Effectiveness of a Comic Book Intervention in Preventing Second-hand Smoke Exposure for Pregnant Indonesian Women: A Randomised Controlled Trial

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Abstract

This randomised controlled trial evaluated the effectiveness of a comic book intervention to promote second-hand smoke (SHS) avoidance among pregnant women and appropriate smoking behaviours among their male partners. We allocated 140 couples to the experimental group (EG) and 146 couples to the control group (CG), who received usual care. The primary outcome was women's self-reported SHS exposure and their male partners' smoking behaviours. Secondary outcomes included knowledge and awareness of SHS. Independent *t*-tests revealed that three months post-intervention, more male partners in the EG intended to quit smoking (*t*-test (*df* = 205) = 2.12, *MD* = .24, *p*-value = .035). Significantly more pregnant women in the EG recognised their partners' intentions to quit smoking (*t*-test (*df* = 205) = 2.72, *MD* = .30, *p*-value = .007), reported that they distanced themselves from smoking (*t*-test (*df* = 210) = 2.09, *MD* = 0.19, *p*-value = .038), and avoided exposure to SHS (*t*-test (*df* = 184) = 2.30, *MD* = .02, *p*-value = .023). These findings suggest that a comic book intervention might be effective against SHS exposure by providing several cues to action through knowledge and awareness of SHS.

Introduction

Maternal exposure to second-hand smoke (SHS) during pregnancy can have negative consequences, including preterm birth[1], decreased placental weight[2], higher cord blood cotinine levels, and increased risk of miscarriage[3] and stillbirth[4], compared to pregnant women not exposed to SHS[2]. Furthermore, for the foetus, SHS increases the risk of congenital malformation[5], low birthweight[2, 6], smaller head circumference[6], shorter length[2], and being small for gestational age[7]. Moreover, Zeng and Li found that, among non-smokers, SHS exposure is related to mental health problems, especially depressive symptoms and psychological distress[8]. The developmental origins of health and disease theory[9] posits that the onset risk of non-communicable diseases is influenced by the environment during the foetal development period; this claim has been supported by various studies[10, 11]. Furthermore, Baker[10] and Smith[11] have substantiated a link between preterm birth and low birthweight and the onset of coronary heart disease and its risk factors, including arteriosclerosis-related lesions, diabetes, and high blood pressure.

In Indonesia, 60.4% of men smoke daily[12]. In 2017, a large-scale nationally representative survey revealed that 78% of mothers who reported SHS exposure were exposed to it at home[13]. As a public health initiative, the Indonesian Ministry of Health conducted health education advertising campaigns using shadow puppet theatres to create awareness regarding the harmful effects of both of active and passive smoking on pregnant mothers and their foetuses. The Indonesian government has also disseminated infographics that highlight the dangers of SHS exposure for women and children[14–16].

Several systematic reviews have been conducted on methods to reduce SHS exposure for children and pregnant women. Behbod *et al.*[17] examined the effectiveness of interventions aimed at family and carers for reducing children's SHS exposure, and reported that the results of 24 of the 78 studies were statistically significant. These studies applied 'objective measure[s] of children's SHS exposure, in-person counselling, motivational interviewing, telephone counselling, multi-component counselling-based interventions, multi-component education-based interventions, school-based strategy, educational interventions including picture books, smoking cessation, and brief intervention' (p.2)[17]. However, these effective interventions were evaluated as low quality due to their high risk of bias[17].The studies for which no statistically significant differences were found employed 'more intensive counselling, feedback of biological measure of children's SHS exposure, feedback of maternal cotinine, telephone smoking cessation, [and] educational home visit[s]' (p.2)[17].

Tong *et al.*[18] and Nwosu *et al.*[19] conducted systematic reviews on interventions to reduce SHS exposure among non-smoking pregnant women. Tong *et al.*[18] did not find pharmacological and psychosocial interventions to be effective in preventing SHS exposure for pregnant women in prenatal care settings, owing to the low-quality study designs, as evaluated based on US Preventative Task Force criteria. Nwosu *et al.*[19] reviewed nine individual- and household-level interventions aimed at preventing pregnant women's SHS exposure that fit the following inclusion criteria 'employed educational intervention using direct teaching or counselling, brochures, posters, role-play, and /or video'[19]. Various measurements were used to assess the interventions, including self-reported behaviours, number of cigarettes smoked, and biochemical markers of SHS exposure in pregnant women[19]. Among the nine, only two studies were evaluated to have low risk of bias, as most studies did not report blinding information, concealment of allocation, or study population selection[19].

Dherani *et al.*[20] reported that behaviour change techniques (BCTs) were effective in reducing SHS at home for pregnant women; however, the study methods were weak (e.g. self-reported exposure, lack of an objective outcome assessment, short follow-up period, no control group).

Satyanarayana *et al.*[21] conducted a systematic review as well as a modified Delphi survey with international experts to identify effective BCTs for preventing SHS exposure of pregnant women at home. They found that seven BCTs (e.g. measuring cotinine and providing feedback with regard to the targets, informing about the health consequences of SHS and smoking limitations at home, informing about the social and environmental effects of SHS exposure, showing the barriers to SHS prevention inside homes, and teaching problem solving, etc.) were selected by experts.

Out of six randomised controlled trials (RCTs)[22–27] on SHS exposure prevention for pregnant women, Chi *et al.*[22] provided an educational program based on the health belief model (HBM)[28–30], using a booklet and follow-up telephone calls. They found that this intervention empowered pregnant women to confront smokers in their households and decreased SHS exposure. Developed in the 1950s, HBM focuses on individual health behaviours and includes six key components that contribute to taking action to prevent or control health conditions: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy[30]. Modifying factors that influence individual beliefs and health actions include age, gender, ethnicity, personality, socioeconomic status, and knowledge[30].

The World Health Organisation (WHO) has urged healthcare providers to offer couple-focused interventions to prevent at-home SHS exposure in pregnant women[31]. Couples who received treatment together have been shown to present better long-term adjustment for health problems: 'There was a positive

association between the quality of the relationship and the patient's adjustment' (p.68)[32]. Hence, a partner's participation in an intervention is necessary for successful outcomes.

