



## Effects of birth ball exercise on pain and self-efficacy during childbirth: A randomised controlled trial in Taiwan

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### ABSTRACT

**Objectives:** to examine the effectiveness of a birth ball exercise programme during childbirth by measuring childbirth self-efficacy and childbirth pain. In addition, it tested the mediating effects of childbirth self-efficacy on the relationship between the birth ball exercise programme and childbirth pain.

**Design:** randomised controlled trial.

**Participants and setting:** the study was conducted from December 2008 to November 2009, at two birth units, one at a regional hospital and one at a medical centre, with 600 and 1022 annual births, respectively. One hundred and eighty-eight expectant mothers were recruited (recruitment rate: 47%) and were allocated by block randomisation into the two arms of the study, but only 48 intervention and 39 control group participants completing the trial.

**Interventions:** the birth ball exercise programme consisted of a 26-page booklet and a 19-minute videotape, with periodic follow-ups during prenatal checks. All members of the experimental group were asked to practise the exercises and positions at home for at least 20 minutes three times a week for a period of 6–8 weeks. Each woman in the experimental group was given a birth ball for use during labour and encouraged every hour to choose the most comfortable positions, movements, and exercises. Both the experimental and control groups received standard nursing and midwifery care from hospital staff nurses in all aspects of pregnancy and childbirth.

**Measurement and findings:** when cervical dilations were four centimetres and eight centimetres, the women completed demographic and obstetrics information, the Childbirth Self-efficacy Inventory (CBSEI), and the short form of the McGill Pain Questionnaire (SF-MPQ). Our study revealed that birth ball exercises provided statistically significant improvements in childbirth self-efficacy and pain. Specifically, self-efficacy had a 30–40% mediating effect on relationships between birth ball exercises and childbirth pain. Mothers in the experimental group had shorter first-stage labour duration, less epidural analgesia, and fewer caesarean deliveries than the control group.

**Conclusions and implications for practice:** clinical implementation of the birth ball exercise programme could be an effective adjunctive tool to improve childbirth self-efficacy and reduce pain among women in labour. On the basis of our mediating model, the results further suggest that confidence is greater after prenatal preparation powerfully related to decreased pain perception and decreased medication/analgesia use during labour.

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### Introduction

Although childbirth brings much joy to most women, it is an event uniquely associated with intense experiences of pain. Most women from studies describe childbirth pain as the most severe that they

have ever experienced (Waldenström, 2003; Fenwick et al., 2005; Hauck et al., 2007). Thus, labour pain and its management remains a primary concern for childbearing women, their families, and their health-care providers. In view of the potential side-effects on mothers and fetuses, the use of analgesics and anaesthetic agents may not be the first choice for women in labour. Instead, many women approach childbirth with a desire to avoid pharmacologic pain relief agents or to minimise their use (Gibbins and Thomson, 2001; Fenwick et al., 2005). It is important for health-care givers to use non-pharmacological pain-relieving measures for women in labour.

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Coping strategies can assist in the pain management process, with self-efficacy playing an important role in a woman's ability to cope. Lowe (1989) indicated that self-efficacy affects childbirth experiences, both in terms of bodily functions and in thoughts and feelings regarding childbirth. If women are highly self-confident, they will be able to cope with childbirth, enjoying a positive childbirth experience (Lowe, 1993; Williams et al., 2008; Sun et al., 2010). This premise is backed by studies on maternal self-efficacy during labour (Lowe, 1989; Sinclair and O'Boyle, 1999). Lowe (1989) found that confidence in one's ability to cope during labour accounted for approximately one-third of labour pain variance.

The birth ball, otherwise known as the Swiss ball, was originally developed in 1963 and used in physical therapy for neurodevelopmental treatment (Carriere, 1998; Perez, 2000). It was introduced as a childbirth tool in the 1980s, first by Perez and Simkin, who provided childbirth education to students, nurses, midwives, and professional labour assistants (Perez, 2000). Perez (2001) stated that the birth ball was physically beneficial for use during pregnancy and labour. In terms of its physical benefits, the birth ball promotes optimal positioning and pain reduction during uterine contractions while eliciting non-habitual movement. For these reasons, birth ball exercise can work effectively in childbirth (Simkin, 1995; Perez, 2000, 2001; Watkins, 2001). Psychologically, exercising with the ball improves posture, balance, coordination, and body awareness due to its dynamic nature, helping the mother maintain control of her own body and build body confidence (Perez, 2000; Watkins, 2001). The novelty of the big round ball adds to the element of play, perhaps triggering positive childhood memories. Thus, using the ball is a great way to relieve stress and tension (Perez, 2000, 2001; Watkins, 2001).

