Descriptive title: Web-based versus home-based postnatal psychoeducational interventions for first-time mothers: A randomised controlled trial

Short title: Postnatal psychoeducational interventions

JIAO Nana, MSc, RN
Research Assistant, Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore, Singapore; National University Health System, Singapore
Tel.: (65) 6516 7456; E-mail: nurjn@nus.edu.sg

ZHU Lixia, PhD, RN
Research Fellow, Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore, Singapore; National University Health System, Singapore
Tel.: (65) 6516 7456; E-mail: phczlix@nus.edu.sg

CHONG Yap Seng, MD,
Senior Consultant, Department of Obstetrics and Gynecology, National University Hospital; Associate Professor, Yong Loo Lin School of Medicine, National University of Singapore, Singapore
Tel: (65) 6772 4272, (65) 6516 5852; E-mail: obgcys@nus.edu.sg

Wai-Chi Sally CHAN, PhD, RN
Professor, School of Nursing and Midwifery, Faculty of Health and Medicine, The University of Newcastle, Australia
Tel: (61) 2 4921 6770; E-mail: sally.chan@newcastle.edu.au

LUO Nan, PhD
Associate Professor, Saw Swee Hock School of Public Health, National University of Singapore and National University Health System, Singapore
Tel.: (65) 6516 4966; E-mail: nan_luo@nuhs.edu.sg

WANG Wenru, PHD, RN

Associate Professor, Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore, Singapore; National University Health System, Singapore
Tel.: (65) 66011761; E-mail: nurww@nus.edu.sg

HU Rongfang, PhD, RN

Associate Professor, School of Nursing, Fujian Medical University, Fuzhou, China
Tel.: (86) 135 0936 6729; Email : hulu2886@sina.com

CHAN Yiong Huak, PhD

Head, Senior Biostatistician, Biostatistics Unit, National University of Singapore, Singapore
Email: medcyh@nus.edu.sg

HE Hong-Gu, PhD, RN, MD

Associate Professor, Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore, Singapore; National University Health System, Singapore
Tel.: (65) 6516 7448; E-mail: nurhhg@nus.edu.sg

Corresponding author: A/Prof HE Hong-Gu, PhD, RN, MD**,** Associate Professor, Alice Lee Centre for Nursing Studies Yong Loo Lin School of Medicine National University of Singapore Level 2, Clinical Research Centre Bock MD11, 10 Medical Drive, Singapore 117597 Tel: (65) 6516 7449; Fax: (65) 6776 7135; Email: nurhhg@nus.edu.sg

ABSTRACT

Background: Besides physical and mental changes from childbirth, first-time mothers are also confronted with challenges associated with the demands of adapting to their roles as new parents. While positive effects of home-based psychoeducation intervention for mothers have been demonstrated, limited studies have developed and examined more accessible and cost-effective web-based psychoeducational interventions for mothers.

Objective: To examine the effectiveness of web-based and home-based postnatal psychoeducational interventions for first-time mothers during the early postpartum period.

Methods: A randomized controlled three-group pre-test and post-tests experimental design was adopted. Data were collected over five months, from October 2016 to August 2017, in a public tertiary hospital in Singapore from 204 primiparas who were randomly allocated to the web-based psychoeducation group, the home-based psychoeducation group, or the control group. The measured outcomes included maternal parental self-efficacy, social support, psychological well-being, satisfaction with postnatal care, and cost-effectiveness evaluation. Data were collected at four time points: the baseline, and three post-tests at one month, three and six months post-delivery.

Results: When compared to the control group, the web-based intervention improved self-efficacy at post-test 1 (mean difference = 2.68, p = 0.028) and reduced postnatal depression at post-test 3 (mean difference = -1.82, p = 0.044), while the home-based intervention did not show significant effect on these two outcomes at all post-tests. Both web-based and home-based interventions helped mothers to get better social support at all post-tests than those in the control group. Mothers in both web-based and home-based intervention groups were more satisfied with the postnatal care than those in the control group at all post-test time points (except for web-based group at post-test 1). There were no differences in anxiety scores among the three groups. When compared to the home-based intervention, the web-based intervention showed noninferior effect on all outcomes at all post-tests.

Conclusion: The web-based intervention had better effects on improving self-efficacy, social support, and postnatal depression, which should be introduced to first-time mothers for better postnatal care.

Trial Registration No: ISRCTN45202278.

Keywords: Depression, postnatal care, postpartum, randomized controlled trial, self-efficacy, social support

INTRODUCTION

The postpartum period is a time of change for new mothers physically, mentally, and socially. Studies have shown that new mothers report many physical challenges after birth such as sore nipples, breast engorgement, and mastitis (Keppler and Roudebush, 1999). Moreover, up to 50% of mothers experience tiredness and backache (Glazener et al., 1995, Saurel-Cubizolles et al., 2000, Brown and Lumley, 1998), while a significant proportion of mothers experience headaches (Lagro et al., 2003, Schytt et al., 2005, Woolhouse et al., 2012) and perineal or caesarean wound pain (Declercq et al., 2008). Taking care of newborns around the clock and breastfeeding issues has been reported to lead to fatigue and sleeplessness among new mothers (Kurth et al., 2010). Concurrently, first-time mothers are also confronted with challenges associated with the demand of adapting to their roles as new parents (Cowan and Cowan, 1992). For better transitions into parenthood, all first-time mothers want information about infant care, more specifically on the practical aspects of looking after their newborns (Cooke and Stacey, 2003). Previous literature has shown that confident new mothers tend to have better parenting satisfaction and mothers who are less efficacious tend to be emotionally stressed (Mercer and Ferketich, 1994).

Postnatal depression is also a common mental challenge (Glazener et al., 1995, Saurel-Cubizolles et al., 2000, Brown and Lumley, 1998) that is often associated with physical, relationship, and emotional problems (Brown and Lumley, 2000). The World Health

Organization reported that, worldwide, about 13% of mothers after delivery experience a mental disorder, primarily depression, meanwhile in developing countries the rate of depression was even higher, 19.8 % (World Health Organization, 2016). A recent Singapore study discovered that the prevalence of postnatal depression symptoms at four weeks post-delivery was 13% (Shorey et al., 2015b). Other studies have shown that mothers with postnatal depression are less likely to attend routine postpartum consultations (Lobato et al., 2012), and they may not vaccinate their children in a timely manner (Turner et al., 2003). Their infants are more likely to be unsettled and irritable (Kurth et al., 2010), and they may have delayed language and behavioral problems at three years after birth (Kahn et al., 2002). Mothers with postnatal depression have been found to have difficulties in finding normalizing information about mothering, and they have problems adjusting to and managing infant care (Payne and Myhr, 2010, Grindlay et al., 2000). In worse cases, they have difficulties in accessing and using support from others (Payne and Myhr, 2010). Thus, emotional care has been identified as an essential component to provide quality postnatal care (Tarkka et al., 2000, Dykes, 2005).