Furthermore, the WHO[31] reported a structured program for SHS exposure prevention during pregnancy. The program included educational materials developed by national organisations with jurisdiction over health and medical care. However, these materials were written in English and most of the content was not specific to SHS exposure (i.e. passive smoking) in pregnant women[33–38]. In the rheumatology field, Moll[39] found that patients who read illustrated educational booklets, such as cartoon-and matchstick-illustrated materials, received higher medical knowledge scores compared with patients who did not receive illustrated booklets. In a study on acquired immunodeficiency syndrome (AIDS), comic books were reported as effective for visually engaging people, graphically explaining educational content in a narrative, and maintaining their interest[40]. Two previous studies [39, 40] that used comic book interventions for other reasons reported positive outcomes, such as behaviour changes, improved knowledge, and better treatment outcomes. However, interventions using comic books in the context of smoking cessation or SHS exposure have not been examined in detail.

Comic books provide narrative experiences for readers and graphically present essential information. Using comic books for health education is becoming culturally acceptable. Comic books are being increasingly adopted in the Indonesian society[41]. Indonesian comic book artists are often inspired by foreign styles, especially Japanese manga, which started being imported into the country and translated into Indonesian in the early 1990s[41]. Therefore, as Indonesians are familiar with Japanese comics, they could be used for health education to prevent at-home SHS exposure among pregnant women. However, at present, there are no educational materials utilising visual storytelling or comic book-style educational formats for preventing SHS exposure during pregnancy.

The purpose of this study was to determine the effectiveness of an educational comic book following the HBM framework with a reminder sticker applying BCTs, in reducing SHS exposure during pregnancy by increasing SHS avoidance behaviours in pregnant women and appropriate smoking behaviours in their male partners. The primary outcomes were pregnant women's self-reported SHS exposure and their male partners' smoking behaviours. Secondary outcomes included SHS knowledge and awareness.

Methods

Study design and theoretical framework

A two-armed longitudinal RCT was employed to assess an educational, couple-focused comic book intervention that applied BCTs[20, 42-44] and the HBM[28-30].

Participants

Couples were recruited from public health centres and health posts in Tomohon (rural area) and Manado (urban area) in North Sulawesi, Indonesia, from March 2019 to March 2020. Inclusion criteria were: 18 years of age or older, non-smoking in their first trimester of pregnancy, up to 12 weeks of gestation[45], attending a prenatal visit at the public health centre or health post, and exposed to SHS by their male partner (19 years of age or older).

Inclusion criteria for male partners were: smoking at least six cigarettes per week or more within two months before or after their partner's pregnancy[27] and living in the same household as their partner. The term 'male partner' will be used to indicate a married or unmarried partner who met the inclusion criteria; and 'pregnant woman' for either relationship (married or unmarried). Exclusion criteria were: pregnancy termination after the second trimester, active smoking during pregnancy, and high-risk pregnant women with clinical illnesses, gestational diabetes, pregnancy-induced hypertension, or mental disorders[27].

Randomisation

All eligible participants were assigned to either the experimental group (EG) or control group (CG) based on central randomisation. An Indonesian researcher from the research team conducted the simple random assignment using a computer-based random number generator. The principal investigator, as the outcome assessor, was not informed of the allocation.

Interventions

At baseline, pregnant women and their partners in the EG received an educational comic book and a sticker as a reminder, in addition to regular pregnancy advice from a research assistant. The printed educational comic book was four full-colour pages. The educational content was uniformly illustrated (offer/direct towards appropriate written materials—a BCT strategy). The comic was written in Indonesian and contained standardised information, based on the components of the HBM (i.e. perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action)[46]. The unique strength of this educational comic is its application of both BCTs and the HBM. The main characters in the comic are a midwife, a pregnant woman, and her male partner. When the couple visits the prenatal care clinic, the midwife educates them on what SHS is and how to prevent it in their homes.

The comic includes eight sections utilising BCTs and components of the HBM: (1) explanation of SHS, (2) prevalence of SHS for pregnant women in Tomohon, (3) effects of hazardous substances on pregnant women and foetuses (provide information on the consequences of SHS—a BCT strategy), (4) health risks for pregnant women and foetuses (perceived susceptibility component of the HBM), (5) characteristics of tobacco smoke, (6) benefits of preventing SHS (benefit component of the HBM), (7) barriers to SHS prevention (perceived barriers component of the HBM), and (8) countermeasures for the barriers (HBM component and a BCT strategy), and actions to prevent SHS in the home (facilitate action, plan development, and facilitate goal setting—BCTs).

To assess the suitability of the comic book, 17 Indonesians living in Japan (4 men, 6 pregnant women, and 7 non-pregnant women) evaluated its content, literacy demand, graphics, layout and typography, learning stimulation, motivation, and cultural appropriateness. We revised the book several times based on their evaluation and comments[46]. Moreover, along with the educational comic book, a reminder sticker (cue to action—an HBM component and a BCT strategy) was used to indicate a smoke-free home. The sticker stated that smoking is not allowed inside the house, which was illustrated through a large cross with a picture of a cigarette inside the house.

The participants in the CG received usual care from a research assistant. Usual care for pregnant women involved regular brief advice, which was provided to both the EG and CG. At baseline, SHS avoidance in pregnant women and their male partners' smoking behaviours at home were assessed through partner evaluation and self-report. Three months post-intervention, data on the same variables were collected again, on-site.

Primary outcomes

The primary outcomes were SHS avoidance in pregnant women and appropriateness of their male partners' smoking behaviours at home. For pregnant women, primary outcomes were assessed using self- and partner-report questionnaires that evaluated their behavioural responses when around their smoking partners. The questionnaire included: (a) Martinelli Scale from *Avoidance of Environmental Tobacco Smoke*[47] as evaluated by pregnant women, and (b) a male partner's report on their pregnant partner's behaviours regarding SHS exposure.

For male partners, the primary outcomes were smoking-related behavioural responses when around their pregnant partner. The questionnaire included: (c) the pregnant partner's report on their male partner's smoking behaviours at home, and (d) a self-report of smoking behaviours at home and pregnant partner's behaviours. Except for the Martinelli Scale, the questionnaire was prepared by the research team, based on the content of the educational comic book.

It contained 28 items for pregnant women and 12 for their male partners. The respondents scored their level of agreement with each statement on a four-point Likert scale ranging from 1 (*almost never true*) to 4 (*almost always true)*, with higher values indicating higher SHS avoidance by pregnant women and more appropriate smoking behaviours of male partners, except for some items that only pertained to pregnant women (A2, A4, A8-9, A11, A16, A19).

