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Effectiveness of Health Education on *Toxoplasma*-Related Knowledge, Behavior, and Risk of Seroconversion in Pregnancy

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** See Appendix

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ABSTRACT

We conducted a bibliographic literature search using MEDLINE to review the effectiveness of health education on toxoplasma-related knowledge, behavior, and risk of seroconversion in pregnant women. We pre-selected studies that used comparative study designs (randomized clinical trial, quasi-experimental design or historical control), were conducted among pregnant women, and which employed specific, *Toxoplasma*-related outcome measures: knowledge, behaviour, or *Toxoplasma* infection rate. Four studies met the inclusion criteria. All had serious methodological flaws. A Belgian study reported a significant decrease in the incidence of *Toxoplasma* seroconversion after the introduction of intensive counseling for pregnant women about toxoplasmosis. In Poland, a significant increase in knowledge was observed after a multi-pronged, public health educational program was launched. In Canada, an increase in knowledge and prevention behaviors was reported in the intervention group receiving counseling by trained facilitators compared with the control group. In France, no significant changes in risk behavior were observed following a physician-delivered intervention. This review highlights the weakness of the literature in the area and the lack of studies measuring actual seroconversion. There is suggestive evidence that health education approaches may help reduce risk of congenital toxoplasmosis but this problem requires further study using more rigorous research design and methodology.

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CONDENSATION

A systematic review of studies finds preliminary, suggestive evidence that health education approaches may help reduce risk of congenital toxoplasmosis and calls for a randomized trial.

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INTRODUCTION

While toxoplasmosis infection in women is often benign, transmission of maternal infection to the fetus can lead to severe sequelae resulting in visual or neurological impairment or death [1 ,2]. In Europe, the incidence of toxoplasmosis during pregnancy varies by country, and includes some of the highest incidence rates seen worldwide. The public health response to prevent congenital toxoplasmosis differs among European countries without any consensus on the need or effectiveness of screening or primary prevention [3]. In other countries, such as the US, which has a low overall toxoplasmosis seroprevalence, the Centers for Disease Control and Prevention has published an 8-point set of recommendations for women during pregnancy and urge that health providers underscore these points at each visit [4]. The EUROTOXO project was a European consensus initiative launched in 2002 aimed at defining the implications of current scientific knowledge for a research agenda and policy decisions on how best to prevent congenital toxoplasmosis and its consequences.

Toxoplasmosis can be avoided. In Europe, infection is predominantly acquired by ingestion of the parasite in undercooked meat [5]. Acquisition from food or water contaminated with oocysts is a secondary source [6]. Consequently, health information about the principle sources of infection could encourage women to change their behaviour, and thereby reduce acquisition of infection during pregnancy. In some countries, health education is the sole preventive strategy, whereas in others, it is combined with serological testing. However, few studies have examined the effectiveness of health education despite numerous pleas in the published literature for a stronger focus on primary prevention of *Toxoplasma* infection in pregnancy [7,8,13-16]. In addition, few

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reports address the extent to which health education is actually practised. One exception is a 1994 survey of 196 health districts in the United Kingdom demonstrating that health education was offered in approximately one-half of the health units surveyed, but there were serious deficiencies in monitoring whether information was given to all women [11]. In France, primary prevention is also recommended but its practice is not assessed or evaluated [12]. One case-control study of risk factors for toxoplasmosis seroconversion in pregnant women showed that controls were more likely to have received documentary advice on prevention than cases [13].

To address the lack of evidence, we conducted a systematic review to determine the impact of health education on either toxoplasma-related knowledge, risk behaviour, or seroconversion in pregnancy. A second aim was to describe and evaluate the varied program models used in different settings .

