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Increasing green leafy vegetable consumption through street food dishes in Lagos, Nigeria

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Abstract

Purpose – Despite its health benefits, vegetable consumption is low in urban Nigeria. Interventions have been successful in increasing urban Nigerians' vegetable intake in the home environment, but interventions doing so for popular out-of-home consumption are lacking. This study aimed to design, implement and assess an intervention to increase the vegetable intake of urban Nigerians through street foods.

Design/methodology/approach – A quasi-experimental design was applied in Lagos, Nigeria. During the intervention, 12 trained street food vendors (SFVs) actively promoted the health benefits of vegetables to their customers (using marketing statements and posters) and provided the option to buy an additional green leafy vegetables (GLVs) side dish to their meal. Purchases were observed, and a survey was conducted before and

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during the intervention to measure perceived meal quality and satisfaction. Six to eight weeks after the intervention, a mystery shopper visited the vendor to assess if they were still selling additional GLVs.

Findings – Almost half (46%) of the 1,506 observed customers bought additional GLVs during the intervention. Both at baseline ($N = 452$) and during intervention ($N = 564$), meal satisfaction was high. Users were on average more educated and older than non-users. Most vendors did not perceive the sale of additional GLVs as additional work. Six to eight weeks after the intervention, nine vendors (75%) were still selling additional GLVs.

Originality/value – This study showed that SFVs informing consumers on the potential health benefits of vegetables and offering these vegetables in street food dishes at a commercially viable price is an interesting option to increase vegetable intake.

Keywords Street food, Vegetables, Food system, Intervention, Impact assessment, Nigeria

Paper type Research paper

1. Introduction

1.1 Health status and vegetable consumption in urban Nigeria

Non-communicable diseases (NCDs), such as type II diabetes, cancer, cardiovascular diseases and chronic respiratory diseases, are a leading cause of morbidity and mortality globally (WHO, 2011). They account for seven out of every ten worldwide deaths (WHO, 2018). NCD related mortality is higher in low- and middle-income countries (LMICs) than in higher income countries (Ezzati *et al.*, 2018). Globally, the risk of dying from NCDs is the highest in LMICs, especially in Sub-Saharan Africa (Bennett *et al.*, 2018). By 2030, NCDs are projected to be the leading cause of morbidity and mortality in Nigeria (WHO, 2014).

Poor dietary habits, including low consumption of fruits and vegetables, have been identified as leading contributors to the incidence of NCDs (GBD, 2015; Lim *et al.*, 2012; WHO, 2003). To reduce the risk of getting certain NCDs, the World Health Organization (WHO) recommends a consumption of at least 400 grams of fruits and vegetables per day (WHO, 2003). In Nigeria, average vegetable intake is below this recommended level (Afshin *et al.*, 2019; Olatona *et al.*, 2018; Olawuyi and Adeoye, 2018). Increasing vegetable intake could be a potential intervention to decrease the incidence and related health burden of NCDs in Nigeria.

1.2 Availability and convenience are main barriers for healthy food and vegetable consumption; out of home consumption is common

Barriers for healthy food consumption of urban Nigerians include lack of availability, lack of convenience and food safety issues (Hollinger and Staats, 2015; Raaijmakers *et al.*, 2018). Interventions breaking down such barriers could help to increase vegetable consumption in Nigeria. An important motive for vegetable consumption is health (Raaijmakers *et al.*, 2018). Increased nutrition knowledge is also associated with a higher intake of fruits and vegetables (Dada *et al.*, 2020; Wardle *et al.*, 2000; Spronk *et al.*, 2014). Knowledgeable individuals were 25 times more likely to consume the daily adequate amount of fruits and vegetables than others (Wardle *et al.*, 2000). Olatona *et al.* (2018) found that almost half of their Nigerian study population had a fair level of knowledge about the health impact and daily requirements of fruits and vegetables, while a quarter had a poor level. However, knowledge of the preventive properties against diabetes, hypertension and obesity was low. Interventions focusing on increasing consumer knowledge and awareness about health benefits of vegetables could increase vegetable consumption.

