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# Effect of educational intervention based on the theory of planned behavior (TPB) on amount of salt intake in pregnant women with PreHypertension

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## Abstract

**Background** Prehypertension is one of the common disorders during pregnancy. Reducing salt intake is among the best cost-effective interventions to reduce the risk of hypertension. The present study aimed to explore the effect of an educational intervention based on the Theory of Planned Behavior (TPB) on amount of salt consumed by prehypertensive pregnant women.

**Methods** The present quasi-experimental study was conducted in 2022 on 61 prehypertensive pregnant women visiting the Comprehensive Health Services Centers in Birjand, Iran. Pregnant women were selected through a convenience sampling method and randomly assigned to intervention and control groups. A blood pressure test and a 24-hour urine test were taken in 3 stages (before, immediately after, and one month after the intervention). A reliable and valid questionnaire based on the TPB was used to measure the cognitive variables. The intervention program included three training sessions based on the TPB held on an online platform (WhatsApp social network). Data were analyzed using repeated measures ANOVA and longitudinal marginal model with the GEE approach in SPSS19. The significance level for all statistical tests was set at $p < 0$ 0.05.

**Results** After intervention, the mean score of perceived behavioral control ($p = 0.02$), intention ($p = 0.004$), and salt consumption behavior ($p = 0.03$) increased significantly in the intervention group, and the mean score of systolic blood pressure ($p < 0.001$) and diastolic blood pressure ($P < 0.01$) decreased significantly in this group. In the control group, a statistically significant difference was observed in the systolic and diastolic blood pressure of the subjects ($p < 0.01$). However, the score of attitude, subjective norms, perceived behavioral control, intention, salt consumption behavior and the daily salt intake did not show a statistically significant difference over time ($P < 0.05$).

**Conclusion** The present findings showed that the perceived behavioral control, intention, behavior, systolic and diastolic blood pressure can be modifiable variables to improve the amount of salt consumed by pre-hypertensive pregnant women. Therefore, we recommend that the present model be used to develop interventions to improve health indicators in pregnant women as a highly susceptible group in society.

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**Keywords** Education, Prehypertension, Pregnant women, Salt intake amount, Theory of planned behavior

## Introduction

High blood pressure is a common medical disorder during pregnancy [1]. The World Health Organization (WHO) estimated that 10% of pregnant women worldwide suffer from gestational hypertension [2]. Blood pressure disorders in pregnancy are classified into four types: chronic hypertension, gestational hypertension, preeclampsia and eclampsia. Gestational hypertension is defined as a systolic blood pressure of 140 mmHg or more or a diastolic blood pressure of 90 mmHg or more after 20 weeks of pregnancy, and its prevalence is estimated to be 4.4–1.8% of pregnancies [3]. This disorder can be associated with other pregnancy problems, such as placental abruption, fetal growth disorder, stillbirth, low birth weight, maternal death due to stroke [1, 4], eclampsia, risk of high blood pressure, diabetes [4], renal dysfunction [1, 5], hepatic dysfunction [5], premature birth and cardiovascular diseases for the mother [1, 4]. Preeclampsia and eclampsia are among the most important complications of pregnancy, usually associated with raised blood pressure. Based on Kharaghani and et al. study, overall prevalence of preeclampsia and eclampsia among Iranian pregnant women was 0.05 and 0.23% respectively [6]. Therefore, it is essential to prevent and control blood pressure in pregnant women [1].

In addition to high blood pressure, prehypertension is also considered an important risk factor for cerebrovascular diseases, coronary artery disease, chronic kidney disease, and the fatal consequences of these diseases [7]. Bone et al. (based on American College of Cardiology and American Heart Association guidelines in 2017) contended that during pregnancy, people with a systolic blood pressure of 120–129 and diastole pressure of <80 or systolic blood pressure of 130–139 or diastole of 80–89 or both are exposed to high blood pressure or prehypertension [8]. Prehypertension is a warning indicator that shows a person will tend to develop high blood pressure in near future [9]. Several studies reported that prehypertension in the first half of pregnancy increases the likelihood of adverse outcomes such as gestational hypertension disorders [10], gestational diabetes [11], and preterm birth [12, 13].

There are several strategies to prevent and control blood pressure [14] According to the WHO, reducing salt intake is among the best cost-effective interventions to prevent non-communicable diseases such as blood pressure disorders. Also, there is evidence for a positive relationship between sodium intake and high blood pressure, obesity, osteoporosis, headaches, kidney stones and stomach cancer [15]. It has been observed that reducing salt consumption to 5–6 g/day can decrease systolic and diastolic blood pressure for 5−4 and 1–3 mmHg, respectively [15]. The average salt consumption worldwide is estimated to be approximately 10 g/day, which is twice the WHO guidelines [16]. A body of research showed that more than 95% of the world's population consumes excessive salt [17]. The average salt consumption in Iran is about 9.52 g/day, which is at least twice the recommended level among 40% of adults [18].

One of the main strategies in nutrition-related behaviors is to increase the household food awareness, especially among mothers [19]. The results of a study by Agh atabay et al., which was conducted on the population of rural women in Chabahar, showed that educational interventions can be effective in reducing salt consumption behavior [20]. Moeini et al. (2013) found that an educational intervention reduced the amount of salt consumed by women at the risk of high blood pressure [21].

Health education researchers developed several psychological and social models to modify behaviors [22]. One prominent theory in food selection and nutritional behaviors [20] is the Theory of Planned Behavior (TPB) [23]. According to this theory, the most important determinant of behavior is the behavioral intention, which is influenced by three main constructs: attitude towards the behavior (instrumental or emotional evaluation of behavior), subjective norms (social pressure perceived by the individual to perform the behavior) and perceived behavioral control (personal understanding of the difficulty or ease of performing the relevant behavior) (Fig. 1) [24].

Due to the critical condition of women during pregnancy, high blood pressure in the first trimester of pregnancy leads to the occurrence of pre-eclampsia and subsequent eclampsia in the mother. Moreover, the lack of theory-based studies in the field of salt consumption, as a key factor in the occurrence of high blood pressure, is a major health concern. It is expected that health professionals and decision-makers plan and act to design educational interventions that can improve daily salt consumption in pregnant women. The present study explored the effect of an educational intervention based on the TPB on the amount of daily salt consumed by prehypertensive pregnant women.