METHODS

We searched PubMed using the following keywords to identify any comparative studies assessing health education programs for toxoplasmosis: (toxoplasmosis AND (prenatal care OR pregnancy), AND (health education OR health promotion OR health intervention). We selected studies that assessed the effect of health education. Seventy-five articles included descriptions of health education programs for toxoplasmosis during pregnancy, however briefly, or editorialised about their need and value. Four studies met the inclusion criteria for the review, which were:

- a comparative study design (randomised clinical trial, quasi experimental trial, or comparison of outcomes in populations at different time points)

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- measurement of any of the following specified toxoplasmosis-related outcomes: knowledge, behavioural change, or *Toxoplasma* infection rate.

In addition, unpublished material available at ISPED, University of Bordeaux 2, was reviewed, including a Masters' Thesis and an unpublished manuscript based on this thesis, thus bringing to 6 the total number of documents providing study data. To confirm that no relevant additional thesis material had been overlooked, we conducted an international database search of thesis titles from 1970 to the present, using the website Agence Bibliographique de l'Enseignement Supérieur with broad search phrases including « toxoplasmosis + prevention ». No additional material was located.

RESULTS

The six reports described four separate studies, from Europe and Canada. Table I summarizes information on study design, type of intervention, sample, and outcomes.

Belgian prospective study

Two published reports summarized the experience at a University obstetrics clinic over the years 1979-2001 (see Table I) [16,17]. Investigators described the evolution of primary prevention services for pregnant women, in three phases, as well as the corresponding seroconversion rates for the same periods, via systematic serological testing on consecutive pregnant women. The study design used historical controls. Serological testing for *Toxoplasma* antibodies at the first prenatal visit, and then again at around the 20^{th} and 30^{th} week, and finally, on cord blood during delivery,

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resulted in a sustained drop in seroconversion rates over the three periods, with large and statistically significant differences. There was no adjustment for the prevailing secular decline in the incidence of infection in Europe or for a possible reduction in the mean interval between serological tests over time. Both factors could partly explain the findings.

Polish serial cross-sectional surveys

Pawlowski et al. published cross-sectional data generated from three waves of research, between 1991-1997, conducted on all pregnant women attending four, randomly-selected obstetric wards in the Poznan district of Poland [9]. No comparison population data were collected. During this period, increasingly intensive educational measures were instituted (see Table I). The investigators used interviewer-administered questionnaires to measure the: knowledge and serostatus among varied samples of women at different time points (see Table II). Response to five separate knowledge items were scored and rated as "good" or "inadequate". Behaviour was rated as "correct" if the respondent did not indicate either eating raw meat during pregnancy or having direct contact with cat feces. Investigators also measured whether the respondent had a "healthy lifestyle" (rated as yes or no), which they described as a positive response on one or more behaviour items (including: looking for related information, reading, listening, exchanging views on health matters, and practicing good diet and exercise.

Over the period 1991-92 to 1997, the prevalence of *Toxoplasma* antibodies dropped, the percentage of women reporting having been tested rose, and overall, knowledge increased considerably (see Table II). Since the refusal rate was not given by the authors, it is unclear whether selective drop-out from the study could have accounted for part of the observed result. In the 1997 survey, among

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2710 women, the majority of women who reported having an active "interest in a healthy lifestyle" (78%) practised correct prevention behaviours (versus 69% of those with good knowledge). Sixty percent had heard about toxoplasmosis through television or women's magazines, versus less than 40% via the radio, daily newspapers and health service providers. An estimated 24% of women in the relevant clinics had read the 15-page brochure.

The striking change in knowledge over the course of pregnancy for 1246 women in 1995-1996 was considered to be largely attributable to the educational activities of clinic personnel. The authors pointed to their data as supportive of a general need for more intervention trials using mass media, and visual and personal contacts, rather than written educational material.

