THE ROLE OF PSYCHOLOGICAL FACTORS IN QUESTIONNAIRE-BASED STUDIES ON ROUTES OF HUMAN TOXOPLASMOSIS TRANSMISSION

J. Flegr, Š. Hrdá, J. Tachezy
Department of Parasitology, Faculty of Science, Charles University, Prague, Czech Republic

SUMMARY

The paper studies impacts of particular toxoplasmosis risk factors (consumption of raw meat and contact with cats), their interactions, and their relationship with the personality of the subjects. Among 243 men and 343 women the frequency of subjects with antitoxoplasma immunity was 26.6 % and 21.6 %, respectively. The association of antitoxoplasma immunity (assessed by the toxoplasmin skin test) with the two risk factors was estimated by log-linear analysis. Reported contact with cats has no influence on the probability of having antitoxoplasma immunity (P = 0.23) while the consumption of raw meat increased this probability (P = 0.0008). Very strong positive association between the contact with cats and the raw meat consumption was found among subjects without toxoplasmosis (P = 0.0028), suggesting that among these persons some subjects either incorrectly assessed their exposition to the risk factors or provided false data during the interview. The results of logistic regression suggest that the contact with cat and the consumption of raw meat are associated with particular personality traits. However, these traits differ from those associated with antitoxoplasma immunity suggesting that the correlation between antitoxoplasma immunity and consumption of raw meat reflects epidemiological importance of the raw meat rather than a correlation of both factors (raw meat consumption and probability of acquiring toxoplasmosis) with the subjects personality.

Key words: cat, parasite, prevalence, raw meat, toxoplasmosis, transmission

Address for correspondence: J. Flegr, Department of Parasitology, Faculty of Science, Charles University, Viničná 7, 128 44 Prague 2, Czech Republic

Toxoplasmosis is an infectious disease caused by the parasite *Toxoplasma gondii*. It is one of the most common protozoan diseases in animals and man. The prevalence of serum antibodies to *Toxoplasma* varies from less than 5 % in Navajo Indians, Australian aborigines, and Eskimos (1) to more than 80 % in Parisians (2). *T. gondii* is an economically important cause of disease in animals and produces a variety of clinical manifestation in humans (3, 4).

Except intrauterine transmission, there are two main natural routes of infection with *Toxoplasma*: the faecal-oral, i.e., infection by the oocyst from contact with infected definitive hosts (cats) or exposure to contaminated soil, and the carnivorism, i.e., infection by tissue cysts through ingestion of raw or undercooked meat of intermediate hosts. The relative importance in human population of these two routes varies from one report to another, depending on hygienic, sociological and geographical factors in the survey area and on occupations, socioeconomical status and customs of the inhabitants (5).

Despite the long tradition of toxoplasmosis studies, there is still a controversy concerning the main route of *T. gondii* infection in many countries, including the Czech Republic (6). The epidemiological importance of the two potential risk factors, the contact with cats and the consumption of raw or undercooked meat, is mostly studied in an indirect way, either by questionnaire survey or by interview with infected subjects. Evidently, many subjective factors and biases might obscure the results of such studies. Recently, the difference in personality profiles between *Toxoplasma*-infected and *Toxoplasma*-free subjects was reported (7, 8). The probability of the consumption of raw meat and the contact with cats probably also depends on the subject personality. Therefore, we suspect that the association between toxoplasmosis and reported exposition to some „risk factor" could simply reflect a correlation of both *T. gondii* infection and the studied „risk factor" with the same factor, namely with the subject personality.

In this study the prevalence of antitoxoplasma immunity and associated epidemiological factors were investigated on the group of 586 biology students and biologists. In contrast to previous studies we focused our attention not only on the study of particular risk factors but also on their interactions and their relationship with the personality (and behaviour) of the subjects.

METHODS

Subjects

The data were collected over a period of 40 months in 1992-1995. The experimental group was composed of 243 men and 343 women, mostly biology students and biologists of the Faculty of Science, Charles University, Prague. For stratified analyses the subjects were sorted into three age categories, 18-24 (n = 396), 25-31 (n = 97), and 32-65 (n = 93). The subjects were interviewed by authors about toxoplasmosis risk factors. They were asked: 1. Do (did) you often play with cats or kitten and/or have (or had) you a cat in your household? 2. Do (or did) you ever eat raw meat or food containing raw meat and/or do (or did) you ever taste raw meat or a raw meat paste when cooking? Three hundred and eighty-four (384)

subjects gave either positive or negative answer on at least one question. Most of the subjects also completed Cattell's personality questionnaire (243 men and 200 women). After the interview and completing the questionnaire the subjects were tested for antitoxoplasma immunity. All subjects gave their informed consent before they were accepted for the study.

