DISCOVERING THE BENEFITS OF SOYBEAN: AN INFORMATIVE HALF-DAY NUTRITION EXPERIENCE AMONG LOW INCOME WOMEN IN VAAL REGION OF SOUTH AFRICA

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ABSTRACT

Theory-based nutrition education extremely important in areas where resources and healthcare personnel are scarce, as it empowers and provides people with knowledge, abilities, and motivation to adopt a healthier diet. Thus, the objective of this pilot study was to inform women in the Vaal region of South Africa about the health benefits of soy and how to prepare soy-based foods.

To this end, a registered dietitian implemented a four-hour pilot nutrition education intervention in a purposive sample of 60 female participants, and a validated questionnaire was used before and after the intervention to collect participants' sociodemographic, food-based dietary guidelines and soy knowledge, as well as soy preparation efficacy and perceptions, and dietary diversity. Data were analysed using IBM SPSS, version 29.0.0.0 for descriptive and inferential statistics. More than 50% of the women were unemployed, and more than 65% reported never eating soy. The majority of the participants (95%) met the minimum dietary diversity score, which was collected only for baseline data. There was no statistically significant change in the overall perception, knowledge, or self-efficacy total scores after the intervention. However, statistically significant ($p = < 0.001$) improvement in knowledge of the health benefits of soy was observed. Significant correlations were found between pre total knowledge score and the dietary diversity score ($\rho = 0.441$), knowledge about foods containing soy ($\rho = 0.614$), and soy for human consumption ($\rho = 0.615$). When knowledge questions were analysed separately a statistical significance ($p<0.001$) was found regarding soy health benefits knowledge. Although, this short pilot nutrition education intervention did not significantly improve the overall knowledge score, the participants knowledge about the health benefits of soy significantly improved, indicating the potential of a theory-based nutrition education programme to increase nutritional knowledge if implemented over a longer period. This is one of the only studies that has tested soy knowledge and consumption among women and emphasised the importance of soy for addressing food security and malnutrition.

KEYWORDS

food dietary diversity, malnutrition, soy health benefits, women-headed households

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INTRODUCTION

Women should be given special attention with regards to nutrition and food insecurity due to their pivotal role in society, in food production, as caregivers, and as the head of households (Ivers, 2011). In developing countries, women generate about 80% of food production and are in charge of cooking their family meals. Despite their productivity and contribution in food production, they make up about 70% of the world's impoverished population (Ivers, 2011).

The daily monetary amount which is required for people to afford or consume enough food to meet their daily energy needs is known as the food poverty line (Abrahams, 2018). In 2023, over 18 million South Africans were living on less than the international poverty line of 1.90 USD per day (Statista, 2023b), and 42% of households were led by women in 2022 (Statista, 2023a). Although South Africa (SA) is regarded as nationally food secure, there is a significant proportion of the population that is food insecure and at risk of malnutrition due to inequitable access to resources and high unemployment rates. Furthermore, urbanisation is contributing to a change in diets in both urban and rural areas. In addition, the country has experienced a significant nutrition transition over the last 20 years that resulted in an increased intake of sugar, salt, and saturated fats (Swart, 2022), with low intake of fruits and vegetables (Kruger *et al*. 2022). Under-nutrition (stunting, wasting, and micronutrient deficiencies) and over-nutrition (overweight and obesity) in the same person, household, or country is known as the triple burden of malnutrition (TBM) (Prentice, 2023). The co-morbidities of obesity are hypertension, type 2 diabetes (T2D), and cardiovascular disease (CVD) (French, 2024). In sub-Saharan Africa, women are more prone to experience the TBM (Ahinkorah, 2021). One of the main causes of malnutrition at a household level is a diet lacking in diversity along with poor food choices and eating habits (Korir, 2022).

Soybeans are part of people's diet around the world because they are abundant in both macro- and micro-nutrients. Over the past three decades, soy is the oil seed that has been cultivated the most in many regions around the world. It is major protein source for humans, in addition to containing essential amino acids – including lysine, which tends to be deficient in other primary crops (Agyenim-Boateng *et al*., 2023). Compared to animal protein sources (e.g., fish and meat), which are expensive, soy is much more affordable (Agyenim-Boateng *et al*., 2023). Research has shown that soy consumption has advantages, when combined with a varied diet, in addressing the adverse effects of both under- and over-nutrition (Oldewage-Theron, Morales & Egal, 2020). Its nutritional content and cost-effectiveness make soy suitable for treating malnutrition among underserved populations (Atuna, 2022) because income level directly influences food choices (Chen & Antonelli, 2020).