Canadian randomised controlled trial

A 10-minute, "add-on", prenatal educational module on toxoplasmosis prevention was tested in a randomised, controlled study of pregnant clients of a mixed, urban-rural public health agency in Ontario, Canada, offering a free series of prenatal health classes [18]. Trained instructors delivered the short additional segment which stressed basic knowledge about toxoplasmosis infection, the effect on the fetus and prevention of exposure during pregnancy. Prevention behaviours were divided into 3 areas: cat hygiene, food hygiene and personal hygiene. Teaching materials for this additional module consisted of a 3-page handout at a low-literacy level, a display poster, and resource materials for teachers. The control classes received "routine" material, which contained no mention of toxoplasmosis, and instructors were asked to avoid mention of toxoplasmosis unless a specific question was raised. The instructors distributed the self-filling questionnaires and were not

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blinded to the study question. Prenatal clients were administered a pre- and post-test questionnaire, the post-test data being collected after the last class of the series. Questionnaires contained demographic, knowledge and behavioural items.

The study sample was retrospectively defined, and consisted only of the women who filled out both a baseline and follow-up questionnaire. A total of 432 women completed baseline questionnaires and 285 completed post-test questionnaires (66%). The number of women randomised, and the proportion responding were not reported. However, the authors noted that the percentage lost-to-follow-up was similar across the two arms, and that the variables noted to be associated with loss-to-follow-up (age, education) were equally distributed among those not retained in each arm. The authors thus inferred that dropout was non-differential with respect to study arm. The mean length of time between baseline and post-test was four months. A scoring system for behaviour change was developed which awarded one point when behaviour change was made towards that taught in 'enhanced' classes; and removing a point for a change in behaviour in the opposite direction. Using this system, the only significant change noted between controls and "enhanced training" participants was in cat hygiene behaviour; women with enhanced training scored higher than controls ($p<0.05$). The authors noted that, at baseline, both food and hygiene behaviour and personal hygiene behaviour were similar to that taught in the classes. This reduced the power of the study to detect a difference due to the program, a study limitation acknowledged by the authors [18]. When individual behaviours (as opposed to a pre-grouped behaviour set) were compared across arms at the post-test, a significant difference was found for the cooking of roast beef ($p<.05$) and hamburger ($p<.01$), with 'enhanced' program participants reporting cooking these meats more thoroughly as compared with controls.

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French multi-center, randomized, controlled trial

A French multi-center trial was reported in an unpublished form which was available as a Masters' Thesis completed at the University of Bordeaux, and as a conference poster [19, 20]. The "ERIS" study, conducted in 1994-95, used cluster randomisation of prenatal clinics in seven counties in the area of Lyon, France, where physicians were enlisted to enrol seronegative pregnant women. The women agreed to have their cord blood tested for toxoplasma antibodies upon delivery as a condition of study enrolment. Physicians in control cities received no special instructions. Physicians in experimental cities were instructed to give their patients a 20-page brochure with four pages of information on toxoplasmosis prevention and transmission. In addition, women in the experimental arm received an audiotape of a conversation between a physician and her patient covering frequently–asked questions during pregnancy, and highlighting questions on toxoplasmosis. The women completed a baseline questionnaire including demographic indices, and knowledge and risk behaviours for toxoplasmosis infection, mixed with other unrelated questions. Physicians and participants were blinded to the research question.

As in the Canadian study, the study sample was retrospectively defined and restricted to women who had completed both a baseline and follow-up questionnaire. Investigators compared the change from baseline to delivery, across two arms, in the "perfect" practice of prevention behaviours. For example, in the analysis, women who consumed uncooked beef only *once* in the follow-up interval were grouped with women who *always* consumed uncooked beef. This heterogeneous group of women comprised the "imperfect" behavior group.

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A total of 1953/3268 women (60%) in the experimental arm, and 837/1755 women (48%) in the control arm completed both baseline and follow-up questionnaires (56% overall). Completion of the follow-up questionnaire was significantly associated with study arm. Among the study population analysed, no significant differences were found at baseline between the two arms for knowledge or behaviour. Also, no significant differences were observed between the two groups at baseline regarding age, parity, and nationality at birth, education, occupation, marital status or age of pregnancy at inclusion. The mean age of participants was 28 years. Half were primiparas and 94% were of French nationality. Twenty percent had completed the "baccalaureat" and another 34% had completed some post-baccalaureat study; 70% were employed; 55% lived in an urban area; and two-thirds had married in France since 1978, the date when systematic mandatory prenuptial screening was introduced. Baseline occurred during the third and fourth months of pregnancy in the majority of participants.

