

Application of The PRECEDE -PROCEED Model in Prevention of Brucellosis Focused On Livestock Vaccination Process

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Abstract

Background

This article reports the steps of an educational intervention, which is designed to change livestock breeders' preventive behavior in terms of vaccinating their livestock against brucellosis. The study has been conducted in a rural area in a country with the second highest brucellosis prevalence in the world.

Methods

In a quasi-experimental study and applying PRECEDE-PROCEED model, 45 livestock breeders were trained through basket method, accompanied with constructive feedback from researchers and peers and a brief interactive lecture at the end. The livestock breeders' awareness, attitude and practice level in the intervention group was compared with those of other 45 livestock breeders in a control group, one and six months after the intervention. The presence of anti-brucellosis antibodies in livestock's blood was compared in groups and considered as the outcome measure of the intervention.

Results

Immediately and one month after the intervention, the mean scores of knowledge, awareness and practice of livestock breeders in the intervention group were significantly higher. Six months after the intervention, the results of the Rose Bengal tests were positive in more livestock in the intervention group compared to the animals in the control group.

Conclusion

The model-driven educational intervention could significantly increase livestock breeders' awareness, attitude and practice regarding prevention of brucellosis and vaccination of their livestock against brucellosis; however, a period of non-continuous reinforcement and gradual reduction of the number of the reinforcements by health educator workers is recommended in order to increase the maintenance of the learnt behavior.

Trial registration:

Conducting this study was registered at Iranian Registry of Clinical Trials (IRCT20180304038945N1). Registered 24 December 2018(<https://www.irct.ir/trial/29996>).The proposal was registered before enrollment of the first participant.

Background

Brucellosis, as a zoonotic bacterial disease, is a major public health problem in some parts of Asia in the Middle East [1]. The Middle East covers half of the countries with the highest prevalence of Brucella [2]. Brucellosis is one of the important bacterial zoonotic diseases that affects both animals and human beings[3].

While human brucellosis is caused mainly by *Brucella Abortus*, the most pathogenic disease in humans is *Brucella Melitensis* [3]. This is while; *B. Melitensis* and *B. Suis* are the main causes of brucellosis in cattle, goats/sheep and pigs respectively. Brucellosis can be transmitted through different ways, including consumption of products of infected animals, direct unprotected contact with body parts or secretions of an infected animal or corps and placentas of aborted livestock [4]. According to the statistics released by WHO, 500.000 people are infected with brucellosis annually. Among this number, 45000 people are residents of eastern Mediterranean, EMRO region[5]. The precise statistics of outbreak, the incidence, and prevalence rate of brucellosis is not available. Because some factors such as various misleading symptoms of the disease among human beings as well as some diagnostic problems affect the precision of diagnostic inferences. Different attempts such as implementation of control and eradication programs help many countries to reduce the number of infections by brucellosis. However, in Iran, the rate of infection is still high(about 15.4%) and brucellosis is a serious public concern for Iranian health organizations [5]. Clinical manifestations of brucellosis in its acute phase (including fever, malaise, anorexia, headache, arthralgia and backache) considerably affect the daily lives of the infected patients. In addition, the complications of the disease, such as arthritis, endocarditis, spondylitis, sacroiliitis, osteomyelitis and meningoencephalitis increase Disability-Adjusted Life Years (DALY) in patients and result in substantial economic losses to livestock breeders[6]. Controlling brucellosis in livestock can be achieved by employment of different methods such as vaccinating livestock, eliminating the infected animals' products and body parts, and quarantining the animals during exchanges [6, 7]. Animal vaccination is regarded as a very effective method in reducing the infection among humans [7] and among the above-mentioned methods, livestock vaccination is considered as the first step in brucellosis eradication [8].

Livestock breeders' insufficient information and awareness about brucellosis transmission ways, complications of infection, prevention ways and consequences of untreated infection leads to low rate of livestock vaccination, while vaccination is provided for free[9]. Emphasizing the importance of livestock breeders' knowledge and awareness does not mean ignoring the role of other factors, such as inappropriate vaccination time, concerns related to the viability of the vaccine, inappropriate storage conditions of the vaccine, inappropriate quarantine conditions and not predicting of any risk of brucellosis- related abortion among vaccinated livestock [10]. The important point is that the role of most of these factors can be diminished with education.

Considering the insufficient vaccine-related knowledge and awareness of Iranian livestock breeders[11–13], it is recommended to train livestock breeders [14].

To educate livestock breeders, planning for a model-driven vaccination-focused training program can be very useful because theories and models have a significant role in designing, implementation and evaluation of educational programs. Applying theories or models, educators can analyze the status of a health problem, with participation of the stakeholders and can focus on the most important predictors of their intended behavior and can tailor the education. That is why a model-driven educational intervention can provide an evidence-based framework to intervene[15, 16].

To the best of our knowledge, there has not been published any model-driven intervention focused on livestock vaccination in order to prevent brucellosis so far. Therefore, it was decided to conduct a model-driven

intervention focused on livestock vaccination through a training program for the livestock breeders to prevent brucellosis.

