Are long working hours and shiftwork risk factors for subfecundity? A study among couples from southern Thailand

Pitchaya Tuntiseranee, Jorn Olsen, Alan Geater, Ounjai Kor-anantakul

Abstract

***Objective*—To estimate the effect of long working hours and shift work on time to pregnancy.**

***Methods*—Cross sectional samples with retrospective data collection from two 700 bed hospitals at secondary to tertiary care level in Hatyai district, Songkhla Province, Thailand. The study was conducted from March 1995 to November 1995 among 1496 pregnant women attending the antenatal clinics. Subfecundity was defined as time to pregnancy longer than 7.8, 9.5, or 12 months (time to pregnancy was calculated from the date at which the couples started having sexual relations without any contraception until last menstrual date).**

***Results*—The descriptive analyses were restricted to 1201 planned pregnancies and the analytical part to 907 working women. Separate analyses on primigravid women were also done. Logistic regressions adjusted for age, education, body mass index, menstrual regularity, obstetric and medical history, coital frequency, and potential exposure to reproductive toxic agents, showed an odds ratio (OR) associated with female exposure to long working hours of 2.3 (95% confidence interval (95% CI) 1.0 to 5.1) in primigravid and 1.6 (1.0 to 2.7) in all pregnant women. Male exposure to long working hours and shiftwork showed no association with subfecundity. The OR of subfecundity was highest when both partners worked >70 hours a week irrespective of the cut off point used (OR 4.1 (95% CI 1.3 to 13.4) in primigravid women; OR 2.0 (95% CI 1.1 to 3.8) in all pregnant women).**

***Conclusions*—Long working hours is a risk factor for subfecundity especially for women. Shiftwork was not associated with subfecundity in this study.**

(*Occup Environ Med* 1998;**55**:99–105)

Keywords: long working hours; shiftwork; subfecundity; occupational risk

Department of Community Medicine
P Tuntiseranee

Epidemiology Unit
A Geater

Department of Obstetrics and Gynecology, Prince of Songkla University, Hatyai, Songkhla 90112, Thailand
O Kor-anantakul

Danish Epidemiology Science Center, Department of Epidemiology and Social Medicine, University of Aarhus, Hoegh-Guldbergs gade 10, DK-8000, Aarhus C, Denmark
P Tuntiseranee
J Olsen

Correspondence to:
Dr Pitchaya Tuntiseranee, Department of Community Medicine, Prince of Songkla University, Hatyai, Songkhla 90112, Thailand.
Tel: 0066 74 212070 ext 1331–2; Fax: 0066 74 212903.

Accepted 22 August 1997

Thailand has a relatively large female labour force. The 1980 census[1] showed that more than 60% of females of 11 years of age or more were employed at some time during the previous year and the percentage share of women in the labour force was 46% in 1993.[2] In urban areas, it is not uncommon for women to work for wages or as independent vendors both before and after marriage. The influx of women into the labour market during the past two decades of rapid industrialisation has recruited young and sexually active women into the industrial sector where they are exposed to potential reproductive hazards. However, in rural areas, most economic activities involve unpaid family work, particularly as farmers or rubber planters.

Long working hours and shiftwork are suspected to be reproductive risk factors because they may interfere with the balance of female hormones and may reduce sexual activity. Many studies of women engaged in intense physical sports—such as marathon runners and aerobic exercise teachers—have shown menstrual dysfunction and amenorrhea. The results of these studies show that physical stress may influence hypothalamic as well as pituitary function and reproductive performance.[3–7] However, it is questionable to generalise results from extremely fit women with low body fat to women who are exposed to typical, strenuous, occupational exertion. Additionally, most studies on women exposed to strenuous work such as shiftwork, heavy lifting, standing, and psychological job stress, have focused on adverse pregnancy outcomes.[8 9] Very few studies have considered subfecundity.[10 11]

Fecundity, as estimated by the time to pregnancy, is probably a sensitive and convenient marker when studying reproductive capacity. In strict terms, fecundity refers to the ability to produce live offspring; we defined the term as the ability to produce a pregnancy that survives to clinical recognition. In clinical practice, infertility is arbitrarily defined as not being able to conceive within a period of 12 months of unprotected intercourse. The variables studied in recent decades that may be related to prolonged time to pregnancy include sexually transmitted diseases, pelvic inflammatory disease,[12–15] maternal age—which has been re-explored in the light of recent research that permits separate determination of the role of the ovary and the role of the uterus in the in vitro fertilisation process and success rates[16]—some male factors,[17] weight loss and obesity,[18–20] use of contraceptives,[20 22] lifestyle factors,[23–27] and a few occupational chemical and physical exposures.[28–30] However, few of these factors (contraception and some chemicals) are well documented.