Immunological Test for Antitoxoplasma Immunity

The antitoxoplasma cellular immunity of experimental subjects was assessed by an intradermal delayed hypersensitivity test (IDHT) (9). This test yields presence/absence data. The assay was performed using toxoplasmin as antigen and sham injection of control antigen (both produced by SEVAC, USOL Prague) as negative control. Positive reactions were of the delayed tuberculin type and were assessed 48 hours after antigen administration. The large-scale use of the skin test in population surveys has shown excellent correlation between the results of this test and the latent *T. gondii* infection (10). Development of the ability to elicit delayed hypersensitivity to *Toxoplasma* antigens in man requires a period of months or even years after initial infection. Therefore, it is practically useless for diagnosis of acute toxoplasmosis. However, the hypersensitivity usually persists for the life of the host so it is the most useful method in the diagnosis of latent infections (10).

Personality Tests

Cattell's sixteen factor questionnaire (form A) (11) was used for the characterization of personality. This questionnaire is widely used for personality studies in many countries, including Czech Republic (12, 13). It covers sixteen personality factors (Sizothymia/Affectothymia, Intelligence, Strength of ego, Submissiveness/Dominance, Desurgency/Surgency, Superego strength, Threctia/Parmia, Harria/Premsia, Alaxia/Protension, Praxernia/Autia, Naivete/Shrewdness, Guilt proneness, Conservatism/Radicalism, Group dependency, Self sentiment integration, Ergic tension). For each factor the test provides a value on 27-points row scale (which can be transformed for age/sex standardized value on 10-points standardized scale). The main advantage of this traditional personality test is that it contains only one hundred and eighty-seven (187) questions. Therefore, most subjects can complete it within one hour. All subjects (except twenty-two parasitologists) completed their questionnaires before the results of the toxoplasmosis test were known.

Statistical Methods

The effects of the risk factors (raw meat consumption and cat contact), confounding variables (gender, age) and their interactions were estimated by log-linear analysis. The correlation between the risk factors and the personality profile was quantified by logistic regression using either cat or raw meat as a dichotomous dependent variable and the raw personality factors and confounding variables (gender and age) as in depended variables. The raw personality factors instead of age-standardized ones were used in statistical analysis to prevent information loss during the transformation of twenty seven-point raw scales into ten-point age-standardized scales and to avoid an application of general population-based correction factors on the highly „nonstandard" subpopulation of biologists. The EpiInfo 6.01 program was used for a stratified log linear analysis and Statistica® program for all other statistical testing.

RESULTS

Association of Antitoxoplasma Immunity with Raw Meat Consumption and Cat Contact

Two hundred and forty-three (243) men and three hundred and forty-three (343) women were tested for cellular immunity against *T. gondii*. Among the men and the women frequency of subjects with antitoxoplasma immunity was 26.6 percent and 21.6 percent, respectively. Before the results of immunological tests were known, the subjects completed the Cattell's 16 personality factors questionnaire and answered two questions concerning two potential Toxoplasma-infection risk factors. All men (243) and 200 women completed the questionnaire and 384 subjects gave either positive or negative answer on at least one risk factor-question. According to their answers the subjects were sorted into four groups: cat minus meat minus, cat plus meat minus, cat minus meat plus, and cat plus meat plus. The frequencies of toxoplasma positive (TP) and toxoplasma negative (Tn) subjects (the subjects with and without antitoxoplasma immunity) in each group were calculated (Table 1a-c). The association of antitoxoplasma immunity with raw meat consumption and cat contact was estimated by log-linear analysis.

The results of simple analysis of 2 x 2 contingency tables showed that the reported contact with cats has either none or only marginal influence on the probability of being toxoplasma positive. Among 215 subjects reporting the contact with a cat, the frequency of toxoplasmosis was 27.0 percent while among 161 subjects without the contact the frequency of antitoxoplasma immunity was 23.6 %. The difference between the two sets was not statistically significant ($P = 0.23$, $n = 376$, one tailed test).