Relationships among parental self-efficacy, social support, and postnatal depression

According to Bandura's self-efficacy theory (Bandura, 1977), self-efficacy in the parenting context means a parent's belief that he/she has the ability to perform parenting tasks successfully. This belief determines how he/she feels, thinks, motivates himself/herself, and behaves, which has been identified as a major determinant of competent parenting behaviors (Jones and Prinz, 2005) and is closely linked to child development (Coleman and Karraker, 2000). Bandura postulates that self-efficacy operates to reduce reactions to stress and depression and it seems reasonable that mothers who feel more efficacious in handling a newborn might experience less stress and anxiety than those with lower self-efficacy (Bandura, 1986). In

addition, mothers' social support has been found to influence maternal self-efficacy in the postpartum period (Gao et al., 2010). Therefore, healthcare professionals need to focus on enhancing parents' self-efficacy by providing support through psychoeducation during the early postnatal period (Shorey et al., 2015b). Social support has also been found to be negatively correlated with postnatal depression (Haslam et al., 2006, Leahy-Warren et al., 2012, Ngai and Chan, 2012). Mothers who are better supported tend to feel better emotionally. Companionship from family members, partners (Brockington, 1998, Dennis and Chung-Lee, 2006, Holopainen, 2002, Oates et al., 2004), and peer support (McLeish and Redshaw, 2017) has been shown to serve as a protective factor against postnatal depression. Specifically, peer support in the form of talking to an experienced mother with similar stressors or situation has been shown to be a buffer against postnatal depression among new mothers (McLeish and Redshaw, 2017).

Maternal care during the antenatal and postnatal periods

In a previous study, first-time mothers stated that receiving support from an expert such as a midwife made them feel prepared for parenting (Dahlen et al., 2010). Midwifery support is not a new idea in some Western countries where antenatal and follow-up community postnatal care are delivered by midwives to new mothers and their families (Brown, 1988, Fenwick et al., 2010, Persson and Dykes, 2002). As an example, in the United Kingdom, mothers have access to midwifery care at home for up to a month and health visitors for the remaining postpartum period (Haran et al., 2014). In Singapore, first-time mothers also revealed the need for support from healthcare professionals due to their lack of knowledge in maternal and infant care (Ong et al., 2014, Shorey et al., 2015a). Local antenatal classes and postnatal support are normally provided by polyclinics and maternity hospitals (Health Promotion Board, 2015). However, antenatal classes are expensive, making them unreachable to specific socioeconomic groups.

Early hospital discharges post-delivery are usually between 1 and 3 days among all the restructured tertiary hospitals in Singapore (Ministry of Health, 2017). Parents feel overwhelmed with the informational contents provided during their short hospital stays (Danbjørg et al., 2014). The only type of support available postpartum is in the form of hospital visits to neonatologists or obstetricians between 1 and 6 weeks postpartum. There is no postpartum support provided by midwives from hospitals or communities (Ong et al., 2014, Shorey et al., 2015a).

Home-based and web-based psychoeducational interventions

Seeing the lack of support for new mothers in the local context, we conducted a preliminary study (Shorey et al., 2015b) whereby a theory-based psychoeducational program was delivered at home in the early postpartum period, and its effectiveness was evaluated by a randomized controlled trial. The results showed that the home-based postnatal psychoeducation program was effective in increasing mothers' self-efficacy and social support as well as reducing postnatal depression (Shorey et al., 2015b). The program was found to be effective and was well-liked by the participants. However, the program's implementation was limited as it required face-to-face home visits from an experienced midwife. Based on our previous research experience, we realized the need to develop a more convenient, widely accessible, and more cost-effective program to provide support to new mothers.

The internet delivery system offers an alternative and promising approach that may circumvent many of the difficulties of face-to-face delivery techniques (Kohn et al., 2004). It provides a level of anonymity that is not possible with face-to-face interventions (Beattie et al., 2009), potentially overcoming women's concerns about stigma related to asking questions regarding their emotional concerns (Dennis and Chung-Lee, 2006). It has also been found to provide flexibility (Clarke et al., 2005) and reduce time strains and economic costs associated

with providing home-based interventions (Henshaw et al., 2011). In Singapore, the home internet and broadband access rates were 88% and 87.5%, respectively, in 2016 (Infocomm Development Authority of Singapore, 2015). This indicates that technology is readily available in the majority of households to provide web-based psychoeducational interventions for maternal postnatal care. Therefore, we developed a web-based psychoeducation intervention based on the home-based psychoeducation intervention and tested its effectiveness on improving the health outcomes of first-time mothers.

Theoretical framework

The theoretical framework for web-based and home-based interventions is based on Bandura's self-efficacy theory and findings from previous international and local literature (Shorey et al., 2015b, Leahy-Warren et al., 2012, Johansson and Darj, 2004, Shorey et al., 2014). Previous literature and the self-efficacy theory have emphasized on multi-dimensional interventions, including health education, skills practice, timely feedback, and learning from the similar others, to enhance self-efficacy (Cheal and Clemson, 2001). Earlier studies have also highlighted that supportive interventions can be facilitated by providing educational social support and keeping the continuity of care through postnatal follow-up home visits by healthcare professionals after discharge from hospitals (Ngai et al., 2010). As such, the web-based and home-based interventions in this study have all those components, including educational support, learning from the similar others and experts, social support, and timely feedback, which are important to enhance self-efficacy (Cohen, 1992).

AIMS AND HYPOTHESIS

The aim of this study was to examine the effectiveness of web-based and home-based psychoeducational programs on self-efficacy in newborn care (primary outcome), as well as

social support, psychological well-being, and maternal satisfaction with postnatal support (secondary outcomes).

