


Effect of Pro-Environmental Prenatal Education Program on Pregnant Women's Environmental Health Awareness and Behaviors based on the Protection Motivation Theory

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Hyun Kyoung Kim, PhD, RN¹ and Geum Hee Jeong, PhD, RN² 

Abstract

This study aimed to verify whether a pro-environmental prenatal education program has an effect on pregnant women's environmental health awareness and behaviors in Korea. This quasi-experimental study employed a nonequivalent control group and nonsynchronized design based on the protection motivation theory as a theoretical framework. In total, 96 pregnant women had their data collected and analyzed in Korea (40 in the experimental group; and 56 in the control group). Data collection through self-reported questionnaire was conducted between September 2017 and August 2018. The program consisted of lectures and group activities aimed at educating participants on environmental awareness and behaviors. The data were analyzed using t-test, chi square test, and ANCOVA using SPSS 24.0 program. After the intervention, the experimental group showed significantly higher sensitivity (54.78 ± 9.47 and 49.75 ± 5.42 ; $F = 15.13$, $P < .001$), susceptibility (26.30 ± 5.18 and 24.28 ± 4.53 ; $F = 53.94$, $P < .001$), response efficacy (27.40 ± 3.40 and 25.18 ± 4.23 ; $F = 39.42$, $P < .001$), self-efficacy (22.43 ± 4.15 and 21.35 ± 4.25 ; $F = 41.13$, $P < .001$), individual environmental behavior (58.59 ± 12.25 and 51.93 ± 12.64 ; $F = 172.75$, $P < .001$), and communal environmental behavior (18.45 ± 9.68 and 13.13 ± 8.24 ; $F = 126.26$, $P < .001$) than the control group. The developed pro-environmental prenatal education program contained content on the environment and pregnancy, environmental toxin, effects of endocrine disruptors, airborne pollutants, water pollutant, soil pollutant, radio-electronic exposure, and pro-environmental health behaviors during pregnancy. Pregnant women who participated in the pro-environmental prenatal education program had positive changes in environmental health perceptions and behaviors. As environmental hazards continue to increase, pregnant women should receive effective motivational education on eco-environmental protection to increase their sensitivity to environmental risk factors and to encourage active environmental health behaviors.

Keywords

environmental health, health behavior, prenatal education, pregnant women, quasi-experimental studies

What do we already know about this topic?

Previous studies have shown that hazardous environmental exposure negatively affects the health of pregnant women and babies, and that environmental

¹Kongju National University, Kongju, South Korea

²Hallym University, Chuncheon, South Korea

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Corresponding Author:

Geum Hee Jeong, PhD, RN, School of Nursing and Research Institute in Nursing Science, Hallym University, 1 Hallymdaehak-gil, Chuncheon, Gangwon-do 24252, South Korea.

Email: ghjeong@hallym.ac.kr



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health behavior can prevent the body from environmental toxins.

How does your research contribute to the field?

This paper is to explore the effects of pro-environmental prenatal education on environmental health awareness and behavior for pregnant women in Korea.

What are your research's implications toward theory, practice, or policy?

This paper evidences that through pro-environmental prenatal education, pregnant women improve their response efficacy and self-efficacy to the benefits of environmental health behavior.

Introduction

Currently, as environmental pollution worsens, concerns grow proportionately regarding environmental toxins and their potential detrimental effect on human health. Chemical substances, heavy metals, fine dust, electromagnetic waves, and radiation are harmful to the human body and that come from environmental elements—such as water, air, and soil.¹ Particularly, women are more sensitive to environmental toxins than men owing to a larger distribution of body fat and many environmental toxin receptors in the reproductive organs.² Further, women are more vulnerable to environmental toxins during pregnancy, and fetal developmental disorders have been correlated with the delivery of environmental toxins through the placenta.³

Recently, studies on the impact of environmental health crises on pregnant women and babies caused by environmental exposure are increasing. The maternal outcomes of environmental health risks were preterm birth from herbicides,⁴ spontaneous abortion from exposure to heavy metal⁵ and electromagnetic fields,⁶ low birth rate from water pollution,⁷ and infertility from endocrine disruptors (EDCs).²

