frontiers in Sustainable Food Systems

ORIGINAL RESEARCH
published: 03 January 2022
doi: 10.3389/fsufs.2021.726404

Drivers of Pigeon Pea Consumption Among School-Aged Children in Central Tanzania

Wanjiku N. Gichohi-Wainaina[1]*, Ruth Mremi[2], Monica Chande[2], John M. Msuya[2], Nelson C. Kumwenda[1], Yasinta C. Muzanila[3], Harry Msere[1], Happiness Muhimbula[2], Mateete Bekunda[4] and Patrick Okori[1]

[1] International Crops Research Institute for the Semi Arid Tropics, Lilongwe, Malawi, [2] Department of Food Technology, Nutrition and Consumer Studies, Sokoine University of Agriculture, Morogoro, Tanzania, [3] Department of Biosciences, Solomon Mahlangu College of Science and Education, Sokoine University of Agriculture, Morogoro, Tanzania, [4] Africa Rising Program, International Institute for Tropical Agriculture, Arusha, Tanzania

OPEN ACCESS

Edited by:
Ian Givens,
University of Reading, United Kingdom

Reviewed by:
Daniela Spina,
University of Catania, Italy
Shalini Gaur Rudra,
Indian Agricultural Research Institute,
India

***Correspondence:**
Wanjiku N. Gichohi-Wainaina
wngichohi@gmail.com;
W.Gichohi@cgiar.org

Specialty section:
This article was submitted to
Nutrition and Sustainable Diets,
a section of the journal
Frontiers in Sustainable Food Systems

Received: 16 June 2021
Accepted: 03 November 2021
Published: 03 January 2022

Citation:
Gichohi-Wainaina WN, Mremi R, Chande M, Msuya JM, Kumwenda NC, Muzanila YC, Msere H, Muhimbula H, Bekunda M and Okori P (2022) Drivers of Pigeon Pea Consumption Among School-Aged Children in Central Tanzania.
Front. Sustain. Food Syst. 5:726404.
doi: 10.3389/fsufs.2021.726404

Background: Protein energy malnutrition (PEM) and iron deficiencies (ID) are of major public health concern in Tanzania including among school-aged children. PEM and ID in early childhood have serious, long-term consequences because they impede motor, sensory, social and emotional development, growth retardation, poor cognitive development, learning disability of children, lowered resistance to infectious diseases, and reduced physical work capacity. The objective of this study was to elucidate the drivers of pigeon pea consumption among school-aged children in Dodoma district, Central Tanzania. Understanding these drivers would be useful in promoting pigeon pea consumption among school-aged children as one of the strategies to increase dietary protein and iron intake.

Methods: This study was a cross-sectional study in which data were collected using a questionnaire based on a combination of the Theory of Planned Behavior and Health Belief Model. The data were collected from caregivers ($n = 138$) in four villages in Kongwa district, Dodoma region, Central Tanzania. We used correlations and multiple regressions to assess associations between constructs and identify predictive constructs. Mann–Whitney *U* tests were used for score comparisons with a significant *p*-value set at <0.10.

Results: Health value was significantly correlated with health behavior identity ($r_S = 0.63$, $p < 0.001$) and also significantly predicted health behavior identity ($r_S = 0.49$, $p = 0.001$). The constructs cues to action and control belief were significantly associated with intention ($\beta = -0.41$, $p = 0.059$ and $\beta = 0.06$, $p = 0.019$ respectively). Finally, we observed that intention was a significant predictor of behavior ($\beta = 1.38$, $p = 0.001$). We also observed a significant negative interaction between perceived barriers and intention to consume pigeon pea ($\beta = -0.04$, $p = 0.006$), indicating that perceived barriers limit intention to consume pigeon pea.

Conclusion and Implication: Our findings indicate that when the caregiver places increased importance on preventing her school-aged child from being iron or protein deficient or indeed anemic (health value), it results in a positive evaluation of the effectiveness of giving pigeon pea to address these nutrient deficiencies. Programs and efforts aimed at promoting pigeon pea consumption should focus on educating caregivers on iron and protein deficiency and the role that pigeon pea could play in addressing these. However, perceived barriers such as pest infestation during storage need to be addressed to increase pigeon pea consumption. The involvement of post-harvest management specialists is therefore crucial. Along with this, increasing productivity and crop management is also crucial to ensure year-round affordable supply of pigeon pea.

Keywords: pigeon pea, iron deficiency, Tanzania, school aged children, drivers of food choice

INTRODUCTION

Appropriate nutrition of school-aged children (SAC) (5–12 years) remains a priority since their health, physical growth, and intellectual development crucially depend on adequate provision of nutrients (WHO, 2000; Buttriss, 2002; Jomaa et al., 2011). Their school performance is dependent on optimal nutrition status (WHO, 2000) especially during a period of increased nutrient needs (Buttriss, 2002). It has been observed that inadequate nutrient consumption is strongly associated with protein energy malnutrition (PEM) and micronutrient deficiencies (Ochola and Masibo, 2014). In central Tanzania, SAC have previously been observed to have high prevalence of anemia partly due to poor food consumption, which limits their ability to thrive and benefit from education (Leonard et al., 2015). Current data indicate that SAC in developing countries mainly consume plant-based diets, which are predominantly from cereals, roots, and tubers (Kassaye et al., 2001; Murphy et al., 2003; Tatala et al., 2005; Ahmed et al., 2006; Gewa et al., 2014), thus predisposing them to nutrient deficiencies.

To address nutrient deficiencies, different strategies such as supplementation, fortification, and other food-based strategies may be utilized (Tontisirin et al., 2002). Experience has shown that food-based strategies such as improved food production and dietary diversification with nutrient-dense legumes, for example, are the most sustainable to increase the macro- and micronutrient intake in a population due to their associated multiple social, economic, and health benefits (Nair et al., 2015). This is because food-based approaches promote wellbeing and health of individuals through supporting incomes and livelihoods while providing the right to healthy food through ecologically sound and sustainable agriculture systems (Amoroso, 2014).

Pigeon pea is a grain legume that is well adapted to low rainfall patterns and thrives in low-fertility soils. It is therefore a crop that can reduce the hunger and nutrient gap in semi-arid regions, serving as a good source of protein and other micronutrients such as iron. It has a protein content of 19–21.7% and an iron content of about 2.5–4.7 mg/100 g dry matter (Amarteifio et al., 2002). The legume protein is a useful alternative (Seetha Anitha et al., 2019) to animal protein, which is not sufficient, often unaffordable and therefore hardly consumed (Schonfeldt and Gibson Hall, 2012). A recent study indicates that incorporation of legumes such as pigeon pea into diets also provides access to all nine essential amino acids, as well as Vitamin B, ascorbic acid, carotenoids, iron, and magnesium (Seetha Anitha et al., 2019). Despite this potential to meet nutrient needs, pigeon pea has been widely grown in Tanzania for export to India. In 2018, however, there was a drastic fall in pigeon pea prices, after Tanzania's' biggest market, India, banned pigeon pea exports directly affecting ∼300,000 Tanzanian farmers engaged in pigeon pea farming (Malawi Investment and Trade Centre, 2018). The study described herein was embedded within a wider program that aimed to, in part, address this situation from a nutrition and health perspective as a basis for sustained production. In the semi-arid Kongwa district of Central Tanzania, we focused on promoting pigeon pea consumption *via* a farm (production)-to-fork (consumption) approach. Increased consumption, besides addressing nutrition directly, offers avenues for farmers to diversify markets and reduce overdependence on export markets.

The combined Theory of Planned Behavior (TPB) and Health Belief Model (HBM) employed herein have previously been used in explaining influential variables in food-related behaviors (Sun et al., 2006). *Via* the model, we elucidate herein the drivers of pigeon pea consumption among Tanzanian SAC.

METHODS

Ethical Approval and Consent

This study did not seek approval from an ethical review board because it did not involve blood collection, any invasive procedure or anthropometry. Prior to implementation of the study, approvals from district administrative officials as well as traditional authorities were obtained. All respondents had the study explained to them in the local language, Kiswahili, and were assured of confidentiality and offered opportunity to ask questions. Respondents were also informed that they were free to decline participation prior to or at any point during the questionnaire administration. Study participants then indicated their approval by giving written consent. Where respondents could not write, approval to participate was indicated *via* thumb print.

Study Site

Kongwa district is one of the action districts of the Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) program. The program aims to create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children (Hoeschle, 2021). Kongwa district is located in the eastern corner of Dodoma region and covers a land area of 4,041 km^2 (NBS, 2013). It borders Kiteto district to the north, Kilosa district in the east, Chamwino district in the west, and Mpwapwa district in the south. The elevation of Kongwa district ranges from 900 to 1,000 m above sea level (**Figure 1**).

The district is characterized by semi-arid conditions, with rainfalls of 450–700 mm/year, but with great variability and often distributed within a very short period. The main economic activities are crop agriculture and livestock keeping. The crops that are grown include maize, pigeon pea, sorghum, and millets, while the livestock kept include cattle, goats, sheep, and pigs (NBS, 2013). The villages selected were Moleti, Laikala, Mlali, and Chitego based on their high pigeon pea production relative to other villages in the district.

Sampling and Study Participants

A sample of 138 caregivers of reproductive age (20–49 years) were randomly selected for the study. As a general rule for the TPB, a sample size of 80 is considered to be minimum and 180 is considered maximum for acceptable statistical analyses (Francis et al., 2004). Caregivers were from households with SAC (5–12 years). Households were selected using the random walk sampling method, and all caregivers from the selected households were listed. From this, one caregiver was randomly selected to represent each household for the questionnaire administration. Of the listed caregivers, the inclusion criteria were prior knowledge and consumption of pigeon pea, and willingness to participate in the study.

Development of Dietary Intake and Food Behavior Assessment Questionnaires

A focus group discussion was conducted to investigate commonly consumed protein- and iron-rich foods as well as their frequency of consumption. Pigeon pea-based recipes were also documented to enable calculation of potential protein and iron contents. Once this was established, a food frequency questionnaire where respondents were asked how many servings of pigeon pea-based foods they intend to consume in the next month was developed and administered (Appendix 1 in **Supplementary Material**). Along with this, the frequency of consumption of protein-rich foods in the past 7 days preceding the survey was investigated (Appendix 2 in **Supplementary Material**). We used a shorter period of recall for protein-based foods because these may not be frequently consumed.

Both questionnaires were validated with women who were in the villages that would eventually not take part in the actual study but had similar consumption habits.

Nutrient content of raw pulses, legumes, and groundnut commonly consumed in Kongwa were obtained from the Tanzanian food composition table (TFCT) (Lukmanji et al., 2008). Nutrient content of recipes was also obtained from the TFCT, and where the recipe was not available in totality, it was calculated from nutrient contents of the various foods that make up the recipe (Appendix 3 in **Supplementary Material**). Iron bioavailability of plant source foods was approximated at 5% as per previous studies by Macharia-Mutie et al. (2011).

Age-appropriate protein and iron requirements were obtained from the Food and Agriculture Organization website (FAO/WHO, 1998; FAO, 2021) and compared with the pigeon pea-based recipes for nutrient adequacy. Proportions of nutrient requirements met were calculated by dividing the amount of protein or iron provided by the meal by the daily requirements.