Soy consumption has many different health benefits. Fermented soy products such as soy yoghurt are beneficial for people suffering from lactose intolerance. It decreases the risk of CVDs by reducing blood pressure (Zuo *et al*., 2023), low-density-lipoprotein cholesterol (LDL-C), and triglycerides, and by raising high -density lipoprotein cholesterol (HDL-C)

(Barańska *et al*., 2021). Due to the isoflavone content of soy, it can be used to manage menopausal symptoms and as an alternative option for hormone treatment during menopause (Qin, 2022). Increased consumption of soy and soy isoflavonoids also has beneficial effects on cancer, metabolic, musculoskeletal, endocrine, neurological, and renal outcomes – particularly in perimenopausal women (Li *et al*., 2020). Soy has been acknowledged as a safe supplement by the Food and Drug Administration (Mehaya *et al*., 2023).

Nutrition has been widely acknowledged for preventing diseases and assisting in disease management. Improving nutrition typically requires willingness to change dietary habits (Brug *et al*., 2004). Nutrition education interventions have been shown to reduce malnutrition. The Food and Agricultural Organization (FAO) highlights the significance of nutrition education, especially in areas where people have limited resources. It is in these areas where nutrition education makes the greatest impact given the scarcity of healthcare personnel and resources (FAO, n.d.). Consequently, nutrition education empowers and provides people in both rural and urban areas with knowledge, skills, and motivation to adopt a healthier diet. Nutrition education should address how to enhance food supplies and how to be more efficient in terms of resource and food utilisation in order to provide healthier diets.

Previous research conducted in the same community as this study showed poor dietary intake and excessive consumption of unhealthy snacks (Ibiyemi & Oldewage-Theron, 2023). To address these issues, soy nuts were recently used as a basis to develop nutritious and healthy snacks for children and adults (Ibiyemi & Oldewage-Theron, 2023). These snacks were incorporated into a school nutrition programme at a school in the Vaal region as part of a pilot study. In addition, a Soy Cow (industrial soy milk processor) was installed at the same school, and soy milk and yoghurt were included in the school nutrition programme. A study is ongoing to evaluate the impact of soy consumption on the nutritional status of the children within this school nutrition programme. Following on from the work already done in Ibiyemi and Oldewage-Theron's (2023) study, the objective of this study was to raise awareness among the mothers and women caregivers of the children attending this school about soy health benefits and how to prepare soy-based foods.

METHODS

Study design and participants

This study was undertaken in the Vaal region of South Africa. The region has approximately 800 000 inhabitants (Ibiyemi & Oldewage-Theron, 2023), and poverty, food insecurity, and malnutrition are prevalent (Oldewage-Theron *et al*., 2020).

This pilot study used a one-group pretest-posttest design with 60 participants. The inclusion criteria were that participants should not have soy allergies and they should be a mother or caretaker of a child in the participating school where the Ibiyemi and Oldewage-Theron (2023) soy project had been implemented.

Data collection and measuring instruments

A validated questionnaire that has been used in previous studies (Oldewage-Theron *et al*., 2020) was used before and after the intervention to collect participants' data. This self-administered questionnaire consisted of four different sections: 1) demographic information, 2) knowledge, 3) perception, and 4) self-efficacy. The questionnaire included nine demographic questions (including ones

regarding age, gender, employment status, and social media use) and three questions using a 3-point scale (yes, no, not sure) to assess perceptions about ease of soy use for meal preparation. Knowledge about soy was assessed using three different questions: one 3-point-scale question and two true/false questions. Five questions using a 6-point Likert scale assessed cooking self-efficacy for healthy meal preparation using soy, ingredient measurements, and ability to follow a recipe. The frequency of soy use and types of soy-based products were also evaluated.

