toxoplasmosis in the United States have been focused on primary prevention, i.e., educating pregnant women and other high-risk groups about potential sources of infection and preventive behaviour. Because the

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prevalence of toxoplasmosis in the United States and the United Kingdom is low,[7,8] it is not considered cost-effective to offer universal serologic testing to pregnant woman in these countries.[8-10] However, several European countries, notably Austria and France, where population prevalence is much higher,[2,8] conduct mandatory prospective screening for toxoplasmosis. Whether health education is as effective in preventing congenital toxoplasmosis as universal screening is a matter of contention.[9,11,12]

In light of this debate, we sought to determine the efficacy of an educational handout to convey knowledge about toxoplasmosis. Participants who agreed to complete the survey were assessed regarding their prior knowledge about *T. gondii* so that we could determine what features of the educational handout had the most impact on knowledge.

METHODS

Study populations, questionnaire design, and data collection

Two sites were selected (Morro Bay and Yolo County, California) to provide populations from different ethnic backgrounds, language and levels of education. Morro Bay is located on California's central coast and was identified as an area where the southern sea otter has been adversely affected by toxoplasmosis.[13-15] The Morro Bay area consists of the three communities of Cayucos, Los Osos and Morro Bay with a population in the year 2000 of approximately 27,644 of whom only 11% were Hispanic.[16] Population growth was projected at 1.6% to 2006 and estimates by ethnicity were not available between censuses in these communities. Yolo County is a rural and suburban county in northern California, about 60 miles from the San Francisco Bay, with an estimated 197,658 residents in 2008, of whom about 26% are Hispanic.[16] Participants were eligible to be in the study if they were over 18 years of age, could read 8th-grade English or Spanish, and agreed to take part in the evaluation of the handout. The goal was to have at least 50 participants from each study site, which would enable us to detect differences in proportions >25% between groups with 95% confidence and 80% power.

Questionnaires were reviewed for literacy level and translated into Spanish at the Yolo County Health Department. A human subjects protocol for this study was reviewed and approved by the Institutional Review at the University of California, Davis. The evaluation consisted of two questionnaires and the educational handout (printable versions available at: http://seaotterresearch.org/Facts_About_Toxo_and_Cat_Poop.pdf [English] and http://seaotterresearch.org/Toxo_gondii_Lo_que_todos_debemos_saber.pdf [Spanish]). Participants completed the first questionnaire, placed it in a sealed envelope, and then removed the handout, which they were instructed to read, from another envelope. After reading the handout, they sealed it in a third envelope and completed the second questionnaire (also extracted from a sealed envelope). The completed questionnaires were then returned to study personnel, and participants could keep the handout for their own reference.

Participants were recruited in Morro Bay by an announcement at a public meeting in September 2006 sponsored by EcoSLO, the Morro Bay National Estuary Program, *New Times* (a local newspaper), the Ocean Outfall Group, the Sierra Club, SLO Coast Alliance and Surfrider Foundation, which was entitled "Talk about the Bay." Attendees included government employees from water agencies and utilities as well as members of the general public interested in environmental matters. Questionnaires were distributed during a meeting break and returned to study personnel at the close of the meeting. In Yolo County between March and July 2007, flyers were posted in the waiting room of the Health Department's Women Infant and Children's Nutrition Program and the study was announced at La Leche League meetings. A $2.00 remuneration was offered for completing the survey. Participants were invited to participate by program staff when they arrived for appointments or attended La Leche League meetings, completed questionnaires while waiting or after the meeting, and then returned the materials to the program staff on the same day. Completed questionnaires were input to an Excel spreadsheet and after data entry was complete, each record was checked by comparing the original questionnaire to the input data.

Statistical analyses

Descriptive and analytic analyses were performed in SAS 9.1 (SAS Institute, Cary, NC, USA). Characteristics of the two populations were compared using a Chi- squared test or a 2-sided Fisher's exact test (where expected cell counts ≤5). Exact 95% binomial confidence intervals were calculated for proportions. Knowledge about *T. gondii* in specific categories before and after reading the handout was compared using the extended Mantel-Haenszel statistic for general association,[17] which is suitable for dependent (matched) data and is equivalent to McNemar's test for 2X2 tables. All statistical tests were considered significant at α=0.05 level.