Successful interventions have been implemented in (urban) Nigeria that increased vegetable intake of consumers through at home preparation and consumption, such as “Veg on Wheels” and “Follow my green food steps” (Lion *et al.*, 2018; Snoek *et al.*, 2022). However, out-of-home consumption or consumption of food away from home (FAFH) is also common and increasing in urban Nigeria, including Lagos (Abrahale *et al.*, 2019; Ayodele and Panama, 2016; Ajayi and Salaudeen, 2014; Bamiro, 2012) and could therefore provide an interesting

entry point for interventions to increase vegetable intake. In Nigeria, FAFH is the fastest and largest growing food type (Tefft *et al.*, 2017). 81% of Nigerian households included in the survey of Akerele *et al.* (2019) consumed FAFH, costing 12.6% of their household budget. In urban areas, street foods are an important category within FAFH. More than 60% of the urban Nigerian respondents in the study of Leshi and Leshi (2017) consumed street foods daily. Street foods are popular because they are considered to be convenient, available, quickly acquired, reasonably priced, tasty and a good alternative for home-cooked meals (Steyn *et al.*, 2014). Consumers spent a large part of their income on street foods (Akinbode *et al.*, 2011). Street foods can make up a significant proportion of daily intake of macro- and micronutrients of consumers eating street foods (Steyn *et al.*, 2014). More than half the daily protein and carbohydrate intake and more than one-third the fat intake of Nigerian adults was through street foods (Oguntona *et al.*, 1998). Selling street foods also provides livelihood, employment and a source of income for many low-income persons (Hollinger and Staatz, 2015; Steyn *et al.*, 2014; Tefft *et al.*, 2017). The diversity of street foods is extensive, ranging from fresh fruits and vegetables, to home-cooked meals and highly processed and energy dense snacks and drinks, and thus, the nutritional value also varies greatly (Abrahale *et al.*, 2019; Fellows and Hilmi, 2012; Steyn *et al.*, 2014). Leshi and Leshi (2017) found that 82% of surveyed consumers preferred a meal as street food, whereas 13% preferred snacks and beverages. Increasing the intake of vegetables through street foods could contribute to decreasing the incidence and related health burden of NCDs in urban areas in Nigeria. However, knowledge about effective interventions to increase vegetable intake through street food consumption in Nigeria is lacking.

1.3 This study

In this study, our main research question was: What is an effective intervention to increase vegetable intake of consumers through street foods in Nigeria? Sub-research questions were: How effective is the intervention in increasing vegetable intake through street foods? How can consumers that buy extra vegetables be characterized? What constraints do street food vendors (SFVs) face in the intervention? Therefore, in this study, we aimed to develop, implement and assess an intervention aiming to increase vegetable intake of consumers through street foods in Lagos, Nigeria. SFVs offered an additional portion of green leafy vegetables (GLVs) as a side dish to dishes they normally sold for a commercially viable price while informing customers about the potential health benefits of vegetable consumption. For this intervention to be sustainable and viable, the additional GLVs should be available in the market, the SFV should find additional effort for purchasing, preparing and selling the additional GLVs acceptable, and customers should be willing to pay a commercial price for these additional GLVs.

2. Materials and methods

2.1 Selection of the intervention

To develop and execute the study, we followed the nine step approach for designing and testing context-specific interventions of Plaisier *et al.* (2019). The selected case study was to improve consumer intake of GLVs in Lagos, Nigeria through street food dishes. Scoping the study was performed by screening available literature on street foods in Nigeria, interviews with Nigerian organizations working in and around street food, conducting focus group discussions (FGDs) with random street food consumers across locations in Lagos and exploratory field visits to SFVs' outlets. SFVs potentially interested to participate in the intervention were identified and selected from a group of SFVs that previously participated in other projects of the Nigerian Institute of Food Science and Technology (NIFST) on food

