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EFFECTS OF ORAL CONTRACEPTIVE USE ON BODY MASS INDEX AND BLOOD PRESSURE AMONG FEMALE VILLAGERS IN NORTH-EAST THAILAND

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Summary. The use of contraceptives has become prevalent among females in Thailand in the past 20 years, and oral contraceptive use has been suggested to trigger changes in fat intake, energy expenditure, fat metabolism and blood pressure. Based on field investigations of 391 married women aged 20 years or over in Yasothon Province, North-east Thailand, this study aims to elucidate the effects of oral contraceptive use on body mass index (BMI: kg/m^2) and blood pressure, taking into account reproductive histories and socioeconomic conditions. The proportion of obese ($BMI \geq 25$) subjects was high in the age groups 30–39, 40–49 and 50–59, accounting for, respectively, 39·4%, 51·1% and 48·5% of these populations. The proportion of women with hypertension (90/140 mmHg) was 23·7%, 18·5% and 26·2% in the 40–49, 50–59 and 60–69 age groups. Current contraceptive practices in the studied population included sterilization by operation, oral contraception and injection. These methods accounted for 43·0%, 12·8% and 8·2% of the population, respectively. Sociodemographic factors such as reproductive history, years of education and household income were not significantly related to BMI or to blood pressure (ANOVA with age adjustment). In contrast, oral contraceptive users had significantly higher BMIs and diastolic blood pressures ($p<0·01$, ANOVA with age adjustment). Multiple regression analysis also revealed that oral contraceptive use was a weak but significant contributing factor to both high BMI and blood pressure when sociodemographic factors were taken into account and controlled for statistically. It can thus be concluded that the use of contraceptive pills, which contain oestrogen and

progestin and are provided free of charge to Thai women, tend to increase BMI and to elevate blood pressure.

Introduction

Obesity is now prevalent in Third World countries, and females are more prone to suffer from this condition than are males (James & Ralph, 1999). In Asian populations, the known hazards of being moderately overweight seem to be more prominent than in other populations. Complications of obesity – including diabetes, dyslipidaemias, hypertension and coronary heart diseases – were found to occur frequently among females whose body mass index (BMI: kg/m^2) was greater than 23 in an Indian population (Singh *et al.*, 1997). In Hong Kong Chinese, BMI values of 23 and 26 were proposed as cut-off values to define, respectively, overweight and obesity (Ko *et al.*, 2001). Obesity is principally the result of a positive or excessive balance of energy intake and expenditure. The metabolic factors concerned include a low metabolic rate, low insulin sensitivity and high respiratory quotient. In addition, various sociodemographic factors, such as smoking habits, dietary habits, socio-economic class, education level, use of contraceptives, postpartum status and rapid weight gain in childhood, have been recognized as modifying factors (Bray, 1999).

Contraceptive practice has expanded rapidly in Thailand over the past 20 years under a strong governmental policy promoting birth control. The proportion of contraceptive users among married women was 14·4% in 1970 and 65·5% in 1987, according to a recent report by USAID and the US Department of Commerce (1998). This report also revealed that the dominant contraceptive methods used in Thailand in 1987 were sterilization (22·8%) and oral contraceptive pills (18·6%). Body weight gain and increased blood pressure have been pointed out as the major side-effects of oral contraceptive use, and suspected causes include alterations in energy balance, fat metabolism and endocrine balance. Increases in blood pressure resulting from use of contraceptive pills have been ascertained by cross-sectional studies (Stern *et al.*, 1976; Ostrander *et al.*, 1980; WHO Task Force on Oral Contraceptives, 1989; Godsland *et al.*, 1995; Sherif, 2000). However, there were inconsistent results regarding the effects of oral contraceptives on body weight gain; some cohort studies reported significant effects (Bradley, 1985; Woutersz & Korba, 1988; Korkeila *et al.*, 1995), while some clinical studies reported non-significant effects (Eck *et al.*, 1997; Rosenberg, 1998).

This study aims to examine the effects of contraceptive practices – particularly the use of oral contraceptive pills – on BMI and blood pressure among free-living female villagers in North-east Thailand, taking into account their reproductive histories and socioeconomic conditions.

Subjects and methods

Subjects

Five farming villages were selected to represent rural villages in Yasothon Province, North-east Thailand, and were characterized according to their occupational patterns and economic levels. In one of the five villages, the authors conducted

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a nutritional–ecological survey, focusing on metabolic energetics (Murayama & Ohtsuka, 1999a, b). The total population of the five villages was 3184 (1607 males and 1577 females) in 1999. In response to the authors' invitation to all married women aged 20 and over, 410 women participated. The exact participation rate was uncertain because there were a considerable number of temporal absentees for work in urban areas, though participation was estimated to be about 50%. Five pregnant women, and another fourteen women whose information about contraceptive use was incomplete, were excluded from the analysis and thus the data for 391 women were analysed.

In the study area, contraceptive devices were provided free of charge by the local health centres, and the selection of contraceptive methods was made by the villagers. Two types of oral contraceptive pills were made available, each of which contained oestrogen and progestin. The low-dose pills contained 30 g ethinyl oestradiol and 150 g desogestrel or 150 g levonorgestrel. The standard-dose pills contained 50 g ethinyl oestradiol and 50 g norgestrel or 1·0 mg lynestrenol. The major injected contraceptive is DMPA (depot medroxyprogesterone acetate), which is injected at a dose of 150 mg every 12 weeks.