On the other hand, the consumption of raw meat significantly increased the probability of being toxoplasmosis positive. Among 172 subjects who reported the consumption of raw meat the frequency of antitoxoplasma immunity was 32.0 % while among the remaining 196 subjects the frequency was only 17.9 % ($P = 0.0008$, $n = 368$, one tailed test). The association between the consumption of raw meat and the antitoxoplasma immunity was significant both for men (33.8 % versus 14.6 %, $P = 0.010$, $n = 113$, one tailed test) and women (30.8 % versus 18.9 percent, $P = 0.014$, $n = 255$, one tailed test).

To reveal possible interactions between the risk factors, the best model for explaining our data was searched for by log-lin-

Table 1. Frequency tables for antitoxoplasma immunity and two risk factors

1 a

(Men Women)	Raw meat minus	Raw meat plus
Toxoplasma negative	41/120	43/74
Toxoplasma positive	7/28	22/33

1 b

(Men/ Women)	Cat minus	Cat plus
Toxolasma negative	35/88	51/106
Toxoplasma positive	13/25	21/37

1 c

(Toxo negative/positive)	Raw meat minus	Raw meat plus
Cat minus	82/15	38/21
Cat plus	76/20	75/33

Tables la and 1b show the association of antitoxoplasma immunity with raw meat consumption and contacts with cats, respectively. Table 1c shows the association of two T. gondii-infection risk factors. The absolute numbers of the subjects in each subset are given.

Table 2. Association of antitoxoplasma immunity with risk factors and confounding variables

	Const. B0	Gender	Age	Cat	Meat
Estimate	– 1.789	0. 0817	0.00447	0.0618	0.749
Odds ratio C.I.		1.08 (0.63 – 1.87)	1.00 (0.98 – 1.02)	1.06 (0.64 – 1.77)	2.11 (1.27 – 3.51)
S.E.	0.692	0.279	0.0122	0.258	0.259
t (345)	– 2.588	0.293	0.366	0.239	2.890
P-level	0.0101	0.769	0.714	0.811	0.0041

Model: Logistic regression (logit). Dep. var: TOXO [1 - presence (n=87) or 0 - absence (n=263) antitoxoplasma immunity]. Loss: Max likelihood (MS-err. scaled to 1). Final loss: 191.54 χ^2 (4)=9.45 P=0.051. The first line shows the constant B0 and β estimates of the regression function, the second line shows odds ratios (p/1-p), i.e., natural logarithm raised to the power of the β estimates, and the 95% confidence intervals (C.I.) for odds ratios.

Table 3. Association of consumption of raw meat with antitoxoplasma immunity, contact with cat, gender and age

	Const.B0	Gender	Toxo	Age	Cat
Estimate	– 1.115	– 0.529	0.747	0.0224	0.564
Odds ratio (C.I.)		0.59 (0.37 – 0.94)	2.11 (1.27 – 3.50)	1.02 (1.00 – 1.05)	1.76 (1.13 – 2.74)
S.E.	0.669	0.243	0.259	0.0115	0.227
t (345)	– 1.667	– 2.173	2.886	1.947	2.485
P - level	0.0965	0.0305	0.00415	0.0524	0.0134

Model: Logistic regression (logit). Dep. var: Meat [0 - raw meat minus (n=186) or 1 - raw meat plus (n=164) subjects]. Loss: Max. likelihood (MS-err. scaled to 1). Final loss: 228.51 χ^2 (4)=26.8 P=0.00002. The first line shows constant B0 and β estimates of the regression function, the second line shows odds ratios (p/1-p), i.e., natural logarithm raised to the power of the β estimates, and the 95% confidence intervals for odds ratios.

ear analysis. The model included following dichotomous factors: gender (1), antitoxoplasma immunity (2), cat (3) and raw meat (4). The best model obtained by standard automatic procedure was 1-4, 2-4, 3-4 (χ^2 = 3.33, df = 8, P = 0.91). Despite the existence of the difference in prevalence of antitoxoplasma immunity among men and women, the inclusion of the 1-2 interaction (gender specific differences in toxoplasmosis susceptibility) had no effect on the model explanatory power (χ^2 = 3.34, df = 7, P = 0.85). It suggests that the difference in prevalence can be explained by interaction 1-4, i.e., by gender specific difference in the consumption of raw meat. Also the inclusion of interaction 2-3 (association of the contact with cats with antitoxoplasma immunity) did not improve the model (χ^2 = 3.32, df = 7, P = 0.85).