We hypothesized that: (1) when compared to those in the control group receiving routine care, first-time mothers in both web-based and home-based psychoeducational intervention groups report significantly higher levels of self-efficacy in newborn care (primary outcome), higher levels of social support received, lower levels of anxiety and depression, and higher levels of satisfaction with postnatal services (secondary outcomes); and (2) when compared to those in the home-based psychoeducational intervention group, mothers in the web-based psychoeducational intervention group do not report significantly poorer aforementioned maternal outcomes.

METHODS

Design

A randomized controlled, single-blinded, three-group pre-test and repeated post-tests experimental design was used. First-time mothers (n=204) who were recruited from the postnatal wards of a tertiary public hospital in Singapore were randomly allocated to one of the three groups (the web-based group receiving the web-based psychoeducational intervention plus routine care, the home-based group receiving the home-based psychoeducational intervention plus routine care, or the control group receiving routine care). The full protocol has been published (He et al., 2018).

Sample size calculation and participants

To achieve a medium effect size of 0.55, using a power of 80% and a significance level of 5% (2-sided), 52 participants in each group were needed based on a power analysis (Cohen, 1992). Based on our previous study (Shorey et al., 2015b), we anticipated a 24% dropout rate in this

study. As such, a minimum sample of 204 (52x3/0.76) participants, with 68 in each group, was needed in this study. The details of the inclusion and exclusion criteria can be found in the protocol (He et al., 2018).

Randomization, allocation concealment and blinding technique

Using a random sequence generator by RANDOM.ORG (RANDOM.ORG., 2016), a Research Fellow (ZL) generated three sets of 68 unique random integers in each set ranged from 1 to 204 without being sorted. Each set of numbers were randomly allocated to the web-based group, the home-based group, or the control group. A Research Assistant (JN), who recruited the participants and collected the baseline data, randomly allocated the mothers into each group by asking each mother to draw a number from an opaque box, which contained 204 paper slips with unique numbers indicating the group. The Research Fellow (AL) who was not aware of the group allocation collected the post-tests data. It was not possible to blind the participants due to the nature of the interventions (Cohen, 1992).

Psychoeducational intervention

Participants assigned to the web-based group received routine care and a web-based postnatal psychoeducational intervention with a one-month unique access to a specially developed website. We pilot-tested the intervention among six first-time mothers whereby they were asked to log in and navigate the whole website and give comments on the design and contents of the website for further improvement. Participants assigned to the home-based group received routine care and a home-based postnatal psychoeducational intervention, including a home visit and a booklet. Participants assigned to the control group received routine care provided by the hospital. Details on the contents of the web-based and home-visit psychoeducational interventions and comparisons with routine care have been provided in the study protocol (Cohen, 1992).

Outcome measures and instruments

The measured outcomes and instruments included: 1) primary outcome of maternal parental self-efficacy measured by the Perceived Maternal Parental Self-efficacy tool (PMPSE), 2) social support measured by the modified Perinatal Infant Care Social Support tool (PICSS-modified), 3) psychological well-being measured by the Edinburgh Postnatal Depression Scale (EPDS) and the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A), and 4) satisfaction with postnatal care measured by the Ordinal Descriptive Scale. Details on these instruments can be found in the study protocol (Cohen, 1992).

PMPSE: It is a 17-item four-point Likert instrument measuring maternal self-efficacy, and the total score ranges from 17 to 68. The Cronbach's alpha value was 0.93 in this study.

PICSS-modified: It includes the Functional Social Support Measuring Subscale (FSSMS) and the Structural Social Support Measuring Subscale (SSSMS). The FSSMS is a 16-item subscale used to measure maternal perceived social support with a Cronbach's alpha value of 0.93 in this study. The total score of this subscale ranges from 22 to 88. The SSSMS is a 6-item subscale used to measure the structural dimension of an individual's social network, and the total score ranges from 0 to 24. The Cronbach's alpha value was 0.84 in this study.

EPDS and HADS-A. They were used to measure mothers' postnatal depression and anxiety. The 10-item EPDS total score ranges from 0 to 30 with a Cronbach's alpha value of 0.84 in this study. The 7-item HADS-A was used to assess anxiety symptoms (Lee et al., 2007) with a four-point scale of 0 to 3, giving a total score of 0 to 21. The Cronbach's alpha was 0.84 in this study.

ODS. It is a 6-point Likert scale that measures mothers' self-reported satisfaction with the postnatal care they received.

Data collection procedure

The staff nurses in-charge at the postnatal inpatient wards were contacted to determine potential participants. The participants were approached after meeting the selection criteria screening by Research Assistant (JN). After obtaining written consent, the mother was recruited to the study, which was followed by demographic and baseline data collection via a self-administered questionnaire before randomization. Follow-up data were collected at one month, three months, and six months post-delivery. Details can be found in the study protocol (Cohen, 1992).

The Research Assistant (JN) was trained by the corresponding author, who has extensive experience in postnatal care, regarding how to deliver the intervention. The standardized intervention protocol was developed to guide the intervention to ensure the consistency of the intervention delivery to each participant. To standardize the intervention, the Research Assistant (JN) conducted a pilot home-based intervention under the supervision of two team members on three first-time mothers who delivered their babies within two weeks. After the completion of each pilot case, the researchers gave feedback to the Research Assistant (JN), and she was asked to record personal experiences on delivering the home-based intervention.

The Research Assistant (JN) recruited participants at the postnatal wards with regular visits. Web access (individual usernames and passwords were assigned) valid for one month was provided to each participant in the web-based group. Overall function and the navigation of the website were shown to the participants in the web-based group. For those assigned to the home-based group, the Research Assistant (JN) provided an educational booklet and went through the booklet with each participant before their discharge from the hospital. Home visits were scheduled within five to ten days post-delivery. Reminder messages were sent to the mothers before the Research Assistant (JN) visited them at home.

The Research Fellow (ZL) provided expert advice via forum under webpage on daily basis. She also collected the post-tests data at the three time points via online links from all the participants.

Statistical analysis

IBM SPSS Version 24.0 for Windows (IBM Corp., Armonk, NY) was used to analyze the data, with the statistical significance set at $p < 0.05$. Intention to treat analysis was conducted. Continuous data and categorical data were reported using descriptive statistics of mean (SD) and n (%), respectively. Chi-square tests and one-way analysis of variance (ANOVA) were used to compare sociodemographic and baseline outcomes, respectively, among the three groups to test for homogeneity at entry. Intention-to-treat analysis was used.