The adverse fetal outcomes were reduction of the follicle from bisphenol A (BPA), phthalates, and pesticides,⁸ decrease of femur length from phthalates,⁹ fetal death from lead pollution,⁷ and congenital anomaly from EDCs.² Newborns had negative health outcomes such as low birth weight related to phthalate, BPA, and lead^{7,9,10} and small head circumference from insecticides exposure.¹¹ Infants had behavioral problems from lead and mercury¹⁰ and male reproductive disorders from phthalate and BPA exposure.¹² Children had cognitive function delay exposed to cellular phones¹³ and

delay of mental and psychomotor development from phthalate.¹⁴

A previous study proved that environmental health practices could protect the body from environmental toxins. Children's concentrations of BPA and trichloroacetic acid were lowered if mothers tried to reduce plastics and pesticides.¹⁵ Although environmental health behavior interventions are increasing, few studies regarding the effects of interventions on pregnant women's health behavior exist. Environmental health educational interventions should be customized to suit pregnant women's needs to enhance environmental health awareness with concomitant behavioral solutions.¹⁶ Therefore, this study aimed to verify whether a developed pro-environmental prenatal education intervention affects pregnant women's environmental health awareness and behaviors.

The study objectives were to develop and provide a pro-environmental prenatal education program (PPEP) and to analyze the effects of environmental health awareness and behaviors between an experimental group that participated in the intervention and a control group. We had the following hypotheses for the effects of PPEP:

Hypothesis 1: The two groups would have different scores for environmental health awareness after the PPEP intervention.

Hypothesis 2: The two groups would have different scores for environmental health behavior after the PPEP intervention.

Background

We chose the protection motivation theory (PMT) as a framework, since our examination focused on the treatment effects of environmental health behavior.¹⁷ This theory addresses that motivation for change in behavior is created only when awareness toward health protection is preceded by the theories for change in health behavior. It also argues that the underlying mechanism is four categories of awareness: *sensitivity*, referring to awareness about health risks; *susceptibility*, referring to awareness about the possible occurrence of a health problem; *response efficacy*, referring to awareness about the capability of one's own behavior to protect one's health; and *self-efficacy*, referring to awareness that one can perform health behaviors. The PMT was used in many studies on health promotion nursing interventions targeting women such as consistent condom use among female sex workers,¹⁸ cervical cancer screening behavior,¹⁹ and intention of sexual transmitted infection screening.²⁰ The PMT was especially useful when applied to environmental concerns.²¹ This study used 4 main concepts except maladaptive reward and response cost of adaptation because of additional process.²¹

This study used 4 cognitive considerations in sequence: sensitivity will refer to awareness about the dangers of environmental toxins to health; susceptibility will refer to awareness about the fact that environmental toxins can cause health problems; response efficacy will refer to awareness about the fact that environmental behavior can be beneficial to health; and self-efficacy will refer to awareness that one can perform environmental health behaviors. Thus, we established a conceptual framework in which these concepts influence pregnant women's environmental health behaviors (Figure 1).

The PPEP was created as 6 concepts of education, with 4 environmental awareness and 2 behavior areas. (1) Sensitivity: Environmental exposure during pregnancy may lead to abortion, premature birth, low birth weight, and fetal developmental problems.^{8,9,14} (2) Susceptibility: Environmental exposure may have a wide impact (on the mother, the fetus, the family, and even the next generation), so it is necessary to diminish pregnant women's exposure to hazardous substances, especially at the preventive level.²² (3) Response efficacy: Health promotion behaviors to reduce EDCs among children have influenced their physiological indicators,¹⁵ which might demonstrate that pregnant women's response efficacy played a toxicant diminishing role. (4) Self-efficacy: The integrated awareness over their beliefs and confidence can perform environmental health behaviors.¹⁷ (5) Environmental health behavior is an individual concept that focuses on self-health and self-protection from environmental toxicity. (6) The pro-environmental behavior is a participatory concept toward the diminishment of environmental threats to health,²³ and it provides preventive, protective, altruistic, and alternative attributes to health.²⁴ Hence, PPEP was structured around the concepts of strengthening pregnant women's awareness and behaviors. The new PPEP based on those 6 educational concepts was provided to pregnant women based on the protection motivation theory.

Design

This quasi-experimental study had a nonequivalent control group and nonsynchronized design. The protection motivation theory by Rogers served as a theoretical framework.¹⁷ It was described according to the TREND statement.