Field survey

The field survey was conducted in each of the five villages from February to March 1999. For collection of data, seven health workers from Yasothon Provincial Health Centre and its branch offices collaborated with the authors. They were well trained and prepared for this study – especially the interview survey – by the authors. The purpose and procedures of the investigation were explained to the participants, and written informed consent was obtained from each of them. The protocol of this research project – 'Primary health and environmental care in rice farming communities in Asian (headed by Ryutaro Ohtsuka)' – was approved by the Ethical Committee of the Graduate School of Medicine, University of Tokyo.

Anthropometry and blood pressure

Anthropometry was performed according to standard methods (Lohman, Roche & Martorell, 1988). Body weight in minimal clothing – which normally consisted of a T-shirt and salon – was measured with a digital balance (Tanita, Japan) to the nearest 0·1 kg. Standing height was measured to the nearest 1 mm with a Martin anthropometer. Body mass index (BMI: kg/m^2) was calculated and then categorized into one of five groups according to WHO (1997) criteria: underweight (<18·5), normal (18·5–24·9), pre-obese (25·0–29·9), class I obese (30·0–34·9) and class II obese (35·0–39·9). Skinfold thickness was measured at five sites (biceps, triceps, subscapular, suprailiac and abdominal) to the nearest 0·2 mm, using Holtain calipers (Holtain Ltd, Briberian, UK). The four-site skinfold equation of Durnin & Womersley (1974) was used in combination with that of Siri (1956) to estimate body fat percentage. Diastolic and systolic blood pressures were measured by the following protocol. The subjects were seated in a chair with their backs supported and their arms bared and supported at heart level. The subjects refrained from smoking or ingesting caffeine during the 30 minutes preceding the measurement. Measurement began after at least 5 minutes of

rest. The cuff sizes were appropriate for the subjects. Measurements were taken by a validated electronic sphygmomanometer (Omuron, Japan). Two readings were taken and averaged. The blood pressures (mmHg) were categorized into six groups according to WHO (1999) criteria: optimal (<80 and <120), normal (<85 or <130), high–normal (85–89 or 130–139), grade I hypertension (90–99 or 140–159), grade II hypertension (100–109 or 160–179) and grade III hypertension ($\geq$110 or $\geq$180). One researcher conducted all body weight and height measurements and another researcher conducted all skinfold thickness and blood pressure measurements. Intra-observer anthropometric and blood pressure measurement errors were not estimated.

Contraceptive use and sociodemographic indicators

Each subject was interviewed regarding contraceptive practices at present and in the past. Thai health workers using a structured questionnaire recorded contraceptive methods, durations and frequencies in interview, as well as perceptions about possible side-effects. This questionnaire was developed specifically for this survey and was translated into the Thai language by Thai health workers. When they translated the questionnaire, they verified its effectiveness and ease of interpretation. Questions regarding problems associated with injections and operations were added to the questionnaire after the pilot test was conducted. The use of contraception was asked with the question 'Have you ever used contraception?' and the categories of answers were: (1) I have never used contraception, (2) I don't use contraception now, but I have used it previously, (3) I use contraception now. When the subject selected the second category, she was then asked: 'From what age to what age have you used contraception?' and 'What kinds of contraceptives have you used?'. When the subject selected the third category, she was then asked: 'What kinds of contraceptive do you use?' and 'How often do you use it?'. Subjects' perception about side-effects was tested by asking the question 'Have you experienced any trouble with contraception?', and possible answers were: (1) No and (2) Yes. If the subject selected 'Yes', she was asked 'What kind of trouble have you ever experienced using the pill?' and the same question was asked for injections and operations. Soicodemographic variables related to obesity and hypertension were also included in the survey: age at menarche, years of education, smoking habits, reproductive history (live births, stillbirths, abortions and child deaths after birth), household income and types and frequencies of food consumption. In this study, frequency of meat consumption was selected as an indicator of modernized dietary habits, and smoking habits were excluded from analysis due to a negligible number of smokers in the test population.

Statistical analyses

All women subjects from the five villages were pooled and divided into six age groups with 10-year intervals. Inter-age-group comparisons of BMI, blood pressure and sociodemographic indicators were made by ANOVA. The relationships of BMI or diastolic or systolic blood pressure with contraceptive use and sociodemographic variables were examined by ANOVA with age as a covariant factor. Multiple

regression analysis was performed to examine the contributing factors of contraceptive use to BMI and blood pressure, with adjustments for age and sociodemographic variables. All statistical analyses were conducted using SPSS 7·5J for Windows (SPSS Inc., Chicago, USA), and a significance level was set at $p<0·05$.