In terms of behavior assessment, a questionnaire based on the TPB and HBM was developed by following the procedures recommended by Sun et al. (2006) (Sun et al., 2006). The first part of the questionnaire included the socio-demographic and socio-economic status variables of the respondent. The second part consisted of 66 items, identified from literature. The items were characterized into 12 constructs based on the combined model of TPB and HBM as was undertaken in several earlier studies (Sun et al., 2006; Fanou-Fogny et al., 2011; Macharia-Mutie et al., 2011; Abizari et al., 2013; Talsma et al., 2013). The following is a description of constructs considered:

1. Knowledge assessed the caregivers understanding of the relationship between pigeon pea consumption and health, and specifically its relationship to iron deficiency or anemia and protein deficiency.
2. Perceived susceptibility assessed caregiver's feeling about her school-aged child being exposed to iron deficiency or anemia and protein deficiency.
3. Perceived severity assessed caregiver's feeling that her school-aged child being exposed to iron deficiency or anemia and protein deficiency is serious.
4. Health value assessed the importance caregiver places on the outcome of her school-aged child being iron deficient, anemic or protein deficient.
5. Health behavior identity assessed caregiver's evaluation of the effectiveness of pigeon pea consumption in reducing iron deficiency or anemia and protein deficiency.
6. Perceived barriers assessed the caregiver's evaluation of various complications that hinder her in giving pigeon pea to her school-aged child.
7. Attitude toward behavior assessed caregiver's evaluation of giving pigeon pea to a school-aged child.
8. Cues to action assessed the surrounding situation that cause a caregiver to change her health behavior in giving pigeon pea to her school-aged child.
9. Control belief assessed a caregiver's perceived ability to make a decision on giving pigeon pea to her school-aged child.
10. Subjective norms reveal a caregiver's perceived social influencers to give, or not to give, pigeon pea to their school-aged child (who is important for the behavior and is the opinion of that person important?).

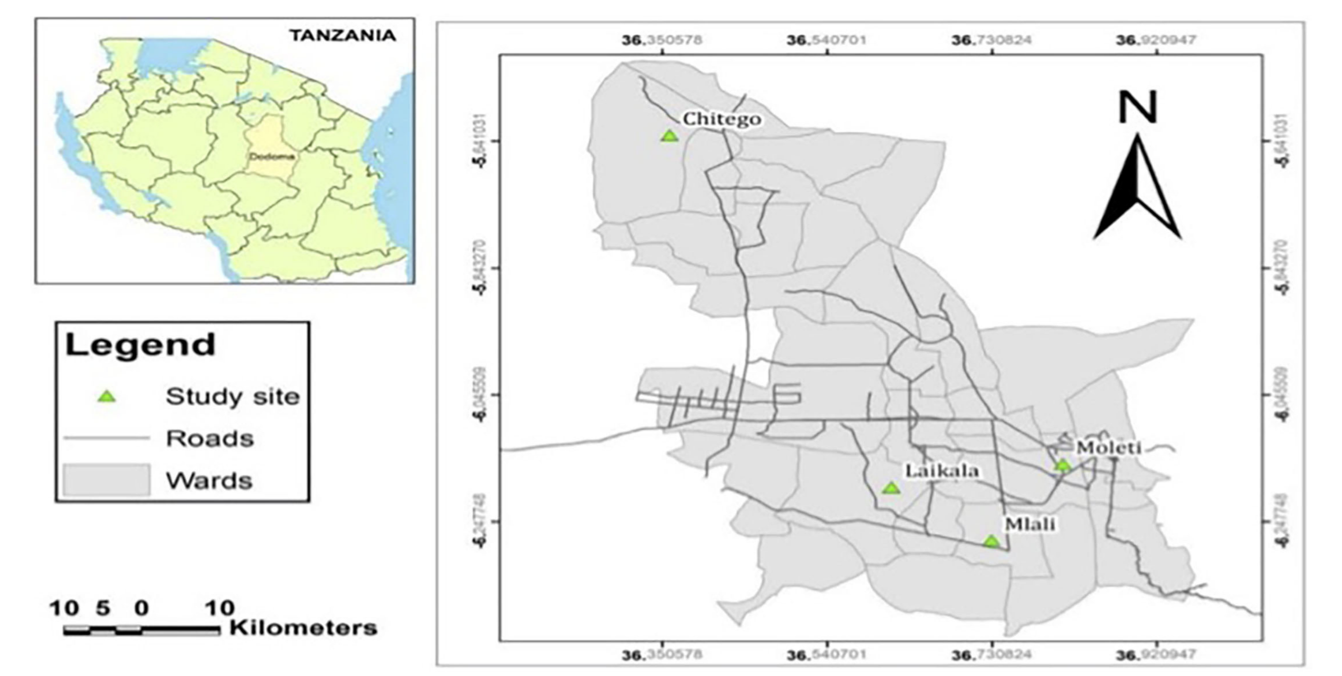

FIGURE 1 | Map of Kongwa district in which the study was conducted.

11. Behavioral intention is a sign of how much effort a caregiver is planning to make, in order to give pigeon pea to school-aged child.
12. Behavior assessed the giving of pigeon pea to school-going children by caregivers.

Respondents were asked to indicate their level of agreement or disagreement with statements on a Likert scale. Pre-testing was done in sites with characteristics similar to those of the four study villages. All questionnaires were administered face-to-face by well-trained research enumerators who were familiar with cultural settings in the study area.

Scale Measurements and Analyses

Knowledge, perceived susceptibility, perceived severity, health value, health behavior identity, perceived barriers, cues to action, and control belief constructs were rated using a five-point Likert scale that ranged from strongly disagree, disagree, neutral, agree, and strongly agree. The reason that odd-numbered scales were chosen was so that a central neutral response and an equal number of positive and negative responses above and below the neutral middle response were provided (Emerson, 2017). The score for each construct was computed as the sum of individual item scores. The scores for the constructs "*Attitudes toward behavior*" and "*Subjective norms*" were sums of products of paired items; *attitudes* × *evaluation of attitudes*, and *normative beliefs* × *motivation to comply*, respectively. To show negative, neutral, or positive influences, item scores of *attitudes* and *normative beliefs* ranged from −2 to 2 and the scores of the *evaluation of attitudes* and *motivation to comply* ranged from +1 to +5. This resulted in a paired-item score range of −10 to 10. For intention and behavior, the rating scale ranged from not consumed, four or less times per month, and eight or more times per month. The scores on intention and behavior constructs were based on the number of times caregivers intended to feed or had fed their school-going child with pigeon pea in the refereed month, respectively. Intention was considered high if it was higher than the median intention score of the group, and low if it was equal to or lower than the median scores as it was in previous studies (Sun et al., 2006; Fanou-Fogny et al., 2011; Macharia-Mutie et al., 2011; Abizari et al., 2013; Talsma et al., 2013).

Statistical Analyses

Descriptive statistics were performed to describe the socio-demographic characteristics of the caregivers and their children. Multiple sentence constructs were tested for reliability of the questionnaire and internal consistency using Cronbach's α and sentence-total correlation. The items within a construct were regarded as consistent when Cronbach's α was $\sim$0.75 or higher and the corrected sentence-total correlation of all sentences in a construct higher than 0.30 (Field, 2005). Mann–Whitney U-tests were used to examine differences in various construct items between high and low intenders. This test was used to compare whether there is a difference in the dependent variable for two independent groups (Karadimitriou, 2018). Spearman's correlation was used to test the bivariate association within the combined model of TPB and HBM. Spearman rank correlation test was selected since, in this case, ranked data were being compared (Schober et al., 2018).

Three multiple linear regression models were used to examine the contribution of constructs to health behavior identity, intention, and behavior. The first model was designed to identify constructs classified within background and perception that were associated with health behavior identity (Model 1). To identify constructs associated with intention, the second model combined internal factors (Perceived barrier, Health behavior identity, and Attitudes toward behavior) and external factors (Subjective norms, Control beliefs, and Cues to action) as predictor variables (Model 2). Finally, to identify constructs associated with pigeon pea consumption among SAC, we included constructs that were significantly associated with intention (Health behavior identity, Attitudes toward behavior, Subjective norms, Cues to action, and External control beliefs) as well as intention. The construct perceived barriers were included as a predictor because of the importance of considering the role barriers may play in influencing pigeon pea consumption. An interaction term between perceived barriers and intention was also included in this final model to investigate how perceived barriers modulated the association between intention and behavior. All models were corrected for age of the child, education, and interviewer effect.

Overall, statistical tests were two-tailed, and *p*-values < 0.10 were considered statistically significant. We used this *p*-value cutoff due to the finite sample size of our study and because this study was prone to random errors (Thiese et al., 2016). All analyses were performed using IBM SPSS Statistics for Windows (Version 20.0. IBM Corp, 2011, Armonk, NY).

RESULTS

Background Characteristics of the Study Participants in Kongwa

A total of 138 caregivers with a similar number of SAC participated in the study. **Table 1** shows the summaries for each of the background characteristics considered in this study. Half of the sampled children were male (50.7%) with 68% of the children in the age group 5 to 8 years. The biggest proportion (91.8%) of children lived with their mothers. Majority of the respondents did not have any formal education (55.8%) while 44.2% had some form of formal education. We observed that 84.8% of the respondent households earned their income through crop farming and livestock keeping. The most dominant ethnic groups were the Kaguru (65.2%).

TABLE 1 | Socio-demographic characteristicts of schoolchidren and their caregivers in Kongwa.

Variables	***n* (%)**
N	138
Schoolchild characteristics	
Age of children, years	
5–6	51 (37.0)
7–8	44 (31.9)
9–10	28 (20.3)
11–12	15 (10.9)
Sex of child	
Male	70 (50.7)
Female	68 (49.3)
Caregiver Characteristics	
Relationship with the caregiver	
Mother	126 (91.3)
Guardian	12 (8.7)
Education	
No school	77 (55.8)
Primary school	46 (33.3)
Secondary school	11 (7.0)
Tertiary education	4 (2.9)
Marital status	
Married	96 (69.6)
Divorced	28 (20.3)
Single	14 (10.1)
Caregiver occupation	
Farming (crop and livestock)	117 (84.8)
Salaried employment	1 (0.7)
Self-employed off farm	13 (9.4)
Casual laborer on farm	7 (5.1)
Ethnic group	
Kaguru	90 (65.2)
Other tribes (Gogo and Rangi)	48 (34.8)
Main consumer of pigeon pea	
Respondent only	3 (2.2)
School-going children (5–12 years) only	2 (1.4)
All household members	131 (94.9)
Household members > 60 years only	2 (1.4)

Consumption of Pigeon Pea and Other Iron- and Protein-Rich Foods and Their Contribution to Nutrient Adequacy

Pigeon pea-based foods were consumed in different forms: as a relish and accompaniment to stiff porridge (ugali) or rice, mixed with rice in a dish known as "mesto," or cooked with maize grains in a dish known as "kande ya mbaazi." The relish was consumed four to five times a week by 37.7% of the respondents compared to 23.2%, 15.2%, and 9.4% who reported to have consumed the same meal once, two, to three times a week or greater than six times per week, respectively (**Figure 2**). Mseto and kande ya mbaazi were consumed by the majority, respectively, by 62.3% and 65.2% of the respondents once a week.