To answer hypothesis 1, repeated measures analysis of covariance (ANCOVA) using mixed models was conducted to compare the four outcomes (self-efficacy, social support, postnatal depression, and anxiety) for all 204 mothers over four time points among the three groups, adjusting for baseline outcome values, age, days since baseline collection, ethnicity, working status, monthly household income, antenatal courses attendance, and skin-to-skin contact with baby. Comparisons of the five outcomes, including satisfaction with postnatal care, among the three groups at each timepoint were compared using ANCOVA (General Linear Model, GLM), adjusting for baseline values (excluding satisfaction) and others that are the same as above. Pairwise comparisons were Bonferroni-adjusted. Using the GLM, regression slopes were used to show the rate of change for four outcomes across the three groups. Missing values were replaced by the best and worst possible values to analyze the sensitivity of missing data. To address the hypothesis 2, the 95% confidence interval of the mean difference of PMPSE, PICSS, EPDS, HADS-A, and ODS scores was calculated and assess against an equivalence region. An

noninferiority should be designed to minimize the possibility that a new therapy that is found to be noninferior to the current therapy can be non-superior to a placebo. One way to minimize this possibility is to choose a value of the equivalence margin based on the margin of superiority of the current therapy against the placebo (Walker and Nowacki, 2011). Thus the Bigger (absolute) number of upper or lower 95% CI of H-C for each analysis was used as the equivalence region.

Ethical considerations

Ethics approval for the study was obtained from the participating hospital on 25 January 2016 (NHG DSRB Ref: 2015/01189). A participant information sheet was provided to each participant with the study details as well as the benefits and risks of their participation. Voluntary participation and anonymity were emphasized. At the end of the study, all participants were provided with a token of appreciation for their time spent in the study as this is a common practice in the study country.

RESULTS

Data were collected from October 2016 to August 2017 with 68 mothers in each group (n = 204). All follow-up data were collected by August 2017. The CONSORT diagram of the study is shown in Figure 1.

Figure 1

Comparisons of the sociodemographic and clinical variables of the participants as well as baseline outcomes among the three groups

No statistically significant differences were found in sociodemographic and clinical characteristics (including age, ethnicity, citizenship, married status, education, working status, monthly household income, disease status, antenatal courses attendance, type of birth, baby's gender, skin-to-skin contact with baby, nasopharyngeal suctioning, baby's Apgar score at 1 and 5

minutes, and baby's birth weight) among the three groups (Table 1). Table 1 also shows that there were no statistically significant differences in the baseline outcomes of self-efficacy, social support, postnatal depression, and anxiety among the three groups.

Table 1

Comparisons of outcomes (self-efficacy, social support, postnatal depression, and anxiety) among the three groups over time and at each post-test timepoint

Hypothesis 1 was partially supported. The repeated measures ANCOVA using mixed models showed that there were significant time effects for outcomes of self-efficacy, social support, postnatal depression, and anxiety among the three groups over time and a significant group*time interaction effect for social support (Table 2 and Supplementary Figure 1).

Table 2 and Supplementary Figure 1

ANCOVA for comparisons of self-efficacy (Table 3), social support (Table 4), and postnatal depression (Table 5) and satisfaction with postnatal care (Table 6) at some post-test time points showed significant differences among the three groups. As shown in Table 3 and Supplementary Figure 1, participants who received the web-based intervention had significantly higher self-efficacy scores compared to those in control group at post-test 1.

Table 3, 4, 5, 6

As shown in Table 4 and Supplementary Figure 1, participants who received the web-based and home-based intervention consistently had significantly higher social support scores compared to those in the control group at all three post-test time points.

As shown in Table 5 and Supplementary Figure 1, participants who received the web-based intervention had significantly lower postnatal depression scores compared to those in the control group at post-test 2.

As shown in Table 6, participants who received the home-based intervention consistently were more satisfied than those in the control group at all post-test time points. Participants who received web-based intervention were more satisfied than those in the control group at post-tests 2 and 3.

In addition, Supplementary Table 1 and Supplementary Figure 1 showed that there were no statistically significant differences in anxiety among the three groups at all post-test time points. Web-based and home-based interventions had no impact on anxiety.

Supplementary Table 1

Using the GLM, regression slopes (Supplementary Table 2) showing the rates of change for self-efficacy, social support, postnatal depression, and anxiety across three groups were compared. There were significant differences in social support between the web-based and control groups as well as between the home-based and control groups. The results confirmed a significant time effect for social support (Table 2), and the two intervention groups performed better in improving social support than the control group. The sensitivity analysis of missing data (Supplementary Table 3 and Supplementary Table 4) showed that most of the results were not sensitive to missing data.

Supplementary Table 2, 3 ,4

The hypothesis 2 of noninferiority of web-based as compared to home-based group was supported. The results showed that web-based intervention was noninferior to home-based for all outcomes at all time points (Table 3-6 and Supplementary Table 1).

DISCUSSION

This study examined the effectiveness of a web-based postnatal psychoeducational program compared to a home-based intervention and routine care on the outcomes of first-time mothers in Singapore. The majority of the participants were over 30 years old, Chinese, Singaporean, married, and working and had bachelor's degree or higher education levels, monthly household incomes of S$5,000 to S$10,000, and normal deliveries. Other local studies reported similar characteristics regarding age, working status, education, and income (Shorey et al., 2015b).

Maternal parental self-efficacy

Our study found that the web-based intervention significantly improved mothers' self-efficacy only at post-test 1 compared with the control group. Based on the self-efficacy theory (Bandura, 1977), the most effective way of creating a strong sense of self-efficacy is through mastery experience (Bandura, 1994). Mastery experience involves hands-on experiences on tasks that ultimately enhance coping and behavioural skills. In this study, mothers were able to build some skills from watching instructional videos on the website or requesting demonstration during home visits from the Research Assistant (JN) when in need. They were also able to revisit videos of their choice when needed. In addition, for one to feel efficacious in the first place, one must have the appropriate knowledge base where they can gain knowledge (Bandura, 1977). Knowledge has been found to be an important predictor of maternal self-efficacy (Conrad, et al., 1992). Parenting knowledge in this study was provided to mothers in both intervention groups

via a website or a booklet. The useful knowledge base might have helped them to accurately anticipate their infants' changing needs and skills independently, which could have improved their confidence. These learning experiences could have also been able to motivate mothers to overcome obstacles of parenting as well as gain a resilient sense of efficacy, hence enhancing their self-efficacy through mastery experiences. It was similarly demonstrated the enhancement of self-efficacy in previous studies (Salonen et al., 2011, Shorey et al., 2017) where parents used online or booklet resources as added supportive sources.