Results

Sociodemographic characteristics

The sociodemographic characteristics of the subjects, broken down into six age groups, are shown in Table 1. All characteristics except for household income varied among the six groups. Age of menarche decreased with birth year ($p<0·001$, ANOVA). The age of menarche was lower in the 20–29 age group than in the 30–39 and other age groups ($p=0·003$ and $p<0·001$, respectively, Bonferoni's multiple comparison test). The numbers of cumulative live births and abortions/stillbirths over the women's total lifetime were lower in the younger age groups ($p<0·001$, ANOVA). The numbers of cumulative live births were lower in the 20–29, 30–39 and 40–49 age groups than in the 50–59, 60–69 and 70+ age groups ($p<0·001$, Bonferoni's multiple comparison test). The number of abortions/stillbirths over lifetime was higher in the 70+ age group than in the other age groups ($p<0·001$, Bonferoni's multiple comparison test). Total years of education were longer in the 20–29 and 30–39 age groups than in the other age groups ($p<0·001$, ANOVA, and $p<0·001$, Bonferoni's multiple comparison test). The frequency of meat consumption in one week was less in the 70+ age group ($p<0·001$, ANOVA, and $p<0·05$, Bonferoni's multiple comparison test). These results indicated that age was a confounding factor with regard to BMI and blood pressure.

BMI and blood pressure

The mean (SD) BMIs were 22·6 (2·9), 24·3 (3·8), 25·3 (4·1), 24·6 (4·1), 23·7 (4·1) and 22·8 (5·0) in the 20–29, 30–39, 40–49, 50–59, 60–69 and 70+ age groups, and significant inter-group differences were found ($p=0·001$, ANOVA), as shown in Table 2. The BMI was higher in the 40–49 age group than in the 20–29 age group ($p=0·001$, Bonferoni's multiple comparison test). The proportion of obese and pre-obese categories (pooled) was high in the 30–39, 40–49 and 50–59 age groups, accounting for 39·4%, 51·1% and 48·5%, respectivley. BMI was significantly correlated with body fat percentage ($p<0·001$, partial correlation analysis with age adjustment), as illustrated in Fig. 1. The mean (SD) diastolic and systolic blood pressures (mmHg), respectively, were 68·9 (9·8), 68·6 (9·8), 74·6 (10·6), 72·0 (12·0), 69·7 (11·2) and 63·8 (9·0), and 112·4 (13·6), 112·9 (14·0), 123·9 (19·3), 123·3 (21·3), 125·4 (22·3) and 117·0 (17·0) for the six age groups, ordered according to increasing age. Significant inter-group differences were seen for both types of blood pressure ($p<0·001$ for both, ANOVA). Diastolic blood pressure was higher in the 40–49 age group than for the other age groups ($p<0·05$, Bonferoni's multiple comparison test). Systolic blood pressure was higher in the 40–49, 50–59 and 60–69 age groups than in the 20–29 and 30–39 age groups ($p<0·05$, Bonferoni's multiple comparison test). The prevalence of

Table 1. Sociodemographic characteristics of the subjects

Variables	Age (years)	*n*	Mean	(SD)	Statistical significance*	Multiple comparison analysis of age groups
Number of live births in lifetime	20–29	60	1·6	(0·9)		20–29 years<all other ages, $p<0·001$
	30–39	109	2·3	(0·9)		30–39<40–49 years, $p=0·004$
	40–49	94	3·2	(1·6)		30–39<50–59, 60–69 and 70+ years, $p<0·001$
	50–59	66	4·7	(2·5)	$p<0·001$	40–49<50–59, 60–69 and 70+ years, $p<0·001$
	60–69	44	6·2	(2·5)		
	70+	18	7·4	(3·5)		
	Total	391	3·5	(2·4)		
Number of abortions/stillbirths in lifetime	20–29	60	0·0	(0·1)		20–29<50–59 years, $p=0·009$
	30–39	109	0·1	(0·4)		20–29<70+ years, $p<0·001$
	40–49	94	0·2	(0·5)		30–39<50–59 years, $p=0·021$
	50–59	66	0·5	(0·9)	$p<0·001$	30–39<70+ years, $p<0·001$
	60–69	44	0·4	(0·9)		40–49<70+ years, $p<0·001$
	70+	18	1·4	(2·5)		50–59<70+ years, $p<0·001$
	Total	391	0·3	(0·9)		60–69<70+ years; $p<0·001$
Education (years)	20–29	60	6·3	(1·6)		20–29>40–49, 50–59, 60–69 and 70+ years, $p<0·001$
	30–39	109	5·8	(2·5)		30–39>40–49, 50–59, 60–69 and 70+ years, $p<0·001$
	40–49	94	4·3	(1·1)		
	50–59	66	4·0	(0·2)	$p<0·001$	
	60–69	44	3·9	(0·9)		
	70+	18	3·9	(0·2)		
	Total	391	4·9	(1·8)		