RESULTS

Twenty individuals agreed to complete the survey in Morro Bay from approximately 100 in attendance at the meeting, and 34 individuals completed surveys at the Yolo County Health Department, where 100 surveys were made available in English and 50 in Spanish. Comparison of demographics between the two study locations showed that participants differed significantly by race/ethnicity, gender, age and education (Table 1). Participants from Morro Bay were more likely to be non-Hispanic white, male, aged over 45 years and have postgraduate education, while most participants from Yolo County were Hispanic women under 25 years old with a high school education or less. Twenty-five (46%) of participants had pre-existing knowledge about *T. gondii*. While participants from Morro Bay were more likely to have prior knowledge about *T. gondii* than those from Yolo County, the difference was not statistically significant (55% vs. 41%, respectively, Chi-squared P=0.33). Prior knowledge about *T. gondii* also did not differ significantly by sex, age group or level of education (data not shown, all P-values >0.13), but did differ by race/ethnicity. Non-Hispanic White participants were more likely to have had prior knowledge about *T. gondii* than Hispanic participants (62% vs. 20%, respectively, Fisher's exact P=0.014). Of the 25 participants from both sites with prior knowledge about *T. gondii*, 36% found out about toxoplasmosis from newspaper articles, 20% from other sources (internet, books, public presentations), 16% from a medical professional, 12% from childbirth education classes, 12% from friends or family, and 4% from a college class. Sources of knowledge also did not differ by site (Fisher's exact P=0.19).

Reading the educational handout significantly improved knowledge about *T. gondii* in all the areas evaluated (Table 2). Eighty-five percent of participants were able to identify *T. gondii* as a parasite after reading the handout compared to only 43% before they had read it. Almost all (98%) of participants were correctly able to identify the cat as the oocyst shedding host after reading the handout, although a small percentage still identified dogs (2%), humans (2%) and opossums (7%) as hosts capable of shedding oocysts. Eighty-nine percent of participants (95% CI, 81-97%) identified only cats as oocyst shedding hosts.

Table 1. Comparison of demographics for participants from Morro Bay area and Yolo County, California, USA, in the evaluation of an educational handout on knowledge about toxoplasmosis

Demographic	Category	Morro Bay n (%)	95% exact binomial CI	Yolo County n (%)	95% exact binomial CI	Fisher's exact *P*-value*
Race/ethnicity	American Indian	0	-	1 (3)	0-15%	<0.001
	Black	0	-	3 (9)	2-24%	
	Hispanic/Mexican	0	-	15 (44)	27-62%	
	Non-Hispanic White	17 (85)	62-97%	12 (35)	20-54%	
	Declined to state	3 (15)	3-38%	3 (9)	2-24%	
Sex	Female	12 (60)	36-81%	30 (88)	73-97%	0.016
	Male	7 (35)	15-59%	2 (6)	1-20%	
	Declined to state	1 (5)	0-25%	2 (6)	1-20%	
Age group	18-25	0	-	14 (41)	25-59%	<0.001
	26-35	2 (10)	1-32%	10 (29)	15-47%	
	35-45	1 (5)	0-25%	7 (21)	9-38%	
	>45	15 (75)	51-91%	1 (3)	0-15%	
	Declined to state	2 (10)	1-32%	2 (6)	1-20%	
Education	Some high school	0	-	9 (26)	13-44%	<0.001
	High school grad	0	-	4 (12)	3-27%	
	Some college	3 (15)	3-38%	12 (35)	20-54%	
	College grad	5 (25)	9-49%	4 (12)	3-27%	
	Postgraduate	11 (55)	32-77%	2 (6)	1-20%	
	Declined to state	1 (5)	0-25%	3 (9)	2-24%	

* Two-sided P-value for a difference between sites.

Table 2. Comparison of knowledge about *Toxoplasma gondii* before and after reading an educational handout.