## Materials and methods

### Design of study

The present quasi-experimental study involved a control and an intervention group. It was conducted from February to August 2022 in Birjand, Iran. The research population included prehypertensive pregnant women visiting Comprehensive Health Services Centers in Birjand. The primary outcome was to modify the amount

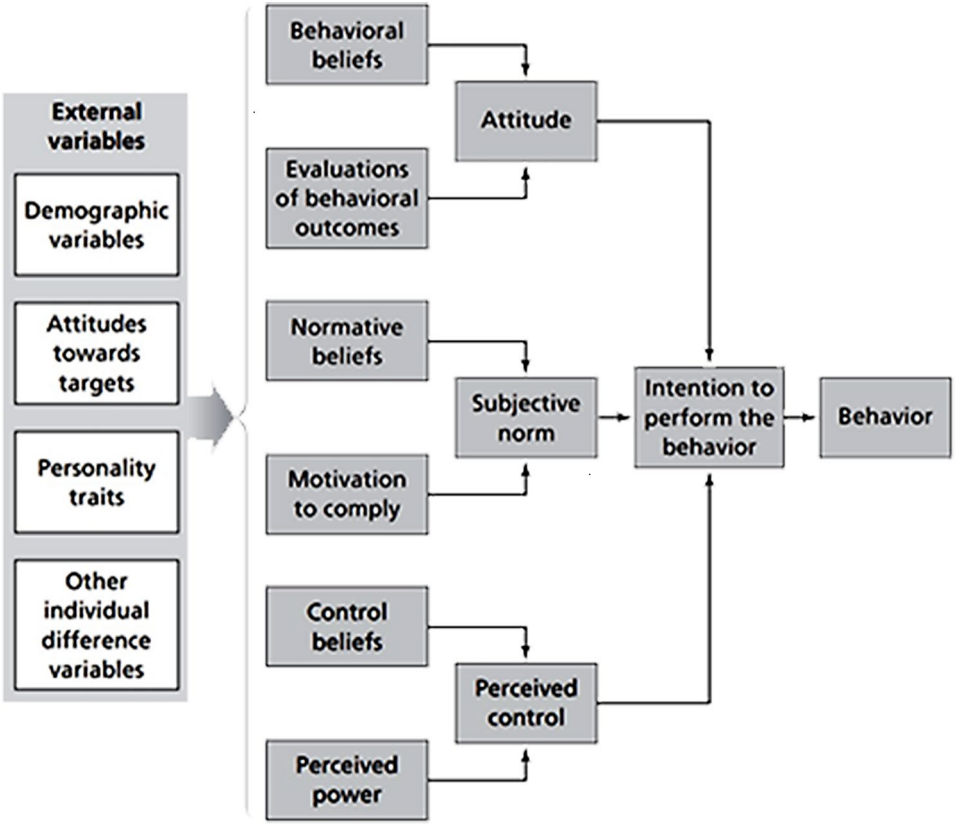


**Fig. 1** TPB constructs and linkages

of salt consumed by pregnant women. The secondary outcome was to improve blood pressure, attitude, subjective norms, perceived behavioral control, intention, and behavior of pregnant women through changing their intention to show the behavior of consuming less salt.

#### Participants and sampling

The inclusion criteria were: being in the 8th to 16th weeks of pregnancy, having a systolic blood pressure of 120–129 and diastolic pressure of < 80 or systolic blood pressure of 130–139 or diastolic pressure of 80–80 or both [8], lack of chronic hypertension, no medication or diet affecting blood pressure, lack of known advanced chronic diseases (e.g. cancer, lupus, advanced heart failure, kidney disease, diabetes, and stroke) and mental disease, non-addiction to drugs and alcohol, no family history of pregnancy hypertension in close relatives, being literate (to be able to read the questions and answer them), having a contact number and smart phone to communicate, and willingness to participate in the study.

The exclusion criteria were: absence in more than one training session, unwillingness to continue with the research procedure, death or illness during the time of study, miscarriage, gestational hypertension, following a special diet prescribed by a doctor, beginning the drug therapy for blood pressure control, failure to collect 24-h urinary at one of the three time phases of the study, and low urinary creatinine level (< 15 mg/kg for women).

We extracted demographic information related to all participants and medical records from the Integrated Health System. This system, which has the required permissions from the ministry of health of Iran, was originally developed to record, maintain and update the electronic health record information of Iranian citizens.

The sample size based on Atabay [20] study, with 95% confidence interval and power of 80% and based on the following formula was 32 but considering the possible attrition rate (10%), the sample size was estimated at 36 at each group.

$$n = \frac{\left(z_{1-\frac{\alpha}{2}} + z_{1-\beta}\right)^2 \left(\sigma_1^2 + \sigma_2^2\right)}{d^2} = \frac{\left(10.959964 + 00.8416212\right)^2 \left(0.8^2 + 1.04^2\right)}{0.66^2} \approx 32$$

Prehypertensive pregnant women were selected and included in the study using the convenience sampling method. Initially, 21 Comprehensive Health Services Centers were visited in Birjand. After checking the list of pregnant women receiving services at each center, the names of mothers who were in the first half of pregnancy

and had prehypertension were retrieved from the existing records. After calling the mothers and arranging for a face-to-face meeting at the health centers, some other inclusion criteria were checked. Using bias coin method, the samples were randomly assigned to groups. If they were willing to participate in training sessions and the 24-h urinary test, they were included in the intervention group, and if they only wanted to perform the 24-h urinary test, they were included in the control group. Those who were unwilling to take part in the study were excluded. Pregnant women of both groups completed the questionnaire survey and performed the required tests three times, before, immediately after, and one month after the educational intervention. Flowchart of study was presented in Fig. 2. The questionnaire was completed, in the presence of the researcher. The reason for the researcher's presence was to explain how to complete the survey, ensure all questions were answered, emphasize honesty in response, and provide oral explanations related to the 24-h urinary test.

### Data collection instrument

The data were collected using a two-part self-administered questionnaire including demographic information and items related to the TPB constructs, as well as a 24-h urinary test, as follows:

The demographic information (24 questions) was related to age, week of pregnancy, education level of the pregnant woman and her husband, their job, family size, family income, comorbidities, craving during pregnancy, and a question about whether the pregnant woman was in charge of cooking at home.

