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Helminthic Infections of Pregnant Women in Maha Sarakham Province, Thailand

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Introduction

Infections and nutritional deficiencies are well known high risk factors especially in pregnant and lactating women: "Pregnancy alters susceptibility to infection and risk of disease which can lead to deterioration in maternal health" and "infections during pregnancy frequently influence the outcome of pregnancy" (1). This is true primarily of viral, bacterial and protozoal infections. With regard to human helminthiases, knowledge is less common as interactions between helminthiases and pregnancy have mainly been studied only in experimentally infected animals. Such experiments have shown that pregnant animals and their offspring are more susceptible to infections with certain helminth species if compared with control groups. Furthermore, helminth infections of pregnant or mother animals can also result in a reduction of litter size and birth weight of the young as well as of weight gain in the offspring (4, 6-12, 21). To broaden our knowledge on the interactions between pregnancy and helminthiases in humans, a field survey was carried out in a rural area of Thailand. This survey was part of a research programme which primarily dealt with the nutritional status of pregnant women and with pregnancy outcome (cf. 17).

Materials and methods

Study area and population surveyed

Maha Sarakham Province was selected as study area. This province is located in the centre of the Northeastern Region of Thailand (about 400 km by air northeast of Bangkok) and had an estimated population of 857,000 in 1986 (19). The main occupation in this area is farming. Due to the eating habits of the people, this region is well known for its extremely high prevalences of food-borne trematode infections (cf. 5, 15).

Beginning in March 1986 and continuing through September 1986, January 1987 and April 1987, baseline data were collected from as many women of child bearing age as possible in 21 villages. These surveys included stool examinations for intestinal parasites as well as measurements of nutritional status. Women becoming pregnant during the period under observation were given special attention. They were examined at about the 3, 6 and 8 months of pregnancy and also about 3 months after delivery. Thus, data from 5 sampling times were available, given as P_0 (before pregnancy), P_3, P_6, P_8 and PP in tables 1 and 2.

Altogether 204 women became pregnant but only 186 of them produced stool samples at least once during the observation period. A rather high percentage of stools were not delivered at certain sampling times, namely 46.8% (P_0), 24.2% (P_3), 17.2% (P_6), 17.8% (P_8) and 10.8% (PP). As a consequence a complete set of data existed for only 57 women. Four stool samples were obtained from 67 women, 3 from 46, 2 from 13 and 1 specimen only from 3 women.

Table 1:

Helminthiases in pregnant women of Maha Sarakham Province, Thailand

	P 0	P 3	P 6	P 8	PP	Total*
No. examined	99	141	154	153	166	186
No. positive	83	119	128	137	133	179
% positive	83.8	84.4	83.1	89.5	80.1	96.2
Prevalence						
Opisthorchis viverrini	54.5	68.1	66.9	73.2	71.1	81.2
Echinostomes	17.2	15.6	14.9	22.2	13.9	32.8
Minute intestinal flukes	18.2	26.2	19.5	22.9	21.7	43.0
Taenia sp.	4.0	1.4	1.9	2.6	1.2	7.5
Hookworms	36.4	39.7	34.4	36.6	22.3	58.1
Strongyloides stercoralis	13.1	7.1	4.5	8.5	3.0	17.2
Index	143.4	158.1	142.1	166.0	133.2	239.8
Percentage with						
1 helminth "species"	42.4	32.6	37.0	39.2	41.0	–
2 helminth "species"	32.3	32.6	33.8	28.1	26.5	–
3 helminth "species"	4.0	17.0	11.7	17.6	11.4	–
4 helminth "species"	2.0	1.4	0.6	3.9	1.2	–
5 helminth "species"	3.0	0.7	0.0	0.7	0.0	–

* = number and percentage of women found infected at least once during the period under observation

P 0 = before pregnancy

P 3, P 6, P 8 = about 3, 6, and 8 months, resp. after conception

PP = 3 months after delivery

The age of the 186 women from whom stools were available varied between 15 and 37 years (mean: 23.1). For the majority (98) it was their first pregnancy. The others had given birth already to 1 child (64), 2 children (16), 3 children (5) and 4 children (3).

Stool examinations

Stool samples collected in the villages were transferred to Khon Kaen and examined for helminth ova and protozoa by the staff of the Department of Parasitology, Faculty of Medicine, Khon Kaen University using the merthiolate-iodine-formalin concentration technique (MIFC).

Statistical analysis

The exact version of the McNemar test was used to compare prevalences of infection between different sampling times.

Results

The composition of the helminth fauna in the women examined (Tab. 1) is characterized by the predominance of food-borne trematodes. Second in prevalence are species which follow the percutaneous route of infection, i. e. hookworms and *Strongyloides stercoralis*. Interestingly, none of the fecal-orally transmitted helminths such as *Ascaris lumbricoides* and *Trichuris trichiura* were ever detected.

