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CHANGE IN SOY AND NUTRITION KNOWLEDGE AND PERCEPTIONS OF SMALLHOLDER SOUTH AFRICAN FARMERS AFTER ATTENDING A SINGLE ONE DAY SOY NUTRITION TRAINING WORKSHOP: A PILOT STUDY

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ABSTRACT

The main aim of this pilot study was to assess smallholder soy farmers' knowledge and perceptions of soy immediately before and after participating in a one-day soy nutrition training workshop. A pre-post study design was used among a convenience sample of 78 soy smallholder farmers from KwaZulu-Natal, South Africa (SA). A total of 78 men and five women participated in the training, but because only five women attended, gender comparison analysis was not carried out. A soy nutrition training workshop, including soy cooking demonstrations, tasting, recipe development, that is based on the Social Cognitive Theory, was implemented for eight consecutive hours with one break of 30 minutes. Pre- and post-quantitative data measuring, soy knowledge and perceptions were collected using a modified version of a survey, tested for face and content validity and reliability, and used previously in other research study projects by the same authors among low-resource communities in SA**.** The data from the pre and post questionnaires indicated that only 41% of the soy smallholder farmers used soy in the household and mainly in meat dishes. The rest of the harvested soy was either sold or used for animal feed. The mean±standard deviation (SD) score of taste preference changed significantly ($p=0.002$) from 4.60±0.84 before, to 4.93±0.13 after the training ($p=0.002$) and the majority of the participants perceived it was easy to prepare soy foods; 82.1% and 88.5% before and after the training, respectively ($p=0.013$). Participants' soy knowledge improved significantly ($p<0.001$) from a mean± (SD) score of 26.33±4.06 before to 32.00±9.46 after the intervention, indicating a significant improvement of 5.67±9.11 [13.83%] in the total score. The results from this study indicate that there is a need for nutrition education programs for smallholder farmers. Thus, improvement in both soy knowledge and preference should result in more soy being consumed first for household nutritional needs before giving it to either animals or sell it on the market. Since smallholder farmers' nutrition education can impact both food insecurity and nutritional status improvement in one setting, more interventions of this kind are needed to further advance the frontier of this niche area of research.

Key words: nutrition education, smallholder famers, soy training, South Africa emerging farmers, Knowledge perception

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INTRODUCTION

Globally, the greatest challenge is to secure healthy food in adequate quantities for all, in an environmentally sustainable manner [1]. Although the prevalence of malnutrition, specifically under-nutrition, has reduced significantly [2], the prevalence of food insecurity has become a global crisis [3]. After a prolonged decline, new evidence has shown an increase in world hunger during recent years with 821 million people facing chronic food deprivation in 2017 [2]. While South Africa (SA) is considered food secure at the national level, food insecurity and hunger is still experienced at the household level, especially in rural areas [4]. Recent reports suggest that vulnerability to hunger and food insecurity has shown an overall decline to 12.1% [5]. Although smallholder farmers are producing a large part of the available food in Africa, it is ironic that most of these farmers are also affected by poverty [6]. However, poverty is not only associated with a lack of income and resources. Food insecurity and malnutrition are but two of the many manifestations of poverty [7]. Research has found that low-income households consume greater amounts of energy-dense, high sugar- and salt containing foods as these are more affordable than nutrient-rich foods [8]. In addition, regular consumption of energy-dense foods is an established risk factor for the development of chronic non-communicable diseases (NCDs) [9].

In SA, the estimated number of smallholder farmers are four million [3]. Smallholder farmers mainly engage in agriculture to procure an extra source of food for household use [3], and also to sell surpluses at the local markets to gain income for purchasing other food items [3]. Thus, improving food security is one of the most pressing challenges for these farmers in sub-Saharan Africa [SSA] [10] and also in SA. A recent study among farmers from Msinga in KwaZulu-Natal (KZN) found a prevalence of food insecurity of 93% [3]. In a previous study among smallholder farmers from KZN we found 45% food insecurity. Although these farmers produce mainly maize and soy, soy was not regularly used in the household as it was considered as animal feed [33].