This study reports the steps of a quasi-experimental and PRECEDE PROCEED- driven interventional study, which is designed to change livestock breeders' preventive behavior in terms of vaccination of their animals against brucellosis. It was hypothesized that livestock breeders' awareness, attitude and practice about brucellosis vaccination in the intervention group will be significantly improved and the antibodies will be increased among animals of the livestock breeders in the intervention group.

Method

This quasi-experimental study was conducted in 2019. It was decided to determine the effects of an educational intervention, based on the PRECEDE-PROCEED model, on changing the awareness, attitude and practice of livestock breeders in prevention of brucellosis and in vaccinating their livestock against brucellosis. The presence of brucellosis antibodies in animals' blood was examined as the outcome measure of the intervention.

Specific objectives of the study were:

- Comparing the livestock breeders' awareness level in intervention group with control group, before and after the intervention
- Comparing the livestock breeders' attitude level in intervention group with control group, before and after the intervention
- Comparing the livestock breeders' practice level in intervention group with control group, before and after the intervention
- Comparing the presence of anti-brucellosis antibody among livestock in the intervention group with the control group, before and after the intervention

Setting

The study was conducted in Lighvan, a village, located in the northern slopes of the Sahand Mountain, in the suburb of Tabriz metropolitan city, Iran. In this region, livestock breeders breed mainly sheep and goats and rarely cattle. In addition to animal breeding, they produce most of the country's dairy products. Animal breeding and dairy production is the main job of Lighvan's residents. So, Lighvan plays a significant role in cheese production in the country. Lighvan has a population of more than ten thousand people. Each year, one hundred thousand sheep and goats and about 15 thousand lambs and yearling are bred in Lighvan and at least 2 veterinarians and 2 livestock vaccinators vaccinate the livestock. They observe adherence to health protocols in more than 100 cheese production workplaces in this region.

Participants

Participants of this study were livestock breeders living in Lighvan. Livestock breeders, who were willing to participate; did not have a history of brucellosis in the past and had not participated in any similar training courses before, were eligible to be included in this study. Participants with the inability to use the educational

package of this study, those who had physical disabilities such as visual or auditory problems, were not included. Being absent in more than 20% of training sessions was an exclusion criterion in this study.

Sample size calculation

Power & Sample Size Calculator software, version 3.0, was employed to calculate the sample size. The sample size was calculated applying confidence interval of 95%, power of 90%. The findings of the previous studies were taken into account too [17]. The final sample size was estimated at 110, considering a 20% drop rate.

Study population and sampling method

Nearly 1700 livestock breeders work in about 100 dairying centers in Lighvan and 10 to 50 breeders work in every center. Eight centers were included in this study upon their manager's willingness to participate in this study. In order to decrease the diffusion effect, breeders in the intervention and control groups were selected from different centers. So, those volunteer centers were randomly assigned to intervention or control groups by the research randomizer software. A stratified quota sampling method was employed to determine the exact number of participants from each center [18].

The steps to design educational intervention

Applying PRECEDE-PROCEED planning model, an educational package was designed to increase awareness, attitude and practice of livestock breeders in preventing brucellosis by animal vaccination. The steps to design the intervention are summarized in [Figure 1](#).

To design the educational package, based on the PRECEDE phase of the model, social, epidemiological, educational and ecological assessments were done in Lighvan. By doing so, predisposing, enabling and reinforcing factors of livestock breeders' vaccination behavior were identified. In this phase, data were collected through semi-structured interviews with all stakeholders, including livestock breeders, veterinarians, vaccinators and health care providers in Lighvan. The data was completed through direct observations of the main researcher (a veterinarian and health education specialist) during one month [10].

The findings from the interviews and observations in the PRECEDE phase were pooled with the reports of some worldwide evidence-based best practices. In this way, the first draft of the intervention effectiveness assessment Brucellosis Prevention Questionnaire (BPQ) was developed and validated. The psychometric properties of the BPQ and the most important predictors of the vaccination behavior of the livestock breeders were identified. The findings of PRECEDE phase and the process of designing and validating BPQ, as a valid and reliable questionnaire for assessment of the educational intervention in this study, has been published in the first article of this project [10]. BPQ has been attached to this text as [Additional file 1](#).

To design the package for the educational intervention, according to Harden's six-level program development model, first, learning objectives and then the content of the training package for animal breeders were determined.

The learning objectives and livestock breeders' educational needs were derived from the assessment results in the PRECEDE phase. The most important predictors of livestock breeders' vaccination-related prevention behavior were identified based on the results of the factor analysis of the research questionnaire. The most

important predictors, which had a greater contribution in determining the educational content, were livestock breeders' awareness, attitude and practice. Items of livestock breeders' awareness in BPQ were subcategorized in three groups of direct awareness, indirect awareness and vaccine awareness. All items are presented in **Additional file 1**. More training hours were considered to cover more important predictors (those which had a higher predictability power). The learning objectives and the educational content of the package were discussed and matched with educational needs of participants by the research team. Later, the content was systematically organized into different training sessions.