Although the birth ball has been shown to be a valuable and comfortable tool in clinical practice, literature published on the relationship between birth ball exercise and childbirth outcomes is sparse. Therefore, the purposes of this study were two-fold: (1) to examine the effects of a birth ball exercise programme during childbirth in terms of childbirth self-efficacy and childbirth pain, and (2) to test the mediating effects of childbirth self-efficacy on the relationship between the birth ball exercise programme and childbirth pain.

## Methods

### Design

The study was performed as a randomised controlled study, without blinding. Participants were randomly assigned to intervention (birth ball exercise programme) and control groups. In order that participants were distributed evenly, a computer-generated block randomisation list (with block-sizes of four and eight varied randomly) was independently prepared by a statistician, and delivered by two certified midwives in the form of sequentially numbered, sealed opaque envelopes, which contained allocation to the appropriate group. The study was conducted from December 2008 to November 2009, at one regional hospital and one medical centre with 600 and 1022 annual births, respectively.

### Participants

The following inclusion criteria were used at recruitment: (1) women were 30–32 weeks of gestation, (2) older than 18 years, (3) had no major obstetric or medical pregnancy complications according to the prenatal check chart, (4) a singleton pregnancy, (5) normal extremities and ability to undertake activities, (6) a partner who was to be present during labour, and (7) the ability to speak, read, and write Chinese. After recruitment, participants were

excluded if they had been admitted to the hospital prior to 37 weeks of gestation, estimated cervical dilations of more than four centimetres, were in labour and had used epidural anaesthesia, and underwent an emergency caesarean section.

G\*Power (Germany; version 3.1.1) software was used to estimate the required sample size (Faul et al., 2007). A pilot study of 21 subjects revealed that values for the mean and standard deviation (SD) of the pain scores (Visual Analogue Scale) at eight centimetres cervical dilation for the experimental and control groups were 8.09 (SD 2.31) and 6.54 (SD 2.42), respectively. Given a true difference in pain scores of 1.55 between the experimental and control groups and a statistical power of 0.8 to reject a null effect at the 0.05 significant level, we calculated that 38 subjects would be needed in each group. By taking into account a possible attrition rate of 55%, the authors set the target sample size at 85 per group. The suggested attrition rate was estimated from a previous childbirth longitudinal study (40–60.4%) (Saisto et al., 2001; Ip, 2005); as well as considerations of the overall caesarean rate (33–35%) in Taiwan (Department of Health, 2006).

### Measurements

The following demographic and obstetrical information was collected: age, education level, occupation, parity, antenatal class attendance, induction, birth mode, gestational age, and newborn baby birth weight, and Apgar scores.

Labour pain was assessed by the Short Form McGill Pain Questionnaire (SF-MPQ), which is a multidimensional assessment, combining a Visual Analogue Scale (VAS), Verbal Response Scale (VRS), and a Present Pain Intensity Scale (PPI) (Melzack, 1987). It was developed for use in childbirth where rapid pain management is required (Melzack, 1987; Baker et al., 2001; Chang et al., 2002, 2006). It is capable of eliciting the qualitative dimensions of pain (sensory and affective) as well as its overall intensity (Baker et al., 2001). The VRS measures 11 sensory and four affective qualities of pain, ranking as either none, mild, moderate, or severe (0–4). The PPI measures pain intensity on a 0–5 numerical rating scale from 'no pain' (0) to 'excruciating' (5). The VAS used was a 10-centimetre horizontal line with a 'no pain at all' at the left and 'worst possible pain' at the right. Women indicated their level of pain intensity by placing a cross on the line. The SF-MPQ was translated into Chinese and back-translated into English by bilingual individuals with bicultural experience in order to establish content and semantic equivalence (Chen, 1998; Chang et al., 2002, 2006; Ip et al., 2005; Sun et al., 2010). Cronbach's  $\alpha$  for the Chinese VRS has been previously rated at 0.62–0.87, showing adequate internal consistency (Chen, 1998; Chang et al., 2002, 2006). In this study, Cronbach's  $\alpha$  coefficient for all the scales was 0.92.

The Childbirth Self-Efficacy Inventory (CBSEI) is a self-reporting scale that measures maternal confidence for labour and birth (Lowe, 1993). This four-factor structure tool has two parallel subscales and a total of 62 items. The first two factors are 15-item expectancy subscales (EE-15 & OE-15), which are completed during the first stage of labour. The other two are 16-item expectancy subscales (OE-16 & EE-16) completed during the second stage of labour (Lowe, 1993). This study only applied the EE-15 & OE-15 subscales to measure maternal confidence when the cervical dilations were four and eight centimetres. Each item consisted of a statement and responses made on a 10-point Likert scale (which has established psychometric properties) from one (not at all helpful) to 10 (very helpful) for the OE subscales, and one (not at all sure) to 10 (very sure) for the EE subscales (Lowe, 1993; Drummond and Rickwood, 1997; Sinclair and O'Boyle, 1999; Ip et al., 2005; Khorsandi et al., 2008). A higher score indicated a higher level of self-efficacy or labour outcome expectancy. The CBSEI was translated into Chinese and