Table 1. *Continued*

Variables	Age (years)	*n*	Mean	(SD)	Statistical significance*	Multiple comparison analysis of age groups
Household income (Bharts/year)	20–29	60	64,722	(129,557)		
	30–39	109	63,870	(71,182)		
	40–49	94	72,679	(125,893)		
	50–59	66	85,777	(180,707)	p=0·84 (ns)	
	60–69	44	58,520	(73,761)		
	70+	18	57,222	(132,979)		
	Total	391	68,921	(121,826)		
Consumption of meat (times/week)	20–29	60	3·8	(2·3)		20–29>60–69 years, p=0·021
	30–39	109	3·6	(2·3)		20–29>70+ years, p=0·004
	40–49	94	3·5	(2·3)		30–39>60–69 years, p=0·031
	50–59	66	3·4	(2·5)	p<0·001	30–39>70+ years, p=0·006
	60–69	44	2·4	(2·0)		40–49>70+ years, p=0·017
	70+	18	1·5	(1·4)		50–59>70+ years, p=0·040
	Total	391	3·3	(2·4)		
Age of menarche (years)	20–29	60	14·3	(1·4)		20–29<30–39 years, p=0·003
	30–39	109	15·3	(1·8)		20–29<40–49, 50–59, 60–69 and 70+ years, p<0·001
	40–49	94	15·7	(1·4)		30–39<70+ years, p=0·043
	50–59	66	15·6	(1·7)	p<0·001	
	60–69	44	15·8	(1·9)		
	70+	18	16·7	(2·4)		
	Total	391	15·4	(1·8)		

*Statistical significance among age groups was examined by one-way ANOVA with multiple comparison analysis by Bonferoni's method. ns: not significant.

Table 2. Prevalence of obesity for the subject females

Age group (years)	*n*	BMI (kg/m^2)*		Underweight†		Normal†		Pre-obese†		Obese I†		Obese II†		Total	
		Mean	(SD)	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
20–29	60	22·6	(2·9)	2	3·3	46	76·7	12	20·0	0	0·0	0	0·0	12	20·0
30–39	109	24·3	(3·8)	2	1·8	64	58·7	35	32·1	7	6·4	1	0·9	43	39·4
40–49	94	25·3	(4·1)	4	4·3	42	44·7	35	37·2	13	13·8	0	0·0	48	51·1
50–59	66	24·6	(4·1)	7	10·6	27	40·9	28	42·4	3	4·5	1	1·5	32	48·5
60–69	44	23·7	(4·1)	2	4·5	27	61·4	11	25·0	4	9·1	0	0·0	15	34·1
70+	18	22·8	(5·0)	4	22·2	8	44·4	4	22·2	2	11·1	0	0·0	6	33·3
All	391	24·2	(4·0)	21	5·4	214	54·7	125	32·0	31	7·9	2	0·5	158	40·4

*Statistical significance among age groups was examined by one-way ANOVA (p=0·001) with multiple comparison analysis by Bonferoni's method (20–29<40–49 years, p=0·001).

†BMI: Underweight, <18·5; normal, 18·5–24·9; pre-obese, 25·0–29·9; obese class I, 30·0–34·9; obese class II, 35·0–39·9 (WHO, 1997).

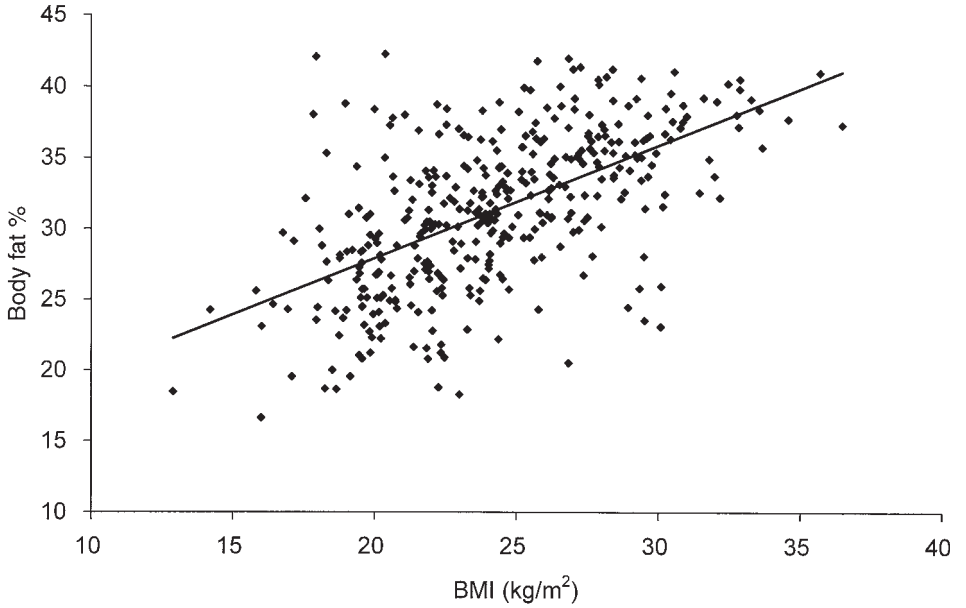

Fig. 1. Body mass index and body fat percentage for females subjects. $Y=0{\cdot}797X+11{\cdot}984$, $R^2=0{\cdot}347$. Partial correlation coefficient=0·585, d.f.=313, $p=0{\cdot}000$.

hypertension, i.e. 90 mmHg for diastolic pressure or 140 mmHg for systolic pressure, was high among the 40–49, 50–59 and 60–69 age groups, whose proportions were, respectively, 23·7%, 18·5% and 26·2% (Table 3).