The educational content was mainly delivered through the basket method [19]. In this method, livestock breeders faced many pictures on a board. Pictures included a range of some proper or improper issues about livestock immunization against brucellosis. Livestock breeders were expected to pick up suitable pictures after they heard a scenario. Those scenarios had been written based on the situational assessment data, which was gathered from the PRECEDE phase of the study. Livestock breeders' choices in selecting the pictures reflected their real-time decisions. Participants received constructive feedback after each individual session. After the individual training was completed in two different sessions, livestock breeders were asked to participate in focus group discussions in order to share their learning and experiences with their peers.

The method for teaching the content was not limited to the basket method and feedback from the researchers and peers. The other training methods and techniques such as questions and answers (Q&A) or brainstorming were flexibly employed when they were necessary. The educational intervention was completed through a final mini-lecture at a proper public place and time by the main researcher. Proper educational strategies such as problem-based and integrated learning were adopted to increase the quality of the education as well. Lesson plans for all training sessions and educational scenarios were written and finalized by the research team members.

The steps to Assessment of vaccination rate

Rose Bengal rapid screening test was used to evaluate and compare the vaccination rate of sheep in the two groups. For this purpose, in two intervention and control groups, three sheep were sampled from each participating livestock breeder in the study. In the time before vaccination, 135 Rose Bengal tests were performed in each group. The sheep were randomly selected with software (<https://www.randomizer.org>). The sampling and the Rose Bengal test were repeated in 2 to 3 weeks after Brucella vaccination, when the antibody level was at the highest rate. Vaccination was performed for free by the Veterinary Organization. The positive result of the Rose Bengal test and the presence of antibodies in the animal's blood was considered as the success of a livestock breeder in vaccinating his animal[20–22].

Statistical Analyses

Data were summarized and expressed as with frequency and percentage for categorical variables and mean (standard deviation (SD)) for numeric variables. The normal distribution of the numeric variables was assessed by Kolmogorov–Smirnov test. Skewness (within ± 1.5 as normal) and kurtosis (within ± 2.0 as normal) of the data were assessed too. To compare the baseline variables between intervention and control groups, independent, Mann-Whitney and Chi-square (utilizing an exact procedure) tests were used.

To assess the within group changes over measurements done, the repeated measure analysis of variance (RMANOVA) were used and the group by time interaction effect and the group and time main effects were investigated. The sphericity as an assumption in this analysis was assessed by Mauchly's test and deviation from the assumption was corrected through Greenhouse-Geiser procedure. To assess the intervention effect i. e. the between group comparisons of changes (immediately after intervention, one month after intervention and six months after intervention), the analysis of covariance was conducted in two models. In the first model, the baseline measurements were analyzed alone and in the second model, the baseline measures and the other potential confounders were adjusted for variables ,including age, occupation, family dimension and education level of the livestock breeders.

The McNemar tests utilizing the exact procedure were utilized to compare the results of the binary outcome i.e. positive/negative Rose Bengal tests results. The percent of changes were computed too. Fisher's exact test was conducted to compare the binary outcome at the baseline and logistic regression model was used to model the difference of the binary outcome at after intervention adjusting for baseline measures. Moreover, to assess the effect of the intervention, the absolute risk reduction (ARR) and number needed to harm (NNH) were estimated along with their 95% confidence interval by Newcomb's method and Bender's methods for ARR and NNH, respectively[23, 24]. In all analyses, $P < 0.05$ was considered as statistically significant. The analyses were conducted using IBM SPSS Statistics version 25 (IBM corporation, Armonk, USA), STATA 16 (Stata Corp, College Station, Texas, USA) and the graphs were drawn by Graph Pad version 8.3 (www.graphpad.com).

All methods were performed in accordance with the relevant guidelines, regulations and ethical standards of the responsible committee approving the research at Tarbiat Modares University and Iranian Registry of Clinical Trials and with the Declaration of Helsinki, as revised in 2000.

Results

This quasi-experimental study was conducted with participation of 90 livestock breeders.

Baseline characteristics of study participants are revealed in **Table 1**. The results indicate that there were no significant differences between intervention and control groups for these characteristics in the baseline (All $P > 0.05$)

