Effect of Diet, Exercise and Sleep (DES) Model in Six Months Postpartum Weight Retention and Body Composition in Thai Mothers: A Quasi-Experimental Study

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KEYWORDS

Postpartum weight retention, After-delivery, Lifestyle behaviours

ABSTRACT

ms: The amount of fatty tissue in women increases during pregnancy, leading to postpartum weight retention after delivery. Thus, pregnancy has been identified as a stimulus leading to the development of overweight and obesity. This study investigates the effect of the diet, exercise and sleep (DES) model on weight retention and body composition among Thai mothers six months to one year post-delivery.

Methods: A total of 64 participants were allocated to the intervention and control groups. The intervention group received health education and a Pilates exercise programme in the first month, which they practiced in months 2–6. During this time, the researchers visited their homes each month, counselling the women based on the transtheoretical model. This research had two primary outcome measures, including after-delivery weight retention and body composition, and three secondary outcome measures, including knowledge, attitudes and practices related to diet, exercise and sleep. The measures were collected at baseline and every month using a questionnaire and body composition analysis. Data were analysed using a t-test and repeated measures ANOVA. All levels of significance were set as $p < 0.05$.

Result: A comparison of postpartum weight retention six months and one year after delivery in the intervention group showed that the mothers' weight decreased significantly. Body fat and visceral fat levels significantly decreased after participating in the programme for six months. In addition, postpartum weight retention and body composition in the intervention group were significantly better than in the control group one year after delivery.

Conclusions: Postpartum weight retention is associated with long-term maternal morbidity. The intervention significantly reduced postpartum weight retention and improved body composition. Therefore, this model may be used in planning the development of maternal health behaviours in the postpartum period.

1. Introduction

Physiological changes during pregnancy and lifestyle behaviours after childbirth result in an increase in women's weight and body composition. The prevalence of obesity among European mothers has increased from 7 to 25% [1], and a similar increase in the prevalence of obesity and overweight has been reported among Asian mothers. [2, 3]. Nagpal et al. [4] investigated the factors affecting weight retention and body composition among postpartum mothers, finding a significant difference in weight one year postpartum and before pregnancy. In addition, there was a statistically significant difference in the body composition of postpartum mothers one year after giving birth compared to before pregnancy. In terms of behaviour, the type of food eaten, physical activity and breastfeeding were all found to affect weight control. Conversely, sleep duration had no effect on postpartum weight retention.

Exercise involves the use of skeletal muscles, and body movements and activities including repeated actions are a way to burn calories. The purpose of exercise is to increase physical fitness, improve health or maintain the integrity of the body. The benefits of exercise include increasing growth and development, preventing aging, improving cardiovascular and respiratory function, reducing anxiety and depression, enhancing physical function, weight control, enhancing well-being and treating many chronic diseases [5]. Although previous studies have shown that postpartum women who exercise experience less weight gain than women who do not, some studies have found that the evidence showing a relationship between physical activity and postpartum weight loss is insufficient. [6].

Dietary intake that exceeds the body's needs can lead to obesity. Thus, it is important to adhere to the principles of healthy eating to ensure an adequate, balanced diet. These principles include balance, variety and minimal seasoning as well as being mindful of the calories the foods contain. Previous

research demonstrated that women who followed a diet or a programme combining diet with exercise lost significantly more weight than women in the control group [7]. Further, women in the diet plus exercise group lost more body fat than women in the diet group. Overall, the findings showed that women who followed a dietary and exercise programme were significantly more likely to return to their pre-pregnancy weight.