safety and hygiene in Lagos. FGDs were organized in November 2019 with SFVs (three FGDs with six participants each) and vegetable suppliers (one FGD with six participants) to gather information about SFVs, current dishes, potential options to increase consumption of GLVs through street foods and willingness of SFVs to participate. All FGDs were led by one trained moderator and one trained assistant. In addition, six FGDs were organized with each six to eight consumers (in total 38 participants) recruited on the street nearby SFV outlets to identify enhancers and barriers for increased vegetable consumption through street foods. It was found that many consumers associated vegetable consumption with health. Street foods were generally considered tasty, but consumers were indecisive whether street foods were nutritious and healthy. In December 2019, a living lab workshop was held in Lagos with two consumer representatives, 12 SFVs and 12 vegetable suppliers. The participants mapped their own value chain and identified providing consumers with a choice of additional GLVs with existing street food dishes as the most promising intervention from a long list of bottlenecks and potential solutions. After this, SFVs who were willing to participate in the study received a questionnaire about the dishes they sold, types of GLVs they used, dish and vegetable prices and portion sizes as background to design the intervention in detail. This all resulted in the selection of the intervention to provide street food consumers with the option of additional GLVs in a vegetable stew to two types of existing street food dishes prepared by most SFVs and eaten by many consumers: swallow (solid porridge made from different kind of flour) and rice dish. The potential health benefits of eating vegetables should be communicated to customers as a trigger.

2.2 Implementation of the intervention of additional GLVs in street food dishes

2.2.1 Selected SFVs, their vegetable suppliers and customers. *SFVs* – In total, twelve SFVs were included in our study. Eleven SFVs had a small type of restaurant, “mamma put” or “bukka”, each on a fixed location in Lagos. One SFV moved around with a mobile restaurant (cart) during the day and settled at a fixed location at the end of the day. Sales locations were low to medium income residential and working areas in different districts of Lagos City, such as Abule, Egba, Agbado, Gbagada, Ikeja, Ifako, Mushin and Surulere. The SFVs had between 30 and 120 customers per day and sold a swallow and/or rice dish, amongst other dish types. All SFVs gave written consent for participating in the study.

Vegetable suppliers – Twelve vegetable suppliers, one for each SFV, were included in our study to identify potential issues arising due to increased demand for GLVs. Each vegetable supplier was a regular supplier of one of the SFVs and was selected by the SFV in cooperation with the enumerator. All vegetable suppliers gave oral consent for participating in the study.

Customers – Customers that bought a swallow or rice dish at the participating SFVs were approached during the selling hours of the SFV to participate in the study. Respondents had to be at least 18 years and attention was paid to ensure diversity in age and gender. All respondents gave oral consent for participating in the study.

2.3 Street food intervention

In the intervention, SFVs provided their customers with the option to buy an additional portion of GLVs in a vegetable stew with their swallow or rice dish. The additional portion of GLVs was provided with a spoon provided by the project and was about 100 g. Customers had to pay 50 Naira (approximately US\$0.12) for a portion. This amount was agreed upon with the SFVs prior to the intervention, assuming this would cover all costs and a reasonable profit margin. However, during the intervention two SFVs put it to 100 Naira claiming that 50 Naira would not cover their costs.

The SFVs actively promoted the health benefits of GLVs with a marketing sentence during the consumer ordering process. Each SFV adapted the provided sentence to his/her

own circumstances, an example “Do you want an additional amount of (green leafy) vegetables with your meal? These are good for your health and only 50 Naira”. Additionally, an A5 flyer was put up at each SFV’s selling location explaining the health benefits of vegetable consumption (Appendix 1).

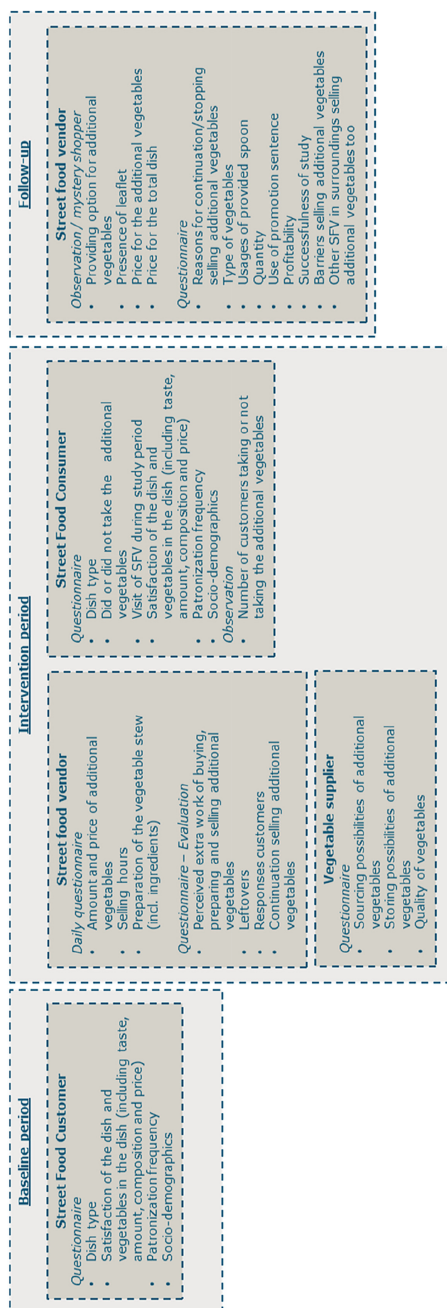
The choice to add the vegetable stew to a swallow or a rice dish was left to the SFVs to maximize their willingness to participate. Six SFVs chose swallow dish and six chose a rice dish. Each SFV prepared the vegetable stew in their own way, matching the specifics of the dish it was added to and the regional background of the SFV. Most stews contained similar ingredients such as water, onion, pepper, a protein source (cray fish, stock fish, or meat), seasoning and salt, locust bean or another gelling agent and (palm) oil. The SFVs bought the additional GLVs from their usual vegetable suppliers. The project covered the SFVs’ costs of these additional GLVs during the intervention to prevent financial losses and to reduce financial risk.