On the other hand the interaction 3-4 (association between the contact with cats and the raw meat consumption) was very important. The model 1-4, 2-4, 3 (χ^2 = 11.21, df = 9, P = 0.26) was significantly worse (χ^2 = 7.88, df = 1, P = 0.005) than the model 1-4, 2-4, 3-4. The interaction between the contact with cats and the raw meat consumption can probably explain (in combination with the interaction 2-4, e.g., the correlation of antitoxoplasma immunity with the raw meat consumption) the higher prevalence of subjects with antitoxoplasma immunity among those with the reported contact with cat. Very strong positive association between these two risk factors was found in the TN subset (Table 1c). The frequencies of subjects reporting the contact with a cat were 66.4 % and 48.1 % among 113 raw meat plus and among 158 raw meat minus subjects, respectively (P = 0.0028, n = 271, two tailed test). No association between the cat and the raw meat was observed in TP subset 61.1 % versus 57.1 % (P = 0.71, n = 89, two tailed test) (see Table 1c).

Influence of Confoundings, Gender and Age, on Meat-Antitoxoplasma Immunity Interaction

For the estimation of importance of the effects of the main risk factor, the raw meat, and confounding variables (gender, age), we used the logistic regression with either the antitoxoplasma immunity or raw meat consumption as the dependent dichotomous variable. The results (including the estimations of odds ratios) are shown in Table 2 and 3. The effect of the confounding variables was studied also by a stratified log-linear analysis. Mantel-Haenszel weighted odds ratio for meat-antitoxoplasma immunity interaction was 2.16 (95 % confidence interval 1.32-3.52). The result of the test does not suggest that odds ratios differ by age-stratum (χ^2 = 0.51, P = 0.774). The same conclusions were obtained by the gender-stratified log-linear analysis (χ^2 = 0.62, P = 0.429).

Influence of Human Personality on Reporting a Contact with Cat or Raw Meat Consumption

The *Toxoplasma* infection of human subjects is associated with a shift of certain personality factors (Low superego strength and Protension for men, and Affectothymia for women) (7, 8). The probability of reporting a contact with cat or raw meat consumption can also be influenced by the subjects personality. Therefore, the association between the raw meat consumption and the antitoxoplasma immunity can simply reflect a correlation of both the reporting of raw meat consumption and the *T. gondii* infection with the subject's personality. To exclude this possibility we measured the personality profiles of 243 men (69 *Toxoplasma* infected and 174 *Toxoplasma* free) and 200 women (44 *Toxoplasma* infected and 156 *Toxoplasma* free) from our biology students set. The correlation between the personality profiles and two risk fac-

Table 4. *Correlation of the contact with cat with personality profile*

Const.B0		A	B	C	E	F	G	H	I	L	M	N	O	Q1	Q2	Q3	Q4	AGE
Mean 0		9.41	9.28	12.5	13.1	11.5	9.46	10.0	12.9	9.46	13.2	8.33	10.5	7.52	13.7	10.7	13.3	28.29
Mean 1 -		10.4	9.40	13.5	13.1	12.3	9.61	10.7	12.4	10.3	13.3	8.03	10.5	7.57	12.6	10.0	14.2	28.12
Estimate	0.134	0.045	0.065	0.191	−0.07	−0.01	0.049	0.015	−0.07	0.065	−0.02	−0.04	0.00	0.004	−0.11	−0.11	0.084	−0.001
S.E.	0.982	0.056	0.080	0.064	0.047	0.053	0.052	0.042	0.052	0.062	0.057	0.061	0.053	0.066	0.065	0.062	0.047	0.015
t (178)	0.137	0.804	0.809	3.01	−1.5	−0.31	0.942	0.345	−1.4	1.05	−0.38	−0.66	−0.14	0.062	−1.7	−1.9	1.79	−0.086
p - level	0.891	0.423	0.420	0.003	0.134	0.753	0.347	0.731	0.149	0.292	0.703	0.507	0.888	0.951	0.084	0.057	0.074	0.932

Model: Logistic regression (logit). Dep. var: Cat [0 - cat minus (n=69) or 1 - cat plus (n=127) subjects]. Loss: Max. likelihood (MS-err. scaled to 1). Final loss: 114.1 χ^2 (17)=26.11 P=0.073. The third line shows constant B0 and β estimates of the regression function. The first and second line show arithmetic mean of raw personality factors for subject with and without contact with cat, respectively. List of personality factors: A - Sizothymia/Affectothymia, B - Intelligence, C - Strength of ego, E - Submissiveness/Dominance, F - Desurgency/Surgency, G - Superego strength, H - Threctia/Parmia, I - Harria/Premsia, L - Alaxia/Protension, M - Praxernia/Autia, N - Naivete/Shrewdness, O - Guilt proneness, Q1 - Conservatism/Radicalism, Q2 - Group dependency, Q3 - Self sentiment integration, Q4 - Ergic tension)