back-translated into English by bilingual individuals with bicultural experience to establish content and semantic equivalence (Ip et al., 2005; Sun et al., 2010). Internal consistency (Cronbach's  $\alpha$ 's) for the Chinese CBSEI has been previously rated at 0.82–0.95 for Taiwanese women (Sun et al., 2010) and 0.92–0.96 for Hong Kong women (Ip et al., 2005). In this study, Cronbach's  $\alpha$  coefficient for all the scales was 0.89–0.96.

Participants required approximately 10–15 minutes to complete the demographic and obstetrical information, CBSEI and SF-MPQ questionnaires at four centimetres cervical dilation. At eight centimetres, it took about 7–9 minutes to complete the CBSEI and SF-MPQ. All questionnaires were administered during the intermittence of uterine contractions. The items were read by the research investigators and the participants reported their levels of self-efficacy and pain.

### *Intervention programme*

The birth ball exercise programme consisted of a 26-page booklet and a 19-minute videotape, with periodic follow-ups during prenatal checks. Initially, the exercise programme was developed by investigators after reviewing the literature (Carriere, 1998; Perez, 2001; Watkins, 2001). It included four different kinds of positions with eight exercises: sitting (pelvic rocking—forward and back, Hula-Hula—side-to-side, and rocking), standing (leaning forward on the ball and leaning against the ball on the wall—up and down), kneeling (hugging the ball and pelvic rocking), and squatting (leaning against the ball on the wall). The developed protocol was reviewed by two certified prenatal childbirth educators, two fitness specialists, and one physical therapist and then revised based on their recommendations. Only minor modifications to the content wording were required (for detailed information, see Chang and Gau (2006) and Chang et al. (2008).

We provided three different ball sizes to the participants, 55, 65, and 75 cm in diameter. The appropriate size of ball is determined by the participant's height (Carriere, 1998; Perez, 2000). In order to maintain balance exercises, the woman has the mobility to maintain a neutral spine easily when sitting with hips and knees at an angle of approximately 90° (Carriere, 1998; Perez, 2000). A long-legged woman requires a large ball (diameter 65 cm or more) than a short-legged one (55 cm diameter or less may be sufficient). For safety, the ball must be firmly inflated, and keep sharp objects away from the ball.

All members of the experimental group were asked to practise the exercises and positions at home for at least twenty minutes three times a week for a period of 6–8 weeks. To ensure compliance with the research protocol, the investigator had biweekly meetings with the woman and her partner during prenatal checks. At that time, the investigator asked the subjects and their partners to practise the birth ball positions and exercises, and answered any questions relating to the subject matter.

### *Data collection*

A consecutive sample was solicited from two antenatal outpatient centres. Two part-time research investigators, who were also certified midwives and working full-time in the study hospital, were trained to recruit eligible subjects and collect data. They contacted each participant in the centres and explained the purpose and procedure of the study during their 30–32 week prenatal check-up. If participants agreed to participate, they were randomly assigned to the experimental or control group.

The participants of the experimental group were taught by the research investigators and shown the birth ball exercises and positions via computer demonstration. In addition, approximately thirty

minutes were spent highlighting the primary points of the booklet contents. The investigator ensured that the participants performed the exercises correctly, promoting tri-weekly exercise. Subsequently, participants could take home a demonstration CD, booklet, and a birth ball; however, women in the control group were not shown birth ball exercises and did not receive the booklet and video.

When the participants arrived at the hospital for childbirth, the nurses in labour units informed the research investigators. All nursing and midwifery care was provided by hospital staff nurses, whereas the research investigators were only present for data collection. Women in the experimental group were given a birth ball for use during labour and were encouraged every hour to choose the most comfortable positions, movements, and exercises. Women in both groups were asked to fill out the CBSEI and SF-MPQ when contractions were occurring once every three to five minutes and cervical dilations were four centimetres. Their partners were asked to record the duration of the upright position. When contractions were occurring once every 1.5–2 minutes and cervical dilations were 7–8 cm, participants were asked to complete the CBSEI and SF-MPQ again.