Other common plant-based foods consumed were bean stew, groundnuts, and green vegetables consumed by 76, 43.5, and 74.6%, respectively, once per week (**Figure 3**). There was frequent consumption of animal source foods that are also rich in protein and iron. In detail, 62% of the population consumed meat, 44.7% dairy foods, and 67.3% fish and sardines more than once a week. In comparison, organ meat and eggs were consumed less frequently, reported as being consumed more than once in the last 7 days by 15.2 and 26.7% of the population, respectively (**Figure 3**).

The protein content of raw pigeon pea was comparable to that of other legumes such as mung bean, common bean, cow pea, and groundnut (**Table 2**), except for soybean,

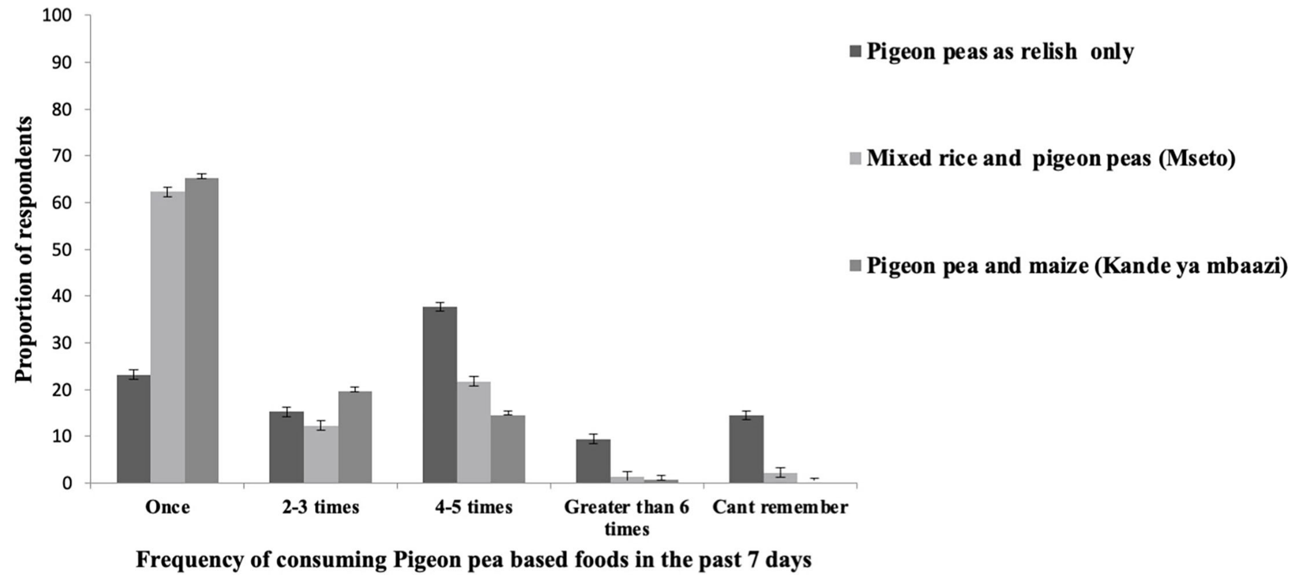

FIGURE 2 | Consumption of pigeon pea based foods in the seven days preceding the survey.

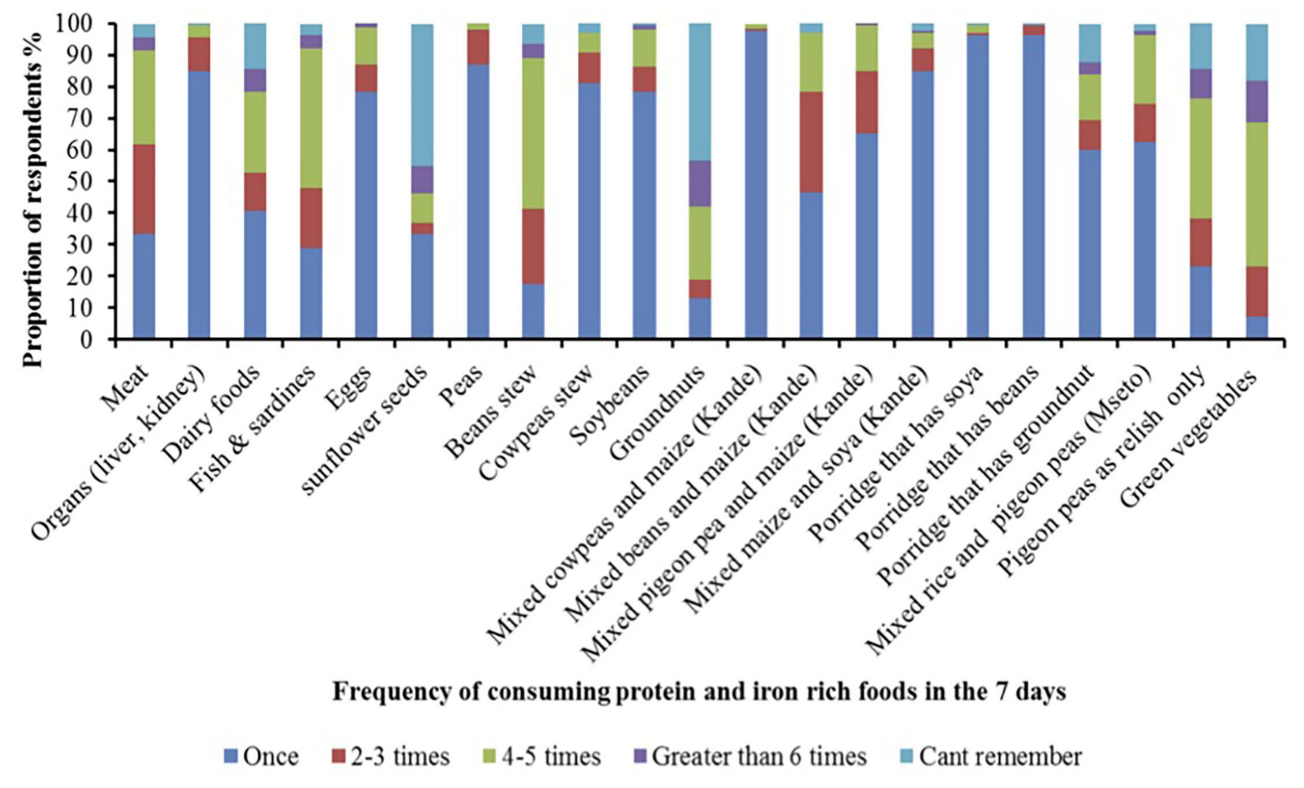

FIGURE 3 | Frequency of consuming protein and iron rich foods in the 7 days preceding the survey.

which was superior by about 15 g. However, pigeon pea has an amino acid profile that compares closely with that of soybean, with the exception of methionine (0.87 vs. 1.55 g/100 g) and cysteine (0.67 vs. 1.44 g/100 g) content for pigeon pea and soybean, respectively. On the other hand, histidine is an essential amino acid found in abundance in split pigeon pea (3.16 mg/100 g) compared with white soybean (2.55 mg/100 g).

TABLE 2 | Protein and iron content of animal source and plant foods consumed in Kongwa based on the Tanzania Food Composition Table (Lukmanji et al., 2008).

Food group	Food	Serving size (g)	Protein (g)	Fe (mg)	Available Fe (mg)
Legumes	Pigeon pea (raw)	100	21.7	4.4	0.22
	Pigeon pea cooked	100	6.1	1.2	0.06
	Pigeon pea relish with oil	100	13.8	2.8	0.14
	Bean, mung, raw	100	20.3	6.6	0.33
	Mung bean (dry, boiled)	100	2.8	0.6	0.03
	Beans, kidney, mature, boiled without salt	100	23.6	7.5	0.38
	Soybean yellow	100	36.5	15.8	0.79
	Cowpea, uncooked	100	23.5	6.6	0.33
	Cow pea (dry) relish with oil	100	7.3	0	0
	Groundnut	100	25.8	4.6	0.23
Meat					
	Chicken	100	18.8	1	-
	Beef	100	16.9	1.1	-
	Goat	100	24.9	1.7	-
	Fish	100	21.4	0.3	-
	Egg, chicken	100	12.6	0	-

Recipes for the pigeon pea-based dishes were recorded. In general, pigeon pea relish consisted of pigeon pea fried with a small quantity of tomatoes and oil as condiments. This relish was often consumed with rice. For kande ya mbaazi, it was prepared similarly to the pigeon pea relish only that 50% of the pigeon pea in the recipe was replaced with maize. It was estimated that the rice-pigeon pea dish (mesto) consisted of 20% pigeon pea. Assuming a consumption of 336 g per meal based on a study in SAC in Kenya (Talsma et al., 2013), the potential protein and iron intakes from the three-pigeon pea-based meals were calculated as follows and is also elaborated in Appendix 3 in **Supplementary Material**:

1. Pigeon pea relish nutrient content is recorded in the Tanzania food composition table (Lukmanji et al., 2008). The iron content in the pigeon pea relish is 2.8 mg/100 g. Considering a 5% bioavailability, iron content in the pigeon pea relish in this calculation is considered as 0.14 mg. Based on a consumption of 336 g per meal, pigeon pea relish was ~40% of the meal, that is, 134.4 g. Rice in this meal would supply an estimated Fe and protein content of 0.03 mg [(201.6/100) * 0.02] and 5.8 g [(201.6/100) * 2.9], respectively. A pigeon pea relish and rice meal would thus supply 0.22 mg of iron and 24.4 g of protein.
2. A similar amount of pigeon pea and maize mix would consist of 50% pigeon pea and 50% maize. Based on a 336-g meal, 118 g of pigeon pea in the mix would supply 0.17 mg [(118/100) * 0.14] of iron and 16.3 g [(118/100) * 13.8] of protein. Iron content in cracked maize that is used in this recipe is 1.2 mg. Considering 5% bioavailability, iron content in this calculation was considered as 0.06 mg. Maize in this recipe would supply 0.07 mg [(118/100) * 0.06] of iron and 3.2 g [(118/100) * 2.7] of protein. In total, the meal would thus potentially supply 0.24 mg (0.17 mg + 0.07 mg) of iron and 19.5 g (16.3 g + 3.2 g) of protein.
3. For mseto, in 336 g, there would be 67.2 g of pigeon pea and 268.8 g of rice. Rice had a recorded iron content of 0.3 mg, with a bioavailable iron of 0.02 mg (0.03 mg * 0.05). Fe and protein content from pigeon pea were recorded as 0.04 mg iron [(67.2/100) * 0.14] and 4.1 g protein [(67.2/100) * 6.1], respectively. The estimated Fe and protein content from the rice was 0.05 mg iron [(268.8/100) * 0.02] and 7.8 g protein [(268.8/100) * 2.9], respectively. In total, this recipe would provide an estimated 0.08 mg Fe and 11.9 g protein.