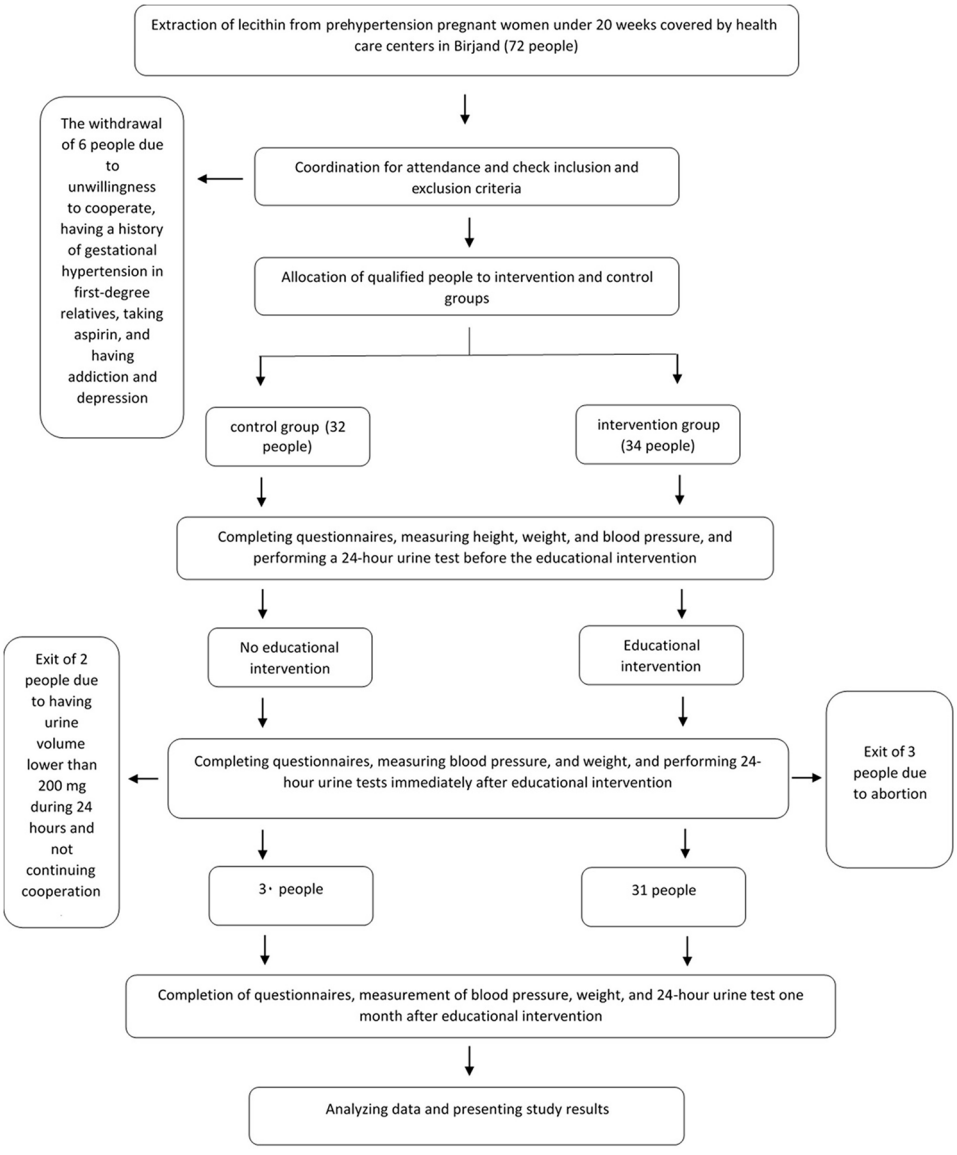


**Fig. 2** Flowchart of participants through each phase of the intervention

### TPB based Questionnaire

To develop this instrument, Rahimdel et al.'s [15] questionnaire was used as a basis and changes were made based on the characteristics of the target population. Accordingly, at first, the face validity of the first draft of the questionnaire was evaluated by 14 pregnant women, and based on their comments, the required revisions were made to the form to maximize the comprehensibility of questions. Then, to check the content validity, the questionnaire was given to 6 health education specialists. Based on the experts' points of view, CVI and CVR for the questionnaire items were approved (CVI=0.99 and CVR=0.99). The reliability was tested using Cronbach's alpha coefficient for each construct of the TPB. The final questionnaire contained 54 questions with the following subscales:

#### *Attitude construct*

The attitude construct included two sub-constructs: behavioral belief construct (12 questions, e.g., *Reducing daily salt intake will reduce my risk of stroke*), and outcome evaluation (12 questions, e.g., *Reducing the risk of stroke is ..... to me*). Pregnant women were asked to respond to each item based on a 5-point Likert scale (for behavioral beliefs, ranging from 1=*strongly disagree* to 5=*strongly agree* and to outcome evaluation from 1=*not important at all* to 5=*completely important*). The final score was between 24 and 120. Lower scores indicated the least favorable attitudes and vice versa. Cronbach's alpha coefficient for these sub-constructs was 0.86 for behavioral belief and 0.8 for outcome evaluation, indicating a good internal consistency for the construct.

#### *Subjective norms construct*

This construct included two sub-constructs: normative beliefs (5 questions, e.g., *My family members believe that I should reduce my daily salt intake*), and motivation to comply (5 questions, e.g., *The opinion of my family members about reducing salt intake is important to me*), and was answered based on a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The final score was between 10 and 50. A higher score indicated stronger social support and vice versa. Cronbach's alpha coefficient for the sub-constructs was 0.72 for normative beliefs and 0.81 for motivation to comply, indicating a good internal consistency of this subscale.

#### *Perceived behavioral control construct*

This construct included two sub-constructs: control beliefs (6 questions, e.g., *The lack of support from family members prevents me from consuming low-salt food*), and perceived power (6 questions, e.g., *Even if my family members do not support me, I still consume low salt food*). Pregnant mothers were asked to rate items on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Final scores ranged from 12 to 60. Higher mean scores indicated greater perceived control for salt consumption behavior. The internal consistency of the sub-constructs was acceptable using Cronbach's alpha coefficient α=0.73 for control beliefs and α=0.90 for perceived power.

#### *Behavioral intention construct*

It included 4 items (e.g., *I plan to eliminate the use of salt shakers on the dining table from next month*) and pregnant women were asked to answer the questions on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Scores ranged from 4 to 20, with lower scores indicating lower intention and vice versa. Cronbach's alpha coefficient (α=0.90) proved the good internal consistency of this subscale.

#### *Behavior construct*

The behavior construct included 4 questions (e.g., *Do you commonly have a salt shaker on the dining table?*). Three questions measured the current performance on a 3-point Likert scale of *yes*, *to some extent*, and *no*. One question was "How many times a week do you usually eat fast food, salty snacks, and canned food?" The options were: once a week, 2–3 times a week, 4–5 times a week, every day, or not at all. The scores for the first three questions ranged from 1 to 3 and for the last question from 1 to 5. Lower scores indicated poorer behavior and vice versa. The estimated Cronbach's alpha coefficient of 0.55 indicated a good internal consistency of the behavior subscale.