This study aimed at examining the problem of impaired fecundity as a result of long working hours and shiftwork in southern Thailand. Most Thai women do not smoke, or drink

Table 1 Comparison of questionnaire content used in the ESIS study and the fecundity study in Thailand

Section	*Main information in the ESIS study*	*Thai version*
A Your recent pregnancy	Date recent baby born. How many months the woman was pregnant. Present residential area	Same
B Prepregnancy group	This section divided the women into 7 groups by choosing the one that best described how she became pregnant: 1 Gravida 1: they have never used BCM 2 Gravida 1: they became pregnant while using a BCM 3 Gravida 1: they became pregnant after stopping use of BCM 4 Gravida > 1: after their previous pregnancy, their menstrual periods started again. Since, they have used no BCM and became pregnant 5 Gravida > 1: they became pregnant while using BCM 6 Gravida > 1: after their previous pregnancy, their menstrual periods started again. Since then they used BCM for a time, gave it up, and then became pregnant 7 Gravida > 1: their periods did not start again after their previous pregnancy. They were not using any BCM then they became pregnant	Same
C For women who became pregnant in spite of using BCM	Type of BCM. Regular or irregular use of BCM. How long the woman used BCM up to her pregnancy. Her ST	Same
D For women who were not using any BCM when they became pregnant	When did they start having unprotected sexual intercourse or their ST? How long was it from ST in months or years? How many periods from ST up to their pregnancy?	Same except the periods from ST up to their pregnancy
E For women whose periods had not started again when they became pregnant	The women were asked to write down the date their pregnancy started as ST	Same
F For women who used no BCM after their previous pregnancy	When did they start unprotected sexual intercourse after their previous pregnancy? Did the menstrual preiods start at ST? How many months and how many periods did it take from ST until they became pregnant?	Same except the periods up to their pregnancy
G 1-10 Maternal occupational factor at ST	Having paid job. Describe kind of work. Job title. Working h/week. Pattern of work. Working with VDUs (computers or word processors with a screen). Chemical exposure. Job stress score (Karasek 14 items)	Same except VDU exposure and job stress score
G 11-15 Maternal lifestyle at ST	Smoking. Passive smoking. Beverage and alcohol drinking. Residence at ST	Same
H Paternal exposure	Smoking. Beverage and alcohol drinking. Physical exercise or sport. Birth date and birthplace. Education level	Same except physical exercise
	Having a paid job. Describe kind of work. Job title. Working h/week. Pattern of work. Driving regularly. Working posture. Chemical exposure	Same
K Maternal health factors	Manarche, menstrual period and menstrual interval, coital frequency. Planned or unplanned pregnancy. Infertility problems and treatment. Gravida and parity. Prepregnancy weight and height	Same
	Casearean section. Miscarriage. Ectopic pregnancy. Stillbirth. Neonatal birth. Induced abortion. Obstetric diseases. IUD use. Oral pill use	Same
L Maternal and general questions	Birth date and birthplace. Marital status. Religion. Education level	Same

BCM = birth control method; ST = start time.

alcohol or coffee; they are young when they try to become pregnant, and many work long hours under physically demanding conditions. This setting was thus considered favourable for studying the association between long working hours, shiftwork, and subfecundity because of large variations in the exposure and little variation in some potential confounders.

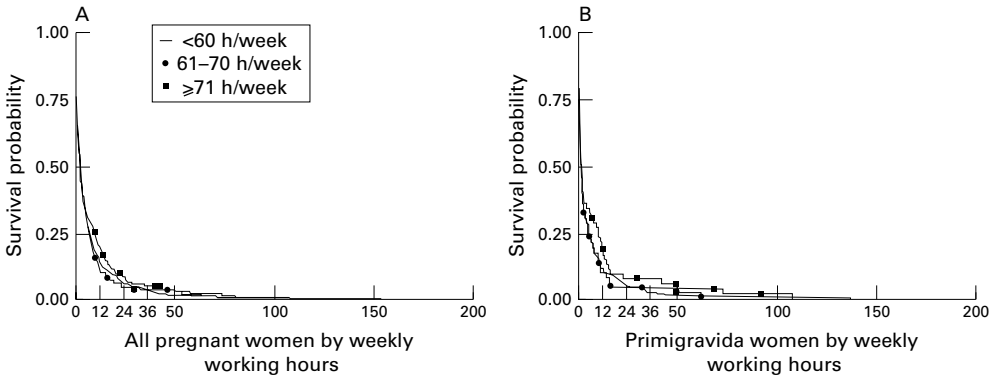
Subjects and methods

The study is based on a consecutive sample of 1496 pregnant women who received antenatal care at the two 700 bed public hospitals, Hatyai Hospital and Songklanagarind University Hospital situated in Hatyai district, Songkhla province, Thailand. The study period was from March to November 1995. Hatyai city is a trade centre of the southern part of Thailand with a population of 300 000. Both public hospitals are responsible for primary and secondary care in Hatyai and serve as tertiary care centres for the whole province. The average number of pregnant women who received antenatal care each month in 1993 was 400 at Hatyai Hospital and 120 at Songklanagarind University Hospital. The coverage of antenatal care by the public sector in Songklha province was 68.2% in 1992. As many well off women prefer to receive antenatal care at private clinics, women of the middle and lower social classes were probably overrepresented.