The forum in the web-based group allowed mothers to share and exchange their experiences with other participants anonymously. It is the second way of creating and strengthening self-beliefs of efficacy through the vicarious experiences provided by social models (Bandura, 1994). Seeing mothers similar to themselves succeed by sustained effort may raise their beliefs that they also possess the capabilities mastering comparable activities to succeed. The impact of modelling on self-efficacy is strongly influenced by perceived similarity to the models. The greater the assumed similarity, the more persuasive the models' successes and failures are (Bandura, 1994). This was similarly reported in a local study whereby self-efficacy was improved by a mobile-health educational programme featuring vicarious experience (Shorey et al., 2017). In addition, the forum in the web-based group and the telephone follow-ups in the home-based group provided platforms for mothers to get useful feedbacks from professionals, which is a form of verbal persuasion to increase their self-efficacy. It is another way of strengthening people's self-efficacy (Bandura, 1994). Persuasion by experts may have led these mothers to try harder to succeed, which might in turn have increased their self-efficacy. This was also shown in other studies whereby parents felt more confident when their queries were answered by a healthcare professional and their worries were addressed (Shorey et al., 2017,

Lindberg et al., 2009). Additionally, mothers in the web-based group were able to play videos and audios repeatedly even when occupied with baby care, e.g. breastfeeding, which was not applicable to mothers in the home-based group. This might have caused the significant difference in self-efficacy between the web-based and home-based groups at post-test 2. For the home-based group, seven mothers (10.3%) refused home visits even though they agreed upon these when recruiting, which might have affected their self-efficacy scores and led to the nonsignificant results.

Perinatal infant care social support and satisfaction with postnatal care

Our study showed an improvement for social support in both web-based and home-based intervention groups across the three timepoints compared with the control group. The intervention contents in this study included how to seek social support from family and others. The internet fostered a social support system and weakened social barriers to people by allowing them access to information, education, and social networks (Shorey et al., 2017, Silva et al., 2015). Home visiting in the home-based group also provided some combinations of emotional, informational, and instrumental support (Shorey et al., 2017). Hence, the psychoeducation intervention in the current study helped mothers to get support from others and buffer against the effects of stress, which can arise in the postpartum period, while providing support remotely.

Mothers in both web-based and home-based intervention groups were more satisfied with the postnatal care than those in the control group at all post-test time points (except for web-based group at post-test 1). The knowledge and skills provided in this study could have allowed mothers to easily find ways to solve any problems encountered, hence increasing their satisfaction levels. This was consistent with some previous studies whereby having an added support in the postpartum period helped to increase satisfaction (Salonen et al., 2011, Danbjørg

et al., 2014). The web-based group had significantly higher self-efficacy scores when compared to the control group at post-test 1 despite a non-significant difference on satisfaction when comparing both groups at the same timepoint. This could be the result of underuse of forum and asynchronous communication for the web-based group. In addition, the home-based intervention allowed more interactions with mothers, e.g. home visit, three weekly follow ups to answer their queries, which might help to increase satisfaction in home-based group.

Psychological well-being

The postnatal depression (Table 5) and HADS-anxiety (Supplementary Table 1) scores for three groups decreased from the baseline to post-test 2 and increased at post-test 3. Social support was reported to significantly affect postnatal depression (Leathers et al., 1997, Wang and Chen, 2006), and there was a negative correlation between postnatal depression and social support (Kamalifard et al., 2014). In this study, there was an increase trend on social support in both intervention groups from the baseline to post-test 3. As first-time mothers, they were provided with different kinds of support from their family members or confinement nannies, especially in the first month after delivery, which might have buffered against postnatal depression. At post-test 3, six months post-delivery, almost all working mothers had started to work after a maximum of four months of maternity leave (for Singaporean citizen. Singapore permanent residents and foreigners have 3 months of maternity leave) in Singapore. These mothers could have been especially vulnerable to workplace stressors because they had to balance between work and new life, e.g. pumping breast milk for their babies during work breaks in non-supportive working environments, stress from poor work performances, and delaying their schedules due to sleep deprivation or role demands of caring for an infant. These might result in the increase of postnatal depression and anxiety scores at post-test 3. Similarly, a study

conducted in Malaysia revealed that the majority of postnatal depression occurring between 3 and 6 months postpartum (Yusuff et al., 2015). Some studies also suggested that an increase in leave duration was associated with a decrease in depressive symptoms until six months postpartum (Dagher et al., 2014, Cooklin et al., 2011).

In addition, the study showed postnatal depression significant difference between web-based and control groups at post-test 2 only (Table 5). There were no significant differences on anxiety for all groups at all time points between two intervention groups and control group (Supplementary Table 1). These could be attributed to the data collection time points. At post-test 1, one month post-delivery, symptoms of postnatal depression may not have developed. At post-test 2, three months post-delivery, these symptoms may have just started to show [15, 70] and the web-based intervention demonstrated the significant impact. It might be because of audio playing component (mindfulness-based practice) for maternal emotional health, which affected the result and decreased postnatal depression score. Also, when recruiting mothers, eight (11.8%) participants in the web-based group, 11 (16.2%) participants in the home-based group, and 13(19.1%) participants in the control group had postnatal depression scores of 13 and above. This could have also affected both intervention results to some extent.

Furthermore, our results found that the web-based intervention was noninferior to the home-based intervention in improving all the outcomes at all post-test time points. While it needs less manpower for web-based intervention than the home-based intervention, it has a good potential to be used in the clinical setting to improve patient care.

Limitations and recommendations for future research

In this study, only mothers who were able to understand and speak English were recruited. This limits the generalization of findings to all first-time mothers in Singapore. Future studies should

look into developing websites or mobile applications in other languages to accommodate mothers who are more comfortable with their mother tongue languages. Another limitation of the study was that the forum was underused due to its inconvenience. Studies in the future should create a chat group or a chatroom with instructors and participants to provide professional and synchronous communication, which will improve vicarious experience, verbal persuasion, and verbal persuasion on self-efficacy and solve mothers' problems in real time. Moreover, our study recruited some participants who had postnatal depression scores of 13 or above. Studies in the future should consider excluding such participants when screening to avoid bias. Also, the majority of the participants in this study were from higher income groups and held higher education levels. Future studies should try to conduct purposive sampling to include mothers from lower income groups since the web-based intervention has the potential for effective psychoeducation information to be provided to mothers at a lower cost.