Both groups received standard nursing and midwifery care from hospital staff nurses in all aspects of pregnancy and childbirth. The standard care that the pregnant women received included 10–12 regular physical check-ups and a variety of childbirth education. There is no standardized system of prenatal childbirth education in Taiwan. Pregnant women have free choice to attend various types of childbirth education classes conducted by hospitals and community health-care centres. Classes come in various formats and vary in educational purpose, qualification of instructors, and length. During childbirth, active management of labour such as induction/augmentation of labour, continuous fetal monitoring, and two to four hourly vaginal examination is the dominant model of care in the units. Women in labour are only allowed to move around the bedside due to the fetal monitoring. All women in labour are cared for mainly by nurses and their infants delivered by obstetricians. Each nurse cares for 2–3 women in labour. The main pharmacological pain relief method is epidural anaesthesia.

### *Data analysis*

The means and standard deviations of continuous variables along with the frequencies and percentages of dichotomous variables were calculated using SPSS Version 17 (SPSS, Inc., Chicago, IL, USA). The Kolmogorov–Smirnov goodness-of-fit test and normality plot were used to investigate the distributional characteristics of the study dependent variables. The results indicated that the values for the target variables were not normally distributed in the population. The Mann–Whitney  $U$ -test and  $\chi^2$  test were used to analyse group differences.

The generalised estimating equations (GEE) model was used to control the effect of study covariates and analyse the independent effect of the birth ball exercise. We used the GEE approach to consider within-person variability and account for correlated data resulting from repeated measurements across different time points and multiple observations of the same individual (Zeger and Liang, 1986). The GEE approach has been proposed as a non-parametric and appropriate method to conduct repeated measurement analysis. Its main advantage (when compared to the maximum likelihood approaches) is its robustness against the working correlation structure, which must be assumed as correct for within-subject correlations. Sobel's significance test (Sobel, 1990; Dudley et al., 2004) was calculated to determine whether the effect of an intervention programme on labour pain was reduced in the presence of childbirth efficacy. The Goodman version of the Sobel test was performed using SPSS syntax

by Dudley et al. (2004), and can be used to describe the relationship between three or more variables. It was calculated to determine whether the presence of a mediator reduced labour pain to zero. All tests of hypotheses were performed at the 5% significance level. All analyses were repeated as intention-to-treat analyses (ITT). In these analyses, participants who did not follow the study protocol were included. Sensitivity analyses (data not shown) suggested no significant differences in effects based on ITT as well as per-protocol approaches.

#### Ethical considerations

After receiving approval from their institutional review boards (IRBs), the PI visited target institutions and associated birth units to explain the research purpose and methods to nursing and midwifery managers, nurse clinicians, and obstetricians prior to data collection. Potential participants who met the study criteria were fully informed of the research purposes, intervention benefits/risks, procedures, and were asked to sign a consent form. Anonymity and confidentiality were ensured, with subjects informed of their right to withdraw from the study at any point without affecting subsequent care.

#### Findings

Initially, 188 participants were recruited; 94 in the experimental group and 94 in the control group. However, some participants ( $n=101$ ) were removed from the study for various reasons including emergency caesarean section ( $n=40$ ), epidural

anaesthesia ( $n=41$ ), preterm labour ( $n=12$ ), having a birth at another hospital ( $n=5$ ), and not following study protocol ( $n=3$ ) (Fig. 1). Forty-six participants from the experimental group and 55 participants from the control group were removed from the original participants, yielding an attrition rate of 53.7%. As a result, the study included 48 participants in the experimental group and 39 in the control. A comparison of the demographic and obstetrical data (age, education level, parity, and prenatal class attendance) between those dropped out ( $n=101$ ) and those end the trial ( $n=87$ ) revealed non-significant difference (Table 1).

Among the 87 on trial participants, the average age was 30.2 (SD=3.6) years. Most had graduated from university ( $n=64$ , 74.4%), were primiparous ( $n=55$ , 62.3%), and had vaginal birth without any instrument assistance ( $n=81$ , 93.1%). None of them used pharmacologic pain relief agents during labour. The groups showed no statistical differences in demographic and obstetrical variables ( $p > 0.05$ ) except for the duration of the upright position and first stage labour (Tables 1 and 2). The experimental spent longer durations in the upright position and had shorter first stage labour durations than the control group (Table 2).

This study found that the birth ball exercise decreased labour pain and increased childbirth self-efficacy. According to Table 3, there was a significant difference in pain scores between the two groups at cervical dilations of four and eight centimetres. In addition, self-efficacy significantly differed between the two groups during four centimetres cervical dilation ( $Z = -5.21$ ,  $p < 0.001$ ) and eight centimetres cervical dilation ( $Z = -2.21$ ,  $p = 0.027$ ).