Based on the above, pigeon pea relish eaten with a rice accompaniment would potentially meet 96% of the iron requirements for children 5–6 years, 69% for those 7–10 years, and 40% for males and females 11–14 years. The pigeon pea maize mix or kande would meet all the iron requirements for 5–6-year-olds, 75% for 7-to-10-year-olds, 44% for those 11 years and older. In terms of protein requirements, a 336-g pigeon pea relish and rice meal would meet 100% of the protein requirements for 5–7-year-olds, 90% for 7–10-year-olds, 70 and 68% for 10–12-year-old boys and girls, respectively. Mseto met the least proportion of iron and protein requirements for SAC. A 336-g meal would meet 35% of iron requirements for 5–6-year-olds, 25% for 7–10-year-olds, and 15% for those over 11 years. When protein requirements were considered, mseto would meet 57% of protein requirements for 5–7-year-olds, 44% for 7–10-year-olds, and 35% and 33% for 10–12-year-old boys and girls, respectively. Iron and protein requirements are presented in **Table 3**.

Drivers of Pigeon Pea Consumption

When comparisons between intention and behavior were made at the consumption level of at least eight or more times a month, a significant difference was observed (57.2 vs. 58.7% respectively; $p = 0.089$). There was no significant difference between intention and behavior for consumption levels of four or less times a month (37.7 vs. 34.1%, respectively; $p = 0.615$) or where there was neither no intention to consume nor consumption (5.1 vs. 7.2%, respectively; $p = 0.467$). These comparisons are represented *via* bar graphs in **Figure 4**.

Internal Drivers Influencing Pigeon Pea Consumption Among School-Aged Children

The internal drivers were identified by assessing the caregiver's knowledge about the relationship between food or nutrients and health as well as their subjective perception of the school children being malnourished and iron deficient or anemic (perceived severity). Nearly all caregivers recognized food as playing a vital role in the health of their children (95.7%) but did not think that food can prevent iron deficiency (48.6%) or know that pigeon pea contains high levels of protein (48.6%) and iron (30.4%). Additionally, majority did not know that protein is important for the growth and health of their children (67.4 and 47.8%, respectively). In terms of the role of nutrients, 37.0% of respondents knew that protein could prevent their children from becoming underweight and 27.5% understood that iron is important in preventing iron deficiency or anemia. Less than half of the caregivers had knowledge of the benefits of pigeon pea as a protein-based food that could prevent underweight in their child or iron deficiency and anemia.

More than half (63.8%) of caregivers perceived anemia as affecting growth, intelligence (65.2%), and school performance (65.9%). A slightly higher proportion recognized anemia as being associated with the child's level of activity (77.5%) as well as mortality (73.9%). In terms of health value, majority of respondents agreed that the following aspects of their school-aged child were important to them: weight (94.9%), growth (96.4%), intelligence (97.8%), school performance (97.1%), strength (94.2%), and survival (97.1%). However only about half of the respondents agreed that iron was important for cognition (50.0%) and activity (58.7%; **Table 4**).

In terms of health behavior identity, almost all (93.5%) caregivers perceived giving pigeon pea as one of the best things that they could do. They also thought of pigeon pea as one of the best foods they can give to improve intelligence

TABLE 3 | Protein and iron requirements for school-aged children (5–11 years).

Age (years)	Protein	
	g/kg	g/day
5 to 7	1	21
7 to 10	1	27
Boys		
10 to 12	1	34
Girls		
10 to 12	1	36
	Fe (mg/day)	
4 to 6	0.23	
7 to 10	0.32	
Male		
11 to 14	0.55	
Female		
11 to 14	0.55	

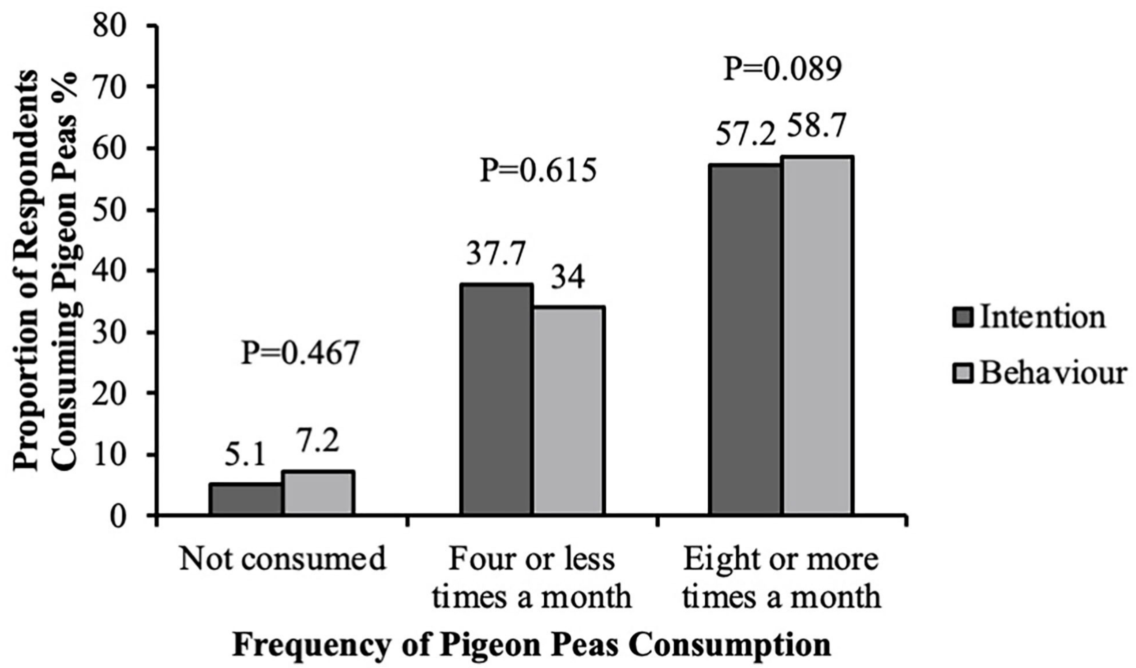

FIGURE 4 | Intention to consume pigeon pea in the coming month and behavior (pigeon pea consumption) of the last month (n = 138).

TABLE 4 | Internal and external factors influencing pigeon pea consumption.

Internal and external factors	Proportion of respondents that agree with statement
Knowledge	
Food is important for the health of my school-aged child	95.7
Food can prevent low weight in my school child	58.7
Food can prevent shortage of blood in my school child	48.6
Pigeon pea contains high levels protein	48.6
Pigeon pea contains high levels of iron	30.4
Protein is important for the growth of my school child	67.4
Iron is important for the health of my school child	47.8
Protein can prevent my school child from becoming underweight	37.0
Iron can prevent shortage of blood in my school child	27.5
Pigeon pea can prevent my school child from becoming underweight	41.3
Pigeon pea can prevent shortage of blood in my school child	34.1
Intestinal worms can cause shortage of blood in my school child	63.8
Perceived susceptibility	31.9
My school child suffers easily from weight loss	
My school child becomes disinterested in his environment easily	27.5
My school child suffers easily from shortage of blood	15.9
My school child becomes weak and tired easily	32.6
Perceived severity	44.9
Protein deficiency plays a role in the weight of my school child	
Iron deficiency plays a role in my school suffering from shortage of blood	32.6
Iron deficiency plays a role in my child disinterested with the environment	22.5
Shortage of blood plays a role in the growth of my school child	63.8
Shortage of blood plays a role in the intelligence of my school child	65.2
Shortage of blood can make my school child perform poorly in school	65.9
Shortage of blood can make my school child weak and tired all the time	77.5
Poor growth can increase the chances of death of my school child	71.7
Shortage of blood can increase the chances of death of my school child	73.9
Health value	96.4
The health of my school child is very important to me	
The weight of my school child is important to me	94.9
The growth of my school child is important to me	96.4
The intelligence of my school child is important to me	97.8
The school performance of my school child is important to me	97.1
It is important that my school child is strong all the time	94.2
The survival of my children is important to me	97.1
Iron is important for the cognitive development of my child	50.7
Iron is important for the activeness of my school child	58.0
Health Behavior Identity	
Giving pigeon pea is one of the best things that I can do for my child	93.5
Giving pigeon pea is one of the best things that I can do for my family members	94.2
Food that contains iron is one of the best things that I can do give to my child to improve his/her cognitive development	61.6
Giving pigeon pea is one of the best things I can do for my child to improve her/his intelligence	71.7
Giving pigeon pea is one of the best things I can do for my child to improve her/his health	87.7
Giving pigeon pea is one of the best things I can do for my child for her/his survival	85.5
Perceived Barriers	
The shorter boiling time makes me want to feed Pigeon pea to my child	66.7
I worry about the availability of pigeon pea on the market	33.3
I worry about the price of pigeon pea on the market	53.6
Pigeon pea requires a long soaking period of time before cooking.	26.8
I worry about the time required for processing pigeon pea	39.1
I worry about peas being contaminated with stones, gravels	48.6
Pigeon pea are easily prone to insect attack such as weevils	77.5
My child complains about the feeling of uneasiness after eating pigeon pea	12.3
My child complains about having a problem with flatulence after eating pigeon pea	17.4
I worry about chemicals used by farmers to control field and storage pests of pigeon pea	35.5
These chemicals have implications on one's health especially children	50.7
Pigeon peas are more expensive in the rainy season than in the dry season	65.9
I worry about the availability of fuel required to cook pigeon pea	47.8
I worry about the quantity of fuel required to cook pigeon pea	42.8
I worry about the availability of ingredients used to prepare pigeon pea relish	34.1
I am worried because the variety I prefer is not readily available	46.4
It is not easy to store/preserve pigeon pea	38.4
Attitudes Toward Behavior	
Pigeon pea has a good taste	97.8
Pigeon pea has a good smell	78.3
My child prefers foods that taste good	94.2
Pigeon pea has a good color	84.1
Pigeon pea causes ulcers	8.7
Pigeon pea is easily digestible in my child digestive system after consumption	81.2
It is necessary for my child to eat something that is easily prepared	81.9

(Continued)

TABLE 4 | Continued

Internal and external factors	Proportion of respondents that agree with statement
Pigeon peas do not require a long boiling time after soaking	43.5
Pigeon pea is a nutritious legume	79.7
It is important to me to feed my child with foods that are nutritious	88.4
Pigeon pea creates variety in my child's meal	53.6
It is important for me to feed my child something that creates variety in his/her meal	79.7
Pigeon pea is an example of a traditional staple food	83.3
It is important for me to feed my child with traditional staple foods	85.5
Feeding my child with pigeon pea helps to have adequate weight for age	78.3
It is important for me that my child has adequate weight for her age	92.0
Giving pigeon pea to my child helps to prevent blood shortage (becoming anemic)	49.3
It is important to feed my child with foods that prevent blood shortage	77.5
Feeding my child with pigeon pea helps stimulate free bowels (prevents constipation)	55.1
It is important that I give foods that stimulate free bowels to my child	84.1
My child does not enjoy eating pigeon pea	65.2
It is important for me to feed my child with food that he/she enjoys eating	96.4
My child enjoys eating pigeon pea with maize such as kande	78.3
It is important for me to feed my child pigeon pea with maize such as kande	81.9
My child enjoys eating pigeon pea with rice such as mseto	79.7
It is important for me to feed my child pigeon pea with rice such as mseto	77.5
External control belief	
I am the one who decides my child should consume pigeon pea	92.8
Cues to action	
Ramadan, harvest time, or women meetings make my child want to eat pigeon pea	76.1
My child likes to eat pigeon pea when we go out to a restaurant	31.2
I comply with the doctors', clinicians', or health workers' advice to give pigeon pea to my child	76.1
Illness/sickness of my child makes me want to use pigeon pea	29.7
My child suffering from anemia makes me want to use pigeon pea	26.1
A shortage of food makes me want to feed my child with pigeon pea	47.8
People around me using pigeon pea makes me want to feed pigeon pea to my child	29.0
Pigeon pea sellers and marketers make me want to buy pigeon pea	25.4
The media makes me want to buy pigeon pea	25.4