We applied a quasi-experimental design with a baseline and intervention period to assess consumers’ perceived quality of and satisfaction with dishes, patronization frequency and choice of dishes. The baseline period ran from 24 to 29 August 2020, directly followed by the intervention period that ran from 31 August to 25 September 2020. Six to eight weeks after the intervention period, we assessed in a follow-up study whether the SFVs were still selling the additional GLVs. Due to the outbreak of coronavirus disease 2019 (COVID-19) in Lagos, the intervention ran eight months after the living lab workshop in which the intervention was selected. Ethical clearance for the study was obtained from the Social Science Ethics Committee of Wageningen University and Research in The Netherlands (number 09215846).

2.4 Measures

Figure 1 provides an overview of the applied data gathering tool and measures with a detailed explanation provided in the following sub-sections. All data were collected by local enumerators trained on the aim and execution of the study and on data collection tools.

2.4.1 Street food customers. Data was collected from street food customers during both the baseline and intervention period. In the baseline period, each SFV was followed for two days, either Monday and Tuesday, or Wednesday and Thursday. In the intervention period, each SFV was followed for four days, from Monday to Thursday. The aim was to have responses from at least 50 different customers per SFV in each period. In the baseline period, a trained enumerator invited customers that bought a dish from the SFV to complete a questionnaire. In the intervention period, only customers that bought the intervention dish with or without additional GLVs were invited to participate. Both questionnaires were largely similar to identify differences between both periods. Both included satisfaction with the whole dish, patronization frequency at this SFV and socio-demographics (gender, educational level and age). To assess dish satisfaction respondents had to rate their satisfaction with the dish with four items (“*How satisfied were you with . . . ?*”, where “. . .” included *taste, amount of food, composition of ingredients and price*) on a 5-point Likert scale ranging from 1 = “very dissatisfied” to 5 = “very satisfied”. Patronization frequency was measured by the sentence “*how often do you eat here?*” (daily, several times per week (2–6 times), once a week, less than once a week, it is the first time I eat here). In addition, the questionnaire in the intervention period included questions about whether the respondent did or did not take additional GLVs and why (“*Why did you take additional vegetables?*”; open question) or why not (“*Why did you not want the additional vegetables?*”; answer options were: price, taste, no need, habits, other reason, namely . . .). In the intervention period, a second trained enumerator counted the number of customers taking the intervention dish with additional GLVs, so-called users and the number taking it without additional GLVs, so-called non-users.



Source(s): Authors' work

Figure 1.
Overview of included
measures in the
intervention

2.4.2 Street food vendors. Each intervention day, amounts (in bundles and weight in grams) and costs of purchased GLVs and operating hours of each SFV were recorded. Additionally, the ingredients used in preparing the additional GLVs were recorded. After the intervention, each SFV was asked to evaluate the intervention with a SFV questionnaire. This included yes/no questions about additional time to purchase, prepare and sell additional GLVs, about leftover GLVs per plate and per day compared to normal, about willingness to continue selling additional GLVs after the intervention and one open question about their perceived customer response.