Ethical Considerations

This study was approved by the institutional review board of the university (HIRB-2017-079) with which the researcher was affiliated. After completing the education program and post-test, all the participants were compensated with a gift of \$20 to avoid the impact of a reward. After obtaining the permission of the directors of the community health centers and managers of the health management department of the respective health centers, and to protect participants' rights, the researcher explained the purpose and method of the study, the gains and losses of participation, how privacy and confidentiality would be protected, the possibility of rejection and withdrawal before data collection, and then received written consents.

Participants

Participants in the PPEP at the community health centers located in Chuncheon and Hongcheon cities of Gangwon-do, Korea were selected by parallel group randomized sampling from September 2017 to August 2018. The community health nurses in 2 centers recruited pregnant women via internet advertisements, banners, and local newspapers. Community health centers are government organizations that are located in 165 local administrative units in Korea. Pregnant women are supported by health centers, but referrals are optional. The 102 participants from 2 health centers were 1:1 allocated using a random numbers table to either 51 in the experimental or 51 in the control group by the research assistant. Nine

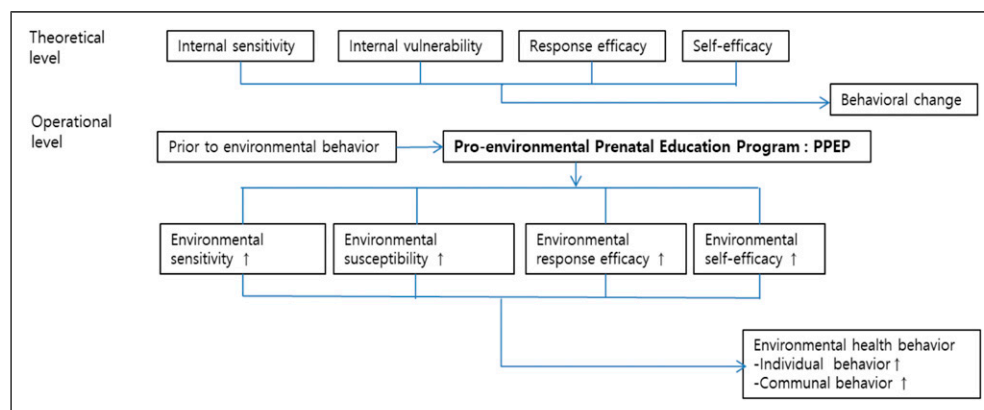


Figure 1. Conceptual framework according to the protection motivation theory.

participants in their second or third trimester moved to the control group, and the number of the control group was increased from 51 to 60 participants because of the possibility that there could be no more pregnant women in the experimental group (Figure 2). Before participation, the researchers provided explanations to the participants in prenatal education toward the methods, aims of this research, and informed consents for them to sign.

The inclusion criteria were Korean pregnant woman aged over 20 years old with a gestational age of less than 36 weeks who had voluntarily participated in all 4 weeks of the PPEP provided in the community health centers and agreed with the purpose of the study. The exclusion criteria were pregnant women who were currently hospitalized, woman with maternal and/or fetal health problems, and those who were unable to understand the requirements for participation and content of the study.

Data Collection

Development of the Pro-environmental Prenatal Education Program

The contents of the PPEP were organized by a literature review. The search method adopted an advanced search using strategy for the terms “((pregnant*) AND health behavior) AND *environment” in the abstract and the title; and also used some wildcard search terms: “pregnancy, health behavior, and environment” as Korean search terms and Boolean operators. Using the search engines of PubMed,

CINAHL, ERIC, SCOPUS, google scholar, and RISS (<http://www.riss.kr/>), 537, 45, 20, 690, 130, and 5 papers were found, respectively, and 8 papers were searched manually. As a result of reading all the titles, abstracts, and selecting the papers that were to be used in the development of the PPEP, 33 papers were included.

The PowerPoint educational materials were developed for the instructor, the pregnant women, and teaching manuals. The educational materials were assessed by 1 environmental engineering researcher and 2 women’s health nursing professors. The items of content validity were adequacy, usability, importance, suitability of education contents, and effectiveness of education time. All items had an average score of above 80% through a five-point Likert-type scale (1 = very inappropriate to 5 = very appropriate).²⁵ The content validity index (Fleiss kappa coefficient) determined for the 5 areas was .70. There was good strength of agreement between the professionals’ judgement, with a 95% confidence interval (CI) between .68 and .72. The Fleiss kappa coefficient was also statistically significant. Based on consensus, we modified and simplified the contents to make it suitable for pregnant women.