(Continued)

TABLE 4 | Continued

Internal and external factors	Proportion of respondents that agree with statement
The training in the community makes me want to feed my child pigeon pea	45.7
Subjective norms	
My husband gives me the advice to feed pigeon pea to my child	47.8
The advice of my husband is important to me	75.4
My mother-in-law advices me to feed pigeon pea to my child	38.4
The advice of my mother-in-law is important to me	68.1
My mother advises me to feed pigeon pea to my child	57.2
Advice from my mother is important to me	87.7
My friend(s) advise me to feed pigeon pea to my child	44.9
The advice of my friend(s) is important to me	66.7
My child's teacher(s) give me the advice to feed my child with pigeon pea	30.4
The advice of my child's teacher(s) is important to me	81.2
My nurse advices me to feed pigeon pea to my child	47.8
The advice of my nurse is important to me	89.9
Doctors give me the advice to feed my child with pigeon pea	53.6
The advice of the doctors is important to me	93.5
My village leaders give me advice to feed my child with pigeon pea	36.2
The advice of my village leaders is important to me	87.7
My religious leaders give me advice to feed my child with pigeon pea	31.9
The advice of my religious leaders is important to me	85.5

(71.7%), health (87.7%), and survival of their school child (85.5%). High intenders had a significantly higher appreciation of the role of foods that contain iron in improving cognition (74.6 vs. 60.9%; $p = 0.022$) and pigeon pea in particular being important for cognition (74.1 vs. 61.7%; $p = 0.031$) (**Table 5**; **Supplementary Table 1**). The findings indicate a gap in knowledge such that caregivers could not connect the benefits of pigeon to the nutrients present in them.

Majority of the respondents perceived pigeon pea seasonality (65.9%) and weevil attacks (77. 5%) as barriers to consumption (**Table 4**). When analyses were stratified according to high- and low-intention groups, there was no significant difference in these aspects (**Supplementary Table 1**). In terms of other aspects considered as possible barriers, we also observed significant differences between high and low intenders when preparation time was considered (61.4 vs. 74.3%; $p = 0.003$) and amount of fuel required for preparation (62.7 vs. 73.5%; $p = 0.081$; **Table 5**). A significantly higher number of low intenders considered preparation time as a barrier to pigeon pea consumption.

To influence consumption, it is crucial to understand the disposition of the caregiver toward giving pigeon pea to the schoolchild (attitude toward behavior). Majority of caregivers perceived pigeon pea as tasty (97.8), and with good aroma

TABLE 5 | Comparison between high and low intenders of pigeon pea consumption.

Variable/Statement	Mean Scores		*p*-value
	Low intention[a]	High intention[b]	
Iron is important for the cognitive development of my child	62.7	73.5	0.079
Iron is important for the activeness of my school child	62.0	73.9	0.053
Food that contains iron is one of the best things that I can do give to my child to improve his/her cognitive development	60.9	74.6	0.022
Giving pigeon pea is one of the best things I can do for my child to improve her/his intelligence	61.7	74.1	0.031
The shorter boiling time makes me want to feed	61.4	74.3	0.003
I worry about the quantity of fuel required to cook pigeon pea	62.7	73.5	0.081
Pigeon pea has a good taste	66.9	71.0	0.021
It is important to me to feed my child with foods that are nutritious	64.0	72.7	0.032
Pigeon pea is an example of a traditional staple food	63.3	73.5	0.033
It is important for me to feed my child with traditional staple foods	64.5	72.4	0.072
Feeding my child with pigeon pea helps to have adequate weight for age	60.1	75.0	0.001
It is important for me that my child has adequate weight for her age	65.6	71.8	0.061
Feeding my child with pigeon pea helps stimulate free bowels (prevents constipation)	61.9	74.0	0.054
My child does not enjoy eating pigeon pea	63.3	73.1	0.100
Illness/sickness of my child makes me want to use pigeon pea	60.1	75.0	0.010
My child suffering from anemia makes me want to use pigeon pea	61.2	74.4	0.020
I comply with the doctors, clinicians or health workers advice to give pigeon pea to my child	64.1	72.7	0.100
A shortage of food makes me want to feed my child with pigeon pea	62.0	73.9	0.053
My nurse advices me to feed pigeon pea to my child	60.3	74.9	0.020
The advice of my nurse is important to me	65.7	71.7	0.100
Doctors give me the advice to feed my child with pigeon pea	62.4	73.7	0.073
The advice of the doctors is important to me	64.6	72.4	0.010

[a] *Low intention ($n = 51$) = intention to consume pigeon pea less than once a week.*
[b] *High intention ($n = 87$) = intention to consume pigeon pea once a week or more.*
p-value obtained using Mann–Whitney test comparisons of mean scores of high and low intenders.
Significant difference between intenders $p \leq 0.10$.

(78.3%) and color (84.1%), as indicated in **Table 4**. Furthermore, a significantly higher proportion of high intenders compared to low intenders (71.0 vs. 66.9%; $p = 0.021$) considered pigeon pea as tasty (**Table 5**). Other factors appreciated by majority of the respondents were easy digestibility (81.2%) and easy preparation (81.9%).

External Drivers Influencing Pigeon Pea Consumption Among School-Aged Children

Majority of respondents agreed that gatherings such as religious ceremonies, harvest time, women meetings, and the advice from the health workers (76.1% each) influenced their choice to feed pigeon pea to their SAC. Majority of the respondents valued doctors' (93.5%) advice to feed pigeon pea to their SAC. High intention groups had a significantly higher value for advice from nurses and doctors (74.9 vs. 60.3%; $p = 0.020$ and 72.4 vs. 64.6%; $p = 0.010$, respectively; **Table 5**). Other groups' opinion perceived as important include village leaders (87.7%), religious leaders (85.5%), teachers (81. 2%), mothers (87.7%), and husbands (75.4%) with no significant difference in opinion between high and low intenders (**Table 4**; **Supplementary Table 1**).

Finally, we elucidated how all the individual constructs influence pigeon pea consumption with an aim to identify specific drivers of pigeon pea consumption among our respondents. As a first step, the reliability of our constructs and then correlations between these constructs were determined.

Associations of Constructs With Pigeon Pea Consumption

Cronbach's α coefficients demonstrated high reliability of the constructs with values ranging from 0.70 to 0.88 (**Table 6**). Three constructs (control belief, intention, and behavior) consisted of only one item each, and therefore, the reliability analyses were not carried out for these constructs. The median scores ranged from 4 (control beliefs) to 69 (attitudes toward behavior). Median scores of perceived severity, health value, health behavior identity, perceived barriers, attitude, and subjective norms constructs were high compared to the range values. This showed that caregivers tended to agree with the statements in those constructs. On the other hand, there were low median values of knowledge, perceived susceptibility, cues to action, control beliefs, intention, and behavior construct compared to their range scores, indicating that most caregivers tended to disagree with the statements. Control belief, behavioral intention, and behavior constructs consisted of only one item each, and therefore, their reliability analyses were not conducted (**Table 6**).

TABLE 6 | Internal consistency and median scores of the constructs.

Construct	Example of item statement	Cronbach α	Items	Median (IQR)	Range values[a]
Knowledge[b]	Pigeon pea contains iron	0.85	12	24 (19, 30)	12–36
Perceived susceptibility[b]	My school-aged child suffers easily from shortage of blood	0.75	4	5.5 (4, 8)	4–12
Perceived severity[b]	Iron deficiency leads to shortage of blood	0.88	9	21 (15, 24)	9–27
Health value[b]	The intelligence of my school-aged child is important to me	0.70	9	25 (23, 27)	9–27
Health behavior identity[b]	Giving pigeon pea is one of the best things I can do for my school child	0.70	7	17 (15, 18)	7–21
Perceived barriers[b]	I worry about the price of pigeon pea on the market	0.78	17	30 (24, 36)	17–51
Attitude toward behavior[c]	(Giving pigeon pea to my child helps to prevent blood shortage) * (It is important to feed my child with foods that prevent blood shortage)	0.78	27	69 (65, 74)	27–81
Cues to action[b]	I comply with the doctors', clinicians', or health workers' advice to give pigeon pea to my school-aged child	0.83	10	16 (13, 22)	10–30
Control belief[b]	I am the one who decides my school-aged child should consume pigeon pea	–	1	4 (4, 5)	1–5
Subjective norms[d]	(My child's teacher(s) gives me the advice to feed my child with pigeon pea) *(The advice of my child's teacher(s) is important to me)	0.85	18	41 (35,48)	18–54
Behavioral intention[e]	How often do you think you will feed pigeon pea to your child in the coming month?	–	1	5 (3, 5)	1–5
Behavior[e]	How often did you feed pigeon pea to your child in the last month?	–	1	3 (1, 5)	1–5

[a]*Range refers to the minimum and maximum possible scores from the complete set of questions within a construct before consistency evaluation, except c and d, whose scores were from paired questions.*
[b]*Scores ranged from 1 = strongly disagree to 5 = strongly agree.*
[c]*(Behavioral beliefs) items ranged from 1 = strongly disagree to 5 = strongly agree * (outcome evaluation) items which ranged from −2 = strongly disagree to 2 = strongly agree.*
[d]*(Normative beliefs) items ranged from 1 = very unlikely to 5 = very likely * (motivation to comply) items which ranged from −2 = strongly disagree to 2 = strongly agree.*
[e]*Items ranged from 1 = none to 5 = more than 2 times a week.*

In terms of correlations between constructs related to internal factors, knowledge ($r_s = 0.29$, $p = 0.001$), perceived severity ($r_s = 0.32$, $p = 0.001$), and health value ($r_s = 0.63$, $p = 0.001$) were significantly correlated with health behavior identity. Within beliefs and attitudes constructs, health behavior identity was significantly correlated with attitude toward behavior ($r_s = 0.51$, $p = 0.001$). In terms of external factors associated with intention, only cues to action ($r_s = 0.19$, $p = 0.03$) was significantly but weakly correlated with intention. Finally, we observed a significant correlation between intention and consumption of pigeon pea among SAC ($r_s = 0.26$, $p = 0.002$). Detailed correlation and p-values are represented in **Figure 5** and **Supplementary Table 2**.

Via regression analyses, a combination of factors that predict pigeon pea consumption among SAC was identified.

Intention as a Predictor of Behavior

The relative contribution of various independent variables to the outcome variables for models 1–4 is shown in **Table 7**. Model 1 accounted for 29% of the variance in health behavior identity and the construct health value significantly predicted health behavior identity ($\beta = 0.45$, $p = 0.000$). Therefore, as the the importance the caregiver placed on the consequences of her school-aged child being iron deficient, anemic, or protein deficient increased, so did the evaluation of the role of pigeon pea consumption in addressing this.