CONCLUSIONS

The web-based intervention helped to improve self-efficacy at post-test 1 and to reduce postnatal depression at post-test 2, while the home-based intervention did not show any significant differences on self-efficacy and postnatal depression at all post-tests when compared to the control group. Both interventions helped mothers to get better social support at all post-test timepoints. Mothers who received the home-based intervention were most satisfied with the treatment, followed by those who received the web-based intervention. There was no difference in anxiety among the three groups. While both web-based and home-based interventions were effective and should be offered to support first-time mothers, the web-based intervention could be a recommended form of delivery due to its ease in delivery, especially when the mothers from

this group reported noninferior effects on all maternal outcomes when compared to those in the home-based group.

AUTHOR CONTRIBUTIONS

Study Design: HHG, CWCS, CYS, LN, CYH

Data Collection and Analysis: ZL, JN, HHG, CYH;

Manuscript Preparation: HHG, JN, CYH, ZL, HR, WW, CWCS, CYS, LN

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DECLARATION OF CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Contribution of the Paper

What is already known about the topic?

- First-time mothers often encounter challenges that are related to physical and mental changes

from childbirth as well as the demands of adapting to their new parenting roles.

- While home-based psychoeducational interventions showed positive effects on improving maternal health outcomes, very limited studies have developed and examined the more accessible and cost-effective web-based psychoeducational interventions for first-time mothers.

What this paper adds:

- When compared to the control group, mothers in the web-based intervention group had significantly improved self-efficacy at post-test 1 and reduced postnatal depression at post-test 3, mothers in both web-based and home-based intervention groups reported better social support at all post-test time points and were more satisfied with the postnatal care at all post-test time points (except for web-based group at post-test 1).
- When compared to the home-based intervention, the web-based intervention showed noninferior effect on all outcomes at all post-tests

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Figure 1. CONSORT diagram

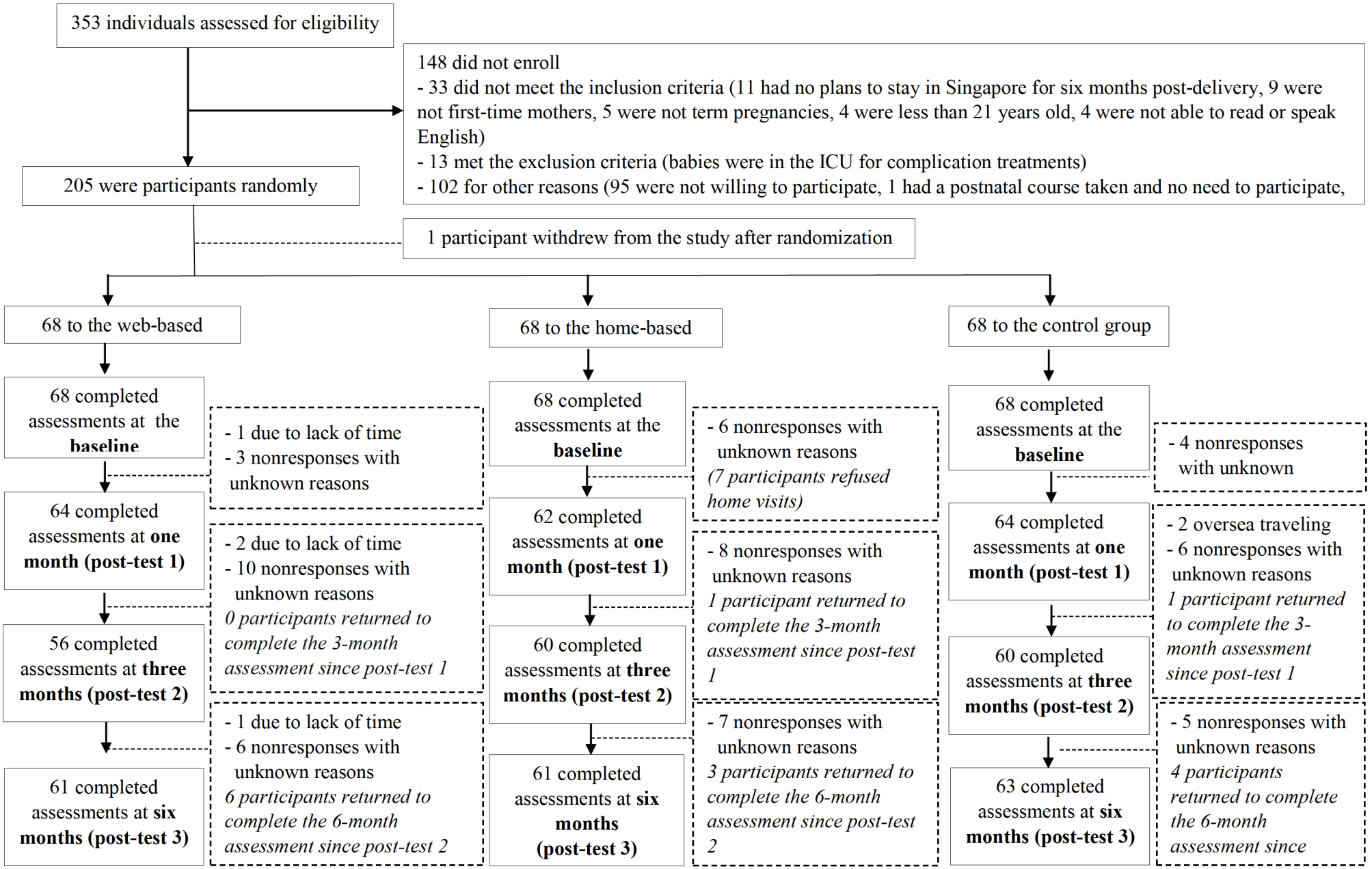

Table 1. Comparisons of the participants' sociodemographic characteristics and clinical data among the three groups (n = 204)