Question on survey	Reading of handout	Yes n (%)	No n (%)	Unk n (%)	MH test statistic*	*P*-value
What is *Toxoplasma gondii*?					26.11	<0.001
Bacterium	Before	6 (11)	NA	NA		
	After	6 (11)	NA	NA		
Fungus	Before	1 (2)	NA	NA		
	After	0 (0)	NA	NA		
Parasite	Before	23 (43)	NA	NA		
	After	46 (85)	NA	NA		
Toxin	Before	1 (2)	NA	NA		
	After	0 (0)	NA	NA		
Virus	Before	2 (4)	NA	NA		
	After	0 (0)	NA	NA		
Did not know	Before	21 (39)	NA	NA		
	After	2 (4)	NA	NA		
***Toxoplasma gondii* oocysts ("eggs") are shed in faeces of:**						
Cat	Before	35 (65)	1 (2)	18 (33)	18.00	<0.001
	After	53 (98)	0 (0)	1 (2)		
Dog	Before	5 (9)	30 (56)	19 (35)	20.67	<0.001
	After	1 (2)	52 (96)	1 (2)		
Human	Before	3 (6)	32 (59)	19 (35)	19.00	<0.001
	After	1 (2)	52 (96)	1 (2)		
Opossum	Before	11 (20)	24 (44)	19 (35)	25.00	<0.001
	After	4 (7)	49 (91)	1 (2)		
***Toxoplasma gondii* can be acquired from:**						
Your mother, before birth	Before	12 (22)	31 (57)	11 (20)	28.17	<0.001
	After	42 (78)	12 (22)	0 (0)		
Soil/dirt	Before	26 (48)	18 (33)	10 (19)	14.90	0.001
	After	42 (78)	12 (22)	0 (0)		
Animal faeces	Before	38 (70)	6 (11)	10 (19)	13.57	0.001
	After	53 (98)	1 (2)	0 (0)		
Stream/lake water	Before	14 (26)	30 (56)	10 (19)	28.85	<0.001
	After	41 (76)	13 (24)	0 (0)		
Undercooked/raw meat	Before	13 (24)	31 (57)	10 (19)	36.36	<0.001
	After	51 (94)	3 (6)	0 (0)		
Shellfish, e.g., clams, mussels	Before	13 (24)	31 (57)	10 (19)	26.58	<0.001
	After	42 (78)	12 (22)	0 (0)		
Unwashed vegetables	Before	10 (19)	33 (61)	11 (20)	25.97	<0.001
	After	37 (69)	31 (17)	0 (0)		
How would your body be affected if you had toxoplasmosis?						
Flu-like symptoms	Before	24 (44)	16 (30)	14 (26)	19.37	<0.001
	After	45 (83)	8 (15)	1 (2)		
Miscarriage	Before	9 (17)	30 (56)	15 (28)	21.45	<0.001
	After	25 (46)	28 (52)	1 (2)		
Neurologic (brain) problems	Before	20 (37)	20 (37)	14 (26)	11.15	0.004
	After	30 (56)	22 (41)	2 (4)		
Vision problems	Before	8 (15)	31 (57)	15 (28)	19.38	<0.001
	After	26 (48)	27 (50)	1 (2)		
What parts of the body are most seriously affected by *Toxoplasma gondii*?						
Brain	Before	24 (44)	18 (33)	12 (22)	12.80	0.002
	After	40 (74)	6 (11)	8 (15)		
Eye	Before	6 (11)	34 (63)	14 (26)	19.59	<0.001
	After	29 (54)	17 (31)	8 (15)		
Who is most likely to become sick with *Toxoplasma gondii*?						
AIDS patients	Before	13 (24)	46 (25)	16 (30)	25.65	<0.001
	After	39 (72)	14 (26)	1 (2)		
Unborn babies	Before	12 (22)	26 (48)	16 (30)	22.61	<0.001
	After	35 (65)	18 (33)	1 (2)		
Newborn babies	Before	15 (28)	22 (41)	17 (31)	16.05	<0.001
	After	22 (41)	31 (57)	1 (2)		
Pregnant women	Before	23 (43)	14 (26)	17 (31)	17.34	<.001
	After	36 (67)	17 (31)	1 (2)		

*The extended Mantel-Haenszel statistic for general association.[1]

Many participants were also able to correctly identify the means whereby humans become infected with *T. gondii* after reading the handout (Table 2); but although they had read the material, 17-24% of participants answered negatively with respect to infection source from a mother to unborn child, soil, stream/lake water, shellfish, and unwashed vegetables. Most did positively identify undercooked/raw meat (94%) and animal faeces (98%) as infection sources, but only 59% (95% CI 45-72%) responded positively for all 7 categories of infection source. With regard to behaviour that could prevent *T. gondii* infection, 59% of participants positively identified all six preventive behaviours after reading the handout. The responses to these categories are depicted in Figure 1.

Although knowledge about infection sources and ways to prevent infection was high after reading the handout, many participants seemed confused about the symptoms of *T. gondii* infection and what parts of the body would be most severely affected (Table 2). Eighty-three percent could identify flu-like symptoms as the most common manifestation, but only about half recognized that miscarriage (46%), neurologic problems (56%), and vision problems (48%) were also symptoms of toxoplasmosis. The majority (74%) recognized the brain as the part of the body most seriously affected, but fewer (54%) could identify the eye as an organ associated with symptomatic disease. After reading the handout, most participants (72%) were able to list AIDS patients as being particularly likely to develop clinical disease, but recognized less frequently that unborn babies (65%) and newborn babies (41%) are at higher risk of developing clinical disease (Table 2).