The fecundity questionnaire was modified from the questionnaire used in the European study of infertility and subfecundity (ESIS, table 1).[31] Data about husbands' exposures were obtained with women as informants. The A-F sections of the questionnaire were aimed at specifying the starting time or the date the woman began to have regular intercourse without any contraception and to calculate time to pregnancy or the duration of time the woman exposed herself to the opportunity of becoming pregnant by unprotected intercourse. These sections divided the women into seven groups according to pregnancy order, birth control method, and menstrual period after recent delivery. Table 1 shows the content of the questionnaire and the comparison between the European study and the Thai study.

Both men and women were considered to be exposed to reproductively toxic substances if they were exposed to paints, varnish, lacquer, dyes, pigments, inks, solvents, welding fumes, insecticides, herbicides, wood preservative agents, anaesthetic gas, *x* ray films, or radioactive agents. Exposure was recorded at four levels (1= most of the working time, 2= two to three times a week, 3= once in a while, 4= never) but in the analysis only two levels were used (1 = most of the working time or two to three times a week, 0 = occasionally or never).

The interviewers were five trained young women. Altogether 164 women were excluded from the study because they were unwilling to wait for the interview. Women unable to communicate in Thai, who had a severe psychiatric illness, or who had more than one pregnancy in the study period were considered ineligible (n= 0). Personal interviews were thus completed for 1496 women. Data on male exposure were obtained with the women as informants. The gestational week was filled in



Kaplan-Meier survival curve by weekly working hours of (A) all pregnant women, and (B) primigravid women.

by the nurse at the antenatal clinic. The mean (SD) gestational age at interview was 19.7 (6.1) weeks; range 4–42 weeks.

STATISTICAL ANALYSIS

Time to pregnancy was calculated directly from the starting time and the last menstrual period after subtracting periods of sexual abstinence due to illness, travel, or other causes. Also, a recheck of the time to pregnancy was based on the question "How many months or years did it take you to become pregnant?" and "How many months were you having sexual intercourse without doing anything to avoid a pregnancy?". If the time to pregnancy calculated by the interviewers differed markedly from that recorded on the basis of these questions, the research assistants would revise the information.

No established definition of subfecundity exists and we thus used the time to pregnancy at the 75th percentile (7.8 months) as a cut off point of subfecundity in this study. The cut off point at the 80th percentile (9.5 months), which was used in the European Study Group on Infertility and Subfecundity, was also used. Both cut off points were made to avoid the censoring of time to pregnancy due to infertility treatment.

Time to pregnancy is usually well defined for couples who plan a pregnancy and the analyses were restricted to 1201 women who indicated that their pregnancy was planned; 515 of these were first pregnancies. The Kaplan-Meier survival analysis stratified by working hours (<60, 61–70, >71 hours a week) was used to analyse times to pregnancy, and logistic regression was used to analyse possible determinants of subfecundity at three different cut off points (7.8, 9.5, and 12 months). The analyses were restricted to 907 women who had had a paid job before becoming pregnant because housewives (n=294) might be different from working women in many aspects. Breast feeding and injectable contraception (depoprovera) were considered potential confounders among women who started to have sexual relations without any contraception within the first four months of breast feeding[32] or within nine months after the last depoprovera injection.[33] Separate analyses were also made for the first pregnancy (n=515), mainly to evaluate the behavioural modification bias due to past pregnancy experience. All confidence intervals are presented as 95% limits.

Table 2 Main characteristics in the analysed subsamples, southern Thailand, 1995

Variables	*Planned pregnancy (n (%))*	
	Primigravida (n = 515)	*All pregnant (n = 1201 (100%))*
Women: age (y):		
⩽ 15	3 (1)	3 (0)
16–18	58 (11)	69 (6)
19–20	100 (19)	130 (11)
21–25	223 (43)	441 (37)
26–30	95 (19)	346 (29)
⩾ 31	36 (7)	212 (17)
Men: age (y):		
⩽ 18	10 (2)	11 (1)
19–20	35 (7)	44 (4)
21–25	219 (42)	315 (26)
26–30	171 (33)	414 (34)
⩾ 31	80 (16)	417 (35)
Gravidity:		
1	515 (100)	515 (43)
> 1		686 (57)
Gestational week at interview:		
⩽ 11	46 (9)	106 (9)
12–19	225 (44)	523 (44)
20–29	217 (42)	521 (43)
30–39	26 (5)	48 (4)
⩾ 40	1 (0)	3 (0)
Women: working at starting time	407 (78)	907 (76)
Men: working at starting time	509 (99)	1191 (99)
Women: working (h/week):		
⩽ 40	97 (24)	258 (28)
41–50	99 (24)	203 (22)
51–60	116 (29)	224 (25)
61–70	45 (11)	98 (11)
⩾ 71	50 (12)	124 (14)
Missing		
Men: working (h/week):	114 (22)	295 (25)
⩽ 40	103 (20)	218 (18)
41–50	167 (32)	338 (28)
51–60	57 (11)	149 (12)
61–70	68 (13)	191 (16)
⩾ 71	6 (2)	10 (1)
Women: shiftwork	132 (32)	302 (33)
Men: shiftwork	223 (44)	523 (44)
Time to pregnancy (TTP) (months):		
⩽ 3	289 (56)	632 (53)
3.1–7.8	116 (23)	268 (22)
7.9–12	48 (9)	109 (9)
⩾ 12.1	62 (12)	192 (16)