Rosenbaum et al. [8] found that postpartum mothers had poor sleep quality. The amount of time spent sleeping is related to the duration of breastfeeding and has an indirect effect on body mass index in postpartum women. Jankool [9] reported that 47.1% of Thai mothers exhibited excessive gestational weight gain (GWG), approximately 16–20 kg., 72.4% of postpartum women worried their husbands were dissatisfied with their body shape and 72% of postpartum women wanted to lose weight within one year after delivery. The literature review suggests that breastfeeding or physical activity alone are not enough for women to return to their pre-pregnancy weight if they are not combined with calorie intake restrictions. Further, reduced sleep affects both eating habits and activity patterns, resulting in lower energy expenditure and altering glycaemic metabolism [10]. Thus, reduced sleep appears to represent a novel, independent risk factor for increased weight retention. Additional research is needed to determine whether interventions aimed at increasing sleep may be useful in reducing obesity.

Postpartum weight retention is a significant contributor to obesity risk one year postpartum and is associated with long-term maternal morbidity. Wahabi [11] demonstrated that the prevalence of cardiometabolic risk factors like metabolic syndrome, hyperglycaemia, central obesity and abnormal triglyceride increases along with postpartum weight retention. Liu et al. [12] showed that interventions in pregnancy and up to six months after delivery significantly reduced women's postpartum weight retention.

In Thailand, studies on the effect of the diet, exercise and sleep (DES) model on post delivery weight retention and body composition six months after delivery women have been limited. This study investigates the effectiveness of the DES model on weight retention and body composition six months to one year after delivery among Thai mothers. This intervention consists of education, home exercise, a follow-up programme and use of the transtheoretical model (TTM) to stimulate behaviour modification.

2. Methodology

Study design and population characteristics

This study involved quantitative research based on a quasi-experimental design to examine the effects of the DES model. Purposive sampling was used in constructing the simple random sample, which involved a three-step process. First, the Surat Thani province was purposive selected from Thailand. Second, six districts with the highest birth rates were randomly chosen from the 19 districts in Surat Thani. Three districts were assigned as a control group and three as an intervention group. Finally, Thai mothers 24–27 weeks postpartum were recruited. The inclusion criteria were as follows: age between 20 and 35 years, singleton birth, breastfeeding less than six months, body mass index 18.5–34.9, six-month post-delivery weight higher than pre-pregnancy weight, having a cell phone or some sort of equipment to communicate via the internet and consent to home visit. Exclusion criteria included pregnant women or suspected pregnancies, chronic illness, regular smokers or drinkers and the use of drugs for sleep or weight loss. The sample size was calculated by G Power 3.1.9.2, using a power analysis with a significance level of 0.05 and a power of 0.80. The effect size for the mean difference in postpartum weight retention from a previous study was 0.96 [13], thus in this study the Cohen's d effect size was 0.8. Considering a 20% dropout rate, the sample size of this study was determined to be 32 participants per group. Data collection occurred between September 2021 and April 2022.

Intervention procedure

An orientation session was conducted before starting the experiment. The participants included a physician, consulting team and researcher to standardise their performances as shown in this research.

The DES model included health education and a Pilates exercise programme to reduce participants' weight. In addition, follow-ups were performed using the line application, phone calls and home visits.

To establish a baseline, socio-demographic characteristics, postpartum weight retention and body composition were at week one. In weeks 1–4, health education and exercise interventions were implemented in the intervention group in the classroom and through the online application.

When the participants performed home exercise and ate, they sent pictures to a line group (Line application) and recorded the information in the DES record. Follow-up by phone calls were conducted out every two weeks to remind the participants to record their diet, exercise and sleep behaviours. Home visits were done every month to provide counselling and collect data about the participants' diet, exercise and sleep behaviours. Post-delivery weight retention and body composition were measured every month during the home visits. A single machine was used for measurement by the same person throughout the research.

The counselling was based on the transtheoretical model and provided by a team consisting of a nutritionist, physical therapist and public health technical officer. The transtheoretical model was used to design the interventions, which were based on psychobehavioural strategies for enhancing the readiness of individuals to engage in positive diet, exercise and sleep behaviours.