Table 1. Baseline characteristics of 90 livestock breeders, who participated in a PRECEDE PROCEED model-driven educational intervention

| Variables | Intervention(n=45) | Control(n=45) | P-Value # |
|--|--------------------|---------------|-----------|
| Age (years) (Mean ± SD) | 33.23 ± 10.30 | 34.13 ± 9.13 | 0.68 |
| Animal type(s) (Frequency (%)) | | | 0.50 |
| Sheep & Goat | 39 (87.6) | 41 (91.1) | |
| Cow | 6 (13.3) | 4 (8.9) | |
| Job (Frequency (%)) | | | 0.58 |
| Livestock breeder& Another Private job | 4 (8.9) | 6 (13.3) | |
| Livestock breeder& Farmer | 3 (6.7) | 5 (11.1) | |
| Only livestock breeder | 38 (84.4) | 34 (75.6) | |
| Education (Frequency (%)) | | | 0.41 |
| Illiterate | 10 (22.2) | 9 (20.00) | |
| Elementary | 20 (44.4) | 26 (57.8) | |
| Not completed high school | 12 (26.7) | 6 (13.3) | |
| High school diploma | 3 (6.7) | 4 (8.9) | |
| Number of family members (Median (P25 – P75)) | 5 (4 – 6) | 4 (3.5 – 6) | 0.35 |

P-values are computed based on independent t-, Man-Whitney U and exact Chi-Square tests where appropriate.

Intervention effect

The results of comparing participants' awareness, attitude and practice scores in intervention and control groups in all time points (before intervention, immediately after, one and six months after the intervention) are presented in **Table 2**. As it is shown, there were no significant differences between intervention and control groups for all variables based on the results of independent t-tests for baseline measurements. Besides, based on the results of covariance analysis in model 1, the effect of intervention was significant on all constructs for all post intervention measurements, one and six month after intervention (except for "practice" in six month after intervention, which the increase was not significant). It seems that the educational intervention has led to an increase in the score of participants' awareness, attitude and practice in all three measurements taken after intervention (positive mean differences). Furthermore, based on the results of analysis of covariance in model 2, after adjusting for the age, occupation, family dimension and the education level as the potential confounders, the same results were observed for intervention effect except for after six month measurement of awareness (Indirect) construct, which the amount of increase was not significant.

Table 2. The results of comparing participants' awareness, attitude and practice scores in intervention and control groups

| Variable | Time of measurement | Intervention (n=43) | | Control (n=44) | | MD* (95% CI**) | Model1 P-Value | Model2 P-Value \$ |
|---------------------------|---------------------|---------------------|------|----------------|------|--------------------|----------------|-------------------|
| | | Mean | SD | Mean | SD | | | |
| Direct awareness | Pre-intervention | 23.1 | 9.2 | 25.6 | 9.8 | -2.5 (-6.5 , 1.5) | 0.212 # | — |
| | Post-intervention | 70.4 | 12.1 | 26.5 | 9.6 | 44.4 (39.8 , 48.9) | <0.001 ## | <0.001 |
| | One month after | 61.1 | 16.2 | 24.8 | 10.3 | 36.2 (30.4 , 42.0) | <0.001 ## | <0.001 |
| | Six months after | 53.5 | 8.3 | 24.2 | 9.3 | 29.6 (25.9 , 33.3) | <0.001 ## | <0.001 |
| Indirect awareness | Pre-intervention | 40.7 | 11.4 | 39.3 | 14.5 | 1.4 (-3.9 , 6.9) | 0.591 # | — |
| | Post-intervention | 68.9 | 18.4 | 38.8 | 15.5 | 29.6 (22.8 , 37.1) | <0.001 ## | <0.001 |
| | One month after | 53.6 | 20.0 | 39.3 | 19.1 | 14.5 (6.3 , 22.7) | 0.001 ## | 0.002 |
| | Six months after | 47.9 | 18.0 | 41.0 | 13.4 | 7.0 (0.3 , 13.7) | 0.040 ## | 0.095 |
| Vaccine awareness | Pre-intervention | 41.7 | 13.5 | 42.8 | 11.6 | -1.1 (-6.4 , 4.2) | 0.677 # | — |
| | Post-intervention | 67.8 | 11.0 | 43.9 | 11.7 | 23.8 (19.0 , 28.5) | <0.001 ## | <0.001 |
| | One month after | 58.5 | 17.0 | 44.1 | 10.9 | 14.4 (8.4 , 20.4) | <0.001 ## | <0.001 |
| | Six months after | 54.1 | 18.6 | 44.2 | 12.6 | 9.6 (3.0 , 16.1) | 0.005 ## | 0.015 |
| Awareness in all | Pre-intervention | 35.17 | 6.68 | 35.89 | 8.03 | -0.71(-3.8 , 2.4) | 0.647# | — |
| | Post-intervention | 69.01 | 7.34 | 36.39 | 8.30 | 32.6 (29.3 , 35.9) | <0.001 ## | <0.001 |
| | One month after | 57.76 | 8.96 | 36.07 | 9.31 | 21.7 (17.8 , 25.6) | <0.001 ## | <0.001 |
| | Six Months after | 51.80 | 9.87 | 36.48 | 7.01 | 15.3 (11.7 , 18.9) | <0.001 ## | <0.001 |
| Attitude | Pre-intervention | 50.9 | 10.9 | 48.1 | 11.9 | 2.8 (-2.0 , 7.6) | 0.251 # | — |
| | Post-intervention | 69.7 | 5.8 | 49.0 | 10.1 | 20.6 (17.1 , 27.1) | <0.001 ## | <0.001 |
| | One month after | 64.1 | 9.7 | 52.2 | 10.6 | 11.7 (7.4 , 16.0) | <0.001 ## | <0.001 |