Finally, the PPEP consisted of 8 parts presented within 4 sessions: the environment and pregnancy, environmental toxin, effects of EDCs, airborne pollutants, water pollutant, soil pollutant, radio-electronic exposure, and pro-environmental health behaviors during pregnancy. The PPEP was conducted through lectures, discussions, and question-and-answer moments for 4 weeks. Researchers delivered the PPEP in the prenatal classrooms at 2 community healthcare centers (Table 1).

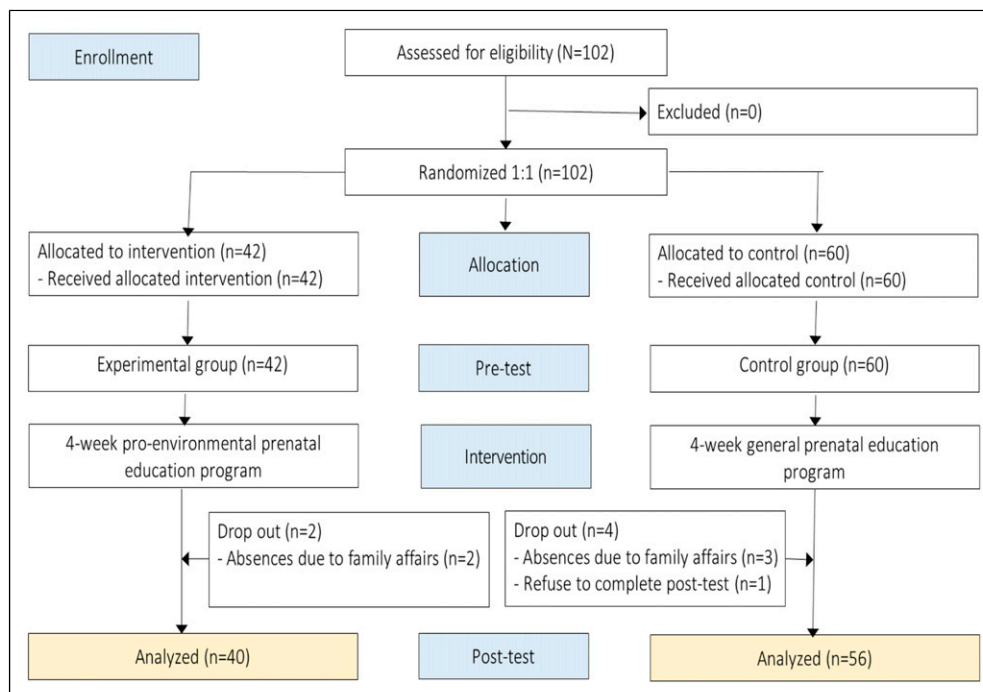


Figure 2. Process flow diagram.

Table 1. Contents of the Pro-Environmental Prenatal Education Program.

Session (week)	Themes	Contents	Concepts of Theory	Time (min)	Methods
1	Orientation Part 1	- Introducing the purpose, content, and method of program	Sensitivity Susceptibility	30	Lecture
	Environment and pregnancy	- Organizing a small group and introducing members - The relationship between the environment and pregnancy	Response efficacy		Discussion
	Part 2	- Sharing environmental concern about pregnancy	Sensitivity	30	Lecture
	Environmental toxin	- Prenatal health promotion - Chemical hazards during pregnancy - Understanding of environmental toxins during pregnancy	Susceptibility Response efficacy		Group discussion Q & A
2	Part 3	- Learn about toxicants	Sensitivity	30	Lecture
	Effects of EDCs	- Endocrine disruptor chemicals (EDCs) and fetus - Effects of EDCs on health during pregnancy	Susceptibility Response efficacy		Group discussion
	Part 4	- Learn about effects from air pollutant exposure during pregnancy	Sensitivity	30	Lecture
	Airborne pollutant	- Effects of airborne pollutants on health during pregnancy - Practice of the comfortable postures and relaxation when labor	Susceptibility Response efficacy Individual environmental behavior		Demonstration and practice
3	Part 5	- Learn about effects from water pollutant exposure during pregnancy	Sensitivity	30	Lecture
	Water pollutant	- Effects of water contamination on health during pregnancy - Breast feeding and environmental hazards	Susceptibility Response efficacy Individual environmental behavior		
	Part 6	- Learn about effects of soil pollutant exposure during pregnancy	Sensitivity	30	Lecture
	Soil pollutant	- Effects of soil pollution on health during pregnancy - Dietary recommendation during pregnancy and breast feeding	Susceptibility Response efficacy Individual environmental behavior		Discussion Q & A
4	Part 7	- Learn about effects from radio-electronic exposure during pregnancy	Sensitivity	30	Lecture
	Radio-electronic exposure	- Effects of radiation-electromagnetic wave on health during pregnancy- Discuss about "taking responsibility for environment"	Susceptibility Communal environmental behavior		Group discussion
	Part 8	- Strategies to practice the pro-environmental health behaviors during pregnancy and after birth	Individual environmental behavior	30	Group discussion
	Pro-environmental health behaviors wrap-up	- Presentation of thoughts by group - Evaluation about the environmental health promotion program	Self-efficacy		Presentation Q & A