Table 5. *Correlation of the reported consumption of raw meat with personality profile*

Const.B0		A	B	C	E	F	G	H	I	L	M	N	O	Q1	Q2	Q3	Q4	AGE
Mean 0		9.78	9.41	13.3	12.2	11.7	9.10	9.18	12.7	9.52	13.1	8.20	10.7	7.33	13.2	10.1	13.3	25.39
Mean 1		10.4	9.29	13.0	13.7	12.7	9.88	11.7	12.5	10.4	13.3	8.06	10.4	7.64	12.8	10.3	14.5	30.29
Estimate	−1.6	−0.02	−0.02	−0.06	−0.01	0.064	0.007	0.083	−0.05	−0.00	−0.01	−0.02	−0.08	0.003	0.017	0.035	0.098	0.035
S.E.	1.05	0.055	0.076	0.057	0.044	0.051	0.050	0.043	0.051	0.061	0.055	0.059	0.051	0.062	0.061	0.060	0.044	0.016
t(176)	−1.5	−0.37	−0.33	−1.0	−0.09	1.25	0.138	1.96	−0.91	−0.02	−0.35	−0.38	−1.5	0.054	0.279	0.574	2.22	2.180
p-level	0.142	0.715	0.745	0.297	0.921	0.214	0.890	0.052	0.366	0.986	0.728	0.708	0.142	0.957	0.780	0.566	0.028	0.031

Model: Logistic regression (logit). Dep. var: Meat [0 - raw meat minus (n=98) or 1 - raw meat plus (n=96) subjects]. Loss: Max. likelihood (MS-err. scaled to 1). Final loss: 120.7 χ^2 (17)=27.54 P=0.051. The third line shows constant B0 and β estimates of the regression function. The first and second line show arithmetic mean of raw personality factors for subject with and without reported consumption of raw meat, respectively. For the list of personality factors see Table 4.

tors (cat and raw meat) was estimated by logistic regression using contact with cat or raw meat consumption as the dependent dichotomous variable and 16 raw personality factors and age as the continuous independent variables (Table 4 and 5). It is evident, that both the contact with cat and the consumption of raw meat are associated with particular personality traits. However, these traits differ from those associated with antitoxoplasma immunity.

DISCUSSION

Our results suggest that in the Czech Republic the important risk factor for acquiring *T. gondii* infection is eating or tasting raw meat. On the other hand the contact with cat seems to play either none or only a minor role.

Raw meat containing *T. gondii* tissue cysts is known to be an important source of infection (14, 15). Its importance varies from one area to another, depending on eating habits.

In comparison with similar studies from other countries, our results showed a very tight association between the consumption of raw meat and the antitoxoplasma immunity. This can be partially explained by the fact that our question covered both the eating and the tasting of raw meat. Many housewives have probably the habit of tasting raw meat such as a paste from chopped pork for meat balls during cooking. They might forget to report this habit when asked about the consumption of raw meat.

The absence of correlation between raw meat and the *T. gondii* infection was reported in several previous studies (16-19). These negative results, however, must be interpreted with a caution. The prevalence of tissue cysts in meat of different animals varies extremely. The highest prevalence is usually reported in sheep (9-23 %) and pigs (12-15 %), the lowest in cattle (0-10 %) and hens (0.3-8 %) (20). Eating of hamburgers or other meals from raw or undercooked beef probably represents only minor risk of inquiring toxoplasmosis.

Our results indicate that the strength of the association between raw meat and toxoplasmosis might in fact be even higher then suggested by basic statistical analysis of contingency tables. The strong association between the contact with a cat and the raw meat consumption that exists in the TN subset suggests that the results of questionnaire studies might be obscured by subjects who intentionally or unintentionally provided incorrect information during the interview. The surplus of double-plus subjects (the ones that gave positive answer about cat and raw meat) in the TN subset suggests that some subjects either a priori believe to be at higher risk of infection or believe that the investigator will be pleased by obtaining positive answers to his questions. Such subjects will answer both questions positively. It is indicative that the association between the cat and the raw meat does not exist in the TP subset. Most of the members of this subset probably correctly reported the consumption of raw meat (otherwise they would not enter TP subset). On the other hand, most subjects reporting consumption of

raw meat in the TN subset probably provided incorrect information (otherwise they would enter TP subset) and many of them probably also provided incorrect information reporting the contact with a cat. If we could eliminate these subjects from TN subset the strength of the association between consuming raw meat and the antitoxoplasma immunity would even increase.