Sociodemographic characteristics and clinical data	Web-based group (n = 68) n (%)	Home-based group (n = 68) n (%)	Control group (n = 68) n (%)	p-value (χ^2)
Age of mother (mean, SD)	31.1 (3.8)	30.5 (3.9)	30.3 (3.7)	0.405 (0.907)[a]
≤ 30 years old	27 (39.7)	32 (47.1)	37 (54.4)	0.229 (2.951)
> 30 years old	41 (60.3)	36 (52.9)	31 (45.6)	
Ethnicity				
Chinese	36 (52.9)	31 (45.6)	30 (44.1)	0.158 (9.295)
Malay	12 (17.6)	12 (17.6)	17 (25.0)	
Indian	7 (10.3)	18(26.5)	14 (20.6)	
Others	13 (19.1)	7(10.3)	7 (10.3)	
Citizenship				
Singaporean	35(51.5)	31(45.6)	41 (60.3)	0.280 (5.075)
Permanent residence	16(23.5)	24(35.3)	15 (22.1)	
Foreigner	17(25.0)	13(19.1)	12 (17.6)	
Married status				
Married	67(98.5)	67(98.5)	64 (94.1)	0.213 (3.091)
Others	1(1.5)	1(1.5)	4 (5.9)	
Education				
Below bachelor level	11 (16.2)	16 (23.5)	12 (17.6)	0.514 (1.331)
Bachelor and above	57 (83.8)	52 (76.0)	56 (82.4)	
Working status				
Working	57(83.8)	57(83.8)	61 (89.7)	0.526 (1.286)
Others	11(16.2)	11(16.2)	7 (10.3)	
Monthly household income (S$)				
≤ 5,000	21 (30.9)	19 (27.9)	22 (32.4)	0.568 (2.940)
5,001-10,000	34 (50.0)	37 (54.4)	28 (41.2)	
> 10,000	13 (19.1)	12 (17.6)	18 (26.5)	
Disease Status				
Chronic disease	9 (13.2)	8 (11.8)	9 (13.2)	0.957 (0.088)
NA	59 (86.8)	60 (88.2)	59 (86.8)	
Attend antenatal courses				
Yes	28(41.2)	30 (44.1)	31 (45.6)	0.870 (0.279)
No	40(58.8)	38 (55.9)	37 (54.4)	
Type of birth				
Normal delivery	45 (66.2)	37 (54.4)	37 (54.4)	0.870 (0.279)
Assisted delivery	5 (7.4)	7 (10.3)	7 (10.3)	
LSCS	18(26.5)	24 (35.3)	24 (35.3)	

Baby's gender				
Male	31 (45.6)	40(58.8)	34 (50.0)	0.290 (2.473)
Female	37 (54.4)	28(41.2)	34 (50.0)	
Skin-to-skin contact with baby				
Yes	66 (97.1)	66 (97.1)	68(100.0)	0.361 (2.040)
No	2 (2.9)	2 (2.9)	0 (0)	
Nasopharyngeal suctioning				
Yes	4 (5.9)	1 (1.5)	4 (5.9)	0.351 (2.092)
No	64 (94.1)	67 (98.5)	64 (94.1)	
Baby's Apgar score at 1 min (mean, SD)	9.0 (0.0)	9.0 (0.4)	9.0 (0.0)	0.372 (0.993)[a]
Baby's Apgar score at 5 min (mean, SD)	9.0 (0.1)	9.0 (0.2)	9.0 (0.1)	0.779 (0.250)[a]
Baby's birth weight (mean, SD)	3.1 (0.4)	3.0 (0.4)	3.1 (0.4)	0.356 (1.037)[a]
Baseline outcomes (mean, SD)				
PMPSE	45.7 (6.9)	46.5 (8.0)	46.4 (7.0)	0.778 (0.251) [a]
PICSS-modified	79.4 (11.7)	80.3 (9.9)	79.1 (9.7)	0.777 (0.253) [a]
EPDS	7.4 (4.5)	7.7 (4.8)	9.0 (4.0)	0.097 (2.355) [a]
HADS-A	5.2 (3.8)	5.4 (3.5)	6.4 (3.7)	0.114 (2.199) [a]

[a] Analysis of variance, with the F-value in the bracket behind p-value.

PMPSE: Perceived Maternal Parental Self-efficacy; **PICSS:** Perinatal Infant Care Social Support
EPDS: Edinburgh Postnatal Depression Scale; **HADS-A:** Hospital Anxiety and Depression Scale.

Table 2. Comparisons of outcome variables change over time among the three groups (n = 204)

Effects	Estimate	95%CI	df	F-value	p-value
PMPSE					
Group			2,564	0.19	0.828
Time	4.47	2.87 to 6.07	1,581	42.09	**<0.001****
Interaction effect (group*time)			2,718	1.57	0.208
PICSS-modified					
Group			2,557	0.02	0.985
Time	-3.96	-6.26 to -1.67	1,562	7.11	**0.008****
Interaction effect (group*time)			2,734	3.42	**0.033***
EPDS					
Group			2,564	1.55	0.214
Time	-1.11	-2.13 to -0.10	1,570	4.96	**0.026***
Interaction effect (group*time)			2,737	0.16	0.857
HADS-A					
Group			2,553	1.74	0.176
Time	-0.97	-1.71 to -0.23	1,560	7.15	**0.008***
Interaction effect (group*time)			2,738	0.42	0.658

Note: *$p < 0.05$; **$p < 0.01$. Repeated measures ANCOVA using mixed models was used, adjusted for age, how many days since baseline, ethnicity, working status, monthly household income, whether attend antenatal courses, and skin-to-skin contact with baby.
PMPSE: Perceived Maternal Parental Self-efficacy; **PICSS:** Perinatal Infant Care Social Support
EPDS: Edinburgh Postnatal Depression Scale; **HADS-A:** Hospital Anxiety and Depression Scale.

Table 3. Comparisons of self-efficacy among the three groups at each post-test time point (n = 204)

Time point	PMPSE: mean[§] (SD)			F-value	p-value[#]	Mean difference (95% CI) p-value[#]		
	W	H	C			W - H	W - C	H - C
Post-test 1 (1 month post-delivery)	52.44 (14.08)	50.58 (13.56)	49.77 (14.86)	3.63	**0.029***	1.87 (-0.61 to 4.34) Noninferior compared to ±3.3[‡]	2.68 (0.21 to 5.14) **p = 0.028***	0.81 (-1.67 to 3.30) p = 1
Post-test 2 (3 months post-delivery)	57.90 (14.47)	54.82 (14.47)	55.28 (15.52)	4.18	**0.017***	3.08 (0.31 to 5.86) Noninferior compared to ±3.1[‡]	2.63 (-0.15 to 5.40) p = 0.069	-0.46 (-3.18 to 2.27) p = 1
Post-test 3 (6 months post-delivery)	60.72 (15.56)	58.76 (15.31)	57.88 (16.78)	3.05	0.050	1.96 (-0.90 to 4.82) Noninferior compared to ±3.7[‡]	2.84 (-0.01 to 5.69) p = 0.051	0.88 (-3.74 to 1.98) p = 1

Note: W: Web-based group, H: Home-based group, C: Control group; PMPSE: Perceived Maternal Parental Self-efficacy.