Results

The Kaplan-Meier curve (figure) shows no difference of time to pregnancy at three levels of female working hours either for the total pregnancy sample (log rank test; p=0.31) and for the sample of primigravid women (log rank test; p=0.13). Table 2 shows the main characteristics of the study population for primigravid as well as all pregnant women. The distribution of long working hours among women and men was similar in both groups. The distributions of

Table 3 Prevalence (n (%)) of three different levels of subfecundity according to selected variables, southern Thailand, 1995

	Time to pregnancy primigravid			*Time to pregnancy all pregnancies*		
Exposure	*> 7.8*	*> 9.5*	*> 12*	*> 7.8*	*> 9.5*	*> 12*
Women:						
Working (h/week):						
⩽ 40	21 (22)	20 (21)	15 (15)	72 (28)	61 (24)	49 (19)
41–50	26 (26)	16 (16)	9 (9)	39 (19)	27 (13)	18 (9)
51–60	18 (16)	15 (13)	9 (8)	51 (23)	44 (20)	30 (13)
61–70	8 (18)	7 (16)	4 (9)	22 (22)	17 (17)	11 (11)
⩾ 71	17 (34)	16 (32)	12 (24)	40 (32)	35 (28)	27 (22)
Shift work*						
Yes	31 (23)	25 (19)	17 (13)	83 (27)	68 (23)	51 (17)
No	59 (21)	49 (18)	32 (12)	141 (23)	116 (19)	84 (14)
Reproductive toxic agents:†						
Yes	11 (20)	10 (19)	5 (9)	28 (27)	25 (24)	16 (15)
No	99 (21)	79 (17)	57 (12)	273 (25)	223 (20)	176 (16)
Men:						
Working (h/week):						
⩽ 40	24 (21)	23 (20)	17 (15)	79 (27)	69 (23)	52 (18)
41–50	18 (17)	13 (13)	7 (7)	39 (18)	33 (15)	25 (11)
51–60	37 (22)	27 (16)	21 (13)	93 (28)	73 (22)	59 (17)
61–70	11 (19)	7 (12)	3 (5)	33 (22)	25 (17)	17 (11)
⩾ 71	19 (28)	18 (26)	14 (21)	55 (29)	46 (24)	38 (20)
Shift work:						
Yes	49 (22)	46 (21)	33 (15)	137 (26)	122 (23)	98 (19)
No	59 (21)	42 (15)	29 (10)	160 (24)	123 (19)	93 (14)
Reproductive toxic agents:						
Yes	22 (18)	14 (12)	9 (13)	63 (25)	50 (20)	38 (15)
No	88 (22)	75 (19)	53 (13)	238 (23)	198 (21)	154 (16)

* Shiftwork; rotating shift, fixed afternoon shift, or fixed nightshift.
† Reproductive toxic agents: paints/varnishes/lacquer, dyes/pigments/inks, welding fumes, insecticides/herbicides, wood preservatives, anaesthetic gases, radioactivity, *x* ray films.

Table 4 The odds ratio† (OR) according to working conditions for three different levels of subfecundity in samples of primigravid and all pregnant women, southern Thailand, 1995

	Primigravida‡ (adj OR (95% CI))			*All pregnancies‡ (adj OR (95% CI))*		
Variables	*TTP > 7.8*	*TTP > 9.5*	*TTP > 12*	*TTP > 7.8*	*TTP > 9.5*	*TTP > 12*
Working hours, women:						
⩽ 60	1	1	1	1	1	1
61–70	1.0 (0.4 to 2.5)	1.2 (0.4 to 3.2)	1.2 (0.4 to 4.0)	1.3 (0.7 to 2.4)	1.3 (0.7 to 2.5)	1.4 (0.6 to 3.0)
⩾ 71	1.6 (0.7 to 3.6)	2.3 (1.0 to 5.1)	2.3 (0.9 to 5.8)	1.4 (0.9 to 2.3)	1.6 (1.0 to 2.7)	1.6 (0.9 to 3.0)
Working hours, men:						
⩽ 60	1	1	1	1	1	1
61–70	0.7 (0.3 to 1.8)	0.5 (0.2 to 1.6)	0.3 (0.1 to 1.3)	0.6 (0.3 to 1.0)	0.5 (0.2 to 0.9)	0.3 (0.1 to 0.8)
⩾ 71	1.4 (0.6 to 3.4)	1.5 (0.6 to 3.9)	2.1 (0.7 to 6.1)	1.0 (0.6 to 1.6)	0.9 (0.5 to 1.5)	1.0 (0.5 to 1.5)
Shift work, women:						
No	1	1	1	1	1	1
Yes	1.3 (0.7 to 2.5)	1.0 (0.5 to 2.0)	1.0 (0.4 to 2.2)	1.3 (0.9 to 2.0)	1.1 (0.7 to 1.7)	1.2 (0.7 to 1.9)
Shift work, men:						
No	1	1	1	1	1	1
Yes	0.8 (0.4 to 1.6)	1.2 (0.6 to 2.5)	1.0 (0.4 to 2.1)	0.9 (0.6 to 1.3)	1.1 (0.7 to 1.6)	1.0 (0.6 to 1.6)