In Model 2, we included the internal and external factors as predictors of intention. The constructs control belief ($\beta = -0.41$, $p = 0.059$) and cues to action ($\beta = 0.06$, $p = 0.019$) significantly predicted intention and accounted for 8% of the variance in intention. Interestingly, the more agency the caregiver had in terms of giving pigeon pea to her SAC (Control belief), there was less effort from her end to ensure this consumption. However, when surrounding situations such as Ramadan or doctors' advice were considered (Cues to action; $\beta = 0.06$, $p = 0.019$), they positively influenced the caregivers' efforts to ensure consumption of pigeon pea.

Model 3 accounted for 22% of the variance in behavior. Intention significantly predicted behavior ($\beta = 1.32$, $p = 0.001$), indicating that as the effort a caregiver was planning to make to ensure pigeon pea increased, the likelihood that her child consumed pigeon pea also increased. Similarly, as the caregiver's evaluation of the effectiveness of pigeon pea consumption in addressing iron deficiency or anemia and protein deficiency in her SAC increased (Health behavior identity), consumption of pigeon pea was more likely ($\beta = 0.09$, $p = 0.044$). Finally, as complications such preparation time, fuel required, and scarcity due to the season were increasingly experienced by the caregiver (perceived barriers), the less likely she was to ensure pigeon pea consumption by her SAC ($\beta = -0.17$, $p = 0.002$). In fact, perceived barriers negatively affected the effort the caregiver was willing to make to ensure her SAC consumed pigeon pea (Perceived barriers * Intention to consume pigeon pea, $\beta = -0.04$, $p = 0.006$).

The relative contribution of the predictor variables to the outcome variables for Models 1–4 is shown in **Table 7**.

DISCUSSION

The last 5 years have been turbulent for the pigeon pea industry worldwide. India is the highest consumer and was also the biggest importer of pigeon pea. Approximately 50% of these

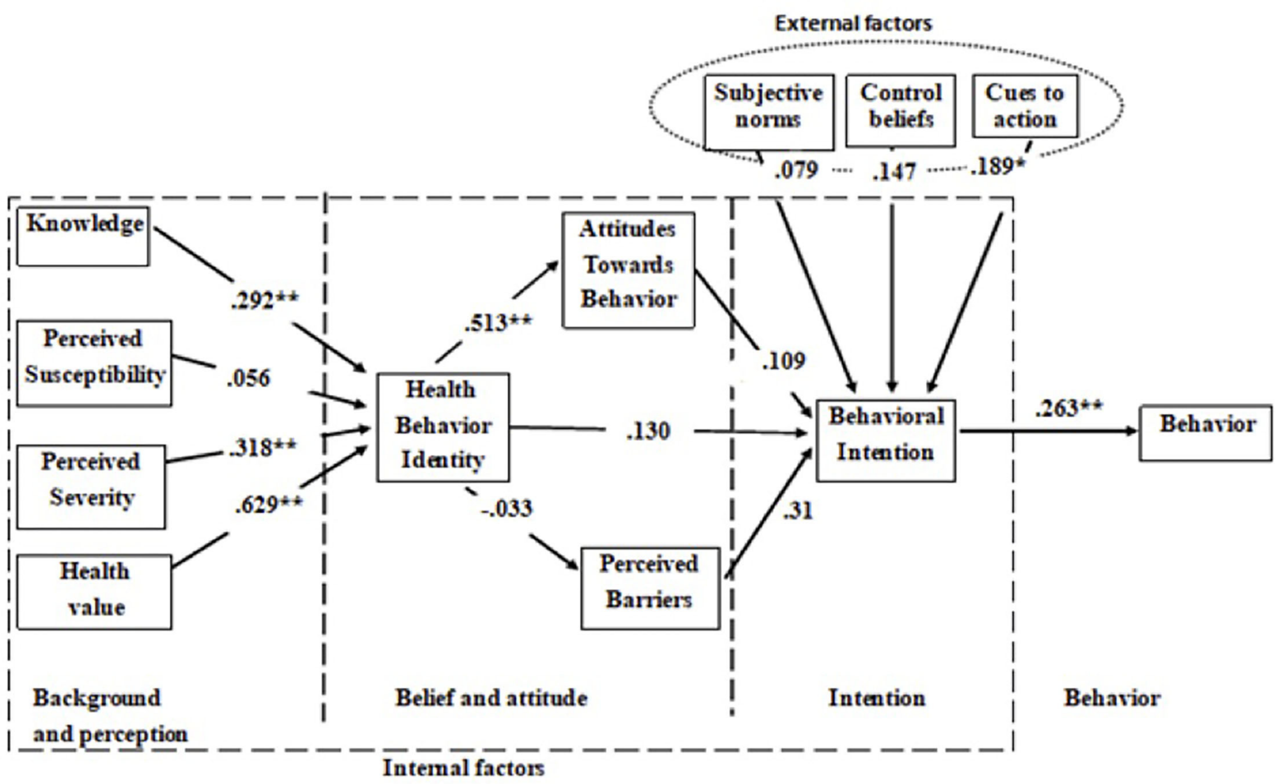

FIGURE 5 | A combined model of the Theory of Planned Behavior and Health Belief Model with spearman correlation coefficients between related constructs $P <$ 0.10 (2-tailed).

imports are from Myanmar, while the other 50% were from Africa—with Tanzania contributing the majority of the imports (ICRISAT, 2019). Farmers in Tanzania ramped up production of pigeon pea to meet the demands of this export market. However, domestic production in India almost doubled in 2016–2017 from the previous years. Along with this, there was a change in trade regulations by the Indian government to support domestic farmers leading to a drastic dip in exports of pulses to India. This greatly affected Tanzania pigeon pea farmers who were exporting as much as 90,000 tons valued at about US$ 80 million, and now export about 30,000 tons. To guarantee a local market for pigeon peas, Tanzania could take advantage of the crop's appreciable protein and iron contents to promote domestic consumption through awareness-creation and the inclusion of pigeon pea in national food assistance programs, such as school feeding. This will not only provide a market avenue for farmers but also offer nutrient-dense food to the local population. This is a crucial opportunity as domestic consumption of pigeon pea remains low (Zahra Saidi Majili et al., 2020).

We show in this study that the protein content of raw pigeon pea is comparable to that of other legumes and nuts such as mung bean, common bean, cow pea, and groundnut. Also, its amino acid profile is comparable to that of soybean. In combination with this, we observe that consumption of animal source foods (including dairy) was relatively lower than that of animal source foods (ASF). Indeed, within developing countries, dietary protein sources are mainly limited to cereals and, to a much lesser extent, to animal sources (Schonfeldt and Gibson Hall, 2012). In fact, data show that in these countries, only 3% of dietary energy is derived from animal products, 11% from roots and tubers, and 6% from pulses, while the remainder is made up mainly of cereals (FAO, 2008). This indicates that though our respondents reported a high frequency of animal source food consumption, it is likely that the quantities consumed are minimal and therefore have a low contribution to nutrient intake. Pigeon pea could thus be an alternative to fill the protein nutrient gap.

Our respondents reported consuming three types of pigeon pea recipes. This likely limits the frequency of consumption of pigeon peas due to the monotony. Worldwide, pigeon peas can be used in a variety of recipes, thus increasing the organoleptic properties (Saxena and Rao, 2002; Opoku et al., 2003; Torres et al., 2007; Okpala, 2011; Ayenan et al., 2017; Olanipekun et al., 2018) and thereby increasing the frequency of their consumption. A study by Figueira et al. (Chinyoka, 2016) has however reported the lack of knowledge surrounding legumes' preparation and the time involved in this preparation as limiting factors for the consumption of legumes. For this reason, community knowledge on preparation of various pigeon pea recipes should be improved so as to widen culinary attribute choices and increase the frequency of consumption.

TABLE 7 | Constructs associated with health behavior identity, intention to feed pigeon pea to school-aged children, and feeding pigeon pea to school-aged children.

Models[a]	Unstandardized β	p	R^2	Adjusted R^2
Model 1				
Y = Health Behavior Identity			0.29	0.26
Predictors				
Knowledge	0.04	0.274		
Perceived susceptibility	−0.03	0.702		
Perceived severity	0.00	0.995		
Health values	0.45	0.000*		
Age of a child	−0.01	0.968		
Interviewer effect	0.21	0.125		
Education	−0.44	0.362		
Model 2				
Y = Intention to consume pigeon pea			0.08	0.01
Predictors				
Health behavior identity	−0.02	0.649		
Perceived barriers	−0.01	0.709		
Attitudes toward behavior	0.00	0.820		
External control beliefs	−0.41	0.059*		
Cues to action	0.06	0.019*		
Subjective norms	−0.01	0.724		
Age of a child	−0.02	0.880		
Interviewer effect	−0.14	0.317		
Education	−0.03	0.823		
Model 3				
Y = Behavior (Actual consumption of pigeon pea)			0.22	0.16
Predictors				
Perceived barriers	0.17	0.002*		
Intention to consume pigeon pea	1.32	0.001*		
Perceived barriers * Intention to consume pigeon pea	−0.04	0.006*		
Health behavior identity	0.09	0.044*		
External control beliefs	−0.10	0.635		
Cues to action	−0.03	0.213		
Age of a child	0.17	0.257		
Interviewer effect	−0.05	0.688		
Education	−0.15	0.394		

[a]*All models are adjusted for age, education of caregivers, and interviewer effect. *P values are significant (P < 0.10).*

This study was nested within a project that ultimately aimed to increase pigeon pea consumption among various groups that included SAC. Nutritionally deficient children are more likely not to perform well in school and score poorly in cognitive tests due to slow memory recall and attention problems than well-nourished children (Taras, 2005; Best et al., 2010; Chinyoka, 2016). However, this can be remedied as it has been shown that improving nutritional status subsequently improves cognition and academic performance among school children (Eilander et al., 2010; Best et al., 2011). Cross-sectional, longitudinal, and intervention studies show that iron deficiency (with or without anemia) in particular has adverse effects on cognitive development and performance in children (Grantham-McGregor and Ani, 2001; Pivina et al., 2019). Anemic children have poorer cognition and school achievement than non-anemic children (Hermoso et al., 2011; Ignacio, 2014). Current worldwide data show that more than 40% SAC in developing countries are suffering from anemia and it is considered a severe public health problem. Sub-Saharan African countries shared a greater burden of this problem (United Nations Children's Fund/United Nations University/World Health Organization (WHO), 2001; Tatala et al., 2008). Unfortunately, there are no published data sources on the iron or anemia status of school-going children in Tanzania. It is plausible to assume that within the Tanzanian context, anemia among SAC would be common based on the anemia burden in Africa.

Although a myriad of factors lead to the development of anemia, iron deficiency does play an important role in its etiology (Tariku et al., 2019). Addressing iron deficiency and anemia in SAC needs greater attention due to the aforementioned consequences. SAC are a neglected group in terms of micronutrient interventions since most intervention strategies are targeted at preschool children or pregnant women. Food-based strategies may be a useful strategy to target this group. Pigeon pea in particular may contribute as a sustainable solution as combining them with other food groups will improve the quality of diet, hence reducing the chances of malnutrition. Despite this potential, the crop is not adequately consumed in Tanzania. It has been estimated that the per-capita consumption of legumes in Tanzania is 14.14 g/day/person, which is less than the 30 g/day/person recommended by the Food and Agriculture Organization of the United Nations (FAO) (Mfikwa and Kilima, 2014). In our simulation, we observe that some of the recipes consumed have the potential to meet iron requirements per day especially for the 4–10 years age group. To ensure that huge groups of school-going children are targeted, pigeon pea could be included in school feeding programs. In terms of acceptability of such an approach, a previous study in Tanzania had positive feedback on pigeon pea from rural schools where over 2,000 students were surveyed. After the intervention, 87% of students changed their perception of pigeon pea and 91% voted to keep them in their school meals (Wangari et al., 2020).