Secondary outcomes

The secondary outcomes were SHS knowledge, health beliefs based on the HBM, and self-efficacy, assessed through self-report questionnaires for the couples. There were 38 items in the questionnaire for pregnant women and 40 in the partners' questionnaire. Regarding SHS knowledge, respondents were asked to select either 'yes' or 'no' for each question. Correct responses received 1 point, while incorrect responses received 0 points. For health beliefs and self-efficacy, the respondents rated their level of agreement with each statement on a four-point Likert scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*), with higher values indicating more appropriate health beliefs and higher self-efficacy. However, for perceived barriers, lower values indicated more appropriate health beliefs.

Sample size

Sample size was determined using G Power 3.1.9.3 software, with a t-test difference between two independent means (two groups), effect size d set at .30, the critical alpha value set at .05 (type-I error), and a power (1-β) of .8 (type-II error)[48,49]. The obtained minimum sample size was 176 couples per group, or 352 couples in total. Based on previous studies[22,27,50], a 15% contingency for loss to follow-up (n = 52) was added to the total. Therefore, the calculated number of couples in each group was 202, and the total final sample size was 404 couples.

Statistical analysis

The comic book intervention was the main independent variable. Demographic variables were also treated as independent variables, which were listed as background characteristics (Table 1). Confounding factors were initially examined using descriptive statistics, such as means, standard deviations, and percentages. The dependent variables were primary outcomes (avoidance of SHS behaviours among pregnant women and their male partners' smoking behaviours) and secondary outcomes (health beliefs, knowledge, and self-efficacy). Independent sample t-tests (two-tailed) were used to check for significant differences in primary and secondary outcomes between the EG and CG, without checking for normality based on the assumptions of the central limit theorem[51]. A 95% CI value ($p < .05$) was considered statistically significant. All statistical analyses were performed using SPSS version 25 for Windows.

Ethical approval and research permissions

This study was conducted with approval from the Research Ethics Committee of St. Luke's International University, Japan (18-A066); the International University of Health and Welfare, Japan (20-Io-200); and Sam Ratulangi University, North Sulawesi, Indonesia (7383/UN12/LL/2018). This research was conducted following the guidelines of *Ethical Principles for Medical Research Involving Human Subjects*[52] and *Ethical Guidelines for Medical and Health Research Involving Human Subjects*[53]. Moreover, this research was also permitted by the Indonesian government (23 November 2018), and the municipal governments of Manado (13 March 2019) and Tomohon (27 March 2019). The study participants were provided with an explanation of the study's purpose and methods, a consent form, and a withdrawal form; those who agreed to participate provided written informed consent.

Clinical trial registration

This study was registered as a randomised clinical trial at the UMIN Clinical Trials Registry (UMIN-CTR) with the registration number UMIN000035423 (01/02/2019).

Results

Participants

Figure 1 shows the flow diagram for participant selection. For baseline analysis, from the 348 couples who consented to participate, data from 286 couples who met the inclusion criteria were analysed. The included couples were randomly assigned to either the EG (140 couples) or CG (146 couples) using a central randomisation process. Three months post-intervention, 110 male partners and 109 pregnant women in the EG (21% dropout rate), and 104 couples in the CG (29% dropout rate), provided data for the primary and secondary outcomes. The final number of couples was 214 (EG: 110; CG: 104). Regarding reasons for dropouts, at three months post-intervention, most of these participants had moved to another place, while some couples could not visit the health facility. At this point, the trial was terminated due to COVID-19 restrictions.

Baseline participant characteristics

Independent sample t-tests were conducted, based on the assumptions of the central limit theorem[51], to identify significant differences in the demographic characteristics of the two groups. Table 1 shows the results for pregnant women and their partners. Most couples were of the Minahasan ethnicity, had completed high school, and were Protestants. SHS at home (EG: 82.1%; CG: 77.4%) was a daily occurrence for most of the women (EG: 75.7%; CG: 68.5%). The mean age of the pregnant women was 27.01 (SD = 6.4) in the EG and 26.89 (SD = 6.1) in the CG. The mean number of gestational weeks was 15.13 (SD = 6.7) in the EG and 15.00 (SD = 6.1) in the CG. The mean age of the male partners was 30.03 (SD = 6.9) in the EG and 30.22 (SD = 6.6) in the CG. The mean number of cigarettes male partners smoked per day was 10.28 (SD = 6.2) in the EG, and 10.75 (SD = 7.5) in the CG. Regarding the frequency of smoking at home, we recruited male partners who smoked at least six cigarettes per week, as per the inclusion criteria. Couple characteristics showed no between-group differences.

Primary outcome analyses for SHS avoidance in pregnant women

For pregnant women's self-reported SHS avoidance, independent sample t-tests were conducted based on the assumptions of the central limit theorem[51] (Table 2, A1– A19). Overall, at baseline, there were no differences between groups, except for the following items: **A16**, 'I routinely associate with people who smoke' (*t*-test (*df* = 283) = -2.16, *MD* = -.2, 95% CI [-.37, .02], *p*-value = .031), and **A17**, **'**when eating out, I always sit in the non-smoking section' (*t*-test (*df* = 282.3) = 2.07, *MD* = .20, 95% CI [.01, .38], *p*-value = .040).

Three months post-intervention, five items showed significant differences: **A1**, **'**when I encounter someone who is smoking, I distance myself to ensure that I am not exposed to the smoke' (*t*-test (*df* = 210) = 2.09, *MD* = 0.19, 95% CI [.01, .37], *p*-value = .038); **A6**, 'when I travel by bus, or any other public transportation I request a non-smoking seat' (*t*-test (*df* = 210) = 2.44, *MD* = .24, 95% CI [.05, .43], *p*-value = .016); **A12**, 'when at outdoor functions where smoking is present, I move away to avoid it' (*t*-test (*df* = 185) = 2.90, *MD* = .25, 95% CI [.08, .41], *p*-value = .004); **A13**, 'when at outdoor functions where water pipe smoking is present, I move away to avoid it' (*t*-test (*df* =185) = 2.67, *MD* = .24, 95% CI [.06, .41] , *p*-value = .008); and **A18**, 'I don't frequently visit places where smoking is prevalent' (*t*-test (*df* = 184) = 2.28, *MD* = .21 95% CI [.03, .39], *p*-value = .024).

For male partners' evaluation of their pregnant partners' SHS avoidance, see Table 2. For B1–B3, there were no differences at baseline or three months post-intervention between groups.