* Maternal and paternal reproductive toxic substances: paints/varnishes/lacquer, dyes/pigments/inks, welding fumes, insecticides/herbicides, wood preservatives, anaesthetic gases, radioactivity, *x* ray films.
† Adjusted for maternal age (⩽ 20, 21–25, 26–30, ⩾ 31), maternal education (⩽ 6, 10–12, 14–16, > 16 years), maternal body mass index (⩽ 17, 17.1–19, 19.1–21, 21.1–23, 23.1–25, 25.1–27, ⩾ 27.1; kg/m^2), menstrual regularity (regular/irregular), obstetric disease (yes/no), medical disease (yes/no), maternal toxic agent (yes/no), paternal toxic agent (yes/no), coital frequency (⩽ 4, 5–8, 9–12, ⩾ 13 times a month), exposure to reproductively toxic agent (yes/no), hormonal pill injection (less or more than 9 months since last injection), and other variables in the table.
‡ 407 Observations in a sample of primigravid women were analysed and 907 observations in a sample of all pregnant women were analysed.
TTP = time to pregnancy.

shiftwork and of having a paid job at the starting time among men and women were similar for primigravid and all pregnant women. In both samples, however, men were more likely to be employed at the starting time and had a higher proportion of shiftwork than women. Among all pregnant women, 53% became pregnant within the first three months of trying but about 25%, 21%, and 16% of the study population experienced a time to pregnancy longer than 7.8, 9.5, and 12 months respectively. The distribution of time to pregnancy among primigravid women was similar to the distribution among all pregnant women.

Women and men working >71 hours a week had the highest percentage of subfecundity both among first pregnancies and the total sample, and shiftwork had a similar distribution of subfecundity in both groups for both men and women (table 3). Grocery owners, owners of small to middle sized enterprises, supermarket saleswomen, construction workers, and food and beverage workers had the highest frequency of subfecundity among those working >71 hours a week. Industrial workers and labourers represent about 32% of the working women and they experienced a longer time to pregnancy than the other groups with

Table 5 The odds ratio† (OR) for three different levels of subfecundity in couples according to specific exposures to long working hours and shiftwork in samples of primigravid and all pregnant women, southern Thailand, 1995

	Primigravida‡ (adj OR (95% CI))			*All pregnancies‡ (adj OR (95% CI))*		
Variables	*TTP > 7.8*	*TTP > 9.5*	*TTP > 12*	*TTP > 7.8*	*TTP > 9.5*	*TTP > 12*
Working hours, couple:§						
None	1	1	1	1	1	1
Only men	1.3 (0.4 to 4.1)	1.5 (0.4 to 5.3)	2.0 (0.5 to 8.9)	0.7 (0.4 to 1.3)	0.7 (0.4 to 1.3)	0.9 (0.4 to 2.0)
Only women	1.4 (0.6 to 3.5)	2.0 (0.8 to 5.2)	1.8 (0.6 to 5.4)	0.9 (0.5 to 1.7)	0.9 (0.5 to 1.7)	1.2 (0.6 to 2.4)
Both	2.8 (0.9 to 8.8)	4.1 (1.3 to 13.4)	6.2 (1.8 to 21.8)	2.0 (1.1 to 3.8)	2.0 (1.1 to 3.8)	2.1 (1.0 to 4.3)
Shift work, couple:¶						
None	1	1	1	1	1	1
Only men	0.7 (0.3 to 1.6)	0.9 (0.4 to 2.2)	0.7 (0.2 to 1.9)	1.0 (0.6 to 1.5)	1.1 (0.7 to 1.9)	1.0 (0.6 to 1.8)
Only women	0.9 (0.3 to 2.5)	0.4 (0.1 to 1.7)	0.4 (0.1 to 2.0)	1.4 (0.8 to 2.5)	1.1 (0.6 to 2.1)	1.0 (0.5 to 2.1)
Both	1.2 (0.6 to 2.3)	1.4 (0.7 to 2.9)	1.1 (0.5 to 2.6)	1.2 (0.8 to 1.8)	1.3 (0.9 to 2.1)	1.4 (0.8 to 2.2)