Contraceptive use

Regarding contraceptive use, the subjects of each age group were categorized into 'never used', 'used only in the past' and 'currently use'. The 'currently use' group was sub-categorized as shown in Table 4. Only 27·6% of this group had never used contraception. The dominant methods were operation (43·0% of the total subjects), oral contraception (12·8%) and injection (8·2%). To examine the effects of different methods on BMI and blood pressure, a sub-dataset consisting of 301 subjects was created by omitting the 60–69 and 70+ age groups ($n=62$). These older groups were omitted because they contained few contraceptive users. There were also only small numbers of individuals in the 'only in the past' ($n=18$) and in the 'currently use implantation and ring' groups ($n=10$), and these individuals were therefore omitted.

Factors related to BMI and blood pressure

Table 5 indicates that neither BMI nor the two blood pressures differed significantly with any sociodemographic variable (ANOVA with age adjustment). As shown in Table 6, however, analysis of the sub-dataset revealed that BMI differed significantly among the 'never used', 'pill', 'injection' and 'operation' groups

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Table 3. Mean (SD) blood pressure and prevalence of hypertension for the subject females

Age group (years)	*n*	Diastolic blood pressure* (mmHg) Mean	(SD)	Systolic blood pressure† (mmHg) Mean	(SD)	Optimal† *n*	%	Normal† *n*	%	High–normal† *n*	%	Grade I hypertension† *n*	%	Grade II hypertension† *n*	%	Grade III hypertension† *n*	%	Total *n*	%
20–29	60	68·9	(9·8)	112·4	(13·6)	41	68·3	8	13·3	7	11·7	4	6·7	0	0·0	0	0·0	4	6·7
30–39	109	68·6	(9·8)	112·9	(14·0)	70	64·2	24	22·0	12	11·0	3	2·8	0	0·0	0	0·0	3	2·8
40–49	94	74·6	(10·6)	123·9	(19·3)	41	44·1	17	18·3	13	14·0	18	19·4	1	1·1	3	3·2	22	23·7
50–59	66	72·0	(12·0)	123·3	(21·3)	29	44·6	16	24·6	8	12·3	6	9·2	4	6·2	2	3·1	12	18·5
60–69	44	69·7	(11·2)	125·4	(22·3)	21	50·0	4	9·5	6	14·3	7	16·7	3	7·1	1	2·4	11	26·2
70+	18	63·8	(9·0)	117·0	(17·0)	11	61·1	3	16·7	4	22·2	0	0·0	0	0·0	0	0·0	0	0·0
All	391	70·5	(10·8)	118·8	(18·5)	213	55·0	72	18·6	50	12·9	38	9·8	8	2·1	6	1·6	52	13·4

*Statistical significance among age groups was examined by one-way ANOVA ($p<0·001$) with multiple comparison analysis by Bonferoni's method (20–29<40–49 years, $p<0·015$; 30–39<40–49 years, $p=0·001$; 70+<40–49 years, $p=0·01$).

†Statistical significance among age groups was examined by one-way ANOVA ($p<0·001$) with multiple comparison analysis by Bonferoni's method (20–29<40–49 years, $p=0·002$; 20–29<50–59 years, $p=0·01$; 20–29<60–69 years, $p=0·005$; 30–39<40–49 years, $p<0·001$; 30–39<50–59 years, $p=0·003$; 30–39<60–69 years, $P=0·002$). Optimal, <80 and <120 mmHg; Normal, <85 or <130 mmHg, High–Normal, 85–89 or 130–139 mmHg; Grade I hypertension, 90–99 or 140–159 mmHg; Grade II hypertension, 100–109 or 160–179 mmHg; Grade III hypertension, >110 or >180 mmHg (WHO, 1999).

Table 4. Contraceptive use by age groups

Age group (years)	Never		Past		Current contraceptive use: Pill		Injection		Implantation		Ring		Operation		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
20–29	8	13·3	4	6·7	16	26·7	17	28·3	1	1·7	0	0·0	14	23·3	60	100·0
30–39	11	10·1	3	2·8	11	10·1	6	5·5	3	2·8	3	2·8	72	66·1	109	100·0
40–49	10	10·6	4	4·3	14	14·9	5	5·3	1	1·1	2	2·1	58	61·7	94	100·0
50–59	27	40·9	7	10·6	7	10·6	3	4·5	0	0·0	0	0·0	22	33·3	66	100·0
60–69	35	79·5	7	20·5	0	0·0	0	0·0	0	0·0	0	0·0	2	4·5	44	100·0
70+	17	94·4	1	5·6	0	0·0	0	0·0	0	0·0	0	0·0	0	0·0	18	100·0
All	108	27·6	23	5·9	50	12·8	32	8·2	5	1·3	5	1·3	168	43·0	391	100·0

Chi–squared test among contraceptive use and age groups: $p<0{\cdot}001$.

($p=0{\cdot}008$, ANOVA with age adjustment), and the 'pill' group had a higher BMI than did the 'never' group ($p=0{\cdot}016$, Bonferoni's multiple comparison test).

Table 7 shows differences in diastolic and systolic blood pressures among the four groups included in the sub-dataset. Diastolic pressures differed significantly among these groups ($p=0{\cdot}002$, ANOVA with age adjustment). The 'pill' group had higher blood pressure values than did the 'never' and 'operation' groups ($p=0{\cdot}007$ and $p=0{\cdot}012$, respectively, Bonferoni's multiple comparison test).