According to our results, contact with cats did not affect the probability of being toxoplasma infected. It has already been pointed out by many authors that the role of cat in *T. gondii* life cycle should not be confused with its role in direct transmission of human toxoplasmosis (21). Absence of an association between the contact with cat and the antitoxoplasma immunity is in a good agreement with results of many but not all (17-19, 22, 23) previous studies. Authors mostly found no or low association between toxoplasmosis and the contact with cats (15, 16, 24-26). Sometimes a modest increase of prevalence of toxoplasmosis was observed among breeders of pedigree cats (24). This increase is usually interpreted as the results of handling of raw offal (27). The increased prevalence among cat owners can be also explained by the facts that the ownership of a cat may be associated not only with the handling raw meat but also with the ownership of other animals. Several studies showed a dramatic increase of toxoplasmosis prevalence among rabbits owners (28, 29). It can be also argued that if cats were important vectors, one would expect to see an increased incidence of disease among children and the elderly. Toxoplasmosis, however, is largely a disease of young adult (30).

Our finding of strong correlation between the reported contact with cat or raw consumption and the personality profile suggests that the subjective factors play an important role in questionnaire-based epidemiological studies. (It cannot be excluded, that the cat owners or the raw meat eaters really have different personality profiles than the general population.) It can be only recommended that in epidemiological studies more objective questions like „When did you play with a cat last time?" or „Did you eat a raw meat during past month (past year)?" should be substituted for the subjective questions like „Do you often play with a cat?" or „Do you often eat raw meat?". Even then the results can be obscured by subjects who provide an incorrect information during the interview. Publishing of questions and of whole frequency tables in papers is necessary in order to make possible the evaluation of impact of these effects. In our file of 30 questionnaire-based epidemiological papers on toxoplasmosis only one provided the frequency tables (31) and two presented the concrete questions given to the probandi (25, 32).

It is known that personality profiles of people with latent toxoplasmosis differ from those of non-infected population (7, 8). Our present results indicate that subjective interpretation of reality influences a character of the person's answers in an interview. It might be speculated that the correlation between the consumption of raw meat and the toxoplasmosis may reflect only a fact that both the probability reporting the consumption of raw meat and the probability of acquiring the toxoplasmosis depend on the same factor, namely on the personality profile of the subject. Our present results, namely the absence of correlation between the reported consumption of raw meat and the personality factors influenced by latent toxoplasmosis, however, suggest that this explanation is probably incorrect. At the same time, the existence of highly significant correlation between contact with cat and raw meat consumption could explain the reported positive association between toxoplasmosis and the cat ownership.

Acknowledgement

We thank Dr. J. Kulda and Dr. I. Hrdý for help with collecting the experimental data. This research was supported by Grant Agency of Czech Republic grant 206/95/0638.