After controlling for several variables with potential effects on childbirth pain, we further used generalised estimation equations (GEEs) to evaluate the differences. Table 4 shows changes for

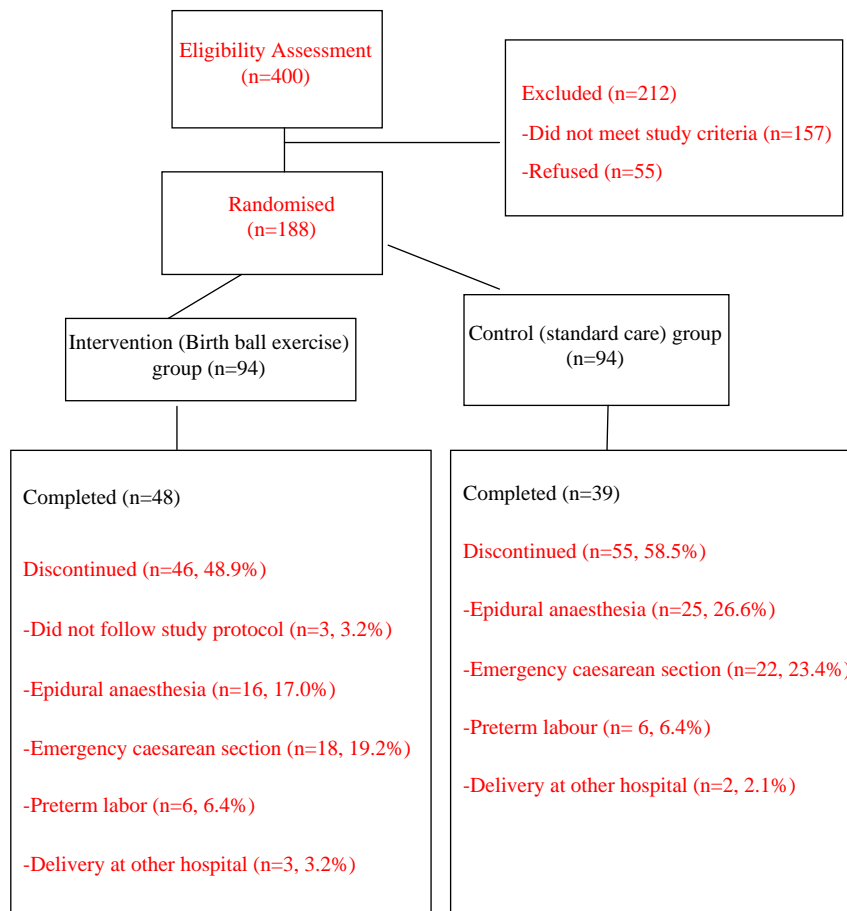


Fig. 1. CONSORT diagram. Passage of participants through each trial stage.

**Table 1**  
Baseline characteristics of research sample.

| Variable                   | Overall (n=188)       |                      | Statistic (p value) | On trial (n=87)                |                           | Statistic (p value) |
|----------------------------|-----------------------|----------------------|---------------------|--------------------------------|---------------------------|---------------------|
|                            | Withdraw (n=101) n(%) | On trail (n=87) n(%) |                     | Experimental group (n=48) n(%) | Control group (n=39) n(%) |                     |
| Age (years), mean (SD)     | 30.4 (3.2)            | 30.2 (3.6)           | 0.40*(0.391)        | 30.1 (3.4)                     | 30.3 (4.0)                | 0.25* (0.806)       |
| Education Level            |                       |                      | 5.29†(0.152)        |                                |                           | 1.28†(0.258)        |
| Junior high school         | 1 (1.0)               | 0 (0)                |                     | 0 (0)                          | 0 (0)                     |                     |
| Senior high school         | 29 (29.6)             | 16 (18.6)            |                     | 6 (12.5)                       | 10 (26.3)                 |                     |
| University                 | 58 (59.2)             | 64 (74.4)            |                     | 39 (81.3)                      | 25 (65.8)                 |                     |
| Postgraduate and above     | 10 (10.2)             | 6 (7.0)              |                     | 3 (6.3)                        | 3 (7.9)                   |                     |
| Antenatal class attendance |                       |                      | 2.10†(0.147)        |                                |                           | 3.80†(0.052)        |
| Yes                        | 54 (53.5)             | 55 (64.0)            |                     | 35 (72.9)                      | 20 (52.6)                 |                     |
| No                         | 47 (46.5)             | 31 (36.0)            |                     | 13 (27.1)                      | 18 (47.4)                 |                     |
| Parity                     |                       |                      | 0.16†(0.691)        |                                |                           | 1.41†(0.235)        |
| Primiparous                | 61 (60.4)             | 55 (63.2)            |                     | 33 (68.8)                      | 22 (56.4)                 |                     |
| Multiparous                | 40 (39.6)             | 32 (36.8)            |                     | 15 (31.3)                      | 17 (43.6)                 |                     |

Note: Numbers may not add to 101 or 87 because of missing data.

\* Independent *t* test.