South Africa is a country facing a health transition characterised by a triple burden of diseases, thus the prevalence of both under- (protein energy malnutrition, micronutrient deficiencies) and over-nutrition (obesity and its related co-morbidities such as cardiovascular disease, type 2 diabetes, cancer, high blood pressure) in the same population, household and/or person, coupled by a co-existence of Human Immunodeficiency Virus (HIV) infection. Healthy diets and regular physical activity are important for good health throughout the life [11]. The benefits associated with the regular consumption of soy, in combination with a diversified diet, have been scientifically proven and are becoming more relevant to prevent or address the negative consequences of both under and over nutrition [12] However, consumption of soybeans has not spread across SA and suggests a limited consumer acceptability as only 2.4% of the soy processed in 2017 was used for human consumption [13].

People in low-income households often have limited knowledge and skills required to make healthy food choices to improve health and wellbeing [9]. Previous studies conducted with adults and children in a rural community of SA found participants' initial knowledge of soy was poor, but increased significantly after participating in a soy

nutrition training program [12]. Many studies exist on the impacts of interventions on poverty and food insecurity among smallholder farmers, but a paucity of data exists on the effects on smallholder farmers' household diets and nutrition. Education and/or training has an important role in combating food insecurity [3] and researchers suggested that sufficient education and training is important for all farmers [11]. In addition, a study among farmers in Tanzania found that nutrition education was valuable to farmers as they perceived that improved nutrition could benefit their health and overall work performance [14]. Similarly, a study in Ghana recommended interventions to adopt Food-Based Dietary Guidelines (FBDGs) in smallholder farming households [15]. Although Grain SA and The Grain Farmer Development Association (GFADA) are providing training to smallholder farmers, this training is mainly focused on improving agricultural production knowledge and soy applications respectively. Limited human nutrition training is included.

The purpose of this study was thus to assess farmers' knowledge and perceptions of soy before and after participating in a soy nutrition training workshop. The objectives that guided this study were to: (a) describe farmers' current use of soy, (b) determine the change in farmers' soy and the South African FBDGs nutrition knowledge, and (c) determine the perceptions of soy after the intervention.

METHODS

Study Design and Participants: This study used a one-group pre-post test design [16]. There was no control group and as a result of the small sample size, this study should be considered a pilot. The farmers were informed about the training by Grain SA representatives and a convenience sample of 78 male smallholder farmers from KZN, who came to participate in the one-day soy nutrition training workshop during August 2017, was used. The smallholder farmers indicated their willingness to participate by signing an informed consent form after the training objectives and format were explained. Each farmer was allocated a code to minimize participants' identification data. The study protocol was approved by the Research and Innovation Committee at the Vaal University of Technology in SA (ECN58-2017) and the Institutional Research Board at Texas Tech University in the United States (IRB2018-596).

Soy Nutrition Training Intervention: A registered dietitian and public health nutrition professor adapted the curriculum that was developed for another population group [12], based on previous discussions with agricultural stakeholders and a baseline survey determining food insecurity, dietary diversity and soy and nutrition knowledge [33]. All the lessons were designed for low-literacy levels (Flesch-Kincaid level <5) and included many visuals (pictures, diagrams). The nutrition training included the FBDGs that were developed by South African experts and adopted by the Department of Health (DoH) to provide information to South Africans, aged 7 years and older, for making healthy food choices and preventing NCDs. [17] The soy and nutrition training was informed by the Social Cognitive Theory (SCT) that does not only focus on imparting knowledge, but also include constructs as potential mediators to change behavior [18], in this case to demonstrate practical strategies to increase the consumption of soy at the household level. Cooking demonstrations included soy milk, soy yoghurt, steamed soy bread and

soy nuts preparation. Soaking and draining of soy were also demonstrated to decrease the anti-nutrients in soy before cooking. In addition, other soy recipes were prepared in advance for tasting as part of lunch. The recipes included in the recipe book were developed in a previous study and took into consideration the limited resources and the availability of culturally accepted foods in resource-poor households in SA [20]. Participants received the South African FBDG pamphlets prepared by the DoH and a soy recipe book [19] to take home in addition to the soy and nutrition training lectures to reinforce the lesson contents and to increase soy preparation skills. A short interactive and participatory training approach of six hours (one day) was followed and organised as indicated in Table 2.