| | | | | | | | | |
|-----------------|-------------------|------|------|------|------|--------------------|---------------------|------------------|
| | Six month after | 61.2 | 11.6 | 50.2 | 10.4 | 11.1 (6.4 , 15.8) | <0.001 ## | <0.001 |
| Practice | Pre-intervention | 30.6 | 6.0 | 32.4 | 9.0 | -1.8 (-5.0 , 1.4) | 0.266 # | — |
| | Post-intervention | 59.9 | 15.1 | 34.2 | 10.1 | 25.6 (20.1 , 31.0) | <0.001 ## | <0.001 |
| | One month after | 44.3 | 16.6 | 33.2 | 9.0 | 12.1 (6.6 , 17.5) | <0.001 ## | <0.001 |
| | Six months after | 36.2 | 21.5 | 33.2 | 7.5 | 3.8 (-2.8 , 10.5) | 0.255 ## | 0.338 |

*MD mean difference; **CI: Confidence interval

Bold fonts indicate the significant differences.

P-values are computed based on independent t-tests for baseline measurements

Model 1 P-values and MD (95% CI) are computed based on Analysis of Covariance for measurements taken on post, one and six month after intervention, after adjusting for baseline measurements.

§ Model 2 P-values are computed based on Analysis of Covariance for measurements taken on post, one and six months after intervention, after adjusting for baseline measurements and potential confounders including the age, occupation, family dimension and the education level.

Time*intervention interaction effect and main time effect

The results of the RMANOVA utilizing the Greenhouse-Geiser correction provided significant interaction effects of time and intervention, which were observed for awareness (direct) ($F_{(3, 264)} = 78.03$, $P\text{-Value} < 0.001$), awareness (indirect) ($F_{(3, 264)} = 13.26$, $P\text{-Value} < 0.001$), awareness (vaccine) ($F_{(3, 264)} = 12.20$, $P\text{-Value} < 0.001$), awareness (total score) ($F_{(3, 264)} = 85.015$, $P\text{-Value} < 0.001$), attitude ($F_{(3, 264)} = 12.14$, $P\text{-Value} < 0.001$), and practice ($F_{(3, 264)} = 23.16$, $P\text{-Value} < 0.001$). Therefore, the time trends of the measurements were different in the intervention group as compared to the control group. In the intervention group, a raise in the score of each construct is observed immediately after intervention but the amount of difference decreased over time at one and six months after the intervention. Besides, the time effect was significant for all constructs (All $P\text{-Value} < 0.001$).

The results of Sidak post hoc test showed significant pairwise differences among measurements in intervention group for awareness (direct), awareness (indirect), awareness (vaccine), attitude and practice constructs (All $P\text{-Values} < 0.05$), but the differences were not significant in control group (All $P\text{-Values} > 0.05$) (the means of constructs remained the same over time).

Between group comparisons of baseline the Rose Bengal tests results:

The results of Fisher's exact test showed that there was no significant difference between scores of presence of antibodies in intervention and control groups at baseline ($P > 0.05$, positive cases about 2.2% versus 1.5% in

intervention and control groups).

The results for between and within group comparisons of baseline measurements of the Rose Bengal test are shown in **Table 3**.

Table 3: Between and within group comparisons of baseline measurements of antibody

| Presence | Time | Intervention (n=135 livestock) | Control (n=135 livestock) | P-Value# |
|-----------------|---|------------------------------------|------------------------------|------------------|
| Positive | Before | 3 (2.2%) | 2(1.5%) | 1.000 |
| | After | 93 (68.9%) | 62(45.9%) | <0.001 |
| | Change Statistics: McNemar's Chi2 (1), Exact P-Value | 84.38, <0.001 | 60.0, <0.001 | |
| Negative | Before | 132 (97.8%) | 133(98.5%) | 1.000 |
| | After | 42 (31.1%) | 73 (54.1%) | <0.001 |
| | Change Statistics: McNemar's Chi2 (1), Exact P-Value | 84.38, <0.001 | 60.0, <0.001 | |

Data area expressed as n (%).

#P-Value based on Fisher's exact test

Significant P-Values are shown in bold.

Within group comparison of the Rose Bengal test results:

The results of McNemar's exact test showed that there were significant changes in scores of in both the intervention and control groups (Both $P < 0.001$, 66.7% changes in the intervention group vs 44.4% in the control group in positive/negative test results). The results of logistic regression to compare intervention and control group's vaccination after intervention measures of antibody adjusted for before intervention measures are presented in **Table 4**.