†  $\chi^2$ .

**Table 2**  
Post-intervention characteristics of research participants (n=87).

| Variable   | Overall |       | Experimental group |        | Control Group |        | Statistic | p       |
|--|---------|-------|--------------------|--------|---------------|--------|-----------|---------|
|  | n       | %     | n                  | %      | n             | %      |           |         |
| Gestational age (weeks), mean (SD)                       | 39.3    | 0.8   | 39.3               | 0.8    | 39.4          | 0.8    | 0.46*     | 0.646   |
| Induction  |         |       |                    |        |               |        | 3.08†     | 0.080   |
| Yes  | 38      | 43.7  | 25                 | 52.1   | 13            | 33.3   |           |         |
| No   | 49      | 56.3  | 23                 | 47.9   | 26            | 66.7   |           |         |
| Duration of upright position (minute), mean (SD)         | 151.9   | 92.3  | 181.3              | 86.56  | 115.8         | 87.0   | −3.50*    | 0.001   |
| Duration of first stage labour (minute), mean (SD)       | 427.2   | 233.4 | 380.0              | 167.82 | 485.4         | 286.7  | 2.14*     | 0.035   |
| Duration of second stage labour (minute), mean (SD)      | 39.7    | 23.4  | 38.48              | 27.69  | 41.3          | 17.0   | 0.55*     | 0.585   |
| Satisfaction with partner supportive measures, mean (SD) | 4.2     | 0.8   | 4.6                | 0.6    | 3.6           | 0.7    | 7.33‡     | < 0.001 |
| Birth mode   |         |       |                    |        |               |        | ‡         | 0.558   |
| Vaginal birth  | 81      | 93.1  | 45                 | 93.8   | 36            | 92.3   |           |         |
| Assisted vaginal birth                                   | 6       | 6.9   | 3                  | 6.2    | 3             | 7.7    |           |         |
| Newborn baby weight (g), mean (SD)                       | 3109.0  | 358.4 | 3082.21            | 311.37 | 3141.92       | 410.73 | 0.77*     | 0.443   |
| Apgar score (five minutes)                               |         |       |                    |        |               |        | ‡         | 0.086   |
| 9  | 84      | 96.6  | 48                 | 100    | 36            | 92.3   |           |         |
| 10   | 3       | 3.4   | 0                  | 0      | 3             | 7.7    |           |         |

\* Independent *t* test.

†  $\chi^2$ .

‡ Fisher's exact test.

**Table 3**  
Differences in childbirth pain and self-efficacy between the two groups (n=87).

| Variable             | Overall mean (SD) | Experimental group mean (SD) | Control group mean (SD) | Statistic* | p       |
|----------------------|-------------------|------------------------------|-------------------------|------------|---------|
| Pain scales          |                   |                              |                         |            |         |
| VAS (4 cm)           | 4.9 (1.9)         | 4.0 (1.7)                    | 6.0 (1.6)               | −4.97      | < 0.001 |
| VRS (4 cm)           | 14.9 (8.3)        | 10.2 (5.3)                   | 20.6 (7.8)              | −5.65      | < 0.001 |
| PPI (4 cm)           | 2.4 (1.1)         | 1.8 (0.9)                    | 3.2 (0.7)               | −6.25      | < 0.001 |
| VAS (8 cm)           | 7.3 (1.5)         | 6.5 (1.3)                    | 8.2 (1.1)               | −5.49      | < 0.001 |
| VRS (8 cm)           | 25.4 (10.8)       | 22.3 (10.2)                  | 29.3(10.3)              | −3.08      | 0.002   |
| PPI (8 cm)           | 3.6 (0.9)         | 3.2 (0.7)                    | 4.0 (0.7)               | −4.47      | < 0.001 |
| Self-efficacy scales |                   |                              |                         |            |         |
| Self-efficacy (4 cm) | 206.0 (29.2)      | 220.4 (22.8)                 | 188.3 (26.5)            | −5.29      | < 0.001 |
| Self-efficacy (8 cm) | 157.6 (34.7)      | 166.7 (39.2)                 | 146.5 (24.3)            | −2.21      | 0.027   |

VAS: Visual Analogue Scale; VRS: Verbal Response Scale; PPI: Present Pain Intensity Scale.

\* The Mann–Whitney *U*-test.

means of VAS ( $\beta = -1.81$ ), VRS ( $\beta = -6.61$ ), and PPI ( $\beta = -0.93$ ) scores to be significantly lower in the intervention group ( $p < 0.001$ ) than in the control group. Time-dependent changes

also indicated that pain scores at four centimetres cervical dilation rose an average 7.61 (VRS), 1.98 (VAS), and 0.80 (PPI) points at eight centimetres cervical dilation, suggesting the



presence of a growth effect. However, there was no significant interaction effect (group difference and time) present. Moreover, pain scores significantly differed between the groups in terms of self-efficacy ( $p \leq 0.005$ ). Women with higher self-efficacy scores had lower pain scores (Table 4).