Multiple regression analysis revealed that the significantly contributing factors to BMI were age and 'pill'. BMI and 'pill' contributed significantly to diastolic pressure. Age, BMI, number of live births, and 'pill' contributed significantly to systolic pressure (Table 8). It is noted that the use of oral contraceptive pills had a weak but significant contribution to increases in BMI (R^2: 1·6%) and elevation of diastolic and systolic blood pressures (R^2: 1·8% and 1·5%, respectively).

Discussion

The levels of BMI and blood pressures of the present subjects were compared with those of other large populations in Thailand. The mean BMI of the present subjects, i.e. 24·2 kg/m^2, was a little higher than the 22·8 kg/m^2 that was found for females aged 30 and above from seventeen provinces of Thailand in 1991 (Tatsanavivat *et al*., 1998). The prevalence of obesity, including pre-obese and obese categories (BMI $\geq$ 25), in the subjects of this study was 43·0% (168/391), with relatively higher values recorded among the 30–39 age group (39·4%), 40–49 age group (51·1%) and 50–59 age group (48·5%). According to the National Nutrition Surveys of Thailand, in 1986 and 1994 (Ministry of Health of Thailand, 1995, 2000) the corresponding prevalences were, respectively, 22·1% and 48·7% in the 30–39 age group, 26·6% and 56·9% in the 40–49 age group, and 29·6% and 42·0% in the 50–59 age group. Thus, the present subjects were almost equal to, or a little thinner than, the general Thai female

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Table 5. Mean (SD) of BMI and diastolic and systolic blood pressures by sociodemographic variables for 20–59-year-old females

Sociodemographic variables	BMI (kg/m^2)				Diastolic blood pressure (mmHg)				Systolic blood pressure (mmHg)			
	n	Mean	(SD)	Statistical significance*	*n*	Mean	(SD)	Statistical significance*	*n*	Mean	(SD)	Statistical significance*
Number of live births												
0	14	23·0	(3·7)		14	70·5	(17·9)		14	119·1	(24·3)	
1–2	150	24·2	(3·5)		150	70·8	(9·7)		150	117·3	(16·3)	
3–4	85	24·0	(4·0)	p=0·436 (ns)	84	69·6	(10·2)	p=0·174 (ns)	84	116·2	(17·3)	p=0·147 (ns)
5+	52	25·0	(4·0)		51	75·2	(11·5)		51	123·1	(17·2)	
No answer	0				1				1			
Consumption of meat (times/week)												
0	19	24·0	(3·9)		19	73·7	(8·3)		19	122·2	(15·7)	
1–2	104	24·3	(4·0)		104	72·1	(10·7)		104	119·8	(17·2)	
3–4	72	24·0	(3·6)	p=0·742 (ns)	72	70·4	(9·2)	p=0·572 (ns)	72	115·9	(15·4)	p=0·503 (ns)
5+	99	24·4	(3·5)		97	70·2	(12·3)		97	117·4	(18·9)	
No answer	7				9				9			
Education (years)												
<5	191	24·6	(3·9)		189	72·2	(11·1)		189	120·9	(18·6)	
5–6	82	23·8	(3·5)		82	69·3	(9·4)		82	113·2	(12·5)	
7–9	14	23·3	(3·4)	p=0·396 (ns)	14	70·1	(13·5)	p=0·968 (ns)	14	115·4	(13·6)	p=0·627 (ns)
10+	13	22·3	(.3·0)		13	69·3	(10·8)		13	110·9	(18·4)	
No answer	1				3				3			
Household income (Bharts/year)												
<30,000	108	23·9	(3·8)		108	70·8	(10·4)		108	117·1	(15·0)	
<60,000	98	24·3	(3·5)		98	71·5	(10·0)		98	118·8	(17·5)	
<90,000	38	24·6	(3·8)	p=0·708 (ns)	38	69·8	(10·1)	p=0·746 (ns)	38	117·6	(15·5)	p=0·898 (ns)
90,000+	56	24·5	(4·0)		54	72·3	(13·1)		54	119·4	(21·9)	
No answer	1				3				3			

*Statistical significance was analysed by ANOVA with age as a covariant; ns: not significant.

Table 6. Mean (SD) BMI (kg/m^2) by contraceptive use for 20–59-year-old females

Age group (years)	Current contraceptive use: Never			Pill			Injection			Operation			Statistical significance*	Statistical significance†
	n	Mean	(SD)	*n*	Mean	(SD)	*n*	Mean	(SD)	n	Mean	(SD)		
20–29	8	21·6	(2·0)	16	22·4	(2·8)	17	23·7	(2·6)	14	22·0	(2·8)	p=0·211 (ns)	p=0·008 (Never<Pill, p=0·016)
30–39	11	21·7	(2·3)	11	26·1	(4·2)	6	24·3	(2·0)	72	24·2	(3·7)	p=0·040 (Never<Pill; p=0·026)	
40–49	10	25·4	(4·1)	14	26·6	(4·1)	5	26·7	(2·4)	58	24·5	(4·1)	p=0·284 (ns)	
50–59	27	23·0	(4·0)	7	26·6	(3·4)	3	25·5	(2·5)	22	25·8	(3·2)	p=0·023	
All	56	23·0	(3·7)	48	25·1	(4·0)	31	24·5	(2·6)	166	24·3	(3·8)		

*Statistical significance among contraceptive use was examined by one-way ANOVA with multiple comparison analysis by Bonferoni's method.
†Statistical significance among contraceptive use adjusted by age groups was examined by two-way ANOVA with multiple comparison analysis by Bonferoni's method.
ns: not significant.