The dietary diversity score (DDS) was determined using the Minimum Dietary Diversity for Women (MDD-W) as an indicator to evaluate the participants' dietary diversity. This scale consisted of 10 different food groups adapted to include typical South African foods. The women were asked to mark the food items within each food group that they had consumed within the last 24 hours. The groups included in the dietary assessment were: 1) flesh (meats); 2) eggs; 3) dairy (milk and milk products); 4) grains, roots, and tubers; 5) pulses (beans, soy, peas, and lentils); 6) nuts and seeds; 7) other Vitamin-A-rich fruits and vegetables; 8) dark green leafy vegetables; 9) other fruits; and 10) other vegetables. For each food group, a score of 1 was assigned if at least one food item was consumed from that group within the preceding day (24 hours), and a score of 0 was assigned if no food item from that group was consumed. The scores from each group were added to calculate the total DDS. Given the nature and duration of the intervention, the participants' dietary diversity was collected only for baseline data.

Nutrition intervention

A registered dietitian implemented a 4-hour nutrition education intervention on the same day (Table 1). The nutrition education intervention was based on previous baseline data collected among farmers to evaluate their nutrition knowledge, dietary diversity, and food -security level (Oldewage-Theron *et al*., 2020). Based on the Social Cognitive Theory (SCT), which focuses on knowledge, behavioural change, and motivation (Schunk and DiBenedetto, 2020), the training included the food-based dietary guidelines (FBDG) for SA , which focus on prevention of non-communicable diseases. The training also included cooking demonstrations of soy products –– namely, nuts, milk, steamed bread, and yoghurt. Additionally, prior to cooking, participants learned how to soak and drain soybeans to reduce soy anti-nutrient compounds. Other recipes containing soy were prepared for food-tasting purposes. Furthermore, 1 kg of soybeans was provided to each participant to take home with the

TABLE 1: SCHEDULE AND ACTIVITIES INCLUDED IN THE NUTRITION TRAINING WORKSHOP

Time	Lesson/activity
8:30 -9:00	Arrival
	Objectives explanation
8:30-9:00	Sign consent form
	Pre-questionnaires completion
9:00-9:30	Food-Based Dietary Guidelines for South Africa
	Preparation and soybeans soaking demonstration
	Soy milk and soy yogurt preparation and soaking
9:30-10:30	Health benefits of soy
	Commercial soy products
	Uses of soy
	Food tasting
10:30-11:30	Soy food products
11:30-12:00	Wrap-up questions
12:00-12:30	Post-questionnaires completion

FBDG printed material and a recipe book with culturally adapted recipes. The lessons that where taught focused on the following: 1) health, 2) South African dietary guidelines, 3) health benefits of soy, 4) commercial soy food products, and 4) soy uses and preparation.

Ethical considerations

The women were informed about the soy nutrition education intervention and voluntarily signed an informed consent form that was obtained from the participants prior to the intervention. Participants' data were de-identified for confidentiality purposes. This study was approved by the Texas Tech University Institutional Review Board 2022-333 and the Human Research Ethics Committee (UFS-HSD2021/0821/22) of the University of the Free State in South Africa.

Data analyses

Data were imported into Microsoft Excel, and nutrition self-efficacy and perception scores were calculated using the same programme.
The IBM SPSS program, version 29.0.0.0, was used for data analysis. Descriptive statistics (frequencies, means, standard deviations) were calculated to analyse sociodemographic information. The Shapiro-Wilk test was used to evaluate the normality of the continuous variables' distribution.

Paired t-tests were used to compare the mean differences related to knowledge, perception, and self-efficacy. Additionally, each question was analysed individually. A score was given based on whether the answer was correct, not sure, or incorrect. For one knowledge question and the perception questions, a score of 2 was assigned for a correct answer, 1 for not sure, and 0 for incorrect answers. For the other two knowledge questions, a score of 1 was assigned if the answer was correct and 0 if it was incorrect. For self-efficacy, a higher number indicates a higher degree of feeling capable of cooking with soy. The total scores were calculated by adding the sum of scores. A higher score denoted more knowledge, self-efficacy, and perception. For non-parametric data, the Wilcoxon signed-rank test was performed. A p-value of < 0.05 was considered statistically significant.

Spearman's rho correlation was used to assess the association between pretest knowledge and the dietary diversity among women, pretest knowledge and posttest knowledge of soy-based foods group (foods containing soy such as polony, Imana, and ProNutro), and knowledge and self-efficacy.