2.4.3 Vegetable suppliers. After the intervention, each vegetable supplier was asked to evaluate it with a vegetable supplier questionnaire that included questions about sourcing and storage possibilities for additional GLVs demand, availability of GLVs of sufficient quality and other possible changes to their business.

2.4.4 Follow-up study. Six to eight weeks after the intervention, depending on when the intervention was conducted, two trained enumerators visited the SFVs to assess if they were still selling additional GLVs by ordering the intervention dish as mystery shoppers. To prevent recognition by the SFV and socially desirable answers, the enumerators were not involved in the project earlier. After revealing themselves as a member of the project team, they asked questions about why they were still or no longer selling additional GLVs (open questions).

2.5 Data analysis

2.5.1 SFV and vegetable suppliers. Descriptive data analysis was used to analyze data of the SFV and vegetable supplier questionnaires. Statistical testing for differences between (groups of) SFVs was not performed, due to the low number (12) of SFVs included in the study.

2.5.2 Street food customers. Descriptive and statistical data analyses were used to analyze data of the street food customers. Observational data were described. Descriptive and difference testing analyses were used for the customer questionnaires' data. *T*-tests and chi-square tests were used to analyze differences between baseline and intervention period, between users and non-users, between dish types (swallow or rice dish), between SFVs and between intervention days (Monday to Thursday).

In the baseline period, a customer questionnaire was taken from 530 respondents. Of these, 78 respondents bought other dishes than the intervention dishes, such as fish or meat stew with a swallow or rice, beans with or without bread, agidi pepper soup and spaghetti and/or plantain. Their data were excluded from the analysis, because these might influence comparison of outcomes between baseline and intervention period, resulting in data of 452 respondents being used in the analysis. In the intervention period, a customer questionnaire was taken from 567 respondents. Data of three customers were excluded from the analysis, because they indicated that the SFV did not ask them whether they wanted additional GLVs, resulting in data of 564 respondents being used in the analysis. In the intervention period, the choice for additional GLVs with the intervention dish or not was recorded of 1,506 customers.

3. Results

3.1 Vegetable purchases and selling times of street food vendors

On average, SFVs purchased 2.1 kg additional GLVs per day at 542 Naira per kg ([Appendix 2](#)). SFVs with a swallow dish bought around 10% less GLVs per day than SFVs with a rice dish, but at a 33% higher price. Differences in average prices can originate from differences in types of GLVs purchased (e.g. waterleaf and ugu are more expensive than spinach), in the location where the GLVs were bought (wholesale market, retailer market, vegetable hawker), or in the bargaining power of the SFV.

Starting time of sales differed between the SFVs from 7 in the morning to 13 in the afternoon (Appendix 2). SFVs selling rice dishes were more likely to start early (between 7 and 10), as consumers prefer a light meal as breakfast. SFVs selling swallow dishes started around lunchtime (between 11 and 13), when a heavier and more energy-rich meal is preferred.

3.2 Customers buying additional GLVs

Almost half (46%, $N = 694$) of the 1,506 street food customers were users buying additional GLVs (Figure 2). Swallow dish consumers showed a higher percentage of users (53%) than rice dish consumers (42%). The percentage of users differed between the twelve SFVs, ranging from 20 to 90%, with seven having more than 50% users. This could originate from the SFV's ability to promote additional GLVs, the SFV's selling location, or the knowledge and/or interest of the customers. The two SFVs 8 and 9 with a price of 100 Naira had 60 and 35% users, respectively, which was not different from that of the other SFVs with a price of 50 Naira. The percentage of users was similar on each of the four intervention days. It should be noted that in the intervention sample, rice dish SFVs had on average more customers than swallow dish SFVs, because 64% ($N = 969$) of the observations were rice dish customers and 36% ($N = 537$) swallow dish customers (each intervention dish was selected by six SFVs).

3.3 Street food customer questionnaire

3.3.1 Sample descriptive. In the baseline sample, around two-third of the 452 respondents were younger than 40, around two-third were male, around 60% had secondary school as highest educational level and just under 60% ate daily at the SFV (Table 1). Compared to the baseline sample, the intervention sample included more people in the 40–49 age group and fewer in the 20–29 age group (Chi-sq. = 12.42, $p = 0.029$) and more females (Chi-sq. = 6.0, $p = 0.014$). The education level and patronization frequency did not differ between the samples. A significantly higher fraction of respondents bought a swallow dish in the intervention (46%) than in the baseline sample (40%) (Table 1). Swallow dish consumers were older and ate less frequently at the SFV compared to rice dish consumers (Appendix 3).