Data Collection and Variables: Data were collected using self-administered questionnaires. A trained fieldworker that could speak the local language was available to assist with the pre- and post-data collection. The questionnaire used was a modified version of an instrument previously tested and used [12]. Before the intervention, participants were asked about soy production and use in the household (2 questions). The farmers completed an additional questionnaire before and immediately after the training was completed. The questionnaire focused on knowledge about the FBDGs (10 true and false and 3 multiple choice questions), health benefits of soy (3 true and false questions), use and preparation of soy (2 true and false and 12 multiple choice questions), commercial foods containing soy (9 true and false questions) and general soy knowledge (2 multiple choice questions). The questionnaire also included one Likert-type scale question to measure soy perception indicating the taste of soy ranging from like a lot (Likert scale 5) to dislike a lot (Likert scale 1).

Data Analysis: A total of 83 individuals, 78 men and five women who were invited by SA Grain and came to participate in the training workshop, completed the pre and post training questionnaire. Only five women attended and their data were not used due to a too small sample. The data were entered on a Microsoft Excel spreadsheet where after the paper questionnaires were shredded. All analyses were done using the IBM SPSS Software, version 25 and $p<0.05$ was considered significant for all statistical analyses. Before data analyses, Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test all continuous variables for normality. All the variables were normally distributed; thus results are reported as means and standard deviations (SDs).

Participants were asked to select the correct answer among the possible knowledge options. Correct answers were given a score of 1 while incorrect answers were coded as 0. The sum of correct answers provided participants' knowledge scores. Face and content validity was established previously by authors. The internal consistency of the knowledge section was measured using the Kuder-Richardson-20 coefficient and it was considered acceptable for analysis [21]. Descriptive statistics (means±SDs and frequencies) were used to describe participants' current use of soy, and pre and post perceptions and knowledge. Paired-sample t-tests (continuous nominal data) and Chi-Square tests (categorical data) were used to determine the change in the participants' perceptions and knowledge after participating in the training. Two null hypotheses were established for testing, stating that: (a) participants' perception of soy does not significantly change after participating in a soy and nutrition training workshop, and (b)

participants' soy knowledge does not significantly change after participating in a soy and nutrition training workshop. An alpha level of 0.05 was set *as priori*. A paired-sample t-test was used to perceive taste difference after training and a McNemar test was used to determine the difference in the preparation of soy foods after the training (easy versus difficult) due to the nature of the dichotomous testing variable. In addition, Pearson correlations were used to determine significant associations among the various change scores.

RESULTS AND DISCUSSION

The majority of the farmers participating in the training workshop did not plant soy every year (88.5%). The farmers who regularly planted soy indicated to have, on average, an annual yield of 59.6 kilograms. The famers indicated that the produced soy was mostly sold (69.2%), used for animal feed (47.4%) and for household food preparation (41%). Soy was mainly used for cooking and adding to meat stews in the households.

The mean±SD (average and standard deviation – data dispersion) score of taste preference changed significantly ($p=0.002$) from 4.60±0.84 before to 4.93±0.13 after the training ($p=0.002$) (Table 3). Also, the majority of the participants perceived it was easy to prepare soy foods 82.1% and 88.5% before and after the training, respectively ($p=0.013$).

The effectiveness of the training workshop was evaluated by comparing the pre- and post-intervention assessments (Table 4). The total soy and nutrition knowledge score ranged from zero to 41 based on the total number of questions included in the questionnaire. The overall mean±SD soy and nutrition knowledge score increased significantly ($p<0.001$) from 26.33±4.06 to 32.00±9.46 after the training workshop, indicating a significant improvement of 5.67±9.11 (13.83%) in the total score. The change in overall knowledge was significantly ($p\leq0.001$) and positively associated with the knowledge change of FBDGs ($r=0.849$), soy health benefits ($r=0.811$), household application (uses) of soy ($r=0.885$) and correct identification of soy foods ($r=0.644$) after the intervention (Table 5).