At baseline, 92% of study participants knew about the risks of infection through consumption of raw beef, 90% about the risks of unwashed salad, and 82% about risk with handling of cat litter. Only 50% knew that washing hands after handling raw meat helped prevent infection. As far as preventive behaviours were concerned, 88-89% reported washing vegetables and fruits eaten raw. But of the 97% of participants who had consumed some meat in the two months preceding inclusion, only 44-45% respectively had not eaten any raw or insufficiently cooked meat. Roughly one-quarter of both control and intervention participants reported always washing their hands before eating or after contact with potential sources of contamination.

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In comparing the two arms across the two time points, weak but statistically significant effects were noted for knowledge changes. No significant association was found between health education group assignment and behaviour at follow-up (see Table III). The consumption of cooked beef 'always' versus 'less than always', was marginally associated with study arm (Model I: OR= 1.21; p=0.08). This marginal effect was explained by the improved knowledge at delivery, on the severity of Toxoplasma infection and on food-borne transmission, suggesting the pathway through which the intervention operated to improve behavior (Model II: p=0.004 for both variables). Handwashing 'always' after contact with soil, raw meat, or unwashed vegetables (presumably analyzed as perfect behaviour for all potential exposures considered together) also showed no association with study arm (see Table IV). Variables that were strongly associated with behaviour change, were baseline knowledge and behaviours concerning toxoplasmosis, smoking, and alcohol consumption (Model I); when follow-up knowledge levels were included- into the model, baseline knowledge was no longer significant (although baseline behaviors continued to be, see Model II). These analyses demonstrated that better knowledge and healthier behaviours, especially measured at delivery, predicted change towards toxoplasmosis prevention behaviours. There was no attempt to impute missing data, despite the large and differential loss-to-follow-up, because of the method used to specify the sample—that is, eliminating those who had been originally randomized but had not completed a follow-up questionnaire, not in keeping with standard trial design techniques [21].

Finally, only 17/3949 (0.43%) pregnant women seroconverted for toxoplasmosis in this trial: 13/2591 in the experimental arm and 4/1358 in the control arm (p=0.35; the number of women available for the analysis of cord blood Toxoplasma antibodies exceeded that for responses to the

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questionnaires). This event was not a preset outcome measure due to a lack of statistical power which reflects the low incidence of seroconversion in this population.

DISCUSSION

This review of effectiveness of health intervention on *Toxoplasma*-related knowledge, behavior, and risk of seroconversion in pregnancy highlights the weakness of the literature in the area. The major weaknesses of the four studies we have presented relate to the potential biases introduced in the study design and analysis. Future studies on this problem need to pay particular attention to these issues.

In two of the studies [16,17], the lack of concurrent control group in the study design rendered their interpretation difficult because other effects besides the tested intervention could account for the observed results. Alternative explanations for the findings of the these types of studies includes: (a) a decline in the force of infection over time; b) a change in services for diagnosing or reporting maternal or neonatal infection which causes an apparent difference; and c) increased awareness among women of the risks of toxoplasmosis, unrelated to their prenatal care.

In one of these, the Belgian study, the authors used the argument that overall seroprevalence in the Brussels general population remained the same over the course of the study to defend the inferences drawn. In addition, they pointed to the additive nature of the interventions in the separate phases. However, the effect of external influences which could have been changing over the same time period as the health education, cannot be excluded. Indeed, the overall prevalence of toxoplasmosis

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in the general population—driven by childhood infection--could remain apparently stable with the incidence in pregnant women being a more dynamic indicator of the decline of the disease in the population of pregnant women [22]. Moreover, it is worthwhile to note that a substantial decrease in toxoplasmosis seroprevalence and incidence was reported across Europe including the UK over the last decades [23].