Table 4: Results of logistic regression to compare intervention and control group's vaccination after intervention measures of antibody adjusted for before intervention measures

| Group | Odds Ratio | 95% CI Lower | 95% CI Upper | P-Value |
|------------------------------------|------------|--------------|--------------|------------------|
| Control | Referent | | | |
| Intervention | 2.632 | 1.598 | 4.335 | <0.001 |
| Before Intervention Measure | | | | |
| Negative | Referent | | | |
| Positive | 0.423 | 0.066 | 2.703 | 0.363 |

CI: Confidence Interval

Significant P-Values are shown in bold.

Between group comparisons of after intervention Rose Bengal tests results:

The results of logistic regression after controlling antibody for baseline measures showed that there was significant difference between the intervention and control groups (OR=2.632, 95% CI: 1.598 – 4.335, P-Value<0.001).

Estimating pure intervention effect by NNH:

The results of intervention effect assessment revealed an ARR=0.24 95% CI (0.13 – 0.35). These results indicate that the intervention controls the adverse events by 24%. NNH=4, 95% CI (2.83 – 7.89) indicates the point that in order to prevent brucellosis in one livestock, four livestock breeders should receive training to vaccinate their livestock .

Discussion

According to the findings of this quasi-experimental study, the PRECEDE-PROCEED model-driven educational intervention led to significant increases in livestock breeders' awareness, attitude and practice regarding prevention of brucellosis and vaccination of their livestock against brucellosis. Immediately after and one month after the intervention, the mean scores of knowledge, awareness and practice of livestock breeders in the intervention group were significantly higher than the mean of these scores in the control group. Six months after the educational intervention, the results of the Rose Bengal tests were positive in more livestock in the intervention group compared to the animals in the control group. These results confirm that livestock breeders in the intervention group, under the model- driven training, behaved better in preventing brucellosis and vaccinating their livestock.

The role of education in increasing the adoption of appropriate behaviors to prevent brucellosis in livestock and humans [25] or the effect of livestock vaccination in reducing the incidence of brucellosis in humans [26] have been already investigated. In most of the previous studies, educational interventions were either scheduled solely on the basis of researchers' knowledge and experience, or were planned based on other models of behavior change, such as Health Belief Model (HBM) [7, 27, 28]. As it is explained by Manoj Sharma, HBM is not "culturally versatile". It does not account for cultural factors and socioeconomic status of the target group. Moreover, it "is not about changing health behavior but only explaining it"[29]. In this regard, it is recommended

to conduct similar studies in different cultural and socioeconomic contexts to examine the ability of similar PRECEDE-PROCEED-driven interventions to produce other desired context-related results.

Previously, the PRECEDE PROCEED model had been employed to focus on only preventative behaviors[17, 30, 31], not livestock vaccination. To the best of our knowledge and up to the time of writing this article, no PRECEDE-PROCEED-based study has been conducted in the field of brucellosis prevention, which has focused on the combination of health education and vaccination. Taking collaborative and interdisciplinary effective actions, such as "vaccine campaigns, community outreach and education" has been recommended to decrease the burden of brucellosis and its prevalence in endemic regions[32]. This recommendation is in line with the findings of this study that interventions are better to focus on the combination of health education and vaccination, not everyone alone.

In our study, the PRECEDE PROCEED model, as one of the most popular participatory planning models [33] which has been applied to design educational programs in different disciplines[34–36], successfully helped us to provide a tailored road map for designing a participatory intervention program through an approach which started with the desired outcome of the presence of brucellosis antibody in the blood of the livestock of the trained livestock breeders. The significant difference in the presence of antibodies in the blood of livestock in the intervention group compared to the control group confirmed the efficacy of PRECEDE-PROCEED-driven interventions in improving preventive behaviors. As the structure of the PRECEDE PROCEED model is designed to assess health and quality of life needs[34], it is recommended to examine the impact of such interventions on improving the health and quality of life of participating livestock breeders through additional longitudinal studies in the future.

One and six months after the intervention, examining the continuity of the impact of the trainings provided revealed that livestock breeders' scores in the intervention group were still higher than these scores in the control group; however, the trends of livestock breeders' scores were declining. Moreover, although six months after the intervention, the mean scores of indirect awareness and practice of livestock breeders in the intervention group were higher than the mean of these scores in the control group, those differences were not statistically significant($P > 0.05$). The declining trend of the scores and the non-significant difference in the scores of livestock breeders in the intervention and control groups six months after the intervention reminds the need for continuous training. In order to maximize the external validity of the findings of this research, in terms of maintenance or long-term effects of the educational program[37], it is recommended that health educators, after ensuring that preventive behavior is learned by livestock breeders, incorporate their behavior into a period of non-continuous reinforcement and gradually reduce the number of the reinforcements until the behavior becomes controlled by stimuli in the natural environment. In fact, health educators need to stay in connection with local livestock breeders until the behavior is internalized and they do not need reinforcement.