Table 5 shows the results of the Sobel tests on the mediated effect of self-efficacy with birth ball exercises and childbirth pain. Results revealed that self-efficacy had a significant mediating effect on the relationship between birth ball exercises and childbirth pain. The Goodman version of the Sobel test further demonstrated that approximately 40.8% (VRS), 32.4% (VAS), and 30.7% (PPI) of the outcome variances were mediated by self-efficacy ( $p < 0.001$ ).

## Discussion

This experimental study, the first of its kind, provides a contribution to the sparse scientific literature about the birth ball exercise programme in improving childbirth self-efficacy and pain relief. There were three potential action mechanisms to explain these findings. First, the gate control theory (Melzack and Wall, 1996) offers a possible explanation as to why the birth ball exercises might work to relieve participant pain. With the soft surface, the ball may provide support for the perineum and/or the lower back without assigning a lot of pressure (Perez, 2001). Moreover, it has been observed that when women roll on the ball, they stimulate normal somatosensory input to the projector neurons, which may reduce pain perception (Melzack et al., 1991; Melzack, 1996; Melzack and Wall, 1996).

Second, studies show that freedom of movement is correlated with pain relief. A woman's rocking motion may encourage the

fetus to settle into a position more conducive to birthing (Simkin, 1995; Shilling and DiFranco, 2004). In conducting a randomised trial, Melzack et al. (1991) found that women who sat or stood during labour experienced significantly less back pain than women who were lying down throughout their labour.

Third, offering the birth ball exercise programme is a tangible, instrumental means of support for women in labour. In this study, we found that the experimental group spent a longer duration in the upright position than the control group. In addition, the satisfaction level of experimental group women towards their partners, who generally offered support beside them during labour, was higher than the control group (Table 1). Consistent with previous studies, Chang and Gau (2006) found that women in labour and their partners developed a sense of 'we-together' when they practised the birth ball exercises and positions. They often tried to figure out optimal and comfort positions in tandem. Thus, the birth ball was instrumental in fostering paternal participation during childbirth. Tseng (2010) found that the birth ball let the women in labour more easily rock her pelvis naturally. The partner also supplied a more physical touch. Many research studies demonstrate that support during labour, especially from the partner, is directly associated with decreased rates of analgesia, reduced labour pain, and a positive maternal rating of the childbirth experience (Hodnett and Osborn, 1989; Shi, 2002; Gungor and Beji, 2007).

The findings of this study suggest that birth ball practice during pregnancy may facilitate self-efficacy during childbirth. The birth ball exercise programme enhanced the participant capacity to cope through positive feedback in coping skills practice, redemonstration, and couple's discussions. During the third trimester of pregnancy, regular birth ball exercise improved alignment and perception of muscle sense and changes in the body's centre of gravity (Watkins, 2001). It also provided pregnant women with some physiological benefits such as good posture and lower back pain prevention (Perez, 2000, 2001; Watkins, 2001). The ball exercises may help the mobilisation of the lumbrosacral fulcrum and sacroiliac coxofemoral articulations, and maintain muscle tone in the oblique and transverse muscles in the abdomen (Perez, 2000). Practise helps the expectant mother to prepare for birth as she masters the art of keeping good posture, and maintaining abdominal and back strength. Thus, the programme was successful in raising a woman's self-belief in her capacity to cope with childbirth (Ip, 2005). Participants in the experimental group were more actively involved in the labour process by positioning, exercising for relieving pain, and promoting labour progress. As indicated by McCrea and Wright (1999), increased coping activities during labour may help promote a woman's feelings of 'being in control' over a painful stimulus which in turn may result in a higher tolerance for pain. Similarly, a study of 85 Chinese women in labour also found that women who had a higher sense of confidence in coping during labour were reported to have less perceived pain in childbirth (Law, 2003). Our study showed that self-efficacy has

**Table 4**  
Generalised estimating equations model\* on the effect of pain scores for birth ball exercise ( $n=87$ ).

| Variables                                   | $\beta$ | SE    | $p$    |
|---|---------|-------|--------|
| <b>Model 1 (PPI)</b>                        |         |       |        |
| Group (experimental versus control)         | -0.93   | 0.17  | <0.001 |
| Time (cervical dilatation 8 cm versus 4 cm) | 0.80    | 0.10  | <0.001 |
| Self-efficacy                               | -0.007  | 0.002 | <0.001 |
| <b>Model 2 (VAS)</b>                        |         |       |        |
| Group (experimental versus control)         | -1.81   | 0.30  | <0.001 |
| Time (cervical dilatation 8 cm versus 4 cm) | 1.98    | 0.22  | <0.001 |
| Self-efficacy                               | -0.01   | 0.003 | 0.005  |
| <b>Model 3 (VRS)</b>                        |         |       |        |
| Group (experimental versus control)         | -6.61   | 1.86  | <0.001 |
| Time (cervical dilatation 8 cm versus 4 cm) | 7.61    | 1.18  | <0.001 |
| Self-efficacy                               | -0.06   | 0.02  | 0.005  |

PPI: Present Pain Intensity Scale; VAS: Visual Analogue Scale; VRS: Verbal Response Scale.