In the Polish study [17], similarly, the data generated from the 1246 women over the course of the pregnancy, adds strength to the authors' inference that particular parts of the intervention may have been of especially high value--for example, personal interactions with the clinic personnel (also validated externally to the extent that it has been shown in other intervention studies). But the study designs of these large studies lacked sufficient rigor to test the interventions mounted.

In fact, an overlooked element common to all studies reviewed here, was an evaluation of medical personnel knowledge and attitudes about Toxoplasma prevention. Changes in knowledge and attitudes of the doctors, nurses and other personnel having contact with the study population over time, whether caused by (ie. mediating the effect on the target population), or independent of the intervention, could easily explain the observed study results, and should be measured and controlled for in the analyses. The lack of such a component was particularly unfortunate in the case of the Polish study, where specific educational and awareness-raising activities for medical personnel had been carefully designed as part of the intervention.

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Although the Canadian and unpublished French studies [18,19] employed randomised controlled trial methodology, a far superior study design, there were also serious limitations in the inferences that could be drawn due to the method used to define the study sample that was actually analyzed—ie. only the subset of enroled women who had completed a follow-up questionnaire. This design feature undermined the benefits of randomization by ignoring the potential bias due to differential loss-to-follow-up. While follow-up rates varied substantially by arm, no attempt was made to impute missing data. Standard randomized trial methodology calls for inclusion in the analysis of all participants randomized, whether or not they complete the follow-up assessments. Non-randomized trials as well must report the valid percentage of participants not retained at follow-up. Considerable resources need to be dedicated to achieving a high retention in research trials to minimise bias due to differential loss-to-follow-up (e.g. subject incentives, rigorous maintenance of subject contact information, multiple and dedicated "follow-up staff", multiple modalities for visit reminders, home and community visits for hard-to-reach participants, etc). Standard trial design approaches requires that all participants who are randomised be accounted for in the analysis. The practice of analysing only participants who contribute data at the two critical time periods will not only compromise data validity but will interfere with an assessment of who "stays in" such intervention studies and why. This outcome is often an exceedingly important one.

Three of the four studies reviewed uncovered clear associations of knowledge and behaviour with demographic variables such as age, previous pregnancy, place of residence, profession and educational level [17,18,20]. Even with multivariable analysis, these variables can be highly interrelated and difficult to control for, further underscoring the need for randomisation and a controlled trial design. Also, two of the studies pointed to various associations of increased

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knowledge about congenital toxoplasmosis and healthier behaviour, with higher educational level and a profession in the medical field [18,20]. The issue was raised as to whether there was sufficient statistical power to detect differences between the two randomized groups. Another need to be carefully considered in any future trial is thus the risk level of the population targeted for study. Here, as is the case for many other areas of prevention research, a strong argument can be made for targeting a high at-risk group with which to intervene – certainly in raising the probability of demonstrating a benefit to the tested intervention if one actually exists, thereby avoiding 'Type II' errors (here, the failure to identify an efficacious intervention when one actually exists) and their inherent costs. For instance, the sample size needed in a trial design to obtain a decrease in incidence of 50%, with a power of 80%, given a baseline incidence of seroconversion of 0.015 in susceptible women in France [15] would be 3365, with a consequent huge economic cost.

Increasingly, behavioural intervention research is adopting a "risk reduction" paradigm--focussing on the *proportionate* increase of healthy behaviours--rather than an all-or-none perspective such as the dichotomizing of behaviours into "perfect" and "imperfect" found in a number of the studies reviewed. The risk-reduction approaches, pioneered in the area of drug and alcohol treatment ("harm reduction"), have also been found to be well-suited to populations at risk for HIV through substance abuse and risky sexual behaviours [24].