In this study, the educational content was delivered mainly through the basket method. In this method, some simple and realistic pictures were planned by the research team members. They were taken in the real cultural context of the participants. Using pictures in this method helped improve our mostly illiterate livestock breeders' comprehension because the pictures showed relationships among their ideas and beliefs. This finding is consistent with the findings of a review that "adding pictures to written and spoken language can increase patient attention, comprehension, recall and adherence" and "patients with very low literacy skills can be helped by spoken directions plus pictures"[38]. As it is highlighted in this review, sensitivity to the culture of the

participating livestock breeders in creating the pictures has been one of the success factors in our intervention. This alignment in paying attention to the culture of participants as a success factor of intervention can be attributed to using the participatory model of the PRECEDE- PROCEED in designing the intended educational intervention.

Conclusions

In this PRECEDE-PROCEED model-driven study, the educational intervention led to significant increases in livestock breeders' awareness, attitude and practice regarding prevention of brucellosis and vaccination of their livestock against brucellosis. According to the findings, the basket method was effective in delivering the educational content for the illiterate participating livestock breeders. A period of non-continuous reinforcement and gradual reduction of the number of the reinforcements by health educator workers until the livestock breeders' behavior become controlled by stimuli in the natural environment is recommended in order to increase the maintenance of the learnt behavior. In this regard, the cooperation of the pertinent public and governmental institutions and many interdisciplinary actions are needed to train and persuade livestock breeders that vaccinating their livestock is crucial in preventing brucellosis in both livestock and human beings.

Limitations Of The Study

There were some limitations in the process of design, implementation and evaluation of the educational intervention in the current study since all livestock breeders living in the study setting were men. Most of the participants in this study were illiterate or had received a very low level of education. Hence, the main researcher had to explain all questions to the participants and complete the research questionnaires by himself. All details about questions were explained such that livestock breeders could understand it. The researcher had to recheck the answers by asking more questions from livestock breeders. Doing all these steps required more time for explanation for each participant. In this regard, repetition of the study with participation of literate and female livestock breeders may have different results.

Moreover, this study was conducted with participation of volunteer centers. Although it was tried to randomly allocate the volunteer centers to the intervention and control groups, it was not possible to randomly assign the livestock breeders of each center to different groups. Because the livestock breeders under the auspices of each center were meeting each other on a daily basis and by assigning them to two different groups, it was possible to exchange information between the livestock breeders of the control and intervention groups. It was not possible to recruit participants from two different villages. There were only two villages with similar context to research in the study region and we had to develop and validate the research questionnaire (BPQ), with participation of animal breeders at one of them, which is different from the one considered for the educational intervention. In future studies, if the participants of the intervention and control groups are selected from two probable different villages and participants from each center are randomly assigned to different groups; more valid results can be achieved.

In this study, it was decided to evaluate the effect of the educational intervention based on an objective criterion. In this regard, compared to the Polymerase Chain Reaction (PCR), which was very specific, while expensive and not affordable for the research team, the presence of antibodies based on the Rose Bengal test

was considered sufficient in this study. Indeed, measuring the presence of antibodies in the blood of vaccinated animals with the Rose Bengal test (without determining antibody level) was the only option feasible to the research team in Iran. To evaluate the effect of the similar educational interventions in future studies, the level or amount of antibody can be determined in a better and more valid way, using more specific and sensitive tests such as PCR.

Strengths Of The Study

The educational intervention in this study is the first PRECED PROCEED-driven intervention with an evidence-based emphasis on brucellosis prevention based on animal vaccination. The intervention has been designed and implemented with the participation of all stakeholders (livestock breeders, health educationists, veterinarians and experts from vaccine and serum production institute). The Educational content and the assessment questionnaire were tailored based on needs and situational assessment. Method triangulation (literature review, the main researcher's field notes and face-to-face interviews with different stakeholders) was employed to do needs and situational assessments.

Abbreviations

DALY

Disability Adjusted Life Year

FAO

Food and Agriculture Organization

WHO

World Health Organization

PRECEDE

Predisposing, Reinforcing and Enabling Constructs in Educational Diagnosis and Evaluation

PROCEED

Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development

HBM

Health Belief Model

MTM

Multi-Theory Model

IRCT

Iranian Registry of Clinical Trials

SPSS

Statistical Package for Social Sciences

NNH

Number Needed to Harm

Declarations

Ethics and Consent to Participate

Conducting this study was approved by the ethical committee board of faculty of medical sciences at Tarbiat Modares University (IRB number: IR.MODARES.REC.1397.001). All methods were performed in accordance with the relevant guidelines, regulations and ethical standards of the responsible committee approving the research at Tarbiat Modares University and Iranian Registry of Clinical Trials and with the Declaration of Helsinki, as revised in 2000.

The purpose of conducting the present study was clearly shared with participants before initiating the study. Recruiting animal breeders for the educational intervention was done based on their willingness to participate, after signing the informed consent form of the study. In case of being illiterate, the animal breeders stamped the consent form after the main researcher read aloud the form to them. Researchers did their best to keep the research data confidential. A unique code was assigned to each participant and they had the right to withdraw from the study at any time, upon their willingness. All participants provided written informed consent and they were assured that their responses would be remained confidential. After the research data analysis, similar training was provided to the participants in the control group as well.