### 24-hour urine test

In this study, the amount of salt intake by pre-hypertensive pregnant women was measured with a 24-h urinary test. For this purpose, plastic containers (2500 cc) were distributed among the members of the two research groups [15]. Dietary sodium, potassium, and creatinine excretion as well as urine volume were evaluated using 24-hour urinary sodium (UNa), potassium (UK), and creatinine (UCr). To teach the subjects how to collect 24-h urinary, in addition to oral explanations about this experiment, an educational brochure containing instructions for 24-h urinary collection was given to the participants. Participants were asked to record the time from the next morning, after voiding their first urine. Then, within the next 24 h, they were supposed to collect all their urine in the provided containers and at the end of 24 h, deliver the urine sample to the specialized medical diagnostic laboratory of Imam Reza Hospital in Birjand. UNa and UK excretion were measured using Flame photometry (Japanese), and UCr was measured using the Japanese Prestige

24i device. Next, Kawasaki's formula was used to calculate the daily amount of salt intake [25].

The subjects' blood pressure was measured twice at 3-minute intervals using an Iranian sphygmomanometer (Rossmax) after a 5-minute rest in a sedentary position. To conduct this procedure, a cuff was placed on each participant's right arm so that the arm was at the same level of the heart. Also, to avoid measurement error, the feet soles were placed on the ground. Next, the average blood pressure was calculated and recorded [15].

### Educational intervention

The intervention was planned based on the Template for Intervention Description and Replication checklist (Table 1). After collecting participants' data (intervention and control group) before the intervention, pregnant women in the intervention group participated in an educational program. Due to the COVID-19 pandemic, 3 one-hour training sessions in groups of 6 were held on WhatsApp taught by a senior health education expert and a nutritionist for the intervention group. Educational strategies were selected based on the TPB constructs. According to the educational goals of each session, several educational strategies were used, including lectures, problem-based learning, and Q&As. In addition, several short educational clips were shared in each session to emphasize the educational content. The scientific content of the educational sessions was evaluated and approved by two health education and nutrition experts. The details of the training sessions are shown in Table 2.

### Ethical considerations

The present study was approved by the Ethics Committee of Birjand University of Medical Sciences (IR.BUMS.REC.1400.305). All pregnant women were assured that participation in the study was voluntary and that they could withdraw from the study at any time. They were informed that the details of the information in the questionnaire would be kept confidential. To respect all participants, one month after the educational intervention, the members of the control group received all the educational materials in the form of brochures.

**Table 1** Template for intervention description and replication checklist of the study

| Items | Description |
|---|---|
| **BRIEF NAME** | Theory based intervention to control salt intake |
| **WHY (Rationale of treatment)** | **C**onsidering that no interventional study using the TPB has been conducted in Iran to reduce the amount of salt consumption in the target group of Prehypertension pregnant women, and since the health of the mother during pregnancy not only affects her quality of life also affects the health of the fetus and future generations as well, the present study was conducted to investigate "the effect of an educational intervention based on the TPB on the amount of salt consumed by pre-hypertensive pregnant women". |
| **WHAT (Materials)** | **T**he intervention was conducted by the TPB. According to this theory, the most important determinant of behavior is the behavioral intention, which is influenced by three factors: attitude towards behavior, subjective norms, and behavioral control. |
| **WHAT (Procedures)** | **T**his quasi-experimental included intervention and control groups. The experimental group received the full intervention program and consulting support. The control group did not receive any intervention. Three training sessions were scheduled with a focus on the key constructs of the TPB that were explained in detail in Table 2 |
| **WHO PROVIDED (Profession, expertise, background, specific training)** | Senior health education expert and a nutritionist |
| **HOW (modes of delivery)** | In intervention group: pregnant women participated in an educational program. 3 one-hour training sessions in groups of 6 people were conducted on WhatsApp by a senior health education expert and a nutritionist for a week for the intervention group. Educational strategies were selected based on TPB constructs. The educational strategies were used, including lectures, problem-based learning, and Q&A. In addition, several short educational clips were displayed each session to emphasize the educational content. The control group did not receive any training and counseling |
| **WHERE (Infrastructure and relevant features)** | **Comprehensive Health Service centers s**in Birjand |
| **WHEN and HOW MUCH (Number of sessions, duration, intensity, or dose)** | Each participant underwent a training program consisting of three, 1-h sessions for a week |
| **TAILORING (Personalization)** | lecture, problem-based learning, Q&A, and short educational clips |
| **MODIFICATIONS** | No modifications occurred to the planned intervention. |
| **HOW WELL: planned (Adherence and procedure to maintain it)** | Adherence to the protocol intervention was optimal for all participants, 3 people in the intervention group were excluded from follow-up because of the abortion, and 2 people from the control group due to having urine volume lower than 200 mg during 24 h and not continuing cooperation. |
| **HOW WELL: Actual** | Due to the spread of corona virus and the condition of pregnant women, the face-to-face training sessions were replaced by the virtually training sessions. |

**Table 2** Content and structure of training sessions based on TPB

| | Times | Intervention's instruction | Target variables & Key constructs of the TPB | Intervention method |
|---|---|---|---|---|
| 1 | **Sessions 1** | --Definition of prehypertension, hypertension, and study objective.<br>Presentation of facts and figures on blood pressure, statement of causes of hypertension with an emphasis on salt consumption behavior (significance of the topic) | raising awareness | Lecture, Q&A, clip presentation, and PowerPoint presentation |
| | **Sessions 2** | Identifying participants' beliefs about salt consumption behavior and its effect on blood pressure during pregnancy<br>Explain the effect of interpersonal influence's behavior and beliefs regarding salt consumption behavior | improving the attitude and affecting the subjective norm construct | Q&A, clip presentation |
| | **Sessions 3** | Identifying the barriers and facilitators to reduce and control the amount of salt consumed –<br>Identifying and providing solutions to overcome the barriers to reduce and control the amount of salt consumed - Providing nutritional recommendations - Summarizing the content, answering questions, and solving problems | influencing the control beliefs - promoting people's control beliefs and promoting awareness -informational support - | Lecture, Q&A, and clip presentation |
| 2 | **Counseling support** | -Providing solutions to overcome barriers and choose healthier foods with less salt<br>- Providing explanations on how to perform a 24-hour urine test<br>- Reminder to perform a 24-hour urine test<br>- Coordination to attend health centers | Women received further information via phone contact and internet messaging service such as WhatsApp group | |