Finally, these studies point out the need for careful attention to the design and content of the intervention itself. It is clear from the health promotion literature, and cited by a number of authors in the debate over European approaches to prevention of congenital toxoplasmosis [8,17], that providing written recommendations to women at risk, as a primary prevention approach, is grossly

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insufficient to change behaviour. The authors of the Belgian and Polish studies both pointed out the critical need for personal interaction in successful diffusion of a prevention message. In addition, due to a lack of specific training regarding patient communications and counselling techniques in standard medical school curricula, physicians may not be the best people for delivering this message. Often, peer counsellors or ancillary health personnel are more effective [25, 26]. Also, in other areas of health education, it has been found that utilisation of multi-media approaches (e.g. videotapes, audiotapes) to complement personal interaction and use of waiting-room teaching elements, are effective [27]. One pitfall to be avoided in the construction of health education messages is resorting to 'fear tactics'--for example, the presumption that reading about the (frightening) effects of toxoplasmosis on the fetus/infant would incite adherence with the prescribed prevention behaviour in pregnant women. Fear has not been shown to be beneficial in helping individuals achieve long-lasting behaviour change and may have unintended, deleterious effects [28].

Taken as a whole, this body of data provides only preliminary, suggestive evidence that health education approaches may help prevent congenital toxoplasmosis. The lack of clear evidence argues for a randomized controlled trial of health education using state-of-the-art behavioural intervention techniques. Such a study: (1) should target women at highest risk of toxoplasmosis infection during pregnancy, and (2) should be conducted where prevalence and incidence are at least moderately high and, ideally, where other policies in place to prevent congenital toxoplasmosis, will not in any way compete or interfere with the research.

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APPENDIX

The EUROTOXO initiative represents a join initiative of three partners: the Institute of Child Health (London, UK), the Staten Serum Institute (Copenhagen, Denmark), and the Institute of Public Health, Epidemiology and Development (Bordeaux, France). It was conducted during 2002-2005 with a European Union funding (5th PCRDT; Contract No.QLG4-CT-2002-30262).

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Panel 1: L. Rachid Salmi, ISPED, Bordeaux, France (Chair). By alphabetical order: Antoine Bénard (France), Christine Binquet (France), Michel Cot (France), Catherine De Vigan (France), Marianne Forsgren (Sweden), Justus Garweg (Switzerland), Dorota Nowakowska (Poland), Stefania Salmaso (Italy), Alessandra Sensini (Italy), Rudiger Von Kries (Germany), Anton Van Loon (The Netherlands).

Panel 2: Rodolphe Thiébaut, INSERM U593, EMI 0338, Bordeaux, France (Chair). By alphabetical order: Ole Andersen (Denmark), Alain Berrebi (France), Antoine Brézin (France), Bruno Charpiat (France), Francis Derouin (France), Uwe Gross (Germany), François Kieffer (France), Philippe Lepage (Belgium), Laurent Mandelbrot (France), Valeria Meroni (Italy), Maarten Postma (The Netherlands), Miles Stanford (UK).

Panel 3: Valériane Leroy, INSERM U593, Bordeaux, France (Chair). By alphabetical order: Tony Ades (UK), Marie-Laure Dardé (France), Anne Eskild (Norway), Christos Hadjichristodoulou (Greece), Pal Jenum (Norway), Monique Kaminski (France), Babak Khoshnood (France), Jean-François Korobelnik (France), Bogumila Milewska-Bobula (Poland), Pierre-Alain Raeber (Switzerland), Christoph Rudin (Switzerland), Isabelle Villena (France).