RESULTS

Sixty people participated in the nutrition education intervention; 58 were female and 2 were male. The mean ± SD age was 35.55 ± 8.72 years old. Most of the women that attended the intervention were the mothers (86.7%), followed by grandmothers (6.7%) and sisters (3.3%), of children who were part of the participating school's nutrition programme. As shown in Table 2, the majority were single (66.7%), and 43.3% reported having four people living at home. Regarding education, 96% attended secondary school and 16.7% had a postgraduate degree. More than half of the women (51.7%) were unemployed, and 76.7% did not use social media; they mostly used WhatsApp (68.3%) (Table 2).

Only 5% of the women consumed soy every day, whereas 66.7% indicated they never consumed it. The soy products that were primarily consumed were texturized soy protein (8.3%) and soy milk (8.3%). Regarding their dietary diversity by group, the mean DDS was 7.82 ± 1.89, indicating adequate dietary diversity (Table 3). However, within each group, the food variety was limited.

TABLE 2: DEMOGRAPHIC CHARACTERISTICS

Characteristics	n (%)
Age	33.55
Gender (n=60)	
Female	58 (96.7%)
Male	2 (3.3%)
Marital status	
Single	40 (66.7%)
Married	19 (31.7 %)
Other	1 (1.7%)
Family role	
Mother	52 (86.7%)
Grandmother	4 (6.7%)
Sister	2 (3.3%)
Brother	1 (1.7%)
Father	1 (1.7%)
Number of people in the household	
2	2(3.3%)
3	7 (11.7%)
4	26 (43.3%)
5	12 (20%)
6	13 (21.7)
Education level	
Primary school (1-7) grade)	2 (3.3%)
Secondary school (8-12 grade)	58 (96.7%)
Postgraduate qualification obtained	
Yes	10 (16.7%)
No	50 (83.3%)
Employment status	
Yes	29 (48.3%)
No	31 (51.7%)
Use of social media	
Yes	14 (23.3%)
No	46 (76.7%)

TABLE 3: TOTAL DIVERSITY SCORE BY GROUP

Group	Mean	SD
Flesh	2.4	0.924
Eggs	0.63	0.486
Dairy	2.02	1.269
Grains, roots, and tubers	4.38	1.698
Pulses	0.38	0.555
Nuts	1.02	0.676
Other vitamin A rich fruits and vegetables	1.3	1.03
Dark leafy green vegetable	0.52	0.567
Other fruits and juices diversity	2.48	1.69
Other vegetables diversity	3.7	2.242
Total DDS	7.82	1.891

Table 4 shows the food groups consumed (dietary diversity). The food groups that showed the most diverse consumption were the grains, roots, and tubers group, with a mean ± SD of 4.38 ± 1.70 food items, followed by the other vegetables (3.7 ± 2.24), and other fruits and juices (2.48 ± 1.69) food groups. More than 90% of the participants consumed the flesh foods (96.7%); grains, roots, and tubers (98.3%); and other fruits (95.0%) food groups the previous day. The pulses food group was consumed by the smallest

TABLE 4: PERCENTAGE OF PARTICIPANTS CONSUMING THE DIFFERENT FOOD GROUPS CONSUMED, AND SOY USED AT HOME

Food Groups	n (%)
Flesh foods	*58 (96.7%)*
Eggs	38 (63.3%)
Dairy (milk and milk products)	54 (90%)
Grains, roots and tubers	59 (98.3%)
Pulses	21 (35%)
Nuts and seeds	47 (78.3%)
Other vitamin A fruits and vegetables	44 (73.3%)
Dark leafy green vegetables	39 (65%)
Other fruits	57 (95%)
Other vegetables	52 (86.75)
Use of soy at home	
No	38 (63.3%)
Not sure	5 (8.3%)
Yes	17 (28.3)