As only one stool sample per sampling time was examined the respective prevalences might underestimate the real situation. For example women examined only once in our survey were found infected by only one helminth species, while examination at two sampling times resulted in the detection of an average of two species. Finally, if five stool samples from different sampling times were available, the average number of species came to three. Thus, if we rely on the number and percentage of women found infected at least once during pregnancy during the period under observation, we might come closer to reality (cf. Tab. 1, last column).

Opisthorchis viverrini

The fish-borne liver fluke *(Opisthorchis viverrini)* is the prevailing helminth species in the pregnant rural women of Maha Sarakham Province. Eggs of this trematode were found at least once in stool samples of 81.2% of these women. Prevalence at different sampling times varied between 54.7% and 73.1%. The lowest value represents the situation before conception, while during pregnancy and after delivery the rates were higher by at least 12.4%. To find out whether this increase is statistically significant, only those women were included in the different analyses from whom stool samples were examined at P_0 and P_3, P_0 and P_6 etc. Significantly more previously non-infected women became positive for *O. viverrini* during pregnancy and lactation than converted from positive to negative ($p = 0.014$ or less). This result gives some hints that pregnancy and lactation may enhance susceptibility to *O. viverrini*. There were no differences in prevalence between women bearing their first child and those women who had already borne one or more children (Tab. 2).

Table 2:

Prevalence of helminthic infections in pregnant women of Maha Sarakham Province, Thailand according to the birth order

"Species"	Birth order*	P 0	P 3	P 6	P 8	PP	% of women at least once positive	% of positive stool specimens
Opisthorchis viverrini	1	54.7	70.7	67.1	73.1	68.2	79.8	67.2
	2 - 5	54.3	65.2	66.7	73.3	74.4	82.8	68.4
Echinostomes	1	15.6	12.0	13.4	19.2	12.5	28.3	14.5
	2 - 5	20.0	19.7	16.7	25.3	18.2	35.6	19.3
Minute intestinal flukes	1	14.1	25.3	17.1	19.2	21.6	39.4	19.6
	2 - 5	25.7	17.1	22.2	26.7	21.8	44.8	24.5
Hookworms	1	37.5	42.7	42.7	47.4	28.4	70.7	39.5
	2 - 5	31.4	36.4	25.0	25.3	15.4	42.5	25.5
Strongyloides stercoralis	1	15.6	12.0	7.3	11.5	3.4	25.3	9.6
	2 - 5	0.0	1.5	1.4	5.3	2.6	6.9	2.5

1 = first pregnancy and birth, resp. 2 - 5 = second to fifth pregnancy and birth, resp. P 0 etc. see Table 1

Echinostomes

Trematodes of the family Echinostomatidae also belong to the food-borne helminths with mainly snails as second intermediate hosts. To date five species are known to occur in the human population of the Northeastern Region of Thailand; *Hypoderaeum conoideum, Echinostoma malayanum, E. revolutum, E. ilocanum* and *Episthmium canium* (15). As size and shape of eggs (except for *E. malayanum*) do not allow differentiation between species they have been grouped under one heading.

32.8 percent of women were found to be infected at least once with echinostomes with a variation in prevalence of between 13.9% and 22.2% at the different sampling times (Tab. 1). The highest value was observed at the end of pregnancy, the lowest after delivery during lactation. While the increase in prevalence towards the end of pregnancy cannot be verified by statistical analysis, the decrease from P_8 to PP proves to be statistically significant. More women convert from positive to negative than vice versa ($p < 0.05$). As with opisthorchiasis the number of previous pregnancies seems to have no significant influence on echinostome infections (Tab. 2).

Minute Intestinal Flukes

Another group of food-borne trematodes is represented by the so-called minute intestinal flukes. Eight species have been identified as parasites of man in Northeastern Thailand (13, 15, 16), namely the heterophyids *Haplorchis taichui, H. yokogawai, H. pumilio* and *Stellantchasmus falcatus,* the plagiorchiid *Plagiorchis harinasutai* and the lecithodendriids *Phaneropsolus bonnei, P. spinicirrus* and *Prosthodendrium molenkampi.* Sources of infection are either fish (heterophyids), or snails (plagiorchiids) or, most probably, naiads of dragonflies (lecithodendriids). As the small-sized eggs of these trematodes are difficult or even impossible to differentiate, they also have to be dealt with as one single group.

Out of the 186 women examined, 43% revealed, at least once, eggs of the minute intestinal flukes in their stools. Although prevalence varied between 18.2% and 26.2% during the observation period (Tab. 1), none of the differences were statistically significant. The same is true if women with different numbers of pregnancies are compared (Tab. 2).

Hookworms

Among hookworms *Necator americanus* is the predominant species in Thailand, followed by *Ancylostoma duodenale* and, rarely, by *A. ceylanicum* (cf. 18). As differentiation of eggs is not possible the group term "hookworm" has to be used.