To increase consumption of crops such as pigeon pea at both household and institutional level, it is crucial to identify the drivers of its consumption. We observe that intention to consume pigeon pea was a significant predictor of consumption ($r_s = 0.26$, $p < 0.001$; **Figure 5**). Cues to action was directly associated with a greater intention to consume pigeon pea. Specifically, feasts such as Ramadhan and health workers' advice were mentioned as important in increasing pigeon pea consumption by over 70% of the respondents. Since the respondents value health workers' advice, nutrition education could be extended through health centers. However, such an approach runs the risk of limiting reach as it would be limited to mainly those seeking reproductive and child health services. This is because the education provided in these centers mostly focuses on maternal and infant feeding, with little given on the nutritional well-being of other groups, especially those not of reproductive ages. Such education should also therefore be incorporated widely to involve producers/farmers through farmer field schools, for example, schools and institution chefs. Respondents also identified village and religious leaders, teachers, mothers, and husbands as crucial influencers and they should be included in nutrition education campaigns. This is especially in light of the fact that we observed that when the caregiver had to make the decision on pigeon pea consumption alone, she was less likely to ensure its consumption, indicating that external influences are crucial to address. Additionally, this approach where various education avenues are used for nutrition education is useful where literacy levels may be low. The majority of our respondents had no formal education or had not completed primary education and therefore may lack knowledge on nutritious and diversified diets. Indeed, we observed this as our respondents could not make the connection between the benefits of pigeon pea consumption and their nutritive value.

We observed that perceived barriers negatively influenced the intention to consume pigeon pea. The specific perceived barriers mentioned by majority of the respondents were price especially during the rainy season and potential pest infestation during storage. A previous study conducted in the Lindi region of Tanzania also observed seasonality as affecting consumption of pigeon pea (Zahra Saidi Majili et al., 2020). In Lindi, the frequency of the consumption of pigeon peas decreases during the lean season for all kinds of pigeon pea dishes. Pigeon pea in the Lindi region was mainly consumed as greens and was only available at the end of the rainy season. Additionally, the alternative dry pigeon pea recipe required time for preparation and farmers preferred to utilize their time on farms rather than on food preparation. Within our investigated population, availability of pigeon pea was limited by seasons as most households were limited in their storage capacity. One way to address this is to introduce innovative processing technologies to increase availability year-round. As storage capacity is increased, training on post-harvest handling of pigeon pea is therefore crucial to households.

Insect pests are a major constraint to pigeon pea production in east and southern Africa region (Abass et al., 2014; Anastasia and Njoroge, 2019). Our findings of pest damage being of concern among smallholder pigeon pea farmers in central Tanzania have previously been observed in a study conducted in Central and Northern Tanzania by Abass et al. (Abass et al., 2014). In this study, 16% of the farmers considered storage pests as one of the factors causing poor crop yields and aggravating food losses. In addition, survey results suggested that the farmers' poor knowledge and skills on post-harvest management were largely responsible for the food losses. Bruchids are the most important storage pests among the various pests that cause storage loss in pigeon pea. These include three major species *viz*., *Collosobruclus chinensis* (L.), *C. maculatus* (F.), and *C. analis* (F.) (Prabhakar, 1979). The post-harvest losses due to bruchids in various pulses have been reported to vary between 30% and 40% within a period of 6 months (Akinkurolere et al., 2006; Soumia et al., 2017). Developing pigeon pea varieties that combine both grain and pod resistance may assist in enabling resistance to bruchid attack. In addition, identifying best practices and innovative technologies related to storage should be a priority to improve income and nutrition of farm households. Furthermore, increasing farmers' knowledge on proper use of improved post-harvest storage technologies would have an impact on the ability of smallholder households to reduce food losses.

CONCLUSIONS AND RECOMMENDATIONS

In the study area, pigeon peas could be among the most important food crop for meeting iron and protein requirements. However, limited recipes due to lack of knowledge, prices during the rainy season, pest attack, preparation time, and fuel requirements are among the barriers identified. Pulses, such as pigeon pea, support a lower carbon footprint because they are nitrogen-fixing crops requiring very little, if any, nitrogen fertilizer and therefore are part of a sustainable diet (Stefanie Havemeier and Joanne, 2017). All these necessitate not only the need to develop new recipes and provide cooking demonstrations but also the need to conduct research that finds innovative ideas for the development of diversified and shelf-stable products to ensure year-round supply of convenient products. In terms of nutrition education, influential situations such as feasts, the health profession, village elders, mothers, and husbands need to be co-opted into nutrition education programs to increase consumption. Additionally, the design of nutrition education programs should emphasize on promoting healthy eating to all age groups, thus improving consumption of pigeon peas throughout the year. Linking agriculture to nutrition in this aspect also remains crucial so that avenues such as farmer field schools or agriculture extension may be engaged in relaying messages on post-harvest handling, storage, and pigeon pea preparation and consumption.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article may be made available upon request by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

WG-W: project administration, conceptualization, methodology, interpretation of results, visualization, writing—original draft, and writing—review and editing and supervision. RM: questionnaire validation and administration, data analyses, interpretation of results, visualization, writing—original draft, and writing final draft—review and editing. MC: data analyses, interpretation of results, visualization, writing—original draft, and writing final draft-review and editing. JM: data analyses and interpretation and review and editing manuscript. NK, YM, HMs, and HMu: questionnaire development and validation, administration, and review of final draft. MB and PO: supervision and review of final draft. All authors contributed to the article and approved the submitted version.

FUNDING

This research publication was made possible with support from the United States Agency for International Development (USAID) through the Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) program as part of the US Government's Feed the Future Initiative. The funders had no role in the design and/or implementation of the study or the preparation of the manuscript thereof.

ACKNOWLEDGMENTS

The authors wish to thank the administrative and local authorities as well as all caregivers/respondents from Moleti, Laikala, Mlali, and Chitego villages that participated in the study. The support of Mr. Peter Ngowi in identifying potential respondents for the survey is appreciated. Additionally, we thank the interviewers for their work in the field. Furthermore, we are grateful to Tanzania Agricultural Research Institute (TARI) Hombolo for all the logistical support. The authors also acknowledge various contributions by the International Institute for Tropical Agriculture (IITA).

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2021.726404/full#supplementary-material

REFERENCES

Abass, A. B., Ndunguru, G., Mamiro, P., Alenkhe, B., Mlingi, N., and Bekunda, M. (2014). Post-harvest food losses in a maize-based farming system of semi-arid savannah area of Tanzania. *J. Stored Product. Res*. 57, 49–57. doi: 10.1016/j.jspr.2013.12.004

Abizari, A. R., Pilime, N., Armar-Klemesu, M., and Brouwer, I. D. (2013). Cowpeas in Northern Ghana and the factors that predict caregivers' intention to give them to schoolchildren. *PLoS ONE.* 8:e72087. doi: 10.1371/journal.pone.0072087

Ahmed, F., Rahman, A., Noor, A. N., Akhtaruzzaman, M., and Hughes, R. (2006). Anaemia and vitamin A status among adolescent schoolboys in Dhaka City, Bangladesh. *Public Health Nutr.* 9, 345–350. doi: 10.1079/PHN2006858

Akinkurolere, R. O., Adedire, C. O., and Odeyemi, O. O. (2006). Laboratory evaluation of the toxic properties of forestanchomanes, Anchomanes difformis against pulse beetle Callosobruchus maculatus (Coleoptera: Bruchidae). *Insect Sci*. 13, 25–9. doi: 10.1111/j.1744-7917.2006.00064.x

Amarteifio, J. O., Munthali, D. C., Karikari, S. K., and Morake, T. K. (2002). The composition of pigeon peas (Cajanus cajan (L.) Millsp.) grown in Botswana. *Plant Foods Hum Nutr.* 57, 173–177. doi: 10.1023/A:1015248326920

Amoroso, B. T. L. (2014). *Improving Diets and Nutrition: Food-based Approaches*. Leesburg, VA: CABI.

Anastasia, W., and Njoroge, I. B. D. B. (2019). Postharvest Management Practices of Grains in the Eastern Region of Kenya. *J. Agricult. Sci*. 11:19. doi: 10.5539/jas.v11n3p33

Ayenan, M. A. T. D. A., Ahoton, L. E., and Kwadwo, O. (2017). Utilization and farmers' knowledge on pigeon pea diversity in Benin, West Africa. *J. Ethnobiol. Ethnomed*. 13, 1–13. doi: 10.1186/s13002-017-0164-9

Best, C., Neufingerl, N., Van Geel, L., van den Briel, T., Osendarp, S. (2010). The nutritional status of school-aged children: why should we care?. *Food Nutr. Bull*. 31, 400–17. doi: 10.1177/156482651003100303

Best, C., Neufingerl, N., Van Geel, L., van den Briel, T., and Osendarp, S. (2011). Can multi-micronutrient food fortification improve the micronutrient status, growth, health, and cognition of schoolchildren? a systematic review. *Nutr. Rev.* 69, 186–204. doi: 10.1111/j.1753-4887.2011.00378.x

Buttriss, J. (2002). Nutrition, health and school children. *Nutri. Bull.* 2, 275–316. doi: 10.1046/j.1467-3010.2002.00271.x

Chinyoka, K. (2016). Impact of poor nutrition on the academic performance of grade seven learners: a case of Zimbabwe. *IJLD*. 4:16. doi: 10.5296/ijld.v4i3.6169

Eilander, A. G. T., Sachdev, H. S., Transler, C., van der Knaap, H. C., Kok, F. J., et al. (2010). Multiple micronutrient supplementation for improving cognitive performance in children: systematic review of randomized controlled trials. *Am. J. Clin. Nutr*. 91, 115–130. doi: 10.3945/ajcn.2009.28376

Emerson, R. W. (2017). Likert scales. *J. Visual Impair. Blind.* 111:488. doi: 10.1177/0145482X1711100511

Fanou-Fogny, N., van Dam, B., Koreissi, Y., Dossa, R. A., and Brouwer, I. D. (2011). Factors predicting consumption of fonio grain (Digitaria exilis) among urban Malian women of reproductive age. *J. Nutr. Educ. Behav.* 43, 219–228. doi: 10.1016/j.jneb.2010.03.008

FAO (2008). FAOSTATS. FAO. Available online at: www.fao.org. (accessed May 3, 2021).

FAO (2021). *Summary of Requirements for Energy and Protein*. Available from: http://www.fao.org/3/AA040E/AA040E09.htm (accessed Feb 4th 2021).