### Data analysis and statistical tests

The data were punched into SPSS 19 (SPSS Inc, Chicago, IL) and the normality was checked by Shapiro Wilk test. Mean, standard deviation, median and interquartile range were used to describe quantitative variables. Frequency and percentage were used to describe qualitative variables. The homogeneity of groups was tested using the independent-samples *t*-test and Mann-Whitney U-test, and chi-square test. A comparison of groups at each phase of study was done using an independent-samples t-test and Mann-Whitney U-test. The comparison of groups over time was done simultaneously using the repeated measurement test. If the distribution of data was not normal, Friedman's test was used. A Greenhouse-Geisser correction was used to account for the effect of the intervention and the interaction effect of time and intervention. To test the relationship between the variables and control confounders using the Longitudinal marginal model with the GEE approach, the effectiveness of the intervention on salt consumption was investigated. The significance level of the tests was considered to be 0.05.

## Results

Considering the possible attrition rate, the sample size was estimated at 72. Thus, finally 36 participants were assigned to each research group. Further, according to the inclusion and exclusion criteria, 5 subjects were excluded from the intervention group and 6 from the control. Eleven subjects withdrew from the study for unwillingness to participate, a history of gestational hypertension in close relatives, taking aspirins, addiction and depression, having a urine volume of lower than 200 mg during 24 h and abortion. Finally, the analysis was done on 31 subjects in the intervention group and 30 in the control group. The average age was 26.39±6.39 and 28.57±5.74 in the intervention and control groups, respectively. Most participants in the intervention group (66.7%) and control group (83.9%) perceived their income at an average level. Most women in the intervention (87.1%) and control (83.3%) groups were housewives. In the control group, most women had a university education (40%), and most participants in the intervention group held a diploma (38.7%). The two groups had no statistically significant difference ($P>0.05$) with each other in terms of demographic variables, except for income assessment ($P=0.03$) (Table 3).

Figure 3; Table 4 show variations in attitude, subjective norms, perceived behavioral control, intention, behavior, amount of salt consumption, systolic and diastolic blood pressure over time in the two research groups. Our findings showed a significant effect of time on perceived behavioral control ($p=0.01$), intention ($p=0.01$), behavior ($p=0.02$), systolic blood pressure ($p<0.001$), and diastolic blood pressure ($p<0.001$) (Table 4). Except for the intention score, the interaction effect of time and intervention was not significant in any of the constructs. The intervention did not show a significant change in any of the model constructs ($P>0.05$), but in general, time can cause changes to some constructs (perceived behavioral control, intention, behavior, systolic and diastolic blood pressure).

To make intra-group and inter-group comparisons (because some time and group interaction were significant), the average scores in the research groups are shown in Fig. 3 (**A** to H). As it can be observed in Fig. 3,

**Table 3** Demographic characteristics of research participants ($n=61$)

| Characteristics | | Intervention group (*n* 31) | | Control group (*n* 30) | | Test statistics | *P*-value |
|---|---|---|---|---|---|---|---|
| | | *N* | % | *N* | % | | |
| **Education** | Under Diploma | 10 | 32.3 | 7 | 23.3 | 0.98 | 0.61 |
| | Diploma | 12 | 38.7 | 11 | 36.7 | | |
| | College Education | 9 | 29 | 12 | 40 | | |
| **Job** | Housewife | 27 | 87.1 | 25 | 83.3 | Fisher exact test | 0.73 |
| | Not a housewife | 4 | 12.9 | 5 | 16.7 | | |
| **Income** | High | 5 | 16.1 | 4 | 13.3 | 6.98 | 0.03 |
| | Medium | 26 | 83.9 | 20 | 66.7 | | |
| | Low | 0 | 0 | 6 | 20 | | |
| **History of abortion(yes)** | | 7 | 22.6 | 7 | 23.3 | 0.005 | 0.94 |
| **Craving for salinity/brininess(yes)** | | 5 | 16.1 | 3 | 10 | Fisher exact test | 0.70 |
| **Craving for sour stuff especially pickles(yes)** | | 15 | 48.4 | 8 | 26.7 | 3.06 | 0.08 |
| **Craving sweets(yes)** | | 6 | 19.4 | 6 | 20 | 0.004 | 0.94 |
| **Craving for the bitter(yes)** | | 2 | 6.5 | 2 | 6.7 | Fisher exact test | 1 |
| | | X ± SD | M[1] (IQR[2]) | X ± SD | M[3] (IQR[4]) | | |
| **Age (year)** | | 26.39 ± 6.39 | 26(11) | 28.57 ± 5.74 | 28.50(6) | t=-1.39 | 0.17 |
| **Gestational age (week)** | | 13.06 ± 3.35 | 13(6) | 12.80 ± 3.27 | 13(4) | t = 0.31 | 0.65 |
| **Pre-pregnancy BMI** | | 26.37 ± 5.16 | 26.69(8.64) | 24.01 ± 4.64 | 24.21(7.96) | t = 1.86 | 0.44 |

n, number of eligible participants

[1]Median

[2]Interquartile Range

[3]Median

[4]Interquartile Range

in the intervention group, intention ($P<0.01$), behavior ($P=0.007$), systolic and diastolic blood pressure ($P<0.05$) showed significant changes before and immediately after the intervention. Perceived behavioral control ($P=0.02$), behavior ($P=0.006$), systolic and diastolic blood pressure ($P<0.05$) showed statistically significant differences before the intervention and one month after the intervention. Within the control group, a statistically significant difference was observed in systolic and diastolic blood pressure before and immediately after the intervention, and also before the intervention, and one month afterwards. However, no statistically significant difference was found in the intervention and control groups at the three phases of study, before, immediately, and one month after the intervention in terms of attitude and subjective norms ($P>0.05$). Similarly, no statistically significant difference was found during the intervention within each group ($P>0.05$).

The two intervention and control groups had a statistically significant difference in terms of the intention construct immediately after the intervention ($P=0.04$). Before the intervention, the two groups differed significantly in terms of the salt consumption behavior score ($P=0.03$).