Among the helminths found in Maha Sarakham Province, hookworms are second in importance. The percentage of women found infected at least once during the observation period was 58.1%. Prevalences before and during pregnancy are rather stable with a minimum of 34.4% and a maximum of 39.7%. But there is a marked decrease from P_8 with 36.6% to PP with 22.3% (Tab. 1). Significantly more previously infected women convert to negative after delivery than conversely ($p < 0.005$). This is true independently of the previous number of pregnancies (Tab. 2). Women having already given birth to children, show lower values than those experiencing their first pregnancy and delivery. Whereas the percentage of those infected at least once during the observation period comes to 42.5% in the first group, it is much higher (70.7%) in the second. Similar differences are to be found with regard to prevalence (P_6: $p < 0.025$; P_8:$p < 0.005$ and PP: $p < 0.05$). This result shows the influence of previous pregnancies on hookworm prevalence, either directly or indirectly.

Strongyloides stercoralis

The threadworm *(Strongyloides stercoralis)* belongs to those helminths with a country-wide distribution in Thailand, although it shows marked differences in prevalence if provinces are compared. Maha Sarakham belongs to those areas where prevalence is well above the average (14, 20). This is confirmed by the results presented here.

The percentage of women found infected during our survey amounted to 17.2% (Tab. 1). But this may still be an underestimate, as in the case of *S. stercoralis,* because the examination of only a single stool specimen will miss many positive cases. Nevertheless, there are pronounced differences in prevalence between the different sampling times. The highest value (13.1%) was observed before pregnancy, the lowest (3.0%) after delivery during lactation. When comparing the two sampling times none of those found negative at the beginning of the observation period proved positive at the end. This difference could be verified statistically ($p < 0.005$).

If birth order is taken into account, differences are even more pronounced than with hookworms. Interestingly, in none of the women already having children were *Strongyloides* larvae found before pregnancy, whereas in those not already having children, the prevalence was as high as 15.6% (Tab. 2). Decrease in prevalence in the latter resulted in similarity of both groups after delivery. In general these results are similar to the observations made on hookworm infections.

Taenia spec.

The taxonomic status of *Taenia* species in Asia awaits clarification. For Thailand as for other parts of Asia, it is still an open question as to whether the tapeworms resembling *Taenia saginata* morphologically, using pigs as intermediate hosts, represent a new species or only a strain (2, 3). As *Taenia* eggs in feces do not allow species differentiation this problem does not affect our survey. On the other hand sampling of only eggs for *Taenia* is likely to underestimate real prevalence. Thus the percentage of infected women should be higher than 7.5% which is the observed rate at which women passed *Taenia* eggs in their stools. As a consequence it is unnecessary to discuss changes in prevalence.

Double and multiple infections

The rates for double and multiple infections are generally in accordance with the so-called "helminth index" (i. e. the sum of prevalences). They are high at the beginning and end of pregnancy and low before conception and after delivery (Tab. 1). No exceptional changes were found during the observation period.

Discussion

In general the helminth prevalences found in pregnant women from Maha Sarakham Province, reflect the situation in the rural population in other parts of Northeastern Thailand. This is characterized by high rates for food-borne trematodes and scarcity of *A. lumbricoides* and *T. trichiura*. As shown by the results of our study pregnancy can be linked with changes in prevalence. This is also true for *O. viverrini*, hookworms and *S. stercoralis*.

With regard to *O. viverrini* the increase in prevalence in women during pregnancy can be attributed to several factors. It is well known that pregnancy alters the "immune status" of a woman and may make her more susceptible to infections with helminths (cf. 1). Besides this direct influence, pregnancy may enhance the fecundity of the parasite, leading to a higher egg-output. Thus a very low worm burden, which might have been unrecognized in the non-pregnant women, could have been diagnosed later on during pregnancy. This could have simulated an increase in prevalence. Theoretically changes of eating habits in the pregnant women also have to be considered. This would mean that women eat raw or undercooked cyprinid fish more often during than before pregnancy. There is, however, no support for this supposition.

With hookworm and *S. stercoralis* the situation is different. The decrease of prevalences during pregnancy or after delivery can possible be traced back to a decrease in exposure. Although it is not certain where women get infected in the rural areas of Maha Sarakham Province this is likely to happen as they work, barefooted, in the field. They work less and less in the field as pregnancy progresses, thus exposure to hookworms and *S. stercoralis* larvae diminishes. This assumption is supported by the observation that women already having children exhibit significantly lower prevalences than those giving birth to their first child. Most probably women with children stay more at home and spend less time in the fields and, thus, are less exposed to percutaneously transmitted helminth species.