FAO/WHO (1998). *Vitamin and Mineral Requirements in Human Nutrition.* Available online at: https://apps.who.int/iris/bitstream/handle/10665/42716/9241546123.pdf;jsessionid=D4B2B7DE4A7B4DE5711A3774FFA88C3B?sequence=1

Field, A. (2005). *Discovering Statistics using SPSS*. 2nd ed. London, United Kingdom: SAGE Publications

Francis, J., Eccles, M. P., Johnston, M., Walker, A. E., Grimshaw, J. M., Foy, R., et al. (2004). *Constructing Questionnaires Based on the Theory of Planned Behaviour: A Manual for Health Services Researchers*. Newcastle: Centre for Health Services Research, University of Newcastle.

Gewa, C. A., Murphy, S. P., Weiss, R. E., and Neumann, C. G. (2014). Determining minimum food intake amounts for diet diversity scores to maximize associations with nutrient adequacy: an analysis of schoolchildren's diets in rural Kenya. *Public Health Nutr.* 17, 2667–2673. doi: 10.1017/S1368980014000469

Grantham-McGregor, S., and Ani, C. (2001). A review of studies on the effect of iron deficiency on cognitive development in children. *J. Nutr*. 131, 649S-66S. doi: 10.1093/jn/131.2.649S

Hermoso, M. V. V., Vollhardt, C., Arsic, A., Roman-Viñas, B., Iglesia-Altaba, I., Mirjana, G., et al. (2011). A review, the effect of iron on cognitive development and function in infants, children and adolescents. *Ann. Nutr. Metabol*. 11, 154–165. doi: 10.1159/000334490

Hoeschle, I. (2021). *Africa Research in Sustainable Intensification for the Next Generation (Africa RISING).* Available online at: https://africa-rising.net/ (accessed January 4, 2021).

ICRISAT (2019). *Several Thousand Waiting Tons: Balancing pigeonpea interests across two continents. ICRISAT*. Available online at: https://www.icrisat.org/several-thousand-waiting-tons-balancing-pigeonpea-interests-across-two-continents/ (accessed May 3, 2021).

Ignacio, J.-L. (2014). Iron deficiency and cognitive functions Neuropsychiatr Dis *Treat*. 10, 2087–2095. doi: 10.2147/NDT.S72491

Jomaa, L. H., McDonnell, E., and Probart, C. (2011). School feeding programs in developing countries: impacts on children's health and educational outcomes. *Nutr Rev.* 69, 83–98. doi: 10.1111/j.1753-4887.2010.00369.x

Karadimitriou, S. M. (2018). *EMaCK*. Mann Whitney U test. Sheffield Hallam University.

Kassaye, T., Receveur, O., Johns, T., and Becklake, M. R. (2001). Prevalence of vitamin A deficiency in children aged 6-9 years in Wukro, northern Ethiopia. *Bull. World Health Organ.* 79, 415–422.

Leonard, E. G., Mboera, V. M. B., Susan, F., Rumisha, R.obert C., Malima, M., Mlozi, R., et al. (2015). Grades Stanley and Tabitha Mlacha Malaria, anaemia and nutritional status among schoolchildren in relation to ecosystems, livelihoods and health systems in Kilosa District in central Tanzania. *BMC Public Health.* 15:369. doi: 10.1186/s12889-015-1932-x

Lukmanji, Z. H. E., Mlingi, N., Assey, V., Ndossi, G., and Fawzi, W. (2008). *Tanzania food composition Tables*. MUHAS- TFNC, HSPH: Dar es Salaam Tanzania.

Macharia-Mutie, C. W., Van de Wiel, A. M., Moreno-Londono, A. M., Mwangi, A. M., and Brouwer, I. D. (2011). Sensory acceptability and factors predicting the consumption of grain amaranth in Kenya. *Ecol. Food. Nutr.* 50, 375–392. doi: 10.1080/03670244.2011.604584

Malawi Investment and Trade Centre (2018). *Trade Information Portal: Tanzanian pigeon pea farmers hit hard by Indian ban* [updated 11th April 2021].

Mfikwa, A. E., Kilima, F. T. (2014). Factors influencing the consumption of pulses in rural and urban areas of Tanzania. *Tanzania J. Agricult. Sci.* 14, 59–74. Available online at: https://www.ajol.info/index.php/tjags/article/view/130187

Murphy, S. P., Gewa, C., Liang, L. J., Grillenberger, M., Bwibo, N. O., and Neumann, C. G. (2003). School snacks containing animal source foods improve dietary quality for children in rural Kenya. *J Nutr.* 133, 3950S-6S. doi: 10.1093/jn/133.11.3950S

Nair, M. K., Augustine, L. F., and Konapur, A. (2015). Food-based interventions to modify diet quality and diversity to address multiple micronutrient deficiency. *Front Public Health.* 3:277. doi: 10.3389/fpubh.2015.00277

NBS (2013). *Dare es Salaam and Office of Chief Government Statistician President's Office*. Zanzibar. United Republic of Tanzania.2012 Population and Housing census: Population Distribution by Administrative Areas.

Ochola, S., and Masibo, P. K. (2014). Dietary intake of schoolchildren and adolescents in developing countries. *Ann. Nutr. Metab.* 64, 24–40. doi: 10.1159/000365125

Okpala, C. V. A. (2011). Physicochemical, nutritional and organoleptic evaluation of cookies from pigeon pea (Cajanus cajan. L) and cocoyam (Xanthosoma sp) flour blends. *Afr. J. Food Agric. Nutr. Dev.* 11, 1–7. doi: 10.18697/ajfand.47.10000

Olanipekun, B. F. A., Oyelade, O. J., and Osemobor, C. O. (2018). Potentials of pigeon pea-wheat flour mixes in bread production. *Asian Food Sci. J.* 4, 1–8. doi: 10.9734/AFSJ/2018/43677

Opoku, A. T., Sundaram, J., Crerar, W. J., and Park, S. J. (2003). Conditioning and dehulling of pigeon peas and mung beans. *Can. Soc. Eng. Agric. Food Biol. Syst.* 12:17.

Pivina, L., Semenova, Y., Dosa, M. D., Dauletyarova, M., and Bjorklund, G. (2019). Iron deficiency, cognitive functions, and neurobehavioral disorders in children. *J. Mol. Neurosci.* 68, 1–10. doi: 10.1007/s12031-019-01276-1

Prabhakar, G. S. (1979). *Studies on the bruchid fauna, infesting pulse crops of Karnataka with special emphasis on bioecology of Callosobruchus chinensis (L.)*. Bangalore: University of Agricultural Sciences.

Saxena, K. B. K., and Rao, P. V. (2002). Pigeon pea nutrition and its improvement. *J. Crop Product.* 5, 227–260. doi: 10.1300/J144v05n01_10

Schober, P., Boer, C., and Schwarte, L. A. (2018). Correlation Coefficients: Appropriate Use and Interpretation. *Anesth Analg.* 126, 1763–1768. doi: 10.1213/ANE.0000000000002864

Schonfeldt, H. C., and Gibson Hall, N. (2012). Dietary protein quality and malnutrition in Africa. *Br. J. Nutr.* 108, S69–76. doi: 10.1017/S0007114512002553

Seetha Anitha, T. T. H., Takuji, W. T., Ashok, J., and Joanna, K. P. (2019). Potential for smart food products in rural Myanmar: use of millets and pigeonpea to fill the nutrition gap. *J. Sci. Food Agricult.* 100, 394–400. doi: 10.1002/jsfa.10067

Soumia, P. S., Srivastava, C., Pandi, G., and Subramanian, S. (2017). Varietal preference of pulse beetle, Callosobruchus maculatus (F.) in greengram. *Indian J. Entomol.* 79, 86–91. doi: 10.5958/0974-8172.2017.00019.0

Stefanie Havemeier, J. E., and Joanne, S. (2017). Dietary guidance for pulses: the challenge and opportunity to be part of both the vegetable and protein food groups. *NW Acad. Sci.* 1392, 58–66. doi: 10.1111/nyas.13308

Sun, X., Guo, Y., Wang, S., and Sun, J. (2006). Predicting iron-fortified soy sauce consumption intention: application of the theory of planned behavior and health belief model. *J. Nutr. Educ. Behav.* 38, 276–285. doi: 10.1016/j.jneb.2006.04.144

Talsma, E. F., Melse-Boonstra, A., de Kok, B. P., Mbera, G. N., Mwangi, A. M., and Brouwer, I. D. (2013). Biofortified cassava with pro-vitamin A is sensory and culturally acceptable for consumption by primary school children in Kenya. *PLoS ONE.* 8:e73433. doi: 10.1371/journal.pone.0073433

Taras, H. (2005). Nutrition and student performance at school. *J. School Health*. 75, 199–213. doi: 10.1111/j.1746-1561.2005.00025.x

Tariku, E. Z., Abebe, G. A., Melketsedik, Z. A., Gutema, B. T., Megersa, N. D., Sorrie, M. B., et al. (2019). Anemia and its associated factors among school-age children living in different climatic zones of Arba Minch Zuria District, Southern Ethiopia. *BMC Hematol.* 19, 1–9. doi: 10.1186/s12878-019-0137-4

Tatala, N. G., Svanberg, U., and Ash, D. (2005). Impact of dietary iron intake on anaemia in Tanzanian schoolchildren. *South Afr. J. Clin. Nutr.* 17, 94–100. doi: 10.1080/16070658.2004.11734026

Tatala, S. R., Kihamia, C. M., Kyungu, L. H., and Svanberg, U. (2008). Risk factors for anaemia in schoolchildren in Tanga Region, Tanzania. *Tanzan J. Health Res.* 10, 189–202. doi: 10.4314/thrb.v10i4.45074

Thiese, M. S., Ronna, B., and Ott, U. (2016). P value interpretations and considerations. *J Thorac Dis.* 8, E928–E31. doi: 10.21037/jtd.2016.08.16

Tontisirin, K., Nantel, G., and Bhattacharjee, L. (2002). Food-based strategies to meet the challenges of micronutrient malnutrition in the developing world. *Proc. Nutr. Soc.* 61, 243–250. doi: 10.1079/PNS2002155

Torres, A. F., Granito, M., Guerra, M., and Vidal-Valverde, C. (2007). Chemical, biological and sensory evaluation of pasta products supplemented with agalactoside-free lupin flours. *J. Sci. Food Agric*. 7, 74–81. doi: 10.1002/jsfa.2673

United Nations Children's Fund/United Nations University/World Health Organization (WHO) (2001). "Iron deficiency anaemia. Assessment, prevention and control," in *A guide for programme managers (WHO/NHD/01.3)*. Geneva,15–31.

Wangari, C., Mwema, C., Siambi, M., Silim, S., Ubwe, R., Malesi, K., et al. (2020). Changing perception through a participatory approach by involving adolescent school children in evaluating smart food dishes in school feeding programs - real-time experience from Central and Northern Tanzania. *Ecol. Food Nutr*. 59, 472–485. doi: 10.1080/03670244.2020.1745788

WHO (2000). *Nutrition for Health and Development: A Global Agenda for Combating Malnutrition*. Geneva: World Health Organization.

Zahra Saidi Majili, C. N., Kissa, K., Khamaldin, M., Constance, R., and Stefan, S. (2020). Preferences and consumption of pigeon peas among rural households as determinants for developing diversified products for sustainable health. *Sustainability*. 12:20. doi: 10.3390/su12156130

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.