Smallholder farmers in SA are dominant in the rural areas where almost 70% of the poorest households are located. These households are characterised by persistent chronic food insecurity and malnutrition [6,10]. The smallholder farming sector is thus a good entry point for improving food security and nutrition [6] and this requires multiple strategies [22], including education and learning focusing on agriculture, food and nutrition [23]. Kerr and co-authors suggested that investment in nutrition education is needed for positive health effects in vulnerable groups (23] and, although nutrition knowledge is an unreliable predictor of behavior change, it is a critical predisposing factor for positive dietary and health changes [9]. This study demonstrates the impact of short duration soy nutrition training workshop on soy perceptions, use and knowledge among male maize and soy smallholder farmers, in whom a prevalence of 45% food insecurity and poor nutrition knowledge score was observed previously [33]. Although women are mainly responsible for food decisions in the household, it is recommended to empower both men and women [24]. In addition, the workshop content supported the

South African FBDGs for healthy living. FBDGs are brief, positive messages that form the basis of all nutrition education to inform consumers on food and beverage choices and combinations that will lead to an adequate diet. Following FBDG recommendations should result in optimum nutrition, physical and mental development, as well as a lower risk for developing NCDs, and thus ensure health and well-being throughout life [17]. The soy nutrition training workshop included lessons, experiential learning (food demonstrations, recipe preparation and tasting) and small group discussions (knowledge, reflection and problem solving) which was consistent with a training program focusing on agriculture and nutrition among farmers in Malawi and Tanzania [23].

The results showed that the majority of the farmers did not regularly plant soy. Despite a large majority (82.1%) that indicated it was easy to prepare soy foods before the training workshop, only 41% used soy in the household, mainly texturised soy protein for cooking stews. This finding is consistent with the fact that soy has not been adopted as a human food in SA as only 2.4% of the soy that is produced nationally, is used for human consumption [14]. Furthermore, a prominent barrier to soy consumption among resource-poor adults in the United States was lack of knowledge about the use of soy [25], which was consistent with our results as only 64% of the farmers knew how to prepare and use soy at baseline, despite demonstrating a good knowledge of the health benefits of soy (74%). This significantly improved to 99% after the training. Soy is considered a good quality plant protein as it has all the essential amino acids needed for growth and development. Plant-based diets, including soy, legumes and vegetables and fruit, are considered a sustainable diet with low environmental impact and can contribute to food and nutrition security [26]. In addition, soy has many nutritional and health benefits such as lowering cholesterol, having anticarcinogenic (anti-cancer) properties, and protects against obesity, diabetes, bone and kidney diseases [27,28] .

The focus of the training workshop implemented in this study significantly improved the taste preference of soy and the null hypothesis was rejected in favour of the alternative hypothesis indicating that there was a statistically significant change in the participants' taste preference of soy products after participating in a soy and nutrition education-training workshop. The majority of the participants perceived it was easy to prepare soy foods and this perception also improved significantly after the training respectively. We thus accept the alternative hypothesis. Not only should soy production improve food security status in these households, but soy consumption should contribute to the health status of all the members of the household as were found in another study among resource-poor households [12].

In addition, the training improved the farmers' overall soy knowledge by 20%. These positive results reflect the impact of using the SCT where the various activities of the training workshop were linked with the SCT constructs, specifically reinforcement, behavioural capability, environment and observational learning. Hands-on activities usually enhance motivation as participants are involved with the learning process and small group sessions also encourage cooperative learning [29]. This was observed for the soy activities. In a study undertaken in the United States, respondents indicated that education about cooking with soy and how to incorporate soy in the daily diet were the main factors that would contribute to soy consumption [25]. Both these factors were

addressed in this training workshop. Unfortunately, no other studies about soy and nutrition training among smallholder farmers were available to compare our study results, but studies among resource-poor women in developing [29] and developed [9] countries reported positive changes in knowledge after nutrition education interventions, consistent to our results.