Preliminary investigations

Preliminary investigations were conducted to identify the usability and suitability of the program and to correct any problems in advance. This preliminary investigation was held at a health center in C City, Gangwon-do, in July 2017. During the first session, the PPP was conducted with 15 pregnant women for 2 hours, followed by a questionnaire application. The modifications incurred by this investigation were the following: the session "Endocrine disruptor chemicals and fetus" was strengthened owing to many questions that arose related to the

topic, and some of the data that were deemed difficult for the target public were modified. On average, it took 13 minutes for participants to complete the questionnaires, and no correction to the questionnaire was made as no problems were found.

Pre-test

The pre-test was conducted consisting of participants' general and obstetrical characteristics, environmental health awareness, and environmental health behaviors. The time required for questionnaire completion was 10–15 minutes.

Interventions

For the control group, 4 sessions (with 240 minutes) of a general prenatal education program called “healthy mom happy family” were performed in September 2017. The content of the program covered maternal health care, postpartum care, breastfeeding, and neonatal care. For the experimental group, 4 sessions (with 240 minutes) of the PPP with additional general prenatal education were conducted in March 2018.

Post-test

The post-test was conducted at the fourth week just after the intervention in both groups. The PPEP mini book including PPT slides was provided after the post-test for the control group.

Outcome Measurement

Environmental Health Awareness

The environmental health awareness scale was used.²⁴ It is a 31-item scale divided into 4 subcategories: internal sensitivity (12 items), internal susceptibility (7 items), response efficacy (6 items), and self-efficacy (6 items). It is responded based on a 5-point Likert scale, ranging from 1-5 (not at all–agree very much). Total scores ranged from 4-155, and the internal consistency reliability values for the subcategories were .91, .93, .87, and .81 in the original study²⁴ and .81, .91, .93, and .89 in this study.

Environmental Health Behavior

The environmental health behavior scale was used.²⁴ It is a 13-item scale divided into 2 subcategories: individual (9 items) and communal behavior (4 items); it is responded based on a 10-point Likert scale, ranging from 0-10 (not at all–always). Total scores ranged from 0-130, and the internal consistency reliability value for the scale was .81 in the original study, and the Cronbach’s alpha values for the subscales were .81 (individual behavior) and .91 (communal behavior) in this study.

Sample Size

Using G* Power 3.1.9.6, the number of subjects for each group was 26, with an effect size (f) of .8, power of .80, and significance level of a two-tailed test of .05.²⁶ The effect size and the power were calculated based on a similar previous study: Pell et al (2017).¹⁵ selected 84 subjects (42 experimental group; 42 control group), considering a 20% dropout rate.¹⁵

Statistical Methods

Collected data were analyzed using the SPSS for Windows version 24.0 (IBM Corp, Armonk, NY, USA). General/obstetric characteristics, environmental health awareness, and behaviors

were analyzed through frequency, percentage, mean, and standard deviation. The t-test and Chi-square test were used for the homogeneity test. The Shapiro–Wilk test was used to test the normality of the environmental health awareness and behavior scores, while the differences between environmental health awareness and behavior scores of the pre/post-test in the control and experimental groups were examined by covariate analysis.

Results

Participant Flow

In total, our study had 102 participants: 60 in the control and 42 in the experimental group. Nevertheless, in the control group, data from 4 participants were excluded from data analysis because 3 participants did not attend the prenatal education program more than 2 times, and 1 participant did not answer the questionnaire in the post-test; in the experimental group, data from 2 participants were excluded because they did not attend for the PPEP due to family affairs. For adherence to the treatment, the authors used a study protocol, and reminder messages were sent to the participants through social network services before each session (Figure 2).