Consent for publication

Not applicable.

Availability of data and materials

All data and materials will be available on reasonable request from the corresponding author.

Competing interests

The authors declare that they have no competing interests; except for the point that the corresponding author is an editorial board member of BMC Medical Education.

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Authors' contributions

FB was the main investigator and conceived the study; collected and analyzed the data; interpreted the findings; wrote the first draft of the manuscript; read and critically revised the first draft of the manuscript.

FGh conceived and the study; analyzed the data; interpreted the findings; read and critically revised the first draft of the manuscript.

FZ developed educational package, analyzed the data; interpreted the findings; read and critically revised the first draft of the manuscript

RZ collected and analyzed the data; interpreted the findings; read and critically revised the first draft of the manuscript.

SGh developed educational package, analyzed the data; interpreted the findings; read and critically revised the first draft of the manuscript. All authors have read and approved the final manuscript.

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Figures

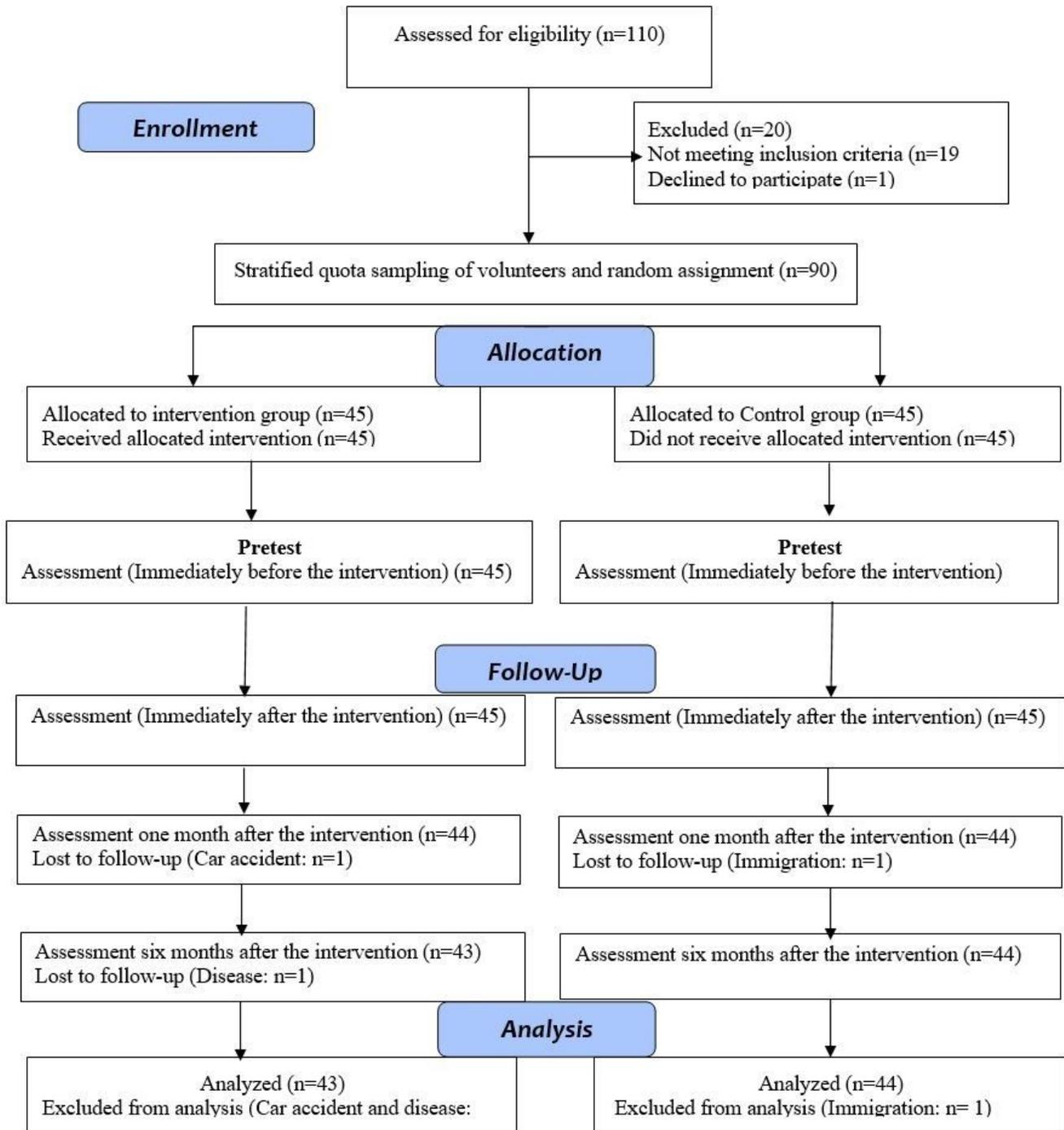


Figure 1

Flow diagram of the educational intervention to improve livestock breeders' awareness, attitude and practice about Brucellosis prevention

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- BPQQuestionnaire.docx