\* All models adjusted for attending prenatal childbirth class, mode of birth, induction, duration of first stage labour, and upright time.

**Table 5**  
The mediated effect of self-efficacy on relationships between birth ball exercise and childbirth pain ( $n=87$ ).

| Dependant variable | Predictor                           | Mediator      | Sobel test           |                 |       |               |
|--------------------|-------------------------------------|---------------|----------------------|-----------------|-------|---------------|
|                    |                                     |               | Sobel test statistic | Indirect effect | Ratio | Mediation (%) |
| VAS                | Group (experimental versus control) | Self-efficacy | -3.80***             | -0.59           | 0.48  | 32.4          |
| VRS                | Group (experimental versus control) | Self-efficacy | -3.89***             | -3.56           | 0.69  | 40.8          |
| PPI                | Group (experimental versus control) | Self-efficacy | -3.93***             | -0.34           | 0.44  | 30.7          |

VAS : Visual Analogue Scale; VRS: Verbal Response Scale; PPI : Present Pain Intensity Scale.

\*\*\*  $p < 0.001$ .

an approximately 30–40% mediating effect on relationships between birth ball exercises and childbirth pain. These findings were also consistent with Lowe's (1993) study.

In addition, this study indicated that mothers in the experimental group had shorter first stage labour durations (Table 2), less epidural analgesia, and fewer caesarean deliveries than the control group (Fig. 1). The birth ball served as a comfort tool for birthing women, allowing them to achieve more comfortable positions to enhance the labour progress. The use of the birth ball may hasten fetal descent by allowing birthing women to be in the upright position and take advantage of gravity (Simkin, 1995; Perez, 2000, 2001). The ball also encourages rhythmic movement that may promote optimal positioning. Overall, the position and movements contribute to both comfort and progress (Simkin, 1995). Finally, this study also indicates that women in the experimental group felt more satisfied with their partners. Further studies could investigate the partners' feelings towards the birth ball, and how the birth ball exercise programme affected their psychological domains (e.g. anxiety levels, self-efficacy, and attitude toward to childbirth).

There are several issues that have been raised from this initial study that need further investigation and evaluation. Firstly, there were 46 participants (experimental group) and 55 participants (control group) removed from the original participants mainly due to emergency caesarean section, epidural anaesthesia and preterm labour. The expectedly high level of drop-out may mean that the initial balance introduced by randomisation may have been lost and it is possible that unmeasured confounding factors may influence the results. Nevertheless, concerning the variables of interest in the current study, there were no statistical differences in pre-labour characteristics between withdraw and on trial groups. Thus, the confounding effect would not reach an important degree. In addition, the completed data rate was comparable to previous obstetric studies (Saisto et al., 2001; Ip, 2005) when taking into account the overall caesarean rate in Taiwan. Secondly, it was not feasible to blind the study subjects or give them a sham birth ball exercise. We felt that this might cause another concern that awareness affected either control or experimental performance (the so-called Hawthorne effect and the notion subject expectancies). Finally, our study results were derived from a population of pregnant Chinese women, and studies in other ethnic populations are needed.

## Conclusions

In summary, this experimental study suggests that the clinical implementation of the birth ball exercise programme could be an effective adjunctive tool to improve childbirth self-efficacy and further reduce pain among women in labour. We look forward to further studies in the literature that may either confirm or refute this suggestion. There are two major implications for health-care educators, researchers, and clinicians. First, controlling pain without harm to the mother, fetus, or labour progress remains a primary focus during the labour experience. The birth ball exercise could be an effective adjunctive tool with non-pharmacological, complementary care strategies for supporting the women in labour. Second, psychological preparation is also extremely important due to the close link between pain and self-efficacy. On the basis of our mediating model, the results further suggest that confidence is greater after prenatal preparation and that confidence is powerfully related to decreased pain perception and decreased medication/analgesia use during labour. We believe that ultimately, health professionals can educate women and their partner prenatally about how to cope

with childbirth pain, assisting them in feeling positive about their experience.

## Conflicts of interest

The authors have no conflicts of interest to report.

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