A statistically significant difference was found in the mean scores of changes in salt consumption behavior before and immediately after the intervention ($P=0.01$). There was also no statistically significant difference in the changes of the mean scores of salt consumption before and one month after the intervention ($P=0.11$), and between immediately after and one month after the intervention ($P=0.41$). Similarly, there was no significant between-group differences in the mean score of changes in systolic blood pressure changes before and immediately after the intervention ($P=0.73$), before and one month after the intervention ($P=0.65$), and immediately after and one month after the intervention ($P=0.93$).

A marginal model with the GEE approach was used for a decisive study of salt consumption in addition to the present intervention. As it can be observed in Table 5, those who craved for salinity/brininess consumed salt 0.19 more than those who did not ($P=0.20$ and B=0.18). Also, mothers who craved for pickles had 0.29 less salt consumption than those who did not have this craving ($P=0.02$ and B=0.29). Pregnant women who craved for sweets consumed 0.33 less salt than other pregnant women in this study ($P=0.01$ and B=0.33).

As it can be viewed in Table 5, women who earned less than one million tomans[1] ($P=0.73$ and B=-0.07), one to three million tomans ($P=0.38$ and B=0.12) and three to five million tomans ($P=0$ and B=0.78 =) of income

[1] Toman is a national currency, each dollar being equal to about 50,000 tomans.

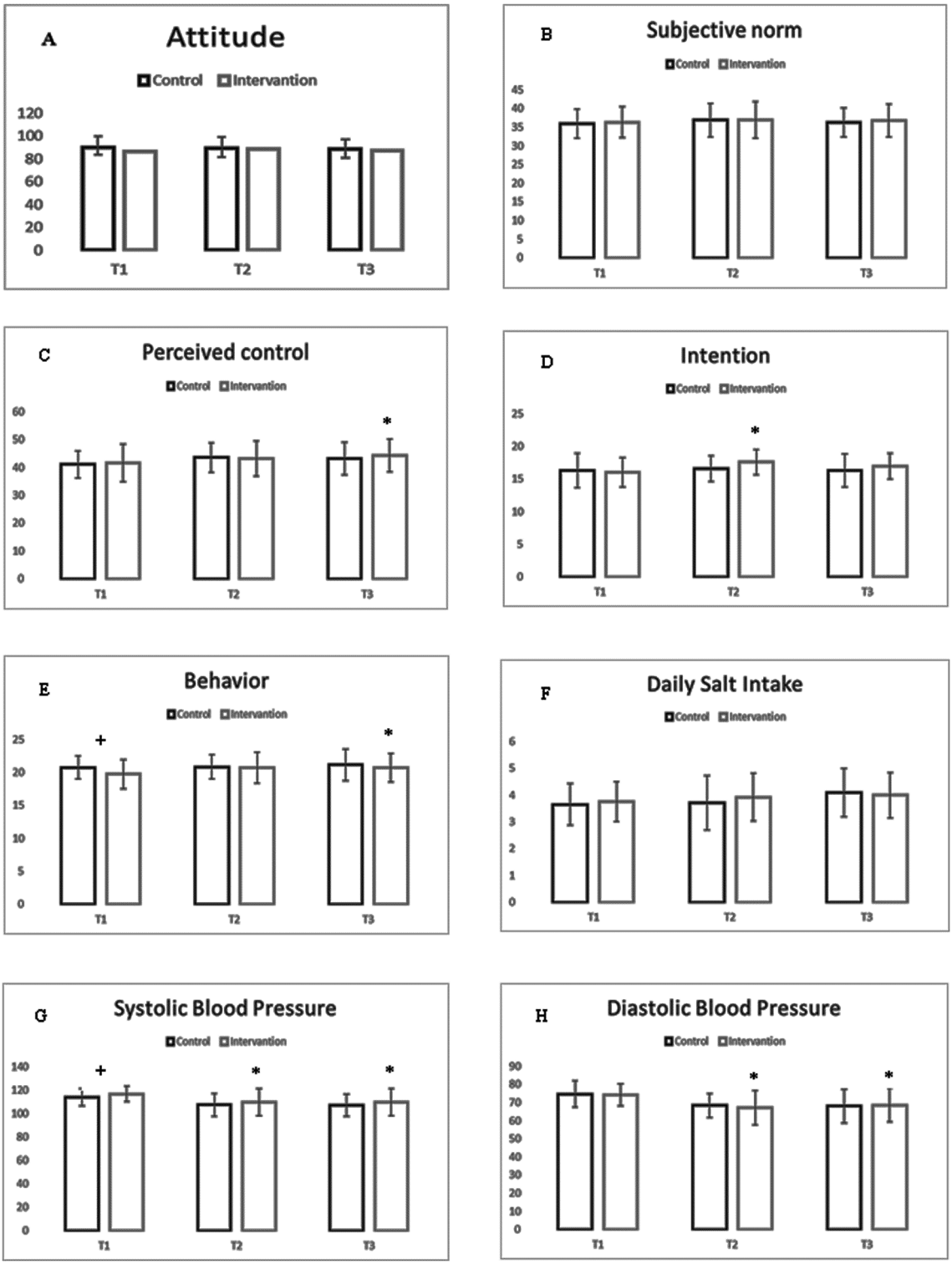


**Fig. 3** Mean scores of TPB constructs, salt consumption behavior, salt consumption amount, and systolic and diastolic blood pressure in the research groups. * Difference with the time before the intervention - $p < 0.05$. + The difference between the intervention and control groups before the intervention. T1: Before the intervention. T2: Immediately after the intervention. T3: One month after the intervention

**Table 4** Repeated measurement analysis of TPB constructs, behavior, daily amount of salt consumption, systolic blood pressure, and diastolic blood pressure