Table 7. Mean (SD) blood pressures (mmHg) by contraceptive use for 20–59-year-old females

Variable	Age group (years)	Current contraceptive use: Never			Pill			Injection			Operation			Statistical significance*	Statistical significance†
		n	Mean	(SD)	*n*	Mean	(SD)	*n*	Mean	(SD)	*n*	Mean	(SD)		
Diastolic blood pressure	20–29	8	68·3	(9·1)	16	71·6	(10·9)	17	68·8	(11·2)	14	66·3	(7·4)	p=0·551 (ns)	p=0·002
	30–39	11	65·2	(11·3)	11	73·3	(5·8)	6	70·2	(9·6)	72	68·6	(9·5)	p=0·243 (ns)	(Never<Pill, p=0·007; Operation<Pill, p=0·012)
	40–49	10	78·1	(15·5)	14	79·6	(8·6)	4	81·0	(16·0)	58	71·9	(9·6)	p=0·030	
	50–59	27	67·6	(7·4)	6	82·0	(13·9)	3	81·3	(18·1)	22	75·2	(13·1)	p=0·009 (Never<Pill, p=0·034)	
	All	56	69·1	(10·9)	47	75·7	(10·3)	30	72·0	(12·7)	166	70·4	(10·2)		
Systolic blood pressure	20–29	8	109·8	(7·6)	16	116·3	(16·9)	17	113·4	(13·1)	14	106·9	(9·9)	p=0·252 (ns)	p=0·062 (ns)
	30–39	11	112·4	(13·8)	11	117·7	(10·9)	6	111·8	(11·5)	72	112·9	(14·7)	p=0·740 (ns)	
	40–49	10	129·5	(24·7)	14	128·0	(11·1)	4	112·0	(16·3)	58	121·3	(16·6)	p=0·185 (ns)	
	50–59	27	115·6	(16·4)	6	138·5	(25·0)	3	141·0	(34·0)	22	130·2	(20·3)	p=0·011	
	All	56	116·6	(17·6)	47	122·9	(16·8)	30	115·6	(17·3)	166	117·6	(17·1)		

*Statistical significance among contraceptive use for each age group was examined by one-way ANOVA with multiple comparison analysis by Bonferoni's method.

†Statistical significance among contraceptive use adjusted by age groups was examined by two-way ANOVA with multiple comparison analysis by Bonferoni's method.

ns: not significant.

Table 8. Multiple regression analysis (stepwise method) for BMI and diastolic and systolic blood pressures for 20–59-year-old females

Dependent variables		Independent variables	β	(SE)	t	p-value	R^2(%)	Model F	Model R^2(%)	Model p-value
BMI (n=293)	Included	Age	0·071	(0·022)	3·215	0·001	3·1	7·1	4·7	0·001
		Contraceptive: Pill	1·310	(0·596)	2·196	0·029	1·6			
	Excluded	Contraceptive: Injection								
		Contraceptive: Operation								
		Number of live birth								
		Years of education								
		Household income								
		Frequency of meat consumption								
Diastolic blood pressure (n=291)	Included	Age	0·169	(0·061)	2·769	0·006	2·2			
		BMI	0·937	(0·158)	5·921	0·000	13·3	20·1	17·3	0·000
		Contraceptive: Pill	4·567	(1·634)	2·795	0·006	1·8			
	Excluded	Contraceptive: Injection								
		Contraceptive: Operation								
		Number of live birth								
		Years of education								
		Household income								
		Frequency of meat consumption								
Systolic blood pressure (n=291)	Included	Age	0·647	(0·121)	5·366	0·000	5·8			
		BMI	1·417	(0·248)	5·719	0·000	12·7	19·4	21·4	0·000
		Number of live birth	− 1·622	(0·625)	–2·593	0·010	1·4			
		Contraceptive: Pill	5·980	(2·597)	2·303	0·022	1·5			
	Excluded	Contraceptive: Injection								
		Contraceptive: Operation								
		Years of education								
		Household income								
		Frequency of meat consumption								

Dummy variables were used for contraceptive methods: Pill, yes=1, no=0; Injection, yes=1, no=0; Operation, yes=1, no=0.

population in 1994, although the 50–59 age group in this study showed a slightly higher proportion of obese individuals. Regarding blood pressure, available data for comparison were limited. According to Tatsanavivat *et al.* (1998), the mean diastolic and systolic blood pressures of females aged 30 or above from seventeen provinces of Thailand in 1991 were 75·8 mmHg and 117·7 mmHg, the former being a little higher and the latter a little lower than the present measurements. These comparisons indicate that the subject females of this study did not markedly differ from the general Thai population.