Recruitment: Data collection was conducted between September 2017 and August 2018.

Baseline data: Data are presented in Table 2.

Baseline equivalence; It was explained in Table 2.

Homogeneity Test

The response rate was 94.1%; the number of participants was 96 (56/40) at the post-test from 102 that were recruitment. The baseline general/obstetric characteristics and environmental health awareness and behavior were homogenous. Medical history included conditions such as vaginitis, uterus myoma, hemorrhoid, hyper/hypothyroidism, dermatitis, and rhinitis. The majority earned less than 4 500 000 in monthly income (49/37) and the other half had previous experience of prenatal education (25/23) (Table 2).

Outcomes and Estimation

Educational Effect

As a result of the Shapiro–Wilk test for the normality of dependent variables, both environmental awareness ($W = .984$, $df = 56$, $P = .679$ / $W = .983$, $df = 40$, $P = .804$) and behavior ($W = .984$, $df = 56$, $P = .653$ / $W = .992$, $df = 40$, $P = .993$) showed normal distributions.

1. Hypothesis 1: The PEPP group had significantly higher sensitivity ($F = 15.13$, $P < .001$), susceptibility ($F = 53.94$, $P < .001$), response efficacy ($F = 39.42$, $P < .001$), and self-efficacy ($F = 41.13$, $P < .001$) post-treatment compared to the control group (Table 3).

Table 2. Analysis of Homogeneity Between the Experimental and Control Groups (N = 96).

Characteristics		Exp. ^a (n = 40) M (SD) or n (%)	Cont. ^b (n = 56) M (SD) or n (%)	t/x ²	P
Age (Year)		32.00 (3.41)	31.38 (5.20)	-.87	.385
Gravity		1.15 (.80)	1.16 (.68)	.07	.944
Number of children		.18 (.44)	.27 (.52)	.91	.304
Spontaneous abortion	Yes	13 (32.5)	9 (16.1)	3.56	.059
	No	27 (67.5)	47 (83.9)		
Artificial abortion	Yes	4 (10.0)	2 (3.6)	1.64	.231 ^c
	No	36 (90.0)	54 (96.4)		
Infertility treatment	Yes	1 (2.5)	2 (3.6)	.88	.766 ^c
	No	39 (97.5)	54 (96.4)		
Present disease	Yes	6 (15.0)	12 (21.4)	.63	.426
	No	34 (85.0)	44 (78.6)		
Medical history	Yes	8 (20.0)	9 (16.1)	.24	.619
	No	32 (80.0)	47 (83.9)		
Education	Middle school	1 (2.5)	7 (12.5)	5.35	.148
	High school	8 (20.0)	19 (33.9)		
	College	29 (72.5)	10 (17.9)		
	University	2 (5.0)	20 (35.7)		
Job	Yes	10 (25.0)	20 (35.7)	2.14	.342
	No	30 (75.0)	36 (64.3)		
Monthly income (Korean dollar: Won)	<1 500 000	2 (5.0)	4 (7.2)	2.78	.594
	<3 000 000	23 (57.5)	33 (58.9)		
	<4 500 000	12 (30.0)	12 (21.4)		
	<6 000 000	2 (5.0)	5 (8.9)		
	≥6 000 000	1 (2.5)	2 (3.6)		
Experience of prenatal education	Yes	23 (57.5)	25 (44.6)	1.54	.214
	No	17 (42.5)	31 (55.4)		
Sensitivity		49.90 (5.28)	50.30 (4.61)	.53	.592
Susceptibility		24.25 (4.45)	25.86 (5.00)	1.62	.108
Response efficacy		25.18 (4.23)	26.54 (2.77)	1.90	.060
Self-efficacy		21.35 (4.25)	21.95 (4.28)	.67	.502
Individual environmental behavior		51.93 (12.64)	55.96 (12.96)	1.52	.132
Communal environmental behavior		13.13 (8.82)	12.70 (8.29)	-.24	.809

^aExp.= Experimental group.

^bCont.= Control group.

^cFisher's exact test.

- Hypothesis 2: The PPEP group had significantly higher individual environmental behavior ($F = 172.75$, $P < .001$) and communal environmental behavior ($F = 126.26$, $P < .001$) post-treatment compared to the control group (Table 3).