In the intervention sample, 64% of 564 respondents were users. Users were higher educated (chi-sq. = 22.20, $p < 0.0001$) and older (Chi-sq. = 32.32, $p < 0.0001$) than non-users (Table 1). Gender and patronization frequency did not differ significantly between users and

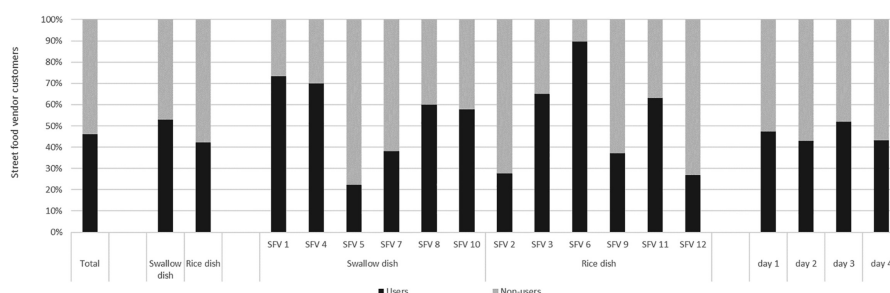


Figure 2. Observed users and non-users (percentages of total observed customers) of the intervention, in total, per dish type, per street food vendor and per intervention day

Note(s): No significant differences in ratio of users to non-users between the SFVs (8 and 9) with increased price of additional GLVs of 100 Naira and the other SFVs with price of 50 Naira ($X^2 = 2.167$; $df = 1$, $p = 0.141$) nor between the type of dish; swallow dish ($X^2 = 1.63472$; $df = 1$, $p = 0.201$) and rice dish ($X^2 = 3.450$; $df = 1$, $p = 0.06$)

Source(s): Authors' work

Table 1.
Socio-demographics,
street food vendor
patronization
frequency, and
intervention dish type
choice of the
respondents in % in the
baseline and
intervention sample

	Baseline sample (<i>N</i> = 452)	Intervention sample (<i>N</i> = 564)	Chi-square: Baseline vs Intervention	Users (<i>N</i> = 358)	Intervention sample Non-users (<i>N</i> = 206)	Chi-square: Users vs non-users
Gender						
Male	64.8	72.0	$\chi^2 = 5.997$; <i>df</i> = 1, <i>p</i> = 0.014	72.9	70.4	$\chi^2 = 0.411$; <i>df</i> = 1, <i>p</i> = 0.522
Female	35.2	28.0		27.1	29.6	
None	3.3	2.8	$\chi^2 = 12.610$; <i>df</i> = 7, <i>p</i> = 0.082	1.7	4.9	$\chi^2 = 32.322$; <i>df</i> = 7, <i>p</i> < 0.0001
Highest educational level						
Primary school	11.5	12.1		13.7	9.2	
Secondary school	44.9	48.4		45.3	53.9	
Polytechnic: OND	12.2	13.7		14.8	11.7	
Polytechnic: HND	9.1	8.7		9.8	6.8	
University (BSc)	11.9	10.5		12.3	7.3	
Post-University (MSc or PhD)	1.5	2.1		2.5	1.5	
Do not want to answer	5.5	1.8		0.0	4.9	
Age						
18–29 years	30.8	23.8	$\chi^2 = 12.419$; <i>df</i> = 5, <i>p</i> = 0.029	19.6	31.1	$\chi^2 = 22.20$; <i>df</i> = 5, <i>p</i> < 0.0001
30–39 years	33.8	33.9		34.4	33.0	
40–49 years	19.9	24.6		25.7	22.8	
50–59 years	10.0	11.7		14.5	6.8	
60 years and older	4.4	3.2		4.2	1.5	
Do not want to answer	1.1	2.8		1.7	4.9	
Patronization frequency at SFV						
Daily	58.0	58.6	$\chi^2 = 2.362$; <i>df</i> = 4, <i>p</i> = 0.670	58.0	59.7	$\chi^2 = 3.901$; <i>df</i> = 4, <i>p</i> = 0.420
Several times per week (2–6 times)	24.1	26.6		27.7	24.8	
Once a week	7.3	5.9		4.8	7.8	
Less than once a week	4.0	3.0		2.8	3.4	
It is the first time I eat here	6.6	5.9		6.7	4.4	
Dish type						
Swallow dish	4.0	4.6	$\chi^2 = 3.828$; <i>df</i> = 1, <i>p</i> = 0.050	4.4	47.5	$\chi^2 = 0.759$; <i>df</i> = 1, <i>p</i> = 0.384
Rice dish	6.0	5.4		5.6	52.5	
Source(s): Authors' work						