Control group

In week one, socio-demographic characteristics, post-delivery weight retention, body composition, knowledge and attitudes and practices related to diet, exercise and sleep were recorded as a baseline. The participants received brochures containing general knowledge about diet, exercise and sleep. Home visits were conducted each month to collect data about the participants' diet, exercise and sleep behaviours. Postpartum weight retention and body composition were measured every month during the home visits.

Outcome measures

The two primary outcomes included postpartum weight retention and body composition, while the intermediate outcomes included the participants' knowledge, attitudes and practices related to diet, exercise and sleep. Postpartum weight retention was calculated as the difference between weight at some time after delivery and pre-pregnancy weight, categorised into one of three levels: less than 0 kg, between 0 and 5 kg and more than 5 kg. Body composition, including body fat and visceral fat, was measured with a body composition analyser. The measurements were performed at the beginning of the study and every month during the home visits in both the control and intervention groups.

Knowledge and attitudes related to diet, exercise and sleep were evaluated through a questionnaire at the beginning of the study and in week 4. The practices were evaluated using three different questionnaires, including the short-form of the stage of exercise behaviour change questionnaire (a standard questionnaire), the S-weight weight management questionnaire (Thai version by Sasipa Karintrakul [14]) and a stage of sleep behaviour change questionnaire, which was created based on the literature review as a modification of the other questionnaires [14-17]. Each questionnaire required the participants to choose from five statements describing their current regular exercise pattern, diet control and sleep patterns. Each of the statements corresponded to one of the five stages of change: precontemplation, contemplation, preparation, action and maintenance. The stage of behaviour change was assessed at the beginning of the study and in week 24.

Statistical analyses

Data were analysed using Statistical Package for the Social Sciences (SPSS) version 29.0. Descriptive statistics were used to describe the participants' demographic characteristics, knowledge, attitudes and practices. For comparisons between groups, the independent samples t-test was used to analyse normally distributed continuous data, while the Mann–Whitney U test was used to analyse non-normally distributed continuous data. Within-group comparisons were performed using the dependent samples t-

test to analyse normally distributed continuous data and Wilcoxon signed ranks test to analyse non-normally distributed continuous data. In addition, postpartum weight retention and body composition were analysed using a repeated measure analysis of variance (ANOVA). All levels of significance were set as $p < 0.05$.

Ethics

The method and procedures of the study were approved by the Ethics Review Committee of Chulalongkorn University (protocol number 044.1/64). All participants received an explanation about the objective of this study and signed an inform consent form.

3. Results and Discussion

Demographic characteristic of participants

In the study, 64 postpartum Thai mothers were assigned to either the intervention group of the control group after screening according to the inclusion–exclusion criteria. Most of the subjects were approximately 28 years old, with an average pre-pregnancy weight of 60.2±14.3 kilograms, an average six-month post-delivery weight of 65.0±15.7 kilograms and an average BMI of 25.9±5.5. All of the participants had a higher weight six months after delivery than before pregnancy. As shown in Table 1, there were no significant group differences in age, pre-pregnancy weight, six-month post-delivery weight, BMI, parity, education level, income level, occupation status, marital status contraception, breast feeding, mode of delivery, child sex and babysitter.