Primary outcome analyses of male partners' smoking behaviours

An independent samples t-test was conducted based on the assumptions of the central limit theorem[51], to assess differences in male partners' self- and partner-reported smoking behaviours (Table 3, A1–A8). For self-reported smoking behaviours at baseline, there were no differences between groups, except for **A1**, 'I read educational comics on preventing SHS at home' (*t*-test (*df* = 273) = 3.23, *MD* = .42, 95% CI [.16, .67], *p*-value < .001). This difference remained statistically significant three months post-intervention. Three months post-intervention, there was a trend towards significance for **A5,** 'I smoke outdoors with the door closed' (*t*-test (*df* = 209) = 1.96, *MD* = .22, 95% CI [-.00, .43], *p*-value = .051). There was a significant difference between groups for **A7**, 'I intend to quit smoking' (*t*-test (*df* = 205) = 2.11, *MD* = .24, 95% CI [.02, .47], *p*-value = .035).

For male partners' smoking behaviours as reported by pregnant women at baseline (Table 3, B1–B8), there were no significant differences between groups, except for **B1**, **'**male partner reads an educational comic on preventing SHS at home' (*t*-test (*df* = 283) = 2.00, *MD* = .25, 95% CI [.00, -.51], *p*-value = .049). Three months post-intervention, there were differences between groups for the following four items: **B1'**male partner reads an educational comic on preventing SHS at home' (*t*-test (*df* = 208) = 4.13, *MD* = .62, 95% CI [.33, .92], *p*-value < .001); **B2**, 'male partner moves away from me when he smokes' (*t*-test (*df* = 205) = 2.11, *MD* = .24, 95% CI [.02, .46], *p*-value = .036); **B4**, **'**male partner smokes near the kitchen fan' (*t*-test (*df* = 204) = 2.52, *MD* = .27, 95% CI [.06, .48], *p*-value = .012); **B5**, **'**male partner smokes outdoors with the door is closed' (*t*-test (*df* =205) = 3.58, *MD* = .38, 95% CI [.17, .59], *p*-value < . 001); and **B7**, 'male partner intends to quit smoking' (*t*-test (*df* =205) = 2.72, *MD* = .30, 95% CI [.08, .51], *p*-value = .007).

Secondary outcome analyses of pregnant women's health beliefs and self-efficacy

An independent samples t-test was conducted based on the assumptions of the central limit theorem[51], to assess differences in pregnant women's health beliefs and self-efficacy (ST1). For most items, no significant differences were observed between groups at baseline or three months post-intervention. Three months post-intervention, the mean score of one self-efficacy item, **I3**, 'it is easy for me to stick to my aims and accomplish my goals', showed a significant between-group difference (*t*-test (*df* = 208) = .188, *MD* = .15, 95% CI [.01, .29], *p*-value = .032).

The cross-tabulation table (ST2) indicates pregnant women's health beliefs and self-efficacy as evaluated by them at three months post-intervention. Three months post-intervention, almost all pregnant women (91.7~100%) in both groups selected the correct answers for all SHS knowledge questions. For perceived SHS-related disease susceptibility, almost all pregnant women in both groups (EG: 95.4%; CG: 95.1%) perceived **D1**, **'**breathing in a room where my partner is smoking can affect foetal development and my health' to be a health risk. Approximately 97% of the women in both groups agreed with **D2**, 'cigarette smoke from smokers in a room is harmful to me and my unborn baby'. More than half of the women in both groups (EG: 60.7%; CG: 57.0%) believed that **D3** 'toxic substances were released from things (clothes, furniture) in rooms where their partner had smoked'. Almost all women in both groups agreed with **E1** 'the harmful effects of SHS exposure on pregnant women' (EG: 97.2%; CG: 95.1%) and **E2** 'their foetuses' (EG: 99.1%; CG: 96.1%). Most women in both groups perceived four benefits of preventing SHS exposure: **F1**, 'better growth for the foetus' (EG: 93.5%; CG: 92.1%); **F2**, 'better mental health for pregnant women' (EG: 91.6%; CG: 96.1%); **F3,** 'normal gestation for pregnant women (EG: 90.7%; CG: 88.2%)'; and **F4**, 'reducing neonatal infants' risks of heart disease and diabetes' (EG: 89.8%; CG: 93.1%).

Less than half of the women in both groups perceived two barriers to preventing SHS exposure: **G2**, 'no smoking norm or policy in the house' (EG: 42.5%; CG: 43.5%); and **G3**, 'difficulty in asking partner not to smoke inside the house' (EG: 40.6%; CG: 34.7%). More than half of the women in both groups perceived a barrier: **G4**, 'smoke-free home is a risk to routine harmonious social relations' (EG: 56.6%; CG: 55.5%). Similarly, more than half of the women in both groups agreed with four cues to action: **H1**, 'knowing what SHS is' (EG: 66.7%; CG: 58.9%); **H2**, 'knowing risks of SHS for the mother' (EG: 73.2%; CG: 59.8%); **H3**, 'knowing risks of SHS for the foetus' (EG: 77.8%; CG: 61.8%); and **H4**, 'knowing how to prevent SHS exposure in the home' (EG: 73.2%; CG: 58.8%). In the EG, almost all women (94.5%) believed that **H6**, 'brief advice from research staff on preventing SHS' was a cue to action, while 90.5% thought **H7**, 'the sticker for preventing SHS' was a cue to action.

Secondary outcome analyses for male partners' health beliefs and self-efficacy

An independent samples-t-test was conducted based on the assumptions of the central limit theorem [51], to assess differences in male partners' health beliefs and self-efficacy (ST3). For most of the items, no between-group differences were observed at baseline or three months post-intervention. However, three months post-intervention, three items in cues to action showed a significant difference between groups: **H1**, 'I know what SHS is' (*t*-test (*df* = 211) = 2.40, *MD* = .27, 95% CI [.05, .50], *p*-value = .017); **H2**, 'I know the risks of SHS for pregnant women' (*t*-test (*df* = 212) = 2.55, *MD* = .30, 95% CI [.07, .54], *p*-value = .012); and **H7**, 'brief advice from research staff on preventing SHS is a cue to action' (*t*-test (*df* = 188) = 2.24, *MD* = .25, 95% CI [.03, .47], *p*-value = .025).

The cross-tabulation table (ST4) indicates male partners' health beliefs and self-efficacy as evaluated by them at three months post-intervention. For SHS knowledge, almost all male partners (89.3–100%) in both groups selected the correct answers post-intervention. In perceived SHS-related disease susceptibility, almost all male partners in both groups (EG: 96.4%, CG: 96.1%) perceived **D1**, 'breathing in a room where I am smoking cigarettes can affect foetal development and pregnant women's health risk', as a health risk. Furthermore, 98.1% and 99.1% of the CG and EG, respectively, agreed with **D2**, 'cigarette smoke from smokers in a room is harmful to pregnant women and their unborn babies'. Almost all male partners in both groups (EG: 84.4%; CG: 85.3%) agreed with **D3**, 'my female partner and unborn baby breathe toxic substances which are released from things (clothes, furniture) in rooms where I smoked'. Almost all male partners in both groups perceived **E1** 'the effects of SHS on pregnant women' (EG: 98.2%; CG: 99.1%) and **E2** 'the foetus' (EG: 98.2%; CG: 98%).