| | | Sum of squares | Mean sum of squares | F | *p*-value | Post-Hoc test |
|---|---|---|---|---|---|---|
| **Attitude** | Group | 144.34 | 144.34 | 0.90 | 0.34 | - |
| | Time | 24.97 | 12.48 | 0.44 | 0.64 | |
| | Group×Time | 22.23 | 11.11 | 0.39 | 0.67 | |
| **subjective norms** | Group | 3.30 | 3.30 | 0.07 | 0.78 | - |
| | Time | 7.48 | 3.74 | 0.75 | 0.47 | |
| | Group×Time | 6.64 | 3.32 | 0.66 | 0.51 | |
| **perceived behavioral control** | Group | 3.32 | 3.32 | 0.04 | 0.83 | - |
| | Time | 128.20 | 72.56 | 4.55 | 0.01 | Time before-1 month after $P=0.03$ |
| | Group×Time | 10.97 | 6.21 | 0.39 | 0.65 | - |
| **Intention** | Group | 20.47 | 20.47 | 2.01 | 0.16 | - |
| | Time | 20.19 | 10.09 | 4.75 | 0.01 | Time before-immediately $P=0.008$ |
| | Group×Time | 14.17 | 7.08 | 3.33 | 0.04 | - |
| **Behavior** | Group | 12.29 | 12.29 | 1.18 | 0.28 | |
| | Time | 9.96 | 4.98 | 3.73 | 0.02 | Time before-immediately $P=0.04$ Time before-1 month later $P=0.02$ |
| | Group×Time | 6.55 | 3.27 | 2.45 | 0.09 | - |
| **Daily amount of salt consumption** | Group | 0.34 | 0.34 | 0.31 | 0.58 | - |
| | Time | 2.88 | 1.44 | 2.66 | 0.07 | |
| | Group×Time | 0.62 | 0.31 | 0.57 | 0.56 | |
| **Systolic blood pressure** | Group | 942.45 | 942.45 | 4.59 | 0.03 | - |
| | Time | 1764.27 | 882.13 | 22.77 | < 0.001 | Time before-immediately $P<0.001$ Time before-1 month later $P<0.001$ |
| | Group×Time | 11.52 | 5.76 | 0.14 | 0.86 | - |
| **Diastolic blood pressure** | Group | 129.78 | 129.78 | 0.88 | 0.35 | |
| | Time | 1605.63 | 802.81 | 25.70 | < 0.001 | Time before-immediately $P<0.001$ Time before-1 month later $P<0.001$ |
| | Group×Time | 12.26 | 6.13 | 0.19 | 0.82 | |

consumed more salt than those with an income of more than five million tomans; thus, with an increase in income, salt consumption increases.

According to the information shown in Table 5, the amount of salt consumption increased significantly over time ($P=0.005$ and B=0.19); however, the intervention group consumed less salt than the control group ($P=0.89$ and B=-0.01). As people get older, salt consumption decreases significantly ($P=0.004$ and B=0.02). Concerning the TPB constructs, it can be observed that with an increase in the subjective norms score, salt consumption increases significantly ($P=0.006$ and B=0.04). As the perceived behavioral control score increases, salt consumption decreases ($P=0.08$ and B=-0.02). Also, as the intention score increases, salt consumption decreases ($P=0.42$ and B=-0.01). As the behavior score increases, salt consumption decreases ($P=0.15$ and B=-0.04).

## Discussion

The present study was conducted to explore the effect of an educational intervention based on the TPB on the amount of salt consumed daily by Prehypertension pregnant women.

The results of the present study showed that training based on the TPB significantly improved the mean score of perceived behavioral control in pre-hypertensive pregnant women. Rahimdel et al. showed that the increase in the mean score of perceived behavioral control regarding salt intake reduction was significantly higher in the intervention group than the control in the crude model and after adjustment for the effects of age, sex, education, job, marital status and BMI [15]. Movahed et al. also showed that training based on TPB can significantly improve the mean score of perceived behavioral control of fruit and vegetable consumption in rural women [26]. Similarly, Miri et al. showed that a training based on the TPB in patients with hypertension significantly improve the score of perceived behavioral control [27], which is consistent with the findings of the present study. According to the answers the pregnant women gave in the present

**Table 5** Marginal model results with GEE approach for salt consumption

| Variable | | Coefficient (B) | The standard error (SE) | Test statistics | *P*-value |
|---|---|---|---|---|---|
| **Intervention group (Base level of the control group)** | | -0.01 | 0.12 | 0.01 | 0.89 |
| **Craving for salinity/brininess** | | 0.18 | 0.14 | 1.59 | 0.20 |
| **Craving for sour stuff especially pickle** | | -0.29 | 0.12 | 5.22 | 0.02 |
| **Craving sweets** | | -0.33 | 0.13 | 6.20 | 0.01 |
| **Income (base level above 5 million Tomans)** | < 1 million Tomans | -0.07 | 0.20 | 0.11 | 0.73 |
| | 1–3 million Tomans | 0.12 | 0.14 | 0.77 | 0.38 |
| | 3–5 million Tomans | 0.78 | 0.18 | 18.68 | < 0.001 |
| **Time** | | 0.19 | 0.07 | 8 | 0.005 |
| **Age** | | -0.02 | 0.008 | 8.30 | 0.004 |
| **Attitude** | | 0.01 | 0.01 | 1.57 | 0.21 |
| **Subjective norms** | | 0.04 | 0.01 | 7.62 | 0.006 |
| **Perceived behavioral control** | | -0.02 | 0.01 | 2.97 | 0.08 |
| **Intention** | | -0.01 | 0.02 | 0.64 | 0.42 |
| **Salt consumption behavior** | | -0.04 | 0.03 | 2.06 | 0.15 |

study, probably, one reason why the perceived behavioral control construct improved after the training was that pregnant women, despite different tastes in their families, learned how to control their salt consumption in the training. They also learned how to make low-salt food palatable using salt substitutes, such as lemon juice, aromatic vegetables, etc. It seems that the training based on the TPB increases perceived behavioral control [22].

The present findings showed that the training based on the TPB significantly improved the mean score of intention to reduce salt consumption and the participants' behavior of reducing salt consumption. Similarly, in Rahimdel et al. study the mean score of behavioral intention to reduce salt consumption increased after the intervention [15]. In the study by Agh Atbay et al., the mean score of intention and behavior to reduce salt consumption increased significantly in rural women of Chabahar [20]. Similarly, Movahed et al. found that after the educational intervention, the intention and behavior scores of fruit and vegetable consumption increased significantly [24]. Perhaps one reason for the improved score of the behavioral intention and the behavior of reduced salt consumption was that the pregnant women's awareness of the detriments of excessive salt consumption during pregnancy increased along the training sessions and made the participants remove salt shakers from their meals in the first place. They also reduced the consumption of fast food because of the high level of salt content. It is suggested to use effective trainings, with a focus on the construct of behavioral intention, which is also an important factor in changing the salt consumption behavior.

The present findings showed that, after the educational intervention, the attitude score towards salt consumption increased, but this increase was not statistically significant. This finding was consistent with the results reported by Agh Atbay et al., which showed that the educational intervention based on the TPB had no significant effect on women's attitudes towards the behavior of reduced salt consumption [20]. Yet, it conflicted with the results of the studies conducted by Rahimdel [15], Movahed [26] and Etezadi [22]. As Movahed et al. reported, after the educational intervention, the attitude score towards the consumption of fruits and vegetables increased significantly [26]. Similarly, Etezadi et al. found that the training based on the TPB in the intervention group was effective in changing pregnant women's attitude towards nutrition behaviors [22]. Perhaps one reason for the insignificant effect of the training on this construct is that we need long-term interventions and more training sessions to improve individuals' attitude. Thus, it is suggested that the training sessions be held face-to-face over a longer period of time to see the effectiveness of the training. The formation of a focused group discussion can also help improve attitude, which is an important construct in the TPB.