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Table I. Characteristics of studies on health education about *Toxoplasma* infection in pregnancy

Location, publication year (1st author)	N	Study design, setting	Primary outcomes	Type of intervention, content	Results	Comments
Belgium, 2004 (Foulon, Naessens et al. 2000; Breugelmans, Naessens et al. 2004)	*phase 1*:2986 pregnant women, 1403 seronegative; *phase 2*: 8300 pregnant women, 3605 sero-negative; *phase 3*:16541 pregnant women, 8492 sero-negative	Historical control, outpatient clinic, Brussels: *phase 1*:1979-1982 *phase 2*:1983-1990 *phase 3*:1991-2001	Seroconversion for *Toxoplasma* antibodies	*Phase 1*: no specific recommendations; *Phase 2*: list of written instructions, explanation by physician; *Phase 3*: in- depth leaflet + physician explanation, plus midwife discussion at mid-gestation at prenatal visits	Seroconversion rate during pregnancy: *ph 1*: 1.43% *ph 2*: 0.53% *ph 3*: 0.09% p-values for risk decrease: *ph1→ph2*, 63%, p=.001 *ph1→ph3*, 92%, p<.0001	Historical control Authors noted that no change in seroprevalence occurred in Brussels over course of study (~ 50%). However, incidence has decreased in Europe over the same time period.
Poland, 2001 (Pawlowski, Gromadecka-Sutkiewicz et al. 2001)	4311 pregnant women (1991-1992); 1246 pregnant women (1995-1996); 2710 pregnant women (1997)	Serial cross-sectional; all women in 4 randomly-selected obstetric wards in Poznan region	Knowledge; behaviour, proportion tested for *Toxoplasma* antibodies	Educational activities in secondary schools' curriculum; training of nurses for outpatient antenatal care; 1-pg fact sheet for pregnant women; 15-pg brochure for pregnant women; medical conferences; discussion at "pg women clubs"	Significant knowledge change over 1991-1997 period; also within same women from baseline to postpartum in 96-97. Preventive behaviours (55%) reported by more women than reported high knowledge levels 45%). Brochure read by only 24%. 44% seroprevalence.	Refusal rate not given. Value of each intervention element difficult to ascertain due to study design. Supportive evidence in favour of mass media, and one-on-one teaching vs. written material. Association of increased knowledge with urban dwelling, educational level, a previous pregnancy and/or age were not analyzed via multivariable methods. Interest in "healthy lifestyle" had greater correlation with healthy behaviours than did good knowledge.

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Table I. Characteristics of studies on health education about *Toxoplasma* infection in pregnancy, cont.

Location, publication year (1st author) – *continued*	N	Study design, setting	Primary outcomes	Type of intervention, content	Results	Comments
Canada, 1989 (Carter, Gelmon et al. 1989)	432 baseline; 285 post-test	Randomized controlled trial, health agency clients	Knowledge; Self-reported behaviour	Trained facilitators delivered an additional 10 min module within the standard 1-hour program, which included a teaching poster and 3 handouts for clients	Change in cat hygiene behaviour $p<0.05$; no change in food hygiene or personal hygiene behaviour according to "scoring" system. Specific meat cooking behaviours were significantly different at post-test across randomization status.	Authors noted limited statistical power; behaviours at outset were relatively healthy. High but non-differential loss to follow-up among randomized group. Study sample retrospectively defined as those completing baseline and follow-up questionnaires.
France, 2004 (Nguyen Hoang Hanh 2004; Wallon, Nguyen et al. 2004)	1953 intervention; 837 control	Randomized (cluster) controlled trial, (with double blinding), pregnant women in prenatal clinics in 7 departments in France	Knowledge; Self-reported behaviour; seroconversion rate	Brochure and audiotape provided to patient; no specific teaching of or by physician, or other facilitator, mentioned, possibly due to use of physicians as both data-gathering agents as well as in intervention delivery, and desire for blinding.	Significant (but not strong) effects for knowledge; No significant association was found between group assignment and behaviours. Baseline and demographic variables were assoc with behaviours. No significant difference in seroconversion rates.	Author raised questions about statistical power in discussion to study the seroconversion rate, noting high level of knowledge and some healthy behaviour. Analytic approach may have masked differences between arms due to emphasis on "perfect" behaviours. High and differential loss to follow-up among randomized group. Study sample retrospectively defined as those completing baseline and follow-up questionnaires.