* Maternal and paternal reproductive toxic substances: paints/varnishes/lacquer, dyes/pigments/inks, welding fumes, insecticides/herbicides, wood preservatives, anaesthetic gases, radioactivity, *x* ray films.
† Adjusted for maternal age (⩽ 20, 21–25, 26–30, ⩾ 31), maternal education (⩽ 6, 10–12, 14–16, > 16 years), maternal body mass index (⩽ 17, 17.1–19, 19.1–21, 21.1–23, 23.1–25, 25.1–27, ⩾ 27.1; kg/m^2), menstrual regularity (regular/irregular), obstetric disease (yes/no), medical disease (yes/no), maternal toxic agent (yes/no), paternal toxic agent (yes/no), coital frequency (⩽ 4, 5–8, 9–12, ⩾ 13 times a month), exposure to reproductively toxic agent (yes/no), hormonal pill injection (less or more than 9 months since last injection), and other variables in the table.
‡ 407 Observations in a sample of primigravid women were analysed and 907 observations in a sample of all pregnant women were analysed.
§ Couples' working hours (none = neither man or woman are working ⩾71 hours/week, only men = only men working ⩾71 hours/week, only women = only women working ⩾71 hours/week, both = both husband and wife working ⩾71 hours/week).
¶ Couples' shiftwork (the same as §).

long working hours. Subfecundity in shiftwork was mostly found in agriculture, the wood furniture industry, the food and beverage industry, and hotel housekeeping.

Exposure to substances potentially toxic to reproduction in men and women was not associated with subfecundity and therefore did not confound the association. The proportion of subfecundity increased in couples with increasing age, increasing female body mass index, and where men smoked traditional cigarettes or worked as lorry or minibus drivers. The women tended to be more subfecund in the lowest and highest category of education and social class (data not shown). Women working >71 hours a week were older, were more likely to have had a previous pregnancy, had less education, had a higher body mass index, had more frequent obstetric and medical diseases, experienced a higher proportion of menstrual irregularity, had fewer sexual contacts, were less likely to have unprotected sexual relations within the first nine months after stopping depoprovera, and more often had husbands with longer working hours.

We analysed the odds ratios (ORs) between coital frequency (<9 times a month *v* >9 times a month) and long working hours adjusted for maternal age and marriage duration and found that long working hours was associated with low coital frequencies. The factors associated with lower coital frequency were female age (>30 years) and marriage duration of more than one year.

Tables 4 and 5 show the association between long working hours (⩾71 hours a week) and subfecundity, which was analysed for men, women, and couples. Three different cut off points of time to pregnancy 7.8, 9.5, and 12 months were used. The adjusted odds ratios for a time to pregnancy of >9.5 months among women working >71 hours a week were high in first pregnancies (OR of 2.3, 95% CI 1.0–5.1) and in the entire pregnancy sample (OR of 1.6, 95% CI 1.0–2.7). Table 5 shows that subfecundity was most frequent when both partners had long working hours irrespective of which cut off point was used. The association was strongest among first pregnancies. Male and female shiftwork was only weakly and inconsistently associated with all three different cut off points of time to pregnancy in both first and in all pregnancies.

Discussion

Our findings indicate that long working hours is a risk factor of subfecundity. Shiftwork showed no association with subfecundity.

One of the possible proximal determinants of fecundity is coital frequency as both long working hours and shift work apparently reduced sexual activity but surprisingly not when both partners had long working hours. Furthermore, long working hours among women may cause hormonal disturbance leading to irregular menstrual bleeding and prolonged time to pregnancy, but the analyses did not support such a mechanism. The OR of subfecundity after adjusting for menstrual irregularity or coital frequency showed the same trend and had almost the same magnitude. This suggests that the possible mechanism to reduce fecundity is not only through sexual activity or menstrual disorders.

This study is subject to selection bias due to recruitment of pregnant women as sterile couples were excluded and subfecund women with long waiting times to pregnancy are underrepresented. The magnitude of selection bias depends on the distribution of times to pregnancy among exposed and unexposed couples. If the exposure causes sterility as the only response, the study will not detect the adverse effect[34] and the study was based on the assumption that the exposure changes the distribution of time to pregnancy in general.

The reason for including only planned pregnancies in the analysis was to provide accurate data on time to pregnancy. This may, however, result in planning bias if exposed and unexposed women have different probabilities of being excluded because of unplanned pregnancies. Weinberg *et al*[35] indicated that the exact magnitude will depend on the prevalence of

unplanned pregnancies and the degree to which exposed and unexposed couples differed in their use of birth control. In this study, the distribution of women who had an unplanned pregnancy despite use of birth control was 6.1% among women working <60 hours a week; 6.5% among women working 61–70 hours a week, and 4.7% among women working >71 hours a week which indicates little or no planning bias. Moreover, the OR of subfecundity when including unplanned pregnancies in the model was decreased, which indicates some planning bias, but not of a magnitude which would have changed the direction of the findings.

The subgroup analysis of primigravid women was done to avoid bias due to past adverse reproductive outcome[36] whereby the subfecund couples may reduce their workload when trying for a subsequent pregnancy to eliminate the risk of repeating subfecundity. Basically, results remained similar among nulliparous and all pregnant women. All exposure data referred to exposures at the starting time of time to pregnancy to avoid any behavioural modifications driven by prolonged waiting times.[37]

Female rubber planters work mainly night shifts but their working hours were short compared with the other occupations involving shiftwork. Workers in small to medium sized businesses reported very long sedentary working hours, often just waiting for the customer. To eliminate the degree of misclassified exposure measurement, rubber planters and women working in small to medium sized groceries were excluded from the analysis, which then showed a slightly increased OR for subfecundity according to working hours among primigravid and all pregnant women.