Most male partners in both groups perceived four benefits of preventing SHS exposure: **F1**, 'better growth for the foetus' (EG: 88.2%; CG: 93.3%); **F2**, 'better mental health for pregnant women' (EG: 84.6%; CG: 92.3%); **F3**, 'pregnant women's normal gestation' (EG: 83.6%; CG: 87.5%); and **F4**, 'reducing neonatal infants' risks of heart disease and diabetes' (EG: 89.7%; CG: 93.2%). Less than half of male partners in both groups perceived four barriers to preventing SHS exposure: **G1**, 'other smokers (visitors) do not accept the smoke-free home policy' (EG: 45.0%; CG: 40.4%); **G2**, 'no smoking norm or policy in home' (EG: 40.4%; CG: 36.5%); **G3**, 'difficulty in asking other smoker not to smoke in the house' (EG: 40.9%; CG: 47.1%); and **G5**, **'**I lost social communication with other smokers (visitors) in my house' (EG: 31.5%; CG: 38.3%). More than half of the male partners in both groups perceived **G4**, 'a smoke-free home is a risk to routine harmonious social relations' (EG: 53.6%; CG: 61.5%) as a barrier to preventing SHS exposure.

Discussion

Hochbaum[54] reported that 'cues touch off behaviours when the individual is ready to behave' (p.8), and 'in the external situation, [cues] such as posters, articles, and a variety of other things which would focus a person's attention and feelings' (p.8)[54]. Consistent with our results, Mayangsari reported that 62.5% of the pregnant women (4 ex-smokers and 76 non-smokers) who were exposed to SHS had fair or good knowledge of smoking-related health risks[55]. In a qualitative study, Kaufman *et al.* reported that local community members had sufficient knowledge of the health risks of SHS which they had received from tobacco control campaigns, mass media, and through health workers and family members[56], and perceived all the key components of health beliefs. Moreover, in our study, as cues to action, the educational comic book and sticker (reminder) accelerated well-prepared couples' desired behavioural changes through perceived threat[29]. The sticker might help couples keep in mind the educational contents learnt in the comic book.

Our study also showed statistical differences for certain SHS avoidance behaviours and male partners' smoking behaviours. However, our results had a small effect size, which could have meant the intervention itself might not be as effective as we suggested. Alternatively, the weak effect sizes could have been affected by assuming that these were due to barriers (e.g. 'spill-over' effects). In fact, in the EG at baseline, approximately 15% of the male partners read the educational comic completely, while approximately 25.7% partially read it. In the CG, even if all participants did not receive the educational comic and sticker, some male partners reported that they 'read the educational comic completely or partly' at baseline and three months post-intervention. It is likely that they read other materials, such as pictures in the maternal and child health handbook, instead of the intervention comic book, and mistakenly answered 'yes' when asked if they had read it. Therefore, we were unable to confirm the actual effect size for our intervention. Other suspected factors that could have reduced the effect size are possible remaining barriers, such as risk to routine harmonious social relations in the community[57], which was mentioned by over 50% of male partners in both groups. As a next step, a community-wide intervention with supportive local leaders is recommended[58].

'An in-depth understanding of the target audience's subjective culture is one of the central elements in designing effective materials' (p.S125)[59]. To increase participants' identification with the situation presented in the comic book, 'skin colour and hair colour of the target group were adapted into the comic character[s]' (p.1189)[46]. These were *peripheral strategies*[60] for enhancing cultural appropriateness to address our first concern that pregnant women and their male partners in the EG might not show interest in the book. Using the Indonesian language further ensured accessibility for the target audience (*linguistic strategies*[60]). To provide evidence (e.g. SHS rate, harmful influence on pregnant women and foetuses) to the participants as *evidential strategies*[60], we used eight BCTs. 'Health-related information, motivation, and behaviour skills are fundamental determinants of performance of health behaviours' (p. 84)[61]. By applying these BCTs[42], this culturally appropriate educational comic book might be able to provide specific action plans for avoiding SHS at home (*behaviour skills*), health-related information (e.g. explanation of SHS, consequences of SHS, and risk for pregnant women and foetuses), and motivation (e.g. describing the benefits of SHS minus the barriers), thereby promoting behavioural changes in pregnant women and their partners.

This study had several limitations. First, owing to limits on research funding and equipment, self-report measures were used without also including more objective measures, such as nicotine or cotinine levels. Hsien-Tsai Chiu examined the relationship between self-reported SHS exposure and cotinine levels in the urine and blood. Results indicated that self-reported SHS exposure can provide a good estimate of biochemical markers of SHS exposure[62]. Thus, instead of measuring nicotine or cotinine levels, we cross-validated the self-reported measures by collecting them from both the pregnant women and their partners. Second, intention-to-treat analysis, which minimises bias when interpreting a study's results, could not be conducted, because responses were not collected from all participants at follow-up. Dropout rates were high for both the EG (21%) and CG (28%). However, participants provided the same reasons for dropping out in both groups, which might indicate less risk of bias. Third, only couples' behavioural and attitudinal changes were confirmed as outcomes. However, other outcomes such as (a) birthweight, height, gestational age at delivery, and sex (which we intended to gather as outcome measures as described in our research protocol), and (b) future disease risks (e.g. risk of respiratory disease by age 5) could not be assessed, as COVID-19 restrictions prevented couples' access to health centres. Fourth, the sample size was smaller than the original target number (404 couples for both groups), because the spread of COVID-19 in Indonesia since February 2020 affected the number of couples who could participate. Fifth, couples in the CG did not receive a placebo-like intervention in addition to usual care, which might have affected the follow-up rate. Sixth, in the EG, at baseline, only approximately 15% of the male partners read the educational comic completely, and approximately 25.7% partly read it. Moreover, at baseline and three months post-intervention, some male partners in the CG, who did not receive the educational comic book and sticker, reported that they 'read the educational comic completely or partly'. It is quite likely that they read other materials, such as pictures in the maternal and child health handbook, instead of the intervention comic book, and mistakenly answered 'yes' to the question regarding whether they had read the intervention comic book. Therefore, we did not analyse the changes in scores between baseline and post-intervention for both groups; only post-intervention between-group differences were analysed.