The purpose of any training programme focusing on nutrition should include knowledge and skills training that are essential for making affordable and culturally acceptable healthy food choices [29]. It was thus important to not only train the farmers on soy, but also on the FBDGs that were adopted by the DoH for all South Africans aged seven years and older. Previous research suggests clear instructions on what and how much should be eaten [9], delivered as simple and straight forward recommendations such as FBDG information, are important [29] and can potentially assist individuals in choosing healthier foods [17]. The FBDGs are short and informative messages used to educate and inform consumers to choose healthy food and beverage combinations for adopting a nutritionally adequate and prudent (healthy) diet to lower the risk of NCDs [17]. In this study, the farmers had a fair knowledge of the FBDGs, but this training workshop did not result in a significant change in the FBDG knowledge. Knowledge was provided about the FBDG and the associated food groups through lessons. A systematic review of 28 studies focusing on FBDGs have shown that, although participants were knowledgeable or aware of the FBDGs, this knowledge did not translate into understanding and use of FBDGs. The meta-analysis also showed that participants had limited abilities in explaining portion and serving sizes [30]. In addition, health professionals receive FBDG training and materials to use for educating the public, but few outside the dietetics and nutrition community were able to effectively communicate and apply the FBDG in SA [31]. Limited information is available about the implementation and evaluation of FBDGs in SA. Studies undertaken among school educators reported poor knowledge about the FBDGs [32]. It is recommended to include active learning activities and group discussions when educating about FBDGs to promote understanding of FBDGs. Most of the activities in this training workshop were focused on soy preparation skills and most of the interaction also happened during the cooking and tasting sessions. Only one activity focused on planning a balanced meal using food models and this may not have been enough to reinforce the FBDG knowledge. However, the overall knowledge score [including soy and FBDG) increased significantly after the training workshop, indicating a significant improvement of 13.83% in the total score. The null hypothesis is thus rejected in favour of the alternative hypothesis stating that soy and nutrition knowledge will improve significantly after a soy and nutrition training workshop. These results are consistent with those among women in a resource-poor, low literacy community in SA where the same soy and nutrition training was implemented over two sessions of two hours each [12]. However, more training sessions specifically covering one FBDG in a session, as well as 6 weeks of soy recipe training with the women in the households, had been implemented before an 18-month intervention study in which soy was consumed regularly. The consumption of soy resulted in significant improvements in food security, dietary diversity, nutrient intakes and health status of the women and pointed to soy production and consumption being an affordable and sustainable solution to food insecurity and health.

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This study had several limitations. Although the measuring instrument had been tested for face, content and internal validity (test-retest) in another resource-poor community [12], it was not tested in a farming community. Another limitation was the time constraints for implementing more activities and lessons due to having access to the farmers for only one day. Furthermore, although SA Grain invited all the smallholder farmers in the area, we could only use those farmers that came to participate in the training workshop and thus the small convenient sample without a control group does not allow results to be generalised to a broader farming community.. The inability to measure long-term knowledge retention and behaviour change in terms of soy consumption was another limitation. Although all men and women smallholder farmers were invited to the training workshop, only five women attended, which is consistent with a finding that women farmers typically access fewer resources and advisory services, and less frequently attend community meetings, or visit demonstration plots compared to men (27). The women data were not included in the analyses and the sample was thus largely skewed to men. Considering that this training was focusing on soy utilisation as a food-based intervention and that women make direct food access and preparation decisions in African households, this is a further limitation. However, despite the mentioned limitations, study strengths include the use of a theory-based training programme using appropriate supporting activities designed for resource-poor and low literate communities. The findings from this study further provide evidence that this short, one-day soy nutrition training is effective in improving knowledge, skills and perceptions about soy, but point to need for revisions in the FBDG part of the training.

CONCLUSION

In this pilot study, men's awareness, knowledge and perceptions about nutrition and the use of soy for human health was investigated. Increased attention to nutrition and education/training has an important role in combating food insecurity and malnutrition. Improving men's awareness and knowledge should have a positive effect in the household in terms of providing adequate resources for food availability and preparation. This short six-hour soy and nutrition training workshop provides comprehensive information about nutritious locally available foods and affordable soy-based recipes that have been developed specifically for South Africans. It has also been proven to be cost-effective and successful in various South African communities and can be used as a model to implement in other communities where food insecurity and malnutrition are experienced to raise soy and nutrition awareness and improve knowledge, which is a predisposing factor for behaviour change. The training materials can be used and easily be adapted in other programs. It is, however, recommended that in future training sessions with smallholder farmers, the wives and husbands also be invited. A multi-sectoral approach is recommended for scaling up. Agricultural organisations often arrange meetings bringing the smallholder farmers and various stakeholders together. To our knowledge, this was the first of such meetings where a nutrition training program was part of the agenda. Nutrition training should become a standard agenda item at all these meetings where not only different aspects of nutrient-dense crops can be discussed, but comprehensive information about the FBDGs can be included in multiple sessions to ensure that knowledge about the FBDGs also improves.