TABLE 5: OVERALL SCORES IN KNOWLEDGE, SELF-EFFICACY, AND PERCEPTION

Knowledge	Pre-test	Correct answers by participants	Post test	Correct answers by participants	Change score	Signifi-cance
	Mean ± SD	%	Mean ± SD	%		p
Soy health benefits	17.22±3.01	21.2	19.60±2.90	26.93	2.38±4.19	<0.001
Use of soy	7.2±3.79	32.83	6.30±3.54	29.25	0.90.38±4.98	0.210
Foods containing soy	3.62±2.55	14.33	3.28±2.07	13.13	-0.34	0.480
Overall knowledge	28.19±6.58	22.07	29.29±5.97	22.67	1.1±7.62	0.275

TABLE 6: SOY NUTRITION KNOWLEDGE PRE AND POST INTERVENTION

Knowledge	Pre-test	Post test	Change score	Significance
	Mean ± SD	Mean ± SD	Mean ± SD	p
Soy health benefits	17.22±3.01	19.60±2.90	2.38±4.19	<0.001
Use of soy	7.2±3.79	6.30±3.54	-0.90.38±4.98	0.210
Foods containing soy	3.62±2.55	3.28±2.07	-0.34	0.480
Overall knowledge	28.19±6.58	29.29±5.97	1.1±7.62	0.275

TABLE 7: RELATIONSHIP BETWEEN KNOWLEDGE WITH FOOD THAT CONTAINS SOY AND SOY FOR HUMAN CONSUMPTION

Relationship	ρ	p
Knowledge of food that contains soy	.614	< .001*
Knowledge of soy for human consumption	.615	< .001*

proportion (35.0%) of the participants.

Table 5 shows the overall scores in knowledge, self-efficacy, and perception. There was no statistically significant change in perception, knowledge, or self-efficacy total scores after the intervention. However, knowledge questions were analysed individually, as shown in Table 6, and the only statistical significance ($p < 0.001$) was found in relation to knowledge of the health benefits of soy, which showed a mean ± SD change score of 2.38 ± 4.19. Although more participants had correct scores after than before the information session, only 26.93% of the participants knew all the health benefits of soy after the session.

There were three statistically significant ($p = < 0.001$) correlations found –– namely, between pre total knowledge score and the DDS,

pretest knowledge and knowledge about foods containing soy, and pretest knowledge and knowledge regarding use of soy for human consumption (ρ = 0.441, ρ =0.614, and ρ = 0.615, respectively) (Table 7).

DISCUSSION

It is known that women face greater disparities when compared to men in terms of employment, wages, economic status (Parry, 2021), and education (United Nations, 2020). The United Nations estimates that approximately 500 million females who are 15 years or younger face illiteracy, and the trend is for women to earn lower wages and frequently to be employed in the informal sector (United Nations, 2020). Therefore, they are the most susceptible to food insecurity and poverty (Dunga, 2020). In SA, the aforementioned disparities are more pronounced in households led by women (Parry, 2021). By 2022, data showed that the female population surpassed the male population in SA (Statista, 2022). Aligning with these statistics, our findings showed that most of our population were single (66.7%) women (96.7%) with relatively good education levels (85% with secondary education). We can thus infer that these participants were mostly from low-income, women-led households.

One way to assess dietary adequacy is to measure dietary diversity due to its association with food accessibility (Hashmi, 2021). Having a diet with higher diversity indicates sufficient intake of vital nutrients and energy (International Dietary Data Expansion Project, 2023). According to the MDD-W, a woman who has consumed at least 5 out of the 10 food groups within a period of 24 hours is considered to have minimally appropriate dietary diversity (International Dietary Data Expansion Project, 2023). This indicator is often used among women between 15–49 years old. It was thus suitable for our population, given that the mean age was 35.55 years old. Consuming diverse foods, both among and within food groups, is very important because it contributes to a proper intake of vitamins and minerals that are necessary to achieve adequate nutrition (Chakona, 2017) and prevent micronutrient deficiencies (Oldewage-Theron & Egal, 2015). The present study's results showed that a large majority of women had adequate dietary diversity within 24 hours. In contrast, a cross-sectional study conducted by Madlala (2022) among adult South African women with similar sociodemographic characteristics as those in the current study (i.e., mostly single, unemployed, with low education level) found that only 29.6% met the minimum dietary diversity level. This discrepancy may be attributed to the differences in sample size (n = 60 and n = 694 for our study and Madlala's study, respectively), the study design between the studies and because, in rural regions of SA, starchy foods are primarily consumed (University of Pretoria, 2016).