Conclusion

To address the weak effect size, future studies should examine barriers to preventing SHS exposure, such as the risk of losing social relations. As a next step, a community-wide intervention with supportive local leaders is recommended.

The results of this RCT can be generalised to (a) adult couples (non-smoking pregnant women and smoking male partners cohabitating), and (b) pregnant women receiving health education. Comic book interventions can be used to provide health education to target groups that use minority languages and cannot be easily educated on disease prevention by only using verbal explanations. Using comic books that include essential educational content will reduce differences in such content due to varying levels of knowledge among healthcare workers. Moreover, especially in perinatal care, this approach can help involve and educate partners as supporters of pregnant women. In other fields, this approach can be used for children and adults.

The authors hope that policymakers and medical personnel will use the intervention to reduce SHS exposure for pregnant women and foetuses in Indonesia. In response to COVID-19 mitigation efforts, instead of using the print version of the comic book, we suggest changing the medium of distribution to digital (e.g. video distribution), to meet social distancing requirements.

Declarations

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Author contributions

K.I. and E.O. designed the study, provided oversight for the study, and conducted data analysis. K.I., J.F.K., and W.M.V.W coordinated on-site data collection. I.H.O and M.G. collected data on-sight. All authors provided input for writing and editing the manuscript.

Data availability

The datasets generated and/or analysed during the current study are available from the corresponding author upon reasonable request.

Additional information

Competing Interests:

The authors declare no competing interests.

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Tables

Table 1

Participant characteristics at baseline

Characteristic		Pregnant women			Male partners		
		EG (*n*=140)	CG (*n*=146)	*p*	EG (*n*=140)	CG (*n*=146)	*p*
		n (%)	*n* (%)		*n* (%)	*n* (%)	
Mean age (*SD*)		27.01 (6.4)	26.89 (6.1)	.874[a]	30.03 (6.9)	30.22 (6.5)	.811[a]
Mean number of gestational weeks (*SD*)		15.13 (6.7)	15.45 (6.0)	.684[a]			
Number of cigarettes smoked/day					10.20 (6.3)	10.75 (7.5)	.962[a]
Smoking status	Never smoked	117 (83.6)	125 (85.6)	.870[b]			
	Quit before pregnancy	6 (4.3)	5 (3.4)				
	Quit after pregnancy	8 (5.7)	10 (6.8)				
Smoking status	Smoked as usual				100 (71.4)	109 (74.7)	.644[c]
	Smoked less after pregnancy				30 (21.4)	28 (19.2)	
	Smoked more after pregnancy				1 (0.7)	3 (2.1)	
Frequency of smoking in home	Daily				116 (82.9)	115 (78.8)	.255[c]
	Weekly				11 (7.9)	20 (13.7)	
	Monthly				0 (0.0)	1 (0.7)	
	Less than monthly				8 (5.7)	6 (4.1)	
Smoke-free home		46 (32.9)	47 (32.2)	.871[c]			
Smoker in home	Male partner	121 (86.4)	120 (82.2)	.136[b]			
	Grandfather	4 (2.9)	6 (4.1)	.412[c]			
	Grandmother	1 (0.7)	3 (2.1)	.333[c]			
	Brother	19 (13.6)	32 (21.9)	.075[c]			
	Sister	5 (3.6)	4 (2.7)	.868[c]			
	Other	16 (11.4)	13 (8.9)	.148[c]			
Frequency of SHS	Daily	106 (75.7)	100 (68.5)	.349[c]			
	Weekly	15 (10.7)	20 (13.7)				
	Monthly	1 (0.7)	1 (0.7)				
	Less than monthly	12 (8.6)	17 (11.6)				
Place of SHS exposure	In home	115 (82.1)	113 (77.4)	.297[c]			
	At work	11 (7.9)	8 (5.5)	.407[b]			
	In a restaurant	8 (5.7)	5 (3.4)	.344[b]			
	On public transportation	20 (14.3)	13 (8.9)	.146[b]			
	In a car	5 (3.6)	2 (1.4)	.203[c]			
	Other	7 (5.0)	15 (10.3)	.098[b]			
Ethnicity	Minahasan	77 (55.0)	76 (52.1)	.782[c]	78 (55.7)	78 (53.4)	.262[c]
	Sangir						

Mogondow		24 (17.1)	21 (14.4)		14 (10.0)	16 (11.0)	
Gorontalo		4 (2.9)	4 (2.7)		7 (5.0)	3 (2.1)	
Tinghoa		16 (11.4)	21 (14.4)		21 (15.0)	19 (13.0)	
	Other	1 (0.7)	0 (0.0)		2 (1.4)	0 (0.0)	
		15 (10.7)	21 (14.4)		15 (10.7)	26 (17.8)	
Religion	Protestant	82 (58.6)	91 (62.3)	.718[c]	77 (55.0)	89 (61.0)	.619[b]
	Catholic	11 (7.9)	8 (5.5)		13 (9.3)	11 (7.5)	
	Muslim	44 (31.4)	45 (30.8)		47 (33.6)	44 (30.1)	
Completed level of education	Elementary school	8 (5.7)	12 (8.2)	.547[b]	17 (12.1)	14 (9.6)	.098[b]
Junior high school		25 (17.9)	28 (19.2)		30 (21.4)	20 (13.7)	
Senior high school		85 (60.7)	91 (62.3)		74 (52.9)	99 (67.8)	
University/College		19 (13.6)	13 (8.9)		15 (10.7)	11 (7.5)	
Occupation	Private employee				42 (30.0)	49 (33.6)	.187[b]
	Entrepreneur				35 (25.0)	22 (15.1)	
	Labourer				29 (20.7)	29 (19.9)	
	Government employee				4 (2.9)	3 (2.1)	
	Farmer				3 (2.1)	8 (5.5)	
	Other				23 (16.4)	33 (22.6)	
Occupation during pregnancy	Housewife	108 (77.1)	114 (78.1)	.945[b]			
Working pregnant women		29 (20.7)	30 (20.5)				
Household earnings Over Rp.2,600,000 per month		58 (41.4)	66 (45.2)	.639[b]			
Rp.2,600,000 per month or less		71 (50.7)	72 (49.3)				
Main workplace	Indoor	75 (53.6)	83 (56.8)	.886[c]			
	Outdoor	13 (9.3)	12 (8.2)				
Both		46 (32.9)	47 (32.2)				
Type of household	Nuclear family	72 (51.4)	70 (47.9)	.583[b]			
	Joint family	64 (45.7)	71 (48.6)				