Also of interest for participants who had read the handout were responses regarding prevention of infection for cats and what means a pregnant woman might take to protect herself against infection if no one else was available to change the cat litter (Figure 2). More than 60% of participants indicated that methods to protect cats from *T. gondii* infection included feeding only dry or canned catfood or cooked meat, keeping cats indoors (which can curtail or prevent predation), and preventing cats from hunting wild animals. The incorrect response category of keeping cats away from other cats was checked by 14% of participants. For women who must change the cat litter during pregnancy, the majority of participants (83%) who read the handout identified use of plastic (disposable) gloves as protective, and about half also selected hand washing after cleaning the litter and changing it daily (Figure 2). Some incorrectly believed that giving the cat away (26%) or removing the litter box

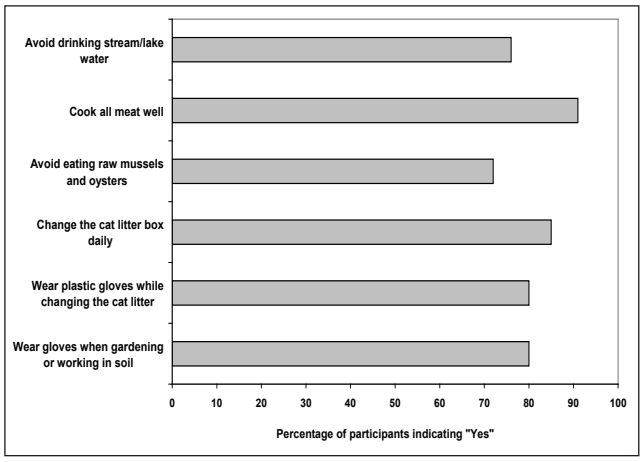

Figure 1. Participants' answers regarding behaviours to prevent human toxoplasmosis, after reading an educational handout.

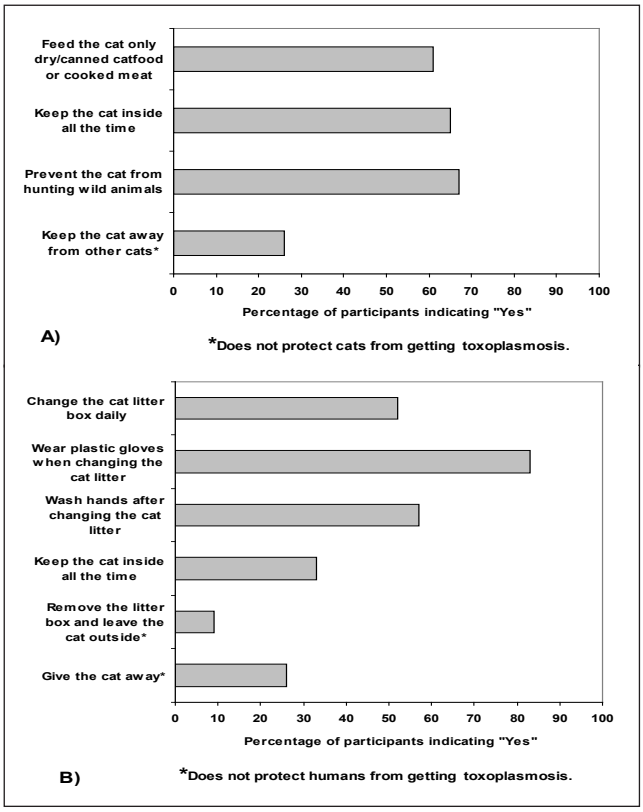

Figure 2. After reading an educational handout, participants' responses regarding measures they would take: **A)** to protect their cats against *Toxoplasma gondii* infection; and **B)** to protect themselves against *Toxoplasma gondii* infection if they were pregnant and no one else was available to change the cat litter.

and leaving the cat outside (9%) would also protect against *T. gondii* infection during pregnancy. Neither of these 2 options was recommended in the educational handout.