In 2021, only 12.8% of the soy produced in SA was utilised for human consumption, whereas the rest of the soy was used to process oil and animal feed (Statista, 2023c). Despite soy being included in the FBDG for SA, low consumption levels have been found among South Africans, with only 2% of the total processed soybeans destined for human consumption (Statista, 2023c). A similar trend was observed in our study. A different study amongst soy farmers in KwaZulu-Natal also found low consumption of soy (Oldewage-Theron *et al*., 2020).

Soy stands out as the most nutritionally dense legume, as it has the highest oil (62% polyunsaturated fatty acids) (Szpunar-Krok and Wondołowska-Grabowska, 2022) and protein content. Its excellent nutritional profile can substantially contribute to meeting the Recommended Dietary Allowances (RDAs) for both children and adults. This is attributed to its composition of carbohydrates, proteins, and lipids (Funduluka, 2023). In addition to its

nutrient content, it is a low-cost, versatile food source (Oldewage-Theron *et al*., 2020).

Nutrition education is one important tool for changing eating habits with the aim of enhancing health (Washington State Department of Social and Health Services, n.d.). A systematic review by Murimi (2017) found that effective, successful nutrition education should be supported by a behavioural theory. For example, using cooking demonstrations enhances participants' motivation to change behaviours (Goh, 2022). Therefore, this pilot study was informed by the SCT. Moreover, when working with low-income populations, it is important to consider their time flexibility, and other factors such as transportation availability, thus, developing a short intervention is suitable (Rustad, 2013).

The present study did not find any significant improvements in nutrition knowledge, self-efficacy, or perception total scores. This is inconsistent with a similar research that was undertaken by Oldewage-Theron *et al*. (2020), which included a one-day nutrition education workshop also based on the SCT and with similar content. The intervention was found to significantly increase the knowledge about soy among male farmers. Their result is likely to be influenced by the duration of the intervention, as the farmers' intervention lasted one full day and included more cooking demonstrations, whereas this pilot study lasted 4 hours, and only two recipes were demonstrated. However, this pilot study shows a positive, statistically significant change in knowledge regarding the health benefits of soy.

Despite finding positive correlations between pretest knowledge and knowledge about foods containing soy, and pretest knowledge and knowledge regarding use of soy for human consumption, when participants were asked if they use soy-based foods in their house they said they did not. This may be explained by the fact that more than half reported feeling neutral about (neither disliking or liking) or disliking the taste of soy. In their systematic review, Appleton *et al*. (2018) found that repeated exposure, which is a strategy that is utilised to increase people's liking of foods and thereby increase their consumption, was successful in increasing people's vegetable intake. Hence, we emphasise the need for implementation of a repeated exposure strategy to increase soy consumption and thereby enhance people's nutritional status.

LIMITATIONS AND STRENGTHS

One limitation of the study is the short amount of time (only 4 hours in total) that was available to teach all the components of the nutrition education programme. Additionally, teaching for only half a day did not allow for evaluation of DDS changes over time. Not having a control group was another limitation because this makes it harder to account for confounding variables and to assess the effect of the intervention.

Despite the limitations of this pilot study, the short nutrition education intervention significantly changed people's knowledge about the health benefits of soy, indicating the potential of a theory-based nutrition education programme to increase nutritional knowledge. This is one of the only studies that has tested soy knowledge and consumption among women and emphasised the importance of soy for addressing food security and malnutrition.

CONCLUSION

This short nutrition education intervention produced valuable information about South African women's dietary diversity, providing a

starting point for improving the quality of their current diet. This information can be used to prepare nutrition education content targeting specifically nutritional needs and food preferences by increasing dietary diversity within groups, taking advantage programme's content, which has been culturally developed and tailored for South Africans. This study aimed to raise awareness on soy health benefits, and soy-based foods preparation. Although, participants' knowledge about soy health benefits increased; self-efficacy in soy preparation did not change significantly. However, this is an important issue for future research as the potential of a theory-based nutrition education programme to increase nutritional knowledge, perceptions and food preparation self-efficacy is crucial in addressing food insecurity and malnutrition prevalence in low-income households. It is recommended extending the nutrition education program implementation with more cooking demonstrations and hands-on cooking experiences in a larger sample of women to allow for more generalisable results

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