$p < .05$ was considered statistically significant. a: *t*-test was conducted, b: Pearson's chi-square test was conducted, c: Fisher exact test was conducted.EG: Experimental group, CG: Control group

Table 2

Comparisons of pregnant women' avoidance of SHS exposure, as evaluated by couples at baseline and three months post-intervention

Evaluated by pregnant women, self-report	Baseline			Three Months Post-intervention		
	EG (*n*=140)	CG (*n*=146)	[95% CI] *p*	EG (*n*=109)	CG (*n*=104)	[95% CI]
	M (*SE*)	*M* (*SE*)		*M* (*SE*)	*M* (*SE*)	*p*
Total scores for the Avoidance of Environmental Tobacco Smoke scale	50.96 (.53)	51.09(.50)	[-1.57,1.32] .865 [a]	52.17 (.50)	51.38 (.71)	[-.93, 2.50] .368[b]
A1. When I encounter someone who is smoking, I distance myself to ensure that I am not exposed to the smoke	2.98 (.08)	3.03 (.07)	[-.26, .16] .650 [a]	3.28 (.05)	3.09 (.07)	[.01, .37] .038 [a]
A2. I allow people to smoke in my home	2.35 (.07)	2.44 (.07)	[-.29, .11] .390 [a]	2.58 (.08)	2.69 (.08)	[-.34, .12] .343 [a]
A3. If I am with a group of people, and someone begins to smoke, I remain with the group	2.71 (.07)	2.78 (.07)	[-.26, .13] .513 [a]	2.72 (.07)	2.85 (.07)	[-.34, .63] .178 [a]
A4. If I encounter a friend or relative who is smoking, I sit and talk with him/her while he/she is smoking	2.74 (.07)	2.87 (.07)	[-.32, .06] .166 [a]	2.80 (.07)	2.84 (.07)	[-.25, .16] .651 [a]
A5. When I am in public place such as a restaurant, office, or clinic, I leave if unable to sit in the non- smoking section	2.67 (.07)	2.58 (.08)	[-.13, .31] .431 [a]	2.62 (.07)	2.50 (.08)	[-.08, .33] .215 [a]
A6. When I travel by bus, or use any other public transportation, I request for a non-smoking seat	2.59 (.07)	2.62 (.07)	[-.24, .17] .768 [a]	2.72 (.07)	2.48 (.07)	[.05, .43] .016 [a]
A7. When I travel by taxi, I ask the driver not to smoke.	2.73 (.07)	2.78 (.07)	[-.24, .13] .578 [a]	2.86 (.06)	2.79 (.08)	[-.12, .28] .452[b]
A8. I allow people to smoke in the car	2.76 (.07)	2.79 (.07)	[-.22, .16] .756 [a]	2.82 (.07)	2.91 (.07)	[-.28, .09] .308 [a]
A9. If my friends or relatives are gathering in a designated smoking area to smoke, I join them rather than be alone	2.79 (.07)	2.80 (.06)	[-.19, .17] .925 [a]	2.80 (.06)	2.86 (.07)	[-.25, .12] .483 [a]
A10. If I am with people who are smoking and I cannot leave, I ask them to refrain from smoking	2.71 (.07)	2.82 (.07)	[-.29, .07] .243 [a]	2.79 (.05)	2.67 (.07)	[-.06, .29] .183[b]
A11. I sit in the smoking section of public places or bus stations if no seats are available elsewhere	2.41 (.07)	2.47 (.07)	[-.26, .13] .508 [a]	2.51 (.07)	2.62 (.07)	[-.29, .08] .252 [a]
A12. When at an outdoor function where smoking is present, I move away to avoid it	2.89 (.06)	2.92 (.06)	[-.20, .14] .720 [a]	3.00 (.05)	2.75 (.07)	[.78, .41] .004 [b]
A13. When at an outdoor function where waterpipe smoking is present, I move away to avoid it	2.89 (.06)	2.92 (.06)	[-.20, .14]	3.04 (.05)	2.80 (.07)	[.06, .40]

			.724 [a]			. 008 [a]
A14. When exposed to SHS, I wash my clothes solely to remove the smell of smoke from them even if they are otherwise clean	2.50 (.07)	2.46 (.07)	[- .16, .23] .699 [a]	2.57 (.06)	2.44 (.08)	[- .07, .33] .190 [a]
A15. I find it unpleasant to be around SHS	3.10 (.05)	2.97 (.06)	[- .02, .28] .094 [a]	3.12 (.05)	2.99 (.07)	[- .04, .30] .131 [a]
A16. I routinely associate with people who smoke	2.26 (.06)	2.46 (.06)	[- .37, .02] .031 [a]	2.54 (.07)	2.71 (.08)	[- .38, .05] .121 [a]
A17. When eating out, I always sit in the non-smoking section	2.79 (.06)	2.60 (.07)	[.01, .38] .040 [b]	2.73 (.07)	2.72 (.07)	[- .18, .21] .870 [a]
A18. I do not frequently visit places where smoking is prevalent	2.86 (.06)	2.74 (.06)	[- .06, .30] .181[a]	2.94 (.05)	2.73 (.08)	[.03, .39] .024 [b]
A19. I do not find SHS offensive	2.38 (.08)	2.25 (.07)	[- .08, .34] .224[b]	2.06 (.08)	2.21 (.08)	[- .37, .06] .160 [a]
Evaluated by male partners	EG (*n*=140)	CG (*n*=146)	[95% CI] *p*	EG (*n*=109)	CG (*n*=104)	[95% CI]
	M (*SE*)	*M* (*SE*)		*M* (*SE*)	*M* (*SE*)	*P*
B1. My female partner moves away from me when I smoke	3.06 (.061)	3.01 (.059)	[- .12, .22] .549 [a]	3.14 (.055)	3.00 (.062)	[- .02, .30] .095 [a]
B2. My female partner reminds me not to smoke in our home when I smoke near away from her or inside the house	3.04 (.059)	3.06 (.057)	[- .19, .14] .751 [a]	3.17 (.050)	3.05 (.061)	[- .04, .27] .137 [a]
B3. My female partner moves away from smokers	3.03 (.061)	3.03 (.057)	[- .16, .17] .751 [a]	3.11 (.048)	3.04 (.057)	[- .08, .22] .335 [a]

p < .05 was considered as statistically significant. a: *t*-test was conducted, b: Welch's test was conducted, SHS = second-hand smoke. EG: Experimental group, CG: Control group