Finally, we sought to determine what participants knew about time to oocyst infectivity (i.e., sporulation) and soil survival of oocysts after reading the handout (Figure 3). Forty-one percent correctly thought oocysts were infectious about 24 hr after defecation and 44% indicated that oocysts could survive in soil for periods longer than one year. In addition, after reading the handout 91% of participants correctly indicated that the safest place for disposal of cat faeces was in garbage destined for a landfill, while a scant 5% selected the toilet, 2% the beach, 2% unknown, and none the garden or back yard.

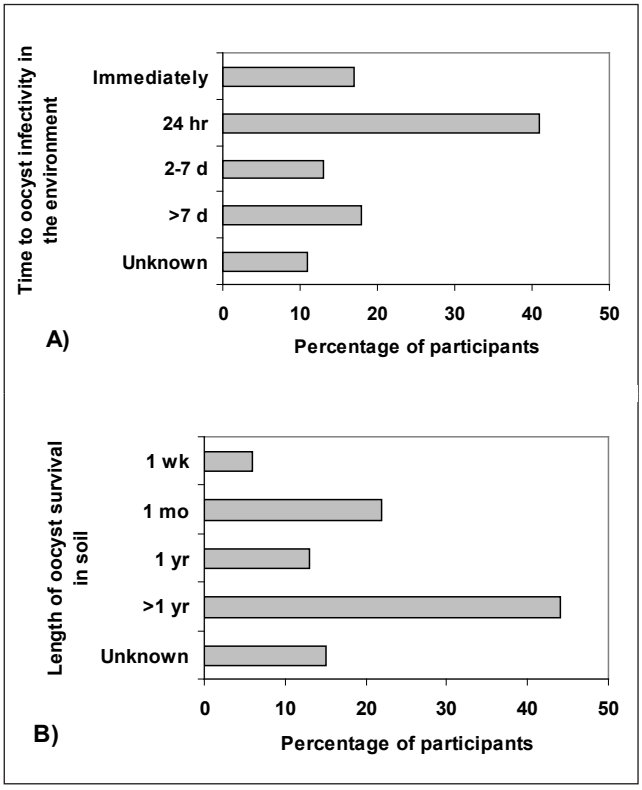

Figure 3. After reading an educational handout, participants' responses regarding: **A)** the length of time until *Toxoplasma gondii* oocysts become infectious after deposition on soil in cat faeces; and **B)** the length of time *Toxoplasma gondii* oocysts can survive in soil.

DISCUSSION

The percentage of participants with pre-existing knowledge about *T. gondii* (46%) was similar to surveys of pregnant women in the United States (48%),[18] Minnesota (42%),[19] and Poland in 1997 (45%).[20] Knowledge about *T. gondii* appears to be much better in France, where prenuptial blood testing for *T. gondii* has been in effect since 1978. An unpublished study[21] reported that 92% of participants (seronegative pregnant women) knew that they could acquire toxoplasmosis from raw beef, 90% from unwashed salad and 82% from cat litter. For comparable categories in the present study prior to reading the handout, only 24% of participants knew *T. gondii* could be acquired from raw meat and 19% from unwashed vegetables, but a high percentage (70%) recognized animal faeces as a potential source (Table 2).

Our study differed from earlier reports that found older age[18,19] and higher education[19] were associated with knowledge about *T. gondii*, but the small sample size in the present study limited our ability to detect statistically significant differences and was insufficient for multivariate analysis. Jones et al. (2003) did find an association between race/ethnicity and prior knowledge about *T. gondii* similar to ours, i.e., participants of white non-Hispanic race/ethnicity were more likely to have previously heard about *T. gondii* than non-white or Hispanic persons.

Sources of knowledge about *T. gondii* differed from earlier studies in the United States.[18,19] Participants in the present study were more likely to have heard about *T. gondii* from newspapers (38%) and less likely to have been advised by a medical professional (16%) or family/friends (12%). Jones et al.[18] reported that 53% of participants received information from a medical professional and 45% from family/friends, while Ogunmodede et al.[19] reported 63% received information from a medical professional and 35% from family/friends. The percentage obtaining information from childbirth classes (12%) was similar to Jones et al. (13%) and Ogunmodede et al. (15%).[18,19] Newspapers as a source may have been more important in California because of articles about the threat to the southern sea otter from toxoplasmosis (for examples, see http://www.seaotterresearch.org/inthenews.shtml) and 2007 legislation (AB2485). This bill required cat litter manufacturers to label their packaging with an advisory against disposal of cat litter in toilets or outside (http://www.otterjoy.com/ newsarchive2006/ news644.html) and established the Sea Otter Research Fund with contributions via the California state income tax return (http://www.ftb.ca.gov/law/legis/06legchng/lc_ab2485.pdf).