Ancillary analysis: None.

Adverse events: There was no harm to subjects because it is not clinical trial for medicine or instruments but prenatal education program.

Discussion

Interpretation

This is the initial study that verified the effects of the PPEP based on the PMT¹⁷ on environmental health awareness

and behavior of pregnant women. Further, this study contained important health issue for vulnerable population in the world context of attention and need increasing. Health care professionals can use this study's results for advocating the pregnant women through access potential pollutant, scientific exploration of health effects, and initiative leadership to produce organization and policies.²⁷

During pregnancy, the sensitivity to environmental exposure helped notice the risk factors quickly.²⁸ Further, exposure to chemicals such as arsenic, lead, and mercury during pregnancy may lead to spontaneous abortion, stillbirth, premature birth, low birth weight, and fetal developmental problems.^{29,30} Hence, these were considered environmental toxins that should be addressed in prenatal education. Pregnant women educated through the PPEP may become more sensitive to environmental hazards. Community nurses

Table 3. Program Effects of the Pro-Environmental Prenatal Education Program between the Experimental and Control Groups (N = 96).

Characteristics		Exp. ^a (n = 40)	Cont. ^b (n = 56)	F ^c	P
		M (SD)	M (SD)		
Sensitivity	Pre-test	49.90 (5.28)	50.30 (4.61)	15.13	<.001***
	Post-test	54.78 (9.47)	49.75 (5.42)		
Susceptibility	Pre-test	24.25 (4.45)	25.86 (5.00)	53.94	<.001***
	Post-test	26.30 (5.18)	24.28 (4.53)		
Response efficacy	Pre-test	25.18 (4.23)	26.54 (2.77)	39.42	<.001***
	Post-test	27.40 (3.40)	25.18 (4.23)		
Self-efficacy	Pre-test	21.35 (4.25)	21.95 (4.28)	41.13	<.001***
	Post-test	22.43 (4.15)	21.35 (4.25)		
Individual environmental behavior	Pre-test	51.93 (12.64)	55.96 (12.96)	172.75	<.001***
	Post-test	58.59 (12.25)	51.93 (12.64)		
Communal environmental behavior	Pre-test	13.13 (8.82)	12.70 (8.29)	126.26	<.001***
	Post-test	18.45 (9.68)	13.13 (8.24)		

^aExp. = Experimental group.

^bCont. = Control group.

^cThe F score was derived from an analysis of covariance with the pre-test scores as covariate variables.

****p* < .001.

should communicate regarding fear of environmental health problems through cognitive appraisal.²¹

Participants' susceptibility indicated their understanding over how vulnerable their health was to environmental toxins during pregnancy.¹⁷ The consequences of this exposure may have a wide-ranging impact (on the mother, the fetus, the family, and even the next generation), so it is necessary to diminish pregnant women's exposure to hazardous substances, especially at the preventive level.²² In this study, pregnant women's susceptibility increased after the PPEP, so community health nurses should closely observe vulnerable pregnant women through scientific assessment tools.³¹

Participants' response efficacy indicated the degree to which they consider this awareness is beneficial to their own and their fetuses' health. Health promotion behaviors to reduce EDCs among children have been found to influence their physiological indicators,¹⁵ which might demonstrate that pregnant women's response efficacy played a toxicant-diminishing role. As pregnant women's response efficacy increased after the PPEP, it may increase positive awareness, that is, they may start seeing health behaviors as effective after the intervention. Community healthcare programs can empower preventive behaviors, magnify behavioral benefits, and enhance the frequency of adaptive responses in pregnant women.²¹

Participants' self-efficacy scores indicated their integrated awareness of their beliefs and confidence, as well as their will to perform environmental health behaviors.¹⁷ As pregnant women's self-efficacy increased after the PPEP, it may increase their abilities to practice health behaviors after the intervention. Self-efficacy was reported as a critical predictor in previous studies based on the PMT.¹⁸⁻²⁰ Pregnant women should feel efficient in the ability to avert the environmental threat, so community health nurses highlighted self-efficacy

to perform the environmental behaviors.²¹ The increase in pregnant women's self-efficacy after the PPEP may also correspond to an increase in their ability to practice health behaviors after the intervention.