Table 3

Comparisons of male partner's smoking behaviour as evaluated by the couple at baseline and three months post-intervention

Evaluated by male partners, self-report	Baseline			Three months post-intervention		
	EG (*n*=140)	CG (*n*=146)	[95% CI] *p*	EG (*n*=110)	CG (*n*=104)	[95% CI] *p*
	M (*SE*)	*M* (*SE*)		*M* (*SE*)	*M* (*SE*)	
A1. I read educational comics on preventing SHS at home	2.09(.10)	1.67 (.08)	[.16, .67] <.001[b]	2.78 (.11)	2.12 (.11)	[.36, .96] <.001[a]
A2. I move away from my female partner when I smoke	2.89 (.07)	2.73 (.08)	[- .04, .36] .112[b]	3.09 (.06)	2.94 (.07)	[- .03, .33] .095 [a]
A3. I smoke near an open door or window	2.99 (.06)	2.89 (.07)	[- .08, .28] .258[a]	2.93 (.06)	2.91 (.07)	[- .17, .20] .880 [a]
A4. I smoke near the kitchen fan	2.58 (.08)	2.46 (.07)	[- .09, .37] .250 [a]	2.49 (.08)	2.30 (.07)	[- .01, .39] .066[b]
A5. I smoke outdoors with the door closed	2.65 (.07)	2.54 (.07)	[- .10, .31] .292 [a]	2.78 (.08)	2.56 (.08)	[- .00, .43] .051 [a]
A6. I smoke outside of the house	2.97 (.07)	2.90 (.07)	[- .12, .25] .473 [a]	3.03 (.07)	3.03 (.07)	[- .19, .19] .991 [a]
A7. I intend to quit smoking	1.64 (.07)	1.66 (.07)	[- .21, .17] .819 [a]	1.98 (.08)	1.74 (.09)	[.02, .47] .035 [b]
A8. I have stopped smoking	1.60 (.07)	1.72 (.08)	[- .32, .09] .276 [a]	2.04 (.10)	1.85 (.09)	[- .07, .44] .153 [a]
Evaluated by pregnant women	EG (*n*=140)	CG (*n*=146)	[95% CI] *p*	EG (*n*=109)	CG (*n*=104)	[95% CI] *p*
	M (*SE*)	*M* (*SE*)		*M* (*SE*)	*M* (*SE*)	
B1. My male partner reads educational comics on preventing SHS at home	1.94 (.10)	1.69 (.09)	[.00, - .51] .049[a]	2.76 (.11)	2.14 (.11)	[.33, .92] <.001 [a]
B2. My male partner moves away from me when he smokes	2.90 (.07)	2.86 (.07)	[- .15, .23] .698 [a]	3.02 (.08)	2.78 (.08)	[.02, .46] .036 [a]
B3. My male partner smokes near an open door or window	2.97 (.06)	2.87 (.07)	[- .08, .28] .266[b]	2.83 (.08)	2.76 (.07)	[- .14, .28] .527 [a]
B4. My male partner smokes near the kitchen fan	2.38 (.07)	2.37(.07)	[- .19, .21] .951 [a]	2.38 (.08)	2.11 (.07)	[.06, .48] .012 [b]
B5. My male partner smokes outdoors with the door closed	2.57 (.07)	2.42 (.08)	[- .05, .35] .132 [a]	2.69 (.08)	2.31 (.07)	[.17, .59] <.001 [a]
B6. My male partner smokes outside of the house	2.91 (.06)	2.89 (.07)	[- .17, .20] .858 [a]	2.94 (.07)	2.76 (.08)	[- .02, .39] .083 [a]
B7. My male partner intends to quit smoking	1.72 (.08)	1.59 (.06)	[- .07, .32] .195 [b]	2.04 (.08)	1.74 (.07)	[.08, .51] .007 [a]
B8. My male partner has stopped smoking	1.66 (.08)	1.58 (.07)	[- .13, .28] .454 [a]	1.95 (.10)	1.90 (.09)	[- .21, .31] .691 [a]

p < .05 was considered as statistically significant. a: *t*-test was conducted, b: Welch's test was conducted, SHS = second-hand smoke. EG: Experimental group, CG: Control group

Figures

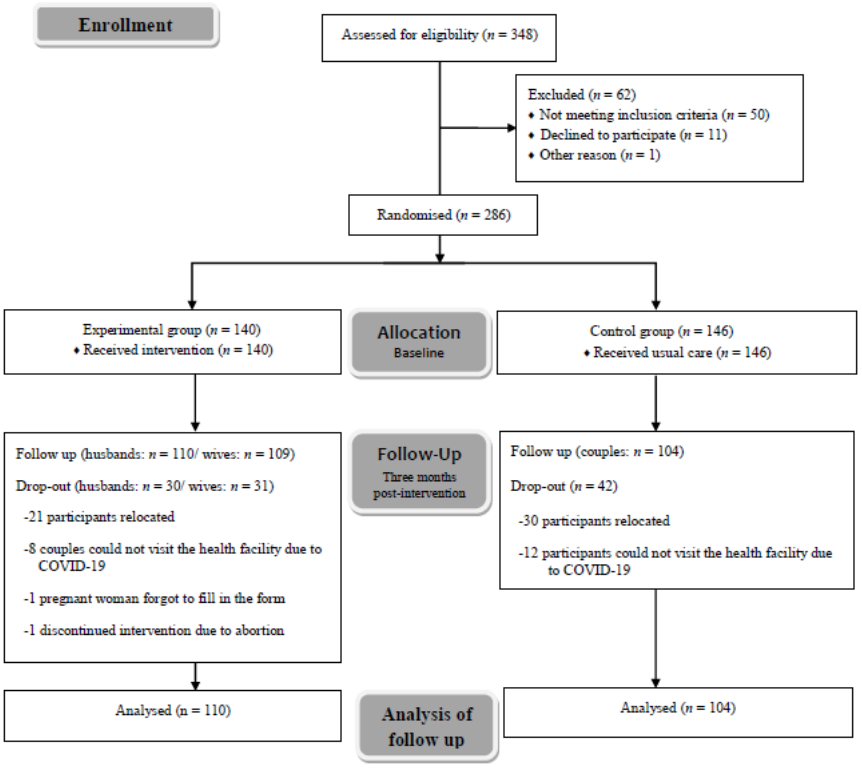

Figure 1

Flow diagram of the participant selection process.

Supplementary Files

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