Women exercising vigorously were prone to menstrual disturbances.[4 38 39] The mechanism is probably mediated by the hypothalamic gonadotrophin releasing hormone (GnRH) pulse generator, normally ensuring the integrity of the menstrual cycle. In the absence of an appropriate GnRH pulse activity, there is luteal phase deficiency, anovulation manifesting itself as irregular menses and amenorrhoea. As well as exercise, low body weight and body fat, loss of body weight, and stress of competitive games likewise diminish pulse generator activity through similar mechanisms.[40] Many women experienced a high although perhaps less strenuous and more normal physical workload in their jobs, but there are few studies on the relation between occupational physical exertion and fecundity. Florack *et al*[39] considered the negative influence of occupational activity on fecundity but not on menstrual disturbances. However, that study lacked details on body mass index, athletic activities, and coital frequency.

Shiftwork has been considered a possible risk for preterm delivery, low birth weight, or spontaneous abortion,[41–43] but very few studies have considered subfecundity. A recent European study reported that female shiftwork reduced a couples' fecundity but male shiftwork did not have any effect.[11] In our study, shiftwork was defined as fixed or rotating shifts and if only a rotating shift was a risk factor, our effect measure would be attenuated. Our findings imply that long working hours could have an adverse effect on the fecundity of the couple which goes beyond the effect on libido and sexual activity. This effect is most likely specific to the type of work and results may well differ from one occupational setting to another.

Further prospective studies aiming at understanding the relation between prolonged waiting time and fertility rate or other reproductive end point should be performed to evaluate the usefulness of subfecundity as a sensitive marker in reproductive epidemiology.

This project was financed by a grant from the Danish International Development Assistance (DANIDA) under the Ministry of Foreign Affairs, Denmark. We thank the interviewers and the participants in the study and the European Study Group on Infertility and Subfecundity (ESIS).

1 Debavalya, Nibhon. *Economic activities of Thai women: as assessed in the 1980 population census (ASEAN-Australian population programme)*. Bangkok: Institute of Population Studies, Chulalongkorn University, 1983.
2 National Statistical Office, Office of the Prime Minister. *Statistical booklet on Thai women and men*. Bangkok: Statistical data bank and information, 1995.
3 Frisch RE, Wyshak G, Vincent L. Delayed menarche and amenorrhea in ballet dancers. *N Engl J Med* 1980;**303**:17–9.
4 Baker ER, Mathur RS, Kirk RF, *et al*. Female runners and secondary amenorrhea: correlation with age, parity, mileage, and plasma hormonal and sex-hormone-binding globulin concentrations. *Fertil Steril* 1981;**36**:183–7.
5 Bullen BA, Skrinar GS, Beitins IZ, *et al*. Induction of menstrual disorders by strenuous exercise in untrained women. *N Engl J Med* 1985;**312**:1349–53.
6 Green BB, Daling JR, Weiss NS, *et al*. Exercise as a risk factor for infertility with ovulatory dysfunction. *Am J Public Health* 1986;**76**:1432–6.
7 Keizer HA, Rogol AD. Physical exercise and menstrual cycle alterations. What are the mechanisms? *Sports Med* 1990;**10**: 218–35.
8 Saurel-Cubizolles MJ, Kaminski M. Work in pregnancy: its evolving relationship with perinatal outcome [a review]. *Soc Sci Med* 1986;**22**:431–42.
9 McDonald AD, McDonald JC, Armstrong B, *et al*. Prematurity and work in pregnancy. *Br J Ind Med* 1988;**45**: 56–62.
10 Florack EI, Zielhuis GA. Rolland R. The influence of occupational physical activity on the menstrual cycle and fecundability. *Epidemiology* 1994;**5**:14–8.
11 Bisanti L, Olsen J, Basso O, *et al*. Shift work and subfecundity: a European multicenter study. *J Occup Environ Med* 1996;**38**:352–8.
12 Cates W, Farley TM, Rowe PJ. Worldwide patterns of infertility: is Africa different? *Lancet* 1985;ii:596–8.
13 World Health Organization. Infections, pregnancies, and fertility: perspectives on prevention. *Fertil Steril* 1987;**47**: 964–8.
14 Grodstein F, Goldman MB, Cramer DW. Relation of tubal infertility to history of sexually transmitted diseases. *Am J Epidemiol* 1993;**137**:577–84.
15 Westrom LV. Sexually transmitted diseases and infertility. *Sex Transm Dis* 1994;**21**(suppl 2):32–7.
16 Navot D, Bergh PA, Williams MA, *et al*. Poor oocyte quality rather than implantation failure as a cause of age-related decline in female fertility. *Lancet* 1991;**337**:1375–7.
17 Silber SJ. Effect of age on male fertility. *Semininars of Reproductive Endocrinology* 1991;**9**:241–8.
18 Hartz AJ, Barboriak PN, Wong A, *et al*. The association of obesity with fertility and related menstrual abnormalities in women. *International Journal of Obesity* 1979;**3**:57–73.
19 Friedl KE, Plymate SR. Effect of obesity on reproduction in the female. *Journal of Obesity and Weight Regulation* 1985;**4**: 129–45.
20 Zaadstra BM, Seidell JC, Van-Noord PA, *et al*. Fat and female fecundity: prospective study of effect of body fat distribution on conception rates. *BMJ* 1993;**306**:484–7.
21 Vessey MP, Wright NH, McPherson K, *et al*. Fertility after stopping different methods of contraception. *BMJ* 1978;i: 265–7.
22 Pardthaisong T, Gray RH. The return of fertility following discontinuation of oral contraceptives in Thailand. *Fertil Steril* 1981:**35**;532–4.
23 Howe G, Westhoff C, Vessey M, *et al*. Effects of age, cigarette smoking, and other factors on fertility: findings in a large prospective study. *Br Med J Clin Res Ed* 1985;**290**:1697–700.
24 Baird DD, Wilcox AJ. Cigarette smoking associated with delayed conception. *JAMA* 1985;**253**:2979–83.
25 Weinberg CR, Wilcox AJ, Baird DD. Reduced fecundability in women with prenatal exposure to cigarette smoking. *Am J Epidemiol* 1989;**129**:1072–8.