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Table II. Toxoplasmosis in Poznan, Poland between 1991 and 1997 ; changes in the seroprevalence , knowledge and behavior (from Pawlowski et al. [9]).

	1991-92	1995-96	1997
Number pregnant women examined	4311	1246	2710
Seropositivity in pregnant women	58.9%		44.0%[a]
Individual serologic antenatal tests	2.7%		4.6%
Good knowledge of toxoplasmosis -in all examined women -in the same women questioned twice -in women attending… -national services -private services -both	24.3% 26.4% 20.6%	 45.5% early preg. 80.3% postpartum	 45.3% 40.4% 43.7% 58.6%
Good knowledge In women.. -having access to brochure (n=352) -with no access (n=2358)			 45.3% [b] 45.5% [b]
Correct behavior -in all examined women -in women attending national services -in women attending private services			 55.2% 73.4% 79.8%
Correct behavior in women.. -having access to brochure (n=352) -with no access (n=2358)			 54.1% [b] 62.8% [b]

a: Data collected in 1997-99 from 1534 women only
b: non-significant values (P>=.08)

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Table III: Multiple logistic regression models for behaviour change in meat consumption. Etude ERIS, 1994-1995. (From Nguyen [19])

(Dependant variable=NO consumption of undercooked meat of any type)

	Model 1			Model 2		
	OR	**95 % CI**	**p**	**OR**	**95 % CI**	p
Study arm						
Specific information vs. Routine information	1.21	0.98-1.50	0.08	1.12	0.89-1.41	0.33
Undercooked meat consumption of any type, measured at baseline						
Never vs. at least once	1.72	1.41-2.10	$<10^{-4}$	1.68	1.36-2.07	$<10^{-4}$
Knowledge on food borne transmission measured at baseline						
Perfect vs. imperfect	1.45	1.18-1.78	<0.001	1.29	1.03-1.63	0.03
Alcohol consumption						
Never vs. at least once	1.25	1.02-1.52	0.03	1.28	1.04-1.58	0.02
Knowledge on the severity of *Toxoplasma* infection, measured at delivery						
Perfect vs. imperfect				1.37	1.10-1.70	0.004
Knowledge on food borne transmission measured at delivery						
Perfect vs. imperfect				1.48	1.14-1.92	0.004

OR Odds Ratio
CI Confidence Interval

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Table IV. Multiple logistic regression models for behaviour change in hand cleanliness. Etude ERIS, 1994-1995 (From Nguyen [19]) .

(Dependent variable = Handwashing after contact with transmission factor [soil, raw meat, unwashed vegetables] and before meals)

	Model 1			Model 2		
	OR	**CI 95 %**	**p**	**OR**	**CI 95 %**	**p**
Study arm						
Specific information vs. Routine information	1.01	0.83-1.22	0.91	0.95	0.78-1.16	0.60
Handwashing after contact with transmission factor (soil, raw meat, unwashed vegetables) and before meals, at baseline						
Always vs. Not always	6.30	5.16-7.70	$<10^{-4}$	6.29	5.14-7.69	$<10^{-4}$
Knowledge on transmission linked with hygiene, measured at baseline						
Perfect vs. imperfect	1.20	1.01-1.44	0.04	1.14	0.95-1.37	0.16
Tobacco consumption						
No vs. yes	1.35	1.08-1.69	<0.01	1.31	1.05-1.65	0.02
Knowledge on severity of *Toxoplasma* infection, measured at delivery						
Perfect vs. imperfect				0.85	0.71-1.02	0.08
Knowledge on transmission linked with hygiene, measured at delivery						
Perfect vs. imperfect				1.52	1.20-1.91	<0.001

OR Odds Ratio
CI Confidence Interval