The present study also showed that training based on the TPB did not have any significant effect on subjective norms. Regarding this construct, the researchers asked pregnant women to share the educational materials they received about salt consumption behavior and its relationship with blood pressure with their influential others and discuss it with them. However, no significant change was observed in subjective norms. The reason can be that we could not hold face-to-face meetings with these influential others and we only shared educational materials with them which was far from enough. We suggest that future interventions use face-to-face training to change this structure. Contrary to the present findings regarding this construct, the Rahimdel [15], Atabay [20], and Etezadi [22] showed that long-term training can be effective to improve the subjective norm.

#### Outcome assessment

The results of the present study showed that our educational intervention did not affect the daily salt intake amount among pregnant women. This finding is similar to the results reported by Manioz et al., who showed a five-month educational program based on the HBM and social cognitive theory, could not significantly reduce the sodium consumption in postmenopausal women [28].

Yet the results of most studies prove the effectiveness of educational interventions in reducing the salt intake amount in different research populations [15, 21, 29–31].

The insignificant effect of educational intervention on pregnant women's daily salt intake can have several reasons. One can be the decreased urine volume in pregnant women in the first trimester. This decrease may be when the woman does not consume enough liquid, loses a lot of liquid due to diarrhea, vomiting, nausea, or does not want to drink. This decrease in the volume of urine causes the daily amount of salt to increase compared to the volume of urine. Also, by controlling the confounding variables, we concluded that various factors can be involved in the daily amount of salt intake. One is the type of craving that pregnant women have. Subjective norms and age are factors that can also affect the amount of salt consumption (as the results of the marginal model with the GEE approach showed). In addition, there may be other reasons influencing the salt consumption behavior, which were not considered in the present study.

When the present researchers observed that the daily amount of salt intake did not change significantly after the intervention, they interviewed the participants. The aim was to find out whether the change in the 24-hour urine volume after intervention was due to the craving or not. It was observed that most women reduced their liquid consumption due to extreme cravings. This could have significantly affected the ratio of daily salt intake to the volume of urine in pregnant women. Because of this bias, the results concerning the pregnant women's daily salt intake should be interpreted with caution. We suggest that future researchers study salt intake and prehypertension in pregnant women, and include the volume of water consumed during pregnancy in their investigation.

Though the daily salt intake did not decrease significantly in this study, the significant decrease in the blood pressure is hard evidence to show that our intervention based on the TPB was successful. The findings of another study by Babaei-Sis et al. showed that the mean systolic and diastolic blood pressure in the intervention group decreased significantly after the educational intervention [32]. This finding is in line with the present findings. Also, a review by Muthuri et al. showed that in a cluster RCT study, diastolic blood pressure decreased by 4 mmHg after an educational intervention. In another study conducted as a randomized cross-sectional trial, a reduction was observed in systolic (4.5 mmHg) and diastolic (2.7 mmHg) blood pressure [33]. In He et al.'s study, systolic and diastolic blood pressure increased over time in the two research groups [34]. In addition, Rahimdel et al. showed that the systolic and diastolic blood pressure did not change significantly in either of the intervention and control groups [15], which is contrary to the present findings. This significant reduction in the systolic and diastolic blood pressure of pre-hypertensive pregnant women in the present study shows that the educational intervention based on the TPB managed to correctly remind pregnant women of the importance of blood pressure control during pregnancy and the potential complications.

### Strengths, weaknesses, and limitations of study

The present study pioneered in exploring the effectiveness of a training program in changing salt consumption behavior of prehypertension pregnant women based on TPB. Therefore, the findings can be shared with health experts and policymakers to develop effective interventions to change the salt consumption behavior. One strength of this study is the use of three 24-hour urine tests to measure pregnant women's sodium, potassium, creatinine, and urine volume and finally estimate their daily amount of salt intake. Also, following up all the participants through phone calls during the study and keeping in touch with them to closely observe the daily amount of salt intake and control blood pressure were other strengths of this study. Nevertheless, there were some limitations including the large number of questions in the questionnaire and the self-reporting nature, which could have exhausted the participants and biased the findings. Another limitation is the lack of any previous research on salt consumption behavior in pregnant women with prehypertension to compare the results with. Other limitations include the obligation to hold the training sessions online due to the COVID-19 pandemic and not to provide any training for husbands. Also, for some participants, a 24-hour urine test was considered painful, and the low volume of pregnant woman's urine during the study due to the craving was another problem.

## Conclusion

The present findings showed that educational interventions based on the TPB can be effective in improving perceived behavioral control, behavioral intention, and the behavior of consuming less salt, and subsequently reducing systolic and diastolic blood pressure. Yet, the present intervention could not affect the daily amount of salt intake. It seems that this variable is affected by many different factors, a few of which were addressed in the present study and many were not included. Considering the above-mentioned limitations, we suggest that future studies focus on other factors affecting salt consumption. It seems there is a need for more comprehensive interventions using different strategies. It is also recommended to hold training to reduce salt consumption in pregnant women in the presence of their husbands to profoundly affect pregnant women's attitude and subjective norms. Also, as the present findings showed, the TPB is probably an appropriate model to improve the level of

behavior, especially in women. It is suggested that other researchers use this theory to investigate other populations for a longer period of time and with a larger sample.

**Abbreviations**
TPB Theory of Planned Behavior

## Supplementary Information

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Supplementary Material 1

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**Author contributions**
F.GM, E.N, F.S and F.H designed the study. F.S analyzed and interpreted the data. F.GM participated in data collection and data management. EN, F.GM and F.S were major contributors to the writing of the manuscript. All authors read and approved the final manuscript.

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**Data availability**
All data generated and analyzed during this study are included in this published article.

## Declarations

**Ethics approval and consent to participate**
The present study was approved by the Ethics Committee of Birjand University of Medical Sciences (IR.BUMS.REC.1400.305). All study participants provided written informed consent. Confidentiality and anonymity were ensured.

**Consent for publication**
Not Applicable.

**Competing interests**
The authors declare no competing interests.

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## Publisher's note