26 Olsen J. Cigarette smoking, tea and coffee drinking, and subfecundity. *Am J Epidemiol* 1991;**133**:734–9.
27 Bolumar F, Olsen J, Boldsen J. Smoking reduces fecundity: a European multicenter study on infertility and subfecundity. *Am J Epidemiol* 1996;**143**:578–87.
28 Rachootin P, Olsen J. The risk of infertilty and delayed conception associated with exposures in the Danish workplace. *J Occup Med* 1983;**25**:394–402.
29 Sallmen M, Lindbohm ML, Kyyronen, *et al*. Reduced fertility among women exposed to organic solvents. *Am J Ind Med* 1995;**27**:699–713.
30 de Cock J, Westveer K, Heederik D, *et al*. Time to pregnancy and occupational exposure to pesticides in fruit growers in the Netherlands. *Occup Environ Med* 1994;**51**:693–9.
31 Juul S. European studies of infertility and subfecundity. In: Vuylsteek K, Hallen M. *Epidemiology*. Amsterdam: IOS Press, 1994:114–7.
32 Chayovan N, Knodel J, Wongboonsin K. Infant feeding practices in Thailand: an update from the 1987 demographic and health survey. *Stud Fam Plann* 1990;**21**:40–50.
33 Pardthaisong T, Gray RH, McDaniel EB. Return of fertility after discontinuation of depot medroxyprogesterone acetate and intra-uterine devices in northern Thailand. *Lancet* 1980;i:509–12.
34 Baird DD. Using time-to-pregnancy data to study occupational exposures: methodology. *Reprod Toxicol* 1988;**2**:205–7.
35 Baird DD, Wilcox AJ, Weinberg CR. Use of time to pregnancy to study environmental exposures. *Am J Epidemiol* 1986;**124**:470–80.
36 Olsen J. Options in making use of pregnancy history in planning and analysing studies of reproductive failure. *J Epidemiol Community Health* 1994;**48**:171–4.
37 Weinberg CR, Baird DD. Wilcox AJ. Sources of bias in studies of time to pregnancy. *Stat Med* 1994;**13**:671–81.
38 Dale E, Gerlach DH, Wilhite AL. Menstrual dysfunction in distance runners. *Obstet Gynecol* 1979;**54**:47–53.
39 Shangold MM, Levine HS. The effect of marathon training upon menstrual function. *Am J Obstet Gynecol* 1982;**143**:862–9.
40 Nader S. Female judoists: their hormones, muscles, and bones. *Lancet* 1996;**347**:919–20.
41 Xu X, Ding M, Li B, *et al*. Association of rotating shift-work with preterm births and low birth weight among never smoking women textile workers in China. *Occup Environ Med* 1994;**51**:470–4.
42 Nurminen T. Shift work, fetal development and course of pregnancy. *Scand J Work Environ Health* 1989;**15**:395–403.
43 Axelsson G, Rylander R, Molin I. Outcome of pregnancy in relation to irregular and inconvenient work schedules. *Br J Ind Med* 1989;**46**:393–8.

Correspondence and editorials

Occupational and Environmental Medicine welcomes correspondence relating to any of the material appearing in the journal. Results from preliminary or small scale studies may also be published in the correspondence column if this seems appropriate. Letters should be not more than 500 words in length and contain a minimum of references. Tables and figures should be kept to an absolute minimum. Letters are accepted on the understanding that they be subject to editorial revision and shortening.

The journal also publishes editorials which are normally specially commissioned. The Editor welcomes suggestions regarding suitable topics; those wishing to submit an editorial, however, should do so only after discussion with the Editor.

Are long working hours and shiftwork risk factors for subfecundity? A study among couples from southern Thailand.

P Tuntiseranee, J Olsen, A Geater, et al.

Occup Environ Med 1998 55: 99-105
doi: 10.1136/oem.55.2.99