The major findings of this study were that the contraceptive pill users tended to have increased BMI and elevated blood pressure, even though the extent of these contributions was small (less than 2%), and sociodemographic factors were not associated with either BMI or blood pressure. Since oral contraception use was not randomly assigned, the associations cannot strictly be interpreted as causal. There may be confounding variables mediating the association of oral contraceptive use and BMI that are outside the scope of the current study. Also, there is the possibility that changes in energy balance lead to increases in BMI, which may in turn – perhaps through effects on ovarian function – lead to increased oral contraceptive use. Based on a retrospective study of overweight females aged 27–65 years (n=214) in Sydney, Australia, Bradley (1985) estimated that the contribution of oral contraceptive use to body weight gain was 3·2%. This suggested that variance in BMIs could be attributed mostly to various metabolic or genetic factors and/or to socioeconomic factors. The extent of contributions from oral contraceptive use in this study was almost identical to the estimate from Bradley's study, although no socioeconomic factors significantly contributed to the variation in BMIs. According to the authors' study in one of the five target villages, the villagers did not have food shortages and the females' energy expenditure was low (Murayama & Ohtsuka, 1999a, b). In addition, their daily living and socioeconomic conditions were remarkably homogeneous among the married females. For instance, most of the households depended on farming, their years of education did not differ markedly, and the foods consumed – except meats and seasonings – were harvested from their gardens (cf. Table 1). Thus, socioeconomic status, which has been considered as a factor in the variation of BMIs (e.g. Sobal & Stunkard, 1989), was not related to BMI significantly in these subjects. The number of live births has been recognized as one of the confounding factors for BMI, but among the present subjects this number basically depended on age (Table 1) and thus did not play a major role when the age factor was controlled.

There are some studies that explain the mechanisms behind the increasing body weight that accompanies use of oral contraceptive pills. Use of oral contraceptives that contain only progestin results in decline in basal metabolic rate (BMR; Bisdee, James & Shaw, 1989). McNeil *et al.* (1988) found that energy intake was slightly higher, physical activity was slightly lower (not significantly) and BMR was significantly decreased in the controlled menstrual cycle due to oral contraceptive progestin relative to the normal cycle. On the other hand, oral contraceptives that contain synthetically derived progestin and oestradiol have been suggested to increase BMR (Diffey *et al.*, 1997), leading to a possible explanation that high oestradiol levels induced by exogenous oestradiol elevate catecholamine levels and energy expenditure. Eck *et al.* (1997) reported that energy intake, together with resting energy expenditure

and physical activity, did not differ between the group that was using an oral contraceptive, i.e. Ortho-Novum 7/7/7 (which contains ethinyl oestradiol and progestin), and non-users. A high percentage of energy was taken from fat in the contraceptive users. One of the reasons for these inconsistent results regarding the effects of oral contraceptives on energy balance seems to come from the different contents of various oral contraceptive pills. Since the pills, which the subjects of this study used, contain oestrogen and progestin, the users may not have decreased BMRs, but alternatively they may have increased energy intake or fat intake. In this regard, Hirschberg *et al.* (1996) suggested a role for cholescystokinin. Oral contraceptives cause suppression of basal levels of serum cholecystokinin, and thus can trigger increases in body fat.

The effects of oral contraceptives on blood pressure have been well documented. Oral contraceptive users have higher systolic and diastolic blood pressures than do non-users (Stern *et al.*, 1976; Fisch & Frank, 1977; Royal College of General Practitioners' Oral Contraception Study, 1977; Ostrander *et al.*, 1980; Godsland *et al.*, 1995; Sherif, 2000) and intrauterine device users (WHO Task Force on Oral Contraceptives, 1989). These results are consistent with this study. The average difference in systolic and diastolic blood pressures between oral contraceptive uses and non-users was, respectively, 5–7 mmHg and 1–3 mmHg for white Americans (Stern *et al.*, 1976; Fisch & Frank, 1977; Royal College of General Practitioners' Oral Contraception Study, 1977; Ostrander *et al.*, 1980). Systolic blood pressure was almost equal to that found in the present study, i.e. 6·3 mmHg, but diastolic blood pressure was a little lower than that seen in the present study, i.e. 6·6 mmHg. However, it is not clear whether the effects on blood pressure came mostly from oestrogen or progestin, despite suggestions that the pills containing oestrogen and progestin elevate blood pressure more than do those containing only oestrogen (Stern *et al.*, 1976), or that progestin induces changes in vascular tone to elevate blood pressure (Baron, 1993; Godsland *et al.*, 1995).

The mechanisms of increasing BMI and blood pressure by the use of oral contraceptives have not been fully explained but this study has made clear that the use of contraceptive pills that contain oestrogen and progestin tended to increase BMI and elevate blood pressure. The pills were provided free of charge to Thai women. This finding is significant, since the subject females are free-living farmers and are thus likely to represent females in rural areas of Thailand as a whole. The use of oral contraceptives has been prevalent due to governmental policies for birth control in many Third World countries, including Thailand. However, these women are clearly vulnerable to side-effects leading to obesity and hypertension, and these effects should be considered in future policy decisions.

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