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Table 1: The major constructs of the Social Cognitive Theory and application in the soy nutrition training workshop

Lessons	Objectives	Format	SCT constructs addressed
Health	1.Understand the definition of health 2.Know the signs of malnutrition	Lesson Group discussions and feedback by groups	Behavioural capability Environment
Food-based dietary guidelines (FBDGs)	1.Familiarise with the SA FBDGs and guide for healthy eating 2.Identify food groups 3.Learn to select different foods for a balanced meal 4.Learn about appropriate portion sizes	Lesson Small groups planning meals with the assistance of food models	Behavioural capability Environment Self-regulation
Health benefits of soy	1.Familiarise with the health benefits of soy in terms of under- and over nutrition	Lesson	Behavioural capability
Commercial soy food products	1.Identify soy-based commercial food products 2.Learn how to read food labels	Lesson Show examples of commercial foods Small groups reading and identifying soy on food labels	Behavioural capability Expectations Self-efficacy Reinforcement Environment
Use and preparation of soy	1.Learn how to soak soy 2.Learn about the different ways of preparing soy 3.Learn how to replace meat/chicken with soy in recipes	Lesson Cooking demonstration [soy milk, yoghurt, bread and nuts] Food tasting Soy recipe book to take home	Self-efficacy Reinforcement Expectations Behavioral capability Observational learning Environment

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Table 2: Activities included in the one-day soy and nutrition training workshop

Time	Lesson/Activity
08h30-09h00	Arrival
09h00-10h00	Explanation of workshop objectives, signed informed consent and completing questionnaires for pre-assessments
10h00-10h30	What is health?
10h30-11h15	FBDGs
11h15-12h15	Soy use and preparation lesion with demonstration of soaking soy beans, soy milk and yoghurt preparation and tasting
12h15-13h00	Health benefits of soy
13h00-14h00	Lunch [various recipes prepared from the soy recipe book]
14h00-14h45	Commercial soy food products
14h45-15h30	Soy nut demonstration and tasting
15h30-16h00	Wrap-up and questions
16h00-17h00	Completing questionnaires for post-assessments

Table 3: Summary of participants' soy food taste preference and paired-sample t-test findings [n = 78] before and after the soy and nutrition training workshop

Characteristic	Pre-Test mean±SD	Post-Test mean±SD	Change score
Taste preference[a]	4.60±0.84	4.93±0.31	0.33±0.12
Variable	Df	T	P
Taste preference	66	3.19	0.002

Note. [a] Likert-type scale:
5 = like a lot,
4 = like a little,
3 = neither like nor dislike,
2 = dislike a little,
1= dislike a lot.

p-value <0 .05

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Table 4: Summary of soy and nutrition knowledge of participants [n = 78] and change scores after the soy and nutrition training workshop

Knowledge Variables	Pre-Test	Correct answers by participants	Post-Test	Correct answers by participants	Change score	Change in overall correct answers by participants	Significant difference between pre- and post
	mean±SD	%	mean±SD	%	mean±SD	%	p
FBDG	7.79±1.80	59.9	7.55±3.05	58.1	-0.24±3.04	-1.85	0.481
Soy uses	9.00±2.32	64.3	13.86±3.73	99.0	4.86±3.65	34.71	<0.001
Soy foods	5.27±2.11	58.6	6.14±1.63	68.2	0.87±2.45	9.67	0.002
Soy health benefits	3.69±1.24	73.8	3.90±1.59	78.0	0.21±1.89	4.20	0.340
Overall soy knowledge	18.54±4.39	66.2	24.45±6.77	87.3	5.91±6.73	20.25	<0.001
Overall soy and FBDG knowledge	26.33±5.06	64.2	32.00±9.46	78.0	5.67±9.11	13.83	<0.001

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Table 5: Correlations between changes in study outcome variables after the soy and nutrition training workshop

Variable	Association							
	Change in FBDG knowledge		Change in soy health benefits knowledge		Change in soy use knowledge		Change in soy foods knowledge	
	Coeffi-cient	p	Coeffi-cient	p	Coeffi-cient	p	Coeffi-cient	p
Change in total knowledge	0.849	<0.001	0.811	<0.001	0.885	<0.001	0.644	<0.001
Change in FBDG knowledge			0.597	<0.001	0.694	<0.001	0.346	0.001
Change in soy health benefits knowledge					0.632	<0.001	0.452	<0.001
Change in soy uses knowledge							0.416	<0.001

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