The results show that pregnancy can influence susceptibility and exposure of women to helminths, resulting in an increase or decrease in prevalence. Dealing with interactions between pregnancy and helminthiases, an opposite effect has also to be considered; i. e. one must consider whether helminthic infections can also have a bearing on the course and outcome of pregnancy.

To answer this questions, we have to refer to results published elsewhere (17). Parallel to the rural women in Maha Sarakham Province, women of a high socio-economic class from nearby Khon Kaen City have been examined for their nutritional status, food intake, haemoglobin, albumin and parasite infection rate. In these urban women prevalences were much lower (*O. viverrini* 9.1 - 16.1%, echinostomes 0.0 - 1.8%, minute intestinal flukes 0.0 - 3.6%, hookworms 1.8 - 3.6%) than for the rural population. Furthermore, the nutritional status among them was better, the maternal weight gain higher and the percentage of low birth weight babies less if compared to the rural women. In the latter it has been found that liver fluke infection was associated with lower maternal weight gain (17). Thus there are some hints that certain helminthic infections can influence pregnancy and pregnancy outcome, but there remain many questions to be answered.

Summary

To study interactions between pregnancy and helminthiases a survey was carried out in rural women of Maha Sarakham Province, Northeastern Thailand. Stool samples were collected before pregnancy, in each trimester and after delivery. Data were available at the different sample times for between 53.2% and 89.2% of 186 women. Food-borne trematodes were the predominant helminths, followed in frequency by percutaneously transmitted helminths. Infection rates for women found infected at least once during the period under observation were: *Opisthorchis viverrini* 81.2%, echinostomes 32.8%, minute intestinal flukes 43.0%, *Taenia* sp. 7.5%, hookworms 58.1% and *Strongyloides stercoralis* 17.2%.

Pregnancy was linked with an increase in *O. viverrini* infections. Significantly more women previously negative were found infected during pregnancy and after delivery than the converse. Factors responsible for this finding may be due to pregnancy related immunosuppression, changes in parasite fecundity or, possibly, an increased consumption of raw fish. For hookworms and *S. stercoralis* significantly more positive women converted to negative after delivery than conversely. Furthermore, women having given birth to children already, showed lower prevalences for hookworm and *S. stercoralis* than women bearing their first child. This could be due to a decrease of exposure to these percutaneously transmitted helminths.

Key words Pregnancy, Thailand, *Opisthorchis viverrini,* intestinal helminths.

Zusammenfassung

Helminthenbefall bei Schwangeren in der Provinz Maha Sarakham, Thailand

Zum Studium der Wechselwirkungen zwischen Schwangerschaft und Helminthenbefall wurden Stuhluntersuchungen bei Frauen aus Dörfern der Provinz Maha Sarakham, Nordostthailand durchgeführt. Erfaßt werden sollte der Helminthenstatus vor der Schwangerschaft, während jedes Trimenons sowie nach der Entbindung. Die Erfassungsrate für die einzelnen Zeitpunkte schwankte zwischen 53,2% und 89,2% bei insgesamt 186 Frauen. Im Wurmbefall herrschten nahrungsmittelübertragene Trematoden vor, in der Häufigkeit gefolgt von Arten, deren Übertragung dem perkutanen Infektionsmodus folgt. Für Frauen, die sich während des Untersuchungszeitraums mindestens einmal als infiziert erwiesen, betrugen die Infektionsraten für *Opisthorchis viverrini* 81,2%, Echinostomen 32,8%, Zwergdarmegel 43,0%, *Taenia* spec. 7,5%, Hakenwürmer 58,1% und für *Strongyloides stercoralis* 17,2%.

Mit Beginn der Schwangerschaft kam es zu einer Zunahme der *O. viverrini*-Infektionen. Signifikant mehr zuvor negative Frauen wurden während der Schwangerschaft und nach der Entbindung positiv gefunden als umgekehrt. Als Ursachen hierfür kommen eine erhöhte Empfänglichkeit als Folge schwangerschaftsbedingter Immunsuppression, auf gleicher Ursache beruhende Fekunditätsänderungen der Leberegel, möglicherweise aber auch vermehrter Verzehr von rohem Fisch in Frage. Hinsichtlich des Befalls mit Hakenwürmern und *S. stercoralis* verhielt es sich anders: Eine signifikant höhere Zahl zuvor positiver Frauen wurde nach der Entbindung negativ, als dies umgekehrt der Fall war. Darüberhinaus zeigten Frauen, die bereits geboren hatten, niedrigere Hakenwurm- und *S. stercoralis*-Prävalenzen als solche Frauen, bei denen es sich um die erste Geburt handelte. Diese Veränderung läßt sich möglicherweise auf eine Abnahme der Exposition gegenüber diesen perkutan übertragenen Helminthen zurückführen.

Schlüsselwörter Schwangerschaft, Thailand, *Opisthorchis viverrini,* Darmhelminthen.

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