REFERENCES

1. **Feldman, H. A., Miller, L. T.:** Serological study of toxoplasmosis prevalence. Amer. J. Hyg. 64, 1956, 320-335.
2. **Desmonts, G., Couvreur, J.:** Congenital toxoplasmosis. A prospective study of 378 pregnancies. N. Engl. J. Med. 290, 1974, 1110-1116.
3. **Sever, J. L., Ellenberg, J. H., Ley, A. C., Madden, D. L., Fucilio, D. A., Tzan, N. R., Edmonds, M.:** Toxoplasmosis: Maternal and pediatric findings in 23000 pregnancies. Pediatrics 82, 1988, 181-192.
4. **Roberts, T., Murrell, K. D., Marks, S.:** Economic losses caused by foodborne parasitic diseases. Parasitol. Today 10, 1994, 419-423.
5. **Zuber, P. L., Jacquier, P., Hohlfeld, P., Walker, A. M.:** Toxoplasma infection among pregnant women in Switzerland: A cross-sectional evaluation of regional and age-specific lifetime average annual incidence. Amer. J. Epidemiol. 141, 1995, 659-666.
6. **Hejlíček, K., Literák, I., Chalupa, B.:** Incidence of *Toxoplasma gondii* antibodies in blood donnors in 1980-1990. Čs. Epidem. 42, 1993, 135-140. (In Czech.)
7. **Flegr, J., Hrdý, I.:** Influence of chronic toxoplasmosis on some human personality factors. Folia parasitol. 41, 1994, 122-126.
8. **Flegr, J., Zitková, Š., Kodym, P., Frynta, D.:** Induction of changes in human behaviour by the parasitic protozoan *Toxoplasma gondii*. Parasitology 113, 1996, 49-54.
9. **Feldman, H. A.:** Laboratory methods in current use for the study of toxoplasmosis. Lausanne Bibliotheca Ophthalmology 39, 1954, 1-11.
10. **Frenkel, J. K.:** Dermal hypersensitivity to Toxoplasma antigens (Toxoplasmins). Proc. Soc. exp. Biol. Med 68, 1948, 634-639.
11. **Cattell, R. B.:** Handbook for the sixteen personality factors questionnaire (16PF), Institute for Personality and Ability Testing, Champain. 1970, 180.
12. **Christiansen, N. D., Goffin, R. D., Johnson, N. G., Rothstei, M. G.:** Correcting the 16PF for faking-effects on criterion validity and individual hiring decision. Person. Psychol. 47, 1994, 847-860.
13. **Grossman, L. S., Craig, R. J.:** Comparison of MCMI-II and 16PF validity scales rate. J. Pers. Assess. 64, 1995, 384-389.
14. **Stagno, S., Thiermann, E.:** Acquisition of toxoplasma infection by children in a developing country. Bull. Wld Hlth Org. 49, 1973, 627-631.
15. **Konishi, E., Takahaski, J.:** Some epidemiological aspects of Toxoplasma infections in a population of farmers in Japan. Int. J. Epidemiol. 16, 1987, 277-281.
16. **Huldt, G., Lagercrantz, R., Sheehe, P. R.:** On the epidemiology of human toxoplasmosis in Scandinavia especially in children. Acta paediat. Scand. 68, 1979, 745-749.
17. **Barbier, D., Ancelle, T., Martin-Bouyer, G.:** Seroepidemiological survey of toxoplasmosis in Le Guadeloupe, French West Indies. Amer. J. trop. Med. Hyg. 32, 1983, 935-942.
18. **Frenkel, J. K., Ruiz, A.:** Human toxoplasmosis and cat contact in Costa Rica. Amer. J. trop. Med. Hyg. 29, 1980, 1167-1180.
19. **Frenkel, J. K., Hassanein, K. M., Hassanein, R. S., Brown, E., Thulliez, P., Quinteronunez, R.:** Transmission of *Toxoplasma gondii* in Panama City, Panama: A five-year prospective cohort study of children, cats, rodents, birds, and soil. Amer. J. trop. Med. Hyg. 53, 1995, 458-468.
20. **Beattie, C. P.:** The ecology of toxoplasmosis. Ecol. Dis. 1, 1982, 13-20.
21. **Hendy-Ibbs, P. M.:** Aetiology of human toxoplasmosis. Brit. med. J. 287, 1983, 1467.
22. **Etheredge, G. D., Frenkel, J. K.:** Human Toxoplasma infection in Kuna and Embera children in the Bayano and San Blas, eastern Panama. Amer. J. trop. Med. Hyg. 53, 1995, 448-457.
23. **Jindřichová, J., Kramářová, K., Rosický, B., Jíra, J., Šimko, A.:** The cat as a possible source of toxoplasma infection for men. Folia parasitol. 22, 1976, 309-315.
24. **Ulmane, I., Leinikki, P.:** The role of pet cats in the seroepidemiology of toxoplasmosis. Scand. J. infect. Dis. 7, 1975, 67-71.

25. **Vaage, L., Midtvedt, T.:** Epidemiological aspects of toxoplasmosis III. The influence of contact with animals upon the prevalence of positive toxoplasmin reactions. Scand. J. infect. Dis. 9, 1977, 135-136.
26. **Yamaoka, M., Konishi, E.:** Prevalence of antibody to *Toxoplasma gondii* among inhabitants under different geographical and climatic conditions in Hyogo prefecture, Japan. Jap. J. med. Sci. Biol. 46, 1993, 121-129.
27. **Price, J. H.:** Toxoplasma infection in an urban community. Brit. med. J. IV, 1969, 141-143.
28. **Zástěra, M., Hübner, J., Pokorný, J., Seeman, J., Peychl, L., Kotrlík, J., Kubásek, M., Koutský, J.:** About the sources of human toxoplasmosis. Čs. Epid. Mikrobiol. Imunol. 15, 1966, 340-345. (In Czech.)
29. **Roseman, C.:** Human toxoplasma infection. J. Hyg. 52, 1954, 37-46.
30. **Larsen, S. O., Lebech, M.:** Models for prediction of the frequency of toxoplasmosis in pregnancy in situations of changing infection rates. Int. J. Epidemiol. 23, 1994, 1309-1314.
31. **Padelt, J., Ocklitz, H. W., Schluter, K., Ruickoldt, E., Kiuge, E.:** Untersuchungen mit dem Toxoplasminhauttest bei Kindern und Jugendlichen. Arztl. Jugdkde 64, 1973, 97-103.