Table 1: Demographic characteristic data in intervention group and control group

Characteristic	**Total (n=64)**	**Intervention group (n=32)**	**Control group (n=32)**
Age (mean±SD)	28.8±5.6	29.1±5.3	28.5±5.9
Pre-pregnancy weight (mean±SD)	60.2±14.3	60.1±15.3	60.3±13.4
Six-months after delivery weight (mean±SD)	65.0±15.7	64.8±16.8	65.4±15.2
BMI (mean±SD)	25.9±5.5	25.7±5.8	26.3±5.4
Parity			
1 child	26	14 (44%)	12 (38%)
2 children	21	10 (31%)	11 (34%)
3 children	9	5 (16%)	4 (13%)
4 children	8	3 (9%)	5 (16%)
Education			
Unlettered	0	0	0
Primary education	9	2 (6%)	7 (22%)
Secondary education	41	20 (63%)	21 (66%)
Bachelor’s Degree	13	9 (28%)	4 (13%)
Higher Bachelor’s Degree	1	1 (3%)	0
Income			
<10,000 Bath	10	4 (13%)	6 (19%)
10,000-20,000 Bath	51	26 (81%)	25 (78%)
>20,000 Bath	3	2 (6%)	1 (3%)
Occupation			
Merchant	16	7 (22%)	9 (28%)
Gardener	21	10 (31%)	11 (34%)
Housewife	21	13 (41%)	8 (25%)
Beautician	2	1 (3%)	1 (3%)
Employee	4	1 (3%)	3 (9%)
Marital status			
Single	0	0	0
Married	61	30 (94%)	31 (97%)
Separated	3	2 (6%)	1 (3%)
Divorced or widowed	0	0	0
Contraception			

Yes	44	20 (62%)	24 (75%)
No	20	12 (38%)	8 (28%)
Breast feeding			
< 1 month	12	6 (19%)	6 (19%)
1-3 months	21	11 (34%)	10 (31%)
more than 3 months but less than 6 months	31	15 (47%)	16 (50%)
Mode of delivery			
Vaginal delivery	34	14 (44%)	20 (63%)
Caesarean section	30	18 (56%)	12 (38%)
Child sex			
Male	33	17 (53%)	16 (50%)
Female	31	15 (47%)	16 (50%)
Baby sitter			
Yes	55	28 (88%)	27 (84%)
No	9	4 (13%)	5 (16%)

Participants' knowledge about diet, exercise and sleep

The Thai mothers in the intervention group had similar levels of knowledge about diet, exercise and sleep at baseline. After using the DES model for four weeks, women in the intervention group had significantly higher average knowledge scores increased than before participating in the programme (p<0.05). Moreover, when comparing scores of knowledges between control group and intervention group after participating in programme, it was found significantly different (p < 0.05) (Table 2).

Table 2: Knowledge score about diet, exercises and sleep of participants at 6 months after delivery (baseline) and 7 months after delivery (after participate in this study)

Time	**Knowledge score**		***p* value**
	Intervention group (n=32)	**Control group (n=32)**	
Baseline	6.06±1.51	6.03±1.39	0.962
After participate in this study	8.83±1.21	6.62±1.24	<0.001
Compare the knowledge score about diet, exercises and sleep of participants within group was used Wilcoxon signed ranks test to analyze. Compare the knowledge score about diet, exercises and sleep of participants between intervention and control group was used Mann Whitney U test.to analyze.			

Participants' attitudes about diet, exercise and sleep

Table 3 shows the participants' attitudes related to diet, exercise and sleep. The majority of the participants in the intervention group had a moderate attitude level (40.6%) before participating in the programme, whereas the majority of the participants had a good attitude level (62.5%) following the programme. In addition, the attitude levels of mothers in the intervention group were higher after participating in the programme. The majority of the participants in the control group did not exhibit any differences in attitude between baseline and after participating in this study (moderate attitude level, 50.0%). Overall, the attitude level in the intervention group (62.5%) was higher than that in the control group (25%).

Table 3: Attitude level about diet, exercises and sleep of participants at 6 months after delivery (baseline) and 7 months after delivery (after participate in this study)

Attitude level	**Intervention group (n=32)**		**Control group (n=32)**	
	baseline	**after**	**baseline**	**after**
Good	4 (12.5%)	20 (62.5%)	4 (12.5%)	8 (25%)
Moderate	13 (40.6%)	6 (18.75%)	16 (50%)	16 (50%)
Poor	15 (46.9%)	6 (18.75%)	12 (37.5%)	8 (25%)

Participants' practices related to diet, exercise and sleep

The stage of behaviour change was assessed using three questionnaires, including the short form of the stage of exercise behaviour changes questionnaire, the S-weight weight management questionnaire and the stage of sleep behaviour change questionnaire. The percentage of participants in the action and maintenance stages increased in the intervention group compared to pre-programme levels (diet action stage 6% to 50%, sleep stage 3% to 56%). Conversely, participants in the control showed little change in the action or maintenance stages before and one year after delivery (table not shown).