Participants' individual behavior scores indicated the extent of health practices they would undertake to prevent exposure to environmental toxins. There is a plethora of evidence on the health effects of environmental toxins on pregnant women's health owing to the recent surge in research on humans.^{12,32,33} Further, individual health behavior during pregnancy is important because mothers are more susceptible to being affected by small amounts of environmental toxins, and their habits can eventually be passed on to the fetus.²² In this study, individual behavior scores increased the highest compared to the other variables; therefore, the effectiveness of the PPEP focused on behavioral change.

Participants' communal behavior indicated the extent of environmentally altruistic behavior to seek alternatives that brought lifestyle changes for environmental sustainability.²⁷ Therefore, communal health behavior through the intervention could minimize the negative impacts on the planet and ensure a better life for the next generation.³⁴ A survey that identified factors of environmental health engagement among pregnant women showed the effect of perceived norm regarding exposure reduction behaviors,³⁵ so it can be inferred that communal behavior will be significant in the environmental health. As pregnant women's communal behavior scores increased after the PPEP, we believe that education not only for individual but also for communal behavior should be included in prenatal education.

Although the effectiveness of experimental intervention measuring environmental health behaviors among pregnant women was not found in previous studies, a survey regarding health behavior to reduce environmental toxins showed

importance of risk perception.³⁵ A qualitative research study presented environmental benefits, barriers, and motivation for changing pregnant women's behavior.³⁶ Thus, it is considered that the PPEP as prenatal education may have a positive effect on fear appraisal, behavioral appraisal, and the intention to change individual and communal behaviors. Environmental health educational interventions should be customized to suit pregnant women's needs and to enhance environmental health awareness with concomitant behavioral solutions.³⁷ Although the threat of environmental toxins owing to global development is increasing to an unprecedented extent,³⁸ prenatal education does not suffice for the specific needs of pregnant women.³⁷ Therefore, this study verified the effects of a pro-environmental prenatal education intervention on pregnant women's environmental health awareness and behaviors, filling a knowledge gap in the literature.

Generalizability

This study has strengths such as the PMT was supported with the construct of study variables. The 4 domains of internal perception could predict readiness to change environmental behaviors. In nursing practice, the existing prenatal education focusing on the understanding of pregnancy, childbirth, breastfeeding, puerperal period, and neonatal care should be supplemented with the PPEP to provide information for women to support them in changing their environmental health behaviors. In nursing education, environmental health literacy should be reinforced through environmental health curriculum. Therefore, the intervention and measurement tools after the intervention may be able to be used for the prenatal education program on pregnant women's environmental health awareness and behaviors. Although present data are from Korea, they can be adopted in other countries without difficulties.

Limitations

This study had several limitations. It was not generalized since this sample was recruited from only 2 health centers. Further, double-blinded test was not performed after assigning participants and instructor and during analysis of the data because allocation sequence was not concealed. Some data were missing because some individuals did not attend the intervention in both groups and chose not to complete the post-test in the control group. The drop-out rates were 4.77% in the experimental group and 6.67% in the control group; since these rates are under 20%, they indicate a low risk of bias. For the control group, ten-page brochures about environmental health during pregnancy were provided after the general prenatal education, although interpersonal education was beneficial to them. Moreover, the PPEP was provided as lecture-oriented and offline education. Rogers's revised model suggested the rewards of maladaptive response and cost of adaptive response¹⁷; however, this study did not reflect new

concepts. Therefore, further research will be needed to verify the effectiveness of this type of intervention by diversifying the media of the educational intervention to online, counseling, and mentoring, by expanding the samples to a larger number of pregnant women from different regions, and by adopting new theoretical approaches that allow for the construction of causality.

Conclusion

The PPEP had a significant effect on environmental health awareness and behavior of pregnant women. After receiving PPEP, pregnant women increased both in sensitivity and susceptibility to environmental risks and vulnerabilities and improved their response efficacy and self-efficacy to the benefits of environmental health behaviors, including individual and communal environmental health behaviors. The results of this study could be applied by public health nurses when providing education to promote environmental health, in addition to the prenatal education for pregnant women.

Author Contributions

Kim and Jeong drafted the first version of the manuscript. Kim and Jeong collected and analyzed the data collaboratively. Kim participated in interpreting the data and revised the manuscript.

Declaration of Conflicting Interests

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ORCID iD

Geum Hee Jeong  <https://orcid.org/0000-0002-2254-1962>

Supplemental Material

Supplemental material for this article is available online.

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