[§] The higher the scores, the better the self-efficacy; [#]ANCOVA using the GLM, adjusted for baseline values, age, how many days since baseline, ethnicity, working status, monthly household income, whether attend antenatal courses, and skin-to-skin contact with baby; Pairwise comparisons were Bonferroni adjusted; [‡] The equivalence region of W-H each time point will be given by the Bigger (absolute) number of Upper or Lower 95% CI of H-C; *$p < 0.05$.

Table 4. Comparisons of social support across the three groups at each post-test time point (n = 204)

Timepoint	PICSS-modified: mean[§] (SD)			F-value	p-value[#]	Mean difference (95% CI) p-value[#]		
	W	H	C			W - H	W - C	H - C
Post-test 1 (1 month post-delivery)	82.92 (20.82)	81.58 (20.43)	77.43 (22.12)	7.12	**0.001****	1.35 (-2.32 to 5.01) Noninferior compared to ±7.8[‡]	5.49 (1.83 to 9.15) **p = 0.001****	4.15 (0.47 to 7.82) **p = 0.021***
Post-test 2 (3 months post-delivery)	85.98 (19.49)	83.34 (20.04)	79.43 (21.28)	8.66	**<0.001****	2.64 (-1.19 to 6.47) Noninferior compared to ±7.6[‡]	6.55 (2.70 to 10.39) **p < 0.001****	3.91 (0.17 to 7.65) **p = 0.037***
Post-test 3 (6 months post-delivery)	85.86 (21.78)	84.42 (21.88)	80.29 (23.57)	5.88	**0.003****	1.44 (-2.59 to 5.46) Noninferior compared to ±8.1[‡]	5.57 (1.49 to 9.64) **p = 0.003***	4.13 (0.08 to 8.18) **p = 0.044***

Note: W: Web-based group, H: Home-based group, C: Control group; PICSS: Perinatal Infant Care Social Support.

[§] The higher the scores, the better the social support; [#]ANCOVA using the GLM, adjusted for baseline values, age, how many days since baseline, ethnicity, working status, monthly household income, whether attend antenatal courses, and skin-to-skin contact with baby; Pairwise comparisons were Bonferroni adjusted; [‡] The equivalence region of W-H each time point will be given by the Bigger (absolute) number of Upper or Lower 95% CI of H-C; *$p < 0.05$; **$p < 0.01$.

Table 5. Comparisons of postnatal depression across the three groups at each post-test time point (n = 204)

Timepoint	EPDS: mean[§] (SD)			F-value	p-value[#]	Mean difference (95% CI) p-value[#]		
	W	H	C			W - H	W - C	H - C
Post-test 1 (1 month post-delivery)	4.73 (9.94)	5.63 (9.70)	5.14 (10.55)	0.79	0.455	-0.90 (-2.63 to 0.83) Noninferior compared to ±2.2[‡]	-0.41 (-2.15 to 1.34) p = 1	0.49 (-1.26 to 2.24) p = 1
Post-test 2 (3 months post-delivery)	2.51 (9.01)	3.65 (9.19)	4.33 (9.76)	3.10	**0.048**[*]	-1.14 (-2.89 to 0.61) Noninferior compared to ±2.4[‡]	-1.82 (-3.61 to -0.04) **p = 0.044**[*]	-0.68 (-2.42 to 1.05) p = 1
Post-test 3 (6 months post-delivery)	4.34 (10.71)	4.87 (10.61)	5.06 (11.49)	0.43	0.653	-0.53 (-2.47 to 1.41) Noninferior compared to ±2.2[‡]	-0.72 (-2.69 to 1.24) p = 1	-0.19 (-2.16 to 1.77) p = 1

Note: W: Web-based group, H: Home-based group, C: Control group; EPDS: Edinburgh Postnatal Depression Scale.

[§] The lower the scores, the less depressed; [#]ANCOVA using the GLM, adjusted for baseline values, age, how many days since baseline, ethnicity, working status, monthly household income, whether attend antenatal courses, and skin-to-skin contact with baby; Pairwise comparisons were Bonferroni adjusted; [‡] The equivalence region of W-H each time point will be given by the Bigger (absolute) number of Upper or Lower 95% CI of H-C; [*]$p < 0.05$.

Table 6. Comparisons of satisfaction with postnatal care across the three groups at each time point (n = 204)

Timepoint	ODS: Mean[§] (SD)			F-value	p-value[#]	Mean difference (95% CI) p-value[#]		
	W	H	C			W - H	W - C	H - C
Post-test 1 (1 month post-delivery)	5.06 (2.59)	5.39 (2.54)	4.70 (2.70)	7.90	**0.001****	-0.33 (-0.75 to 0.09) Noninferior compared to ±1.1[‡]	0.36 (-0.06 to 0.78) p = 0.124	0.69 (0.27 to 1.11) **p < 0.001****
Post-test 2 (3 months post-delivery)	5.12 (1.86)	5.11 (1.90)	4.69 (1.97)	6.46	**0.002****	0.01 (-0.33 to 0.35) Noninferior compared to ±0.7[‡]	0.43 (0.09 to 0.76) **p = 0.007****	0.42 (0.09 to 0.74) **p = 0.007****
Post-test 3 (6 months post-delivery)	5.07 (2.21)	5.09 (2.20)	4.56 (2.34)	7.66	**0.001****	-0.02 (-0.39 to 0.35) Noninferior compared to ±0.9[‡]	0.51 (0.14 to 0.88) **p = 0.003****	0.53 (0.16 to 0.90) **p = 0.002****

Note: W: Web-based group, H: Home-based group, C: Control group; ODS: Ordinal Descriptive Scale.
[§] The higher the scores, the more satisfied; [#]ANCOVA using the GLM, adjusted for age, how many days since baseline, ethnicity, working status, monthly household income, whether attend antenatal courses, and skin-to-skin contact with baby; Pairwise comparisons were Bonferroni adjusted; [‡] The equivalence region of W-H each time point will be given by the Bigger (absolute) number of Upper or Lower 95% CI of H-C; **$p < 0.01$.