Received April 3, 1997

WHO MODEL PRESCRIBING INFORMATION. DRUGS USED IN PARASITIC DISEASES
2nd edition

World Health Organization, Geneva 1995. 146 pages.
Format 145 x 210 cm.
Softcover, price Sw. fr. 35.-. Price in developing countries Sw. fr. 24.50.
ISBN 92 4 140104 4

WHO's revised drug strategy, as adopted in resolution WHA 39.27 of the Thirty-ninth World Health Assembly in 1986, calls for the preparation of model prescribing information which is being developed to complement WHO's Model List of Essential Drugs. This second edition provides relevant information on 39 essential drugs used for prevention and treatment of protozoic and helminthic diseases. First edition of this publication appeared in print in 1990 in English, and in 1993 in French. This volume has been prepared in collaboration with internationally accredited experts and with members of WHO's Expert Advisory Panel on Drug Evaluation and the various WHO advisory panels on parasitic diseases. It has also been reviewed by certain non governmental organizations in official relations with WHO including several pharmaceutical groups and manufacturers.

In this edition, the sections on malaria, African trypanosomiasis, cestode infections, schistosomiasis and onchocerciasis have been extensively revised in the light of new developments in the treatment of these diseases. Descriptions of particular drugs are organized into two parts: protozoans and helminths. Each part introduces parasitic diseases in question. Significant attention is paid to biological characters of infectious agents, clinical features, geographical distribution, transmission, effective control strategies, treatment and prevention. Furthermore, descriptions of antiprotozoal and anthelminthic agents are given, notably general information on chemical composition, absorption, plasma half-live, metabolism and excretion modes. Clinical information highlights uses, dosage and administration, contraindications and precautions, uses in pregnancy, adverse effects (local inflammation, haematological, gastrointestinal, neuromuscular, cardiac, nephrotoxic and other effects), drug interactions, overdosage and storage. Most drug doses are given per kilogram of body weight or as fixed doses calculated for adults of 60 kg.

Among protozoal diseases discussed are amoebiasis (entamoebiasis) and giardiasis, babesiosis, free-living amoebae including *Naegleria fowleri* and *Acanthamoeba* spp, leishmaniasis including visceral, cutaneous, mucocutaneous and diffuse clinical forms, malaria, miscellaneous intestinal disorders caused by protozoan genera *Balantidium, Sarcocystis, Isospora,* and *Cryptosporidium.* Besides, *Dientamoeba fragilis, Entamoeba polecki* and *Blastocystis hominis* are listed. Pneumocystosis, a frequent cause of opportunistic infection in patients who are debilitated or malnourished, is presented as the most frequent immediate cause of death in patients with acquired immunodeficiency syndrome (AIDS). Not omitted here is a remark that *Pneumocystis carinii* has been recently classified both as a protozoan parasite and a fungus. Among other protozooses examined are toxoplasmosis, the urogenital trichomoniasis, African trypanosomiasis and the Chagas disease. Particular drugs are described in connection with major protozoan diseases. Compared with the first edition, some new drugs as halofantrine, doxycycline, artemisinin and its derivates artemether and artesunate in malaria, and eflornithine in African sleeping sickness have been added.

Among helminthiases featured here are cestode (tapeworm) infections, intestinal and tissue nematode infections, loiasis, lymphatic filariasis, onchocerciasis, schistosomiasis, and intestinal, liver and lung flukes. In addition, looked at are minor and exotic helminthic infections - trichostrongyliasis, intestinal capillariasis, cutaneous larva migrans due to animal hookworms, visceral toxocariasis, anisakiasis and angiostrongyliasis. In addition, there are tables informing on dosage schedules for 5-nitroimidazole derivates, in malaria, African sleeping sickness, and schistosomiasis.

This essential text provides all data needed for management of parasitic diseases in the field of internal, infectious and tropical medicine and medical parasitology.

Jindřich Jíra