Participants' post-delivery weight retention

Comparison of the participants' pre-pregnancy weight and six-month postpartum weight revealed a significant increase in both the intervention and control groups. However, after participating in the programme, weight retention one year after delivery was significantly lower than six months after delivery in the intervention group. Conversely, weight retention one year after delivery was significantly higher than six months after delivery in the control group. Therefore, at the end of this study, the participants' weight retention one year after delivery was significantly lower in the intervention group than in the control group. In addition, the percentage of participants in the intervention group who retained more than 5 kg of weight decreased compared to pre-programme levels (from 34% to 25%) (table not shown).

Table 4: Weight change from pre-pregnancy weight to 6 months after delivery (baseline) and 1 year after delivery

Time	**Intervention group (n=32)**	**Control group (n=32)**	****Between group *p* value**
Pre pregnancy weight, kg)			
6 months after delivery weight retention, kg mean difference (95% CI)	-5.047* (-6.405, -3.689)	-4.688* (-6.325, -3.050)	0.361
1 year after delivery weight retention, kg mean difference (95% CI)	-2.366* (-4.276, -.455)	-7.544* (-9.109, -5.978)	<0.001
6 months after delivery weight retention, kg			
Pre pregnancy weight, kg mean difference (95% CI)	5.047* (3.689, 6.405)	4.688* (3.050, 6.325)	
1 year after delivery weight retention, kg mean difference (95% CI)	2.681* (1.456, 3.906)	-2.856* (-3.524, -2.188)	<0.001
* Compare change of the after-delivery weight retention of participants with in group was used repeated measure analysis of variance (ANOVA) to analyze. All levels of significance were set as $p < 0.05$ ** Compare change of the after-delivery weight retention of participants between intervention and control group was used Mann Whitney U test to analyze. All levels of significance were set as $p < 0.05$			

Body composition of the participants

Table 5 shows the participants' body composition six months after delivery (baseline) and one year after delivery. The body composition of all the participants was similar at baseline. However, after participating in the programme, body fat and visceral fat levels one year after delivery were significantly lower than those six months after delivery in the intervention group. Conversely, body fat and visceral fat levels in the control group were significantly higher one year after delivery. Overall, body fat and visceral fat levels one year after delivery were significantly lower for women in the intervention group than in the control group.

Table 5: Body composition of participants at 6 months after delivery (baseline) and 1 year after delivery

Time	**Intervention group (n=32)**	**Control group (n=32)**	**Between group *p* value**
Body fat			
6 months after delivery weight retention, kg mean±SD (95% CI)	33.10±6.21	31.42±5.72	0.266[a]

1 year after delivery weight retention, kg mean±SD (95% CI)	*30.93±6.29	*33.52±5.84	0.293[a]
Change in the body fat	-2.17±2.46	2.10±1.49	<0.001**
Visceral fat			
6 months after delivery weight retention, kg mean±SD (95% CI)	7.19±5.14	7.03±5.84	0.907[a]
1 year after delivery weight retention, kg mean±SD (95% CI)	***6.33±5.02	***8.31±5.75	0.146[a]
Change in the visceral fat	-0.86±1.20	1.28±1.37	<0.001**

[a] Compare change of the body composition of participants between intervention and control group was used independent samples t-test to analyze.
* Significant statistics were found when comparing the body fat of participants within group, was used pair samples t-test to analyze
** Significant statistics were found when comparing change of the body composition of participants between intervention and control group, was used independent samples t-test to analyze.
*** Significant statistics were found when comparing the visceral fat of participants within group, was used Wilcoxon signed ranks test to analyze