After reading the handout, knowledge about *T. gondii* did improve in all the areas evaluated. Nearly all participants were able to identify *T. gondii* as a parasite and the cat as its host, but they had greater difficulty in understanding the symptoms of infection and what parts of the body would be most seriously affected (Table 2). Only about half realized ocular symptoms could occur as a result of toxoplasmosis.[22] An increase in cases of ocular toxoplasmosis was the first indicator of a communitywide outbreak of toxoplasmosis related to drinking water in Victoria, British Columbia, Canada in 1995,[23] and ocular toxoplasmosis is a major concern for adversely affected patients in Brazil and Africa.[24-26] Whereas many participants (72%) readily identified AIDS patients as at-risk persons, only about two-thirds realized that unborn babies could suffer serious consequences as a result of toxoplasmosis. Even fewer (41%) recognized the risk to the congenitally infected neonate, despite the fact that most educational efforts in the United States are focused on the prevention of congenital toxoplasmosis.

Studies from the United States[27,28] have shown that physician counseling about toxoplasmosis for pregnant women, while emphasizing the importance of cats and avoiding contact with cat litter during pregnancy, fails to highlight two other key preventive measures: not eating raw or undercooked meat and wearing gloves when gardening or working with soil. An encouraging 94% of participants did identify raw meat as a potential source of toxoplasmosis after reading the handout, but fewer recognized soil (78%) or improperly washed vegetables (67%) as environmental sources. This may be particularly important for non cat owners, since they may be less well-informed about zoonotic feline diseases and may not realize that soil in their yards or on fresh vegetables could be contaminated with *T. gondii* oocysts from free-roaming cats.

When asked what they would do to protect themselves from toxoplasmosis in the event that they were pregnant and had no one else to change the cat litter, the majority of participants (83%) favored wearing plastic gloves over hand washing after cleaning out the litter box (57%) or changing the litter daily (52%). This suggests that it may be easier to encourage use of disposable gloves to protect against *T. gondii* infection from cat litter than hand washing after changing the litter or more frequent changing of the litter, although all three measures would undoubtedly prevent infection. Others have reported that despite receiving educational information about *T. gondii* and being advised to wash their hands after handling raw meat or gardening, pregnant women showed little change in their behaviour.[21,29,30]

Basic knowledge about the *T. gondii* life cycle was also lacking after reading handout, with 41% of participants indicating the *T. gondii* oocyst is usually infectious 24 hr after defecation and 44% that oocysts could survive longer than a year in soil (Figure 3). Such knowledge might promote daily cleaning of the cat litter box and changes in how cat owners manage their pets. Keeping cats indoors prevents hunting of small mammals and birds (and thereby cat exposure to *T. gondii*) as well as outdoor defecation and contamination of the environment with *T. gondii* oocysts. It has been estimated that the 82 million owned cats in the United States could spread as many as 404 oocysts/m^2 annually onto soils in populated areas of the country.[3]

It appears that providing educational material to the general public could improve their knowledge about *T. gondii* and ultimately prevent some infections. However, we acknowledge that the sample size in this study was small and the populations unrepresentative of California or the United States as a whole. Most of the participants were women, and African and Asian Americans were not represented. Recruitment methods differed for the two sites, and participants in the Morro Bay area who attended the public meeting may have been more motivated to participate because they were concerned about their environment. It is also unclear how long participants would retain important facts about *T. gondii*, since they completed the second questionnaire immediately after reading the handout. It would be desirable to assess knowledge several weeks after educational material was provided to determine the long-term impact of the handout. Primary prevention in public health involves repeating and reinforcing messages using a variety of media at regular time intervals. Written materials alone are usually not sufficient to promote healthy behaviour. Several studies suggest that educational material and posters delivered directly by a physician or health educator with or without audiotape or video were effective in changing some preventive behaviours.[20,21,30] It is particularly important for pregnant women to receive individual counseling from their physicians, childbirth educators and public health staff to reinforce information they may have received in the past.

Medical professionals should continue to educate patients at the greatest risk for toxoplasmosis about under-recognized sources of *T. gondii* infection, e.g., soil, untreated water, and raw shellfish, a newly identified risk factor for *T. gondii* infection.[31] Our results showed that about one-fifth of participants did not recognize these sources as potential risks, even after reading the handout. Educational materials should be communicated to the public in a variety of ways and at regular time intervals for maximum impact.

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