Discussion

Lifestyle behaviours of postpartum women, including breastfeeding, sedentary behaviour, sleep and dietary intake, all have an impact on postpartum weight retention and body composition. In this study, all participants had a higher weight six months postpartum than before pregnancy, which is consistent with previous studies showing that mothers who breastfeed for at least six months had less postpartum weight retention than those who breastfeed for less than six months [8]. In this study, a combined DES intervention based on TTM resulted in significantly less postpartum weight retention and improved body composition one year after delivery among Thai mothers who breastfed for less than six months. Quansah [18] investigated mothers one year postpartum, finding that 64% of the women retained 4.0 ± 7.4 kg. Women who perceived themselves as more physically active than other women retained significantly less weight. Additionally, women with a below-average total energy intake exhibited less weight retention than women with an average total energy intake. Sleeping was inversely associated with absolute weight change, meaning that women who slept more retained less weight [19]. Although one study reported no significant differences in postpartum weight retention immediately after delivery and one year after delivery in the lifestyle intervention group, pregnant women in the lifestyle intervention group tended to retain less postpartum weight (≥ 5 kg) compared to those in the control group [20].
In this study, knowledge scores regarding exercise, dietary intake and sleep in the intervention group were significantly higher than those at baseline and higher than those of women in the control group. However, the scores in the second test increased significantly in the control group, which may be due to using a questionnaire with the same content pre-test and post-test. Although the regular exercise, diet control and adequate sleep are beneficial, more than half of people adopt these behaviours stop within three to six months. Psychobehavioural strategies can be used to increase women's participation in regular exercise and help them maintain diet control and adequate sleep levels [19, 21].

The intervention, based on TTM, resulted in improved diet, exercise and sleep change behaviours in the action stage among Thai mothers six months postpartum. These results suggest that TTM may be used to support behaviour change, which is consistent with previous studies on lifestyle interventions from several countries [13, 22-24]. However, while the percentage of dietary and sleep behaviour changes clearly increased, exercise behaviours increased only slightly. Relatedly, Wu et al. [25] found no statistically significant relationship between good sleep and increased exercise. However, a study on the association between sleep duration and hypertension reported that people who sleep less than

hours per day are more likely to develop hypertension [26]. This highlights the benefits of combining the interventions, as in the DES model used in this study.

Strengths and limitations of this study

The DES Model provides knowledge and multi-channel follow up strategy. Individual counselling can be carried out during follow-up. If there are not enough staff in the postpartum unit but to provide service, the implementation of the model may not be completed successfully.

4. Conclusion and future scope

This study followed a quantitative approach based on a quasi-experimental design to investigate whether the DES model, which combines health education, exercise activity and follow-up based on the TTM model, had effects on weight retention and body composition among Thai mothers in Surat Thani province six months after delivery. There were 32 participants in each study group, and the study period was 24 weeks. The two primary outcome measures were weight retention and body composition after delivery. The three secondary outcomes included knowledge, attitudes and practices related to diet, exercise and sleep. Comparison of postpartum weight retention six months after delivery and one year after delivery revealed a significant decrease in the intervention group. Moreover, weight retention was lower one year after delivery in the intervention group compared to the control group. In addition, body fat and visceral fat levels significantly decreased six months after delivery in the intervention group and were significantly lower than in the control group. There was also a significant difference in knowledge scores between the control group and intervention group after participating in the programme. Furthermore, attitude levels were higher in the intervention group than in the control group. Regarding behaviour change, that percentage of participants in the action and maintenance stages increased following participation in the programme. Postpartum weight retention is associated with long-term maternal morbidity. Thus, cultural health beliefs regarding postpartum practices should be considered when developing the intervention plan. In this study, the intervention resulted in significantly reduced postpartum weight retention and improved body composition among Thai mothers.

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