non-users. Demographic differences between users and non-users were similar for rice dish and swallow dish consumers (Appendix 4).

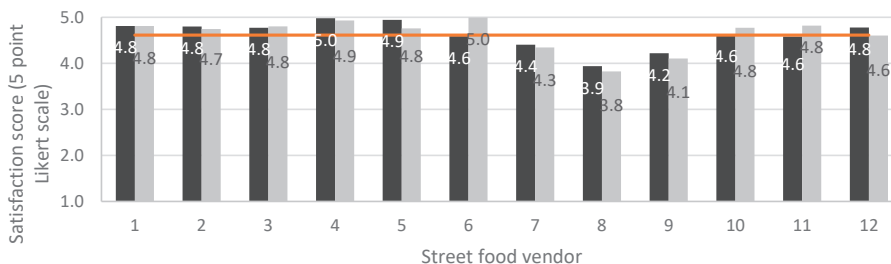
3.3.2 Consumer satisfaction with the dish. In both the baseline and intervention, the average respondent was highly satisfied with the whole dish (both mean = 4.6, no significant difference ($t = 0.533, p = 0.593$)). Customers of SFVs 1, 2, 3, 4, 5 and 12 were significantly more satisfied than average (t -values between 2.14 and 11.50, p -values below 0.05) and customers of SFVs 7, 8 and 9 significantly less (t -values between 2.84 and 6.42, p -values below 0.05). Dish satisfaction level was significantly higher in the intervention than in the baseline for SFVs 6 and 11 while it was significantly lower for SFVs 5 and 12. Dish satisfaction level of customers of SFVs 8 and 9 with the higher price of additional GLVs did not differ significantly between intervention (mean = 4.0) and baseline (mean = 4.1), suggesting no impact of this higher price on the whole dish satisfaction level (Figure 3).

Users were more satisfied with the whole dish (mean = 4.7) than non-users (mean = 4.4) ($t = 5.91, p < 0.0001$). This mean satisfaction score of users in the intervention was higher than in the baseline (mean = 4.6, $t = 4.53, p < 0.001$) and of non-users was lower in the intervention (mean = 4.6, $t = -2.12, p = 0.035$).

No significant differences were found between the satisfaction score of rice dish and swallow dish customers between baseline and intervention period (mean = 4.7 vs mean = 4.6 and mean = 4.6 vs mean = 4.5).

Customers buying additional GLVs with rice dishes were more satisfied with their dish (mean = 4.7) than those with swallow dishes (mean = 4.5) ($t = -2.752, p = 0.004$). For rice dish consumers, users (mean = 4.8) were more satisfied with the dish than non-users (mean = 4.4) ($t = -5.85, p < 0.001$). For swallow dish consumers, no difference between users (mean = 4.6) and non-users (mean = 4.4) was observed.

3.3.3 Consumer motivations for purchasing additional GLVs or not. Users bought additional GLVs mainly because of reasons related to health on a general level (e.g. health in general, good for the body) (34.6%), to health on a functional level (e.g. vitamins, nutritious, blood, digestion, immune system) (28.0%) and to sensory appeal (e.g. liking, taste, appearance) (22.1%) (Figure 4). The main reasons non-users did not buy additional GLVs were no need to eat vegetables or having already eaten vegetables (27.7%), price (21.4%) and sensory appeal (21.4%).



Note(s): Line is average scores for all respondents (baseline mean = 4.6 and intervention mean = 4.6); SFVs 1, 2, 3, 4, 5, and 12 scored significantly higher than the average (t -values between 2.14 and 11.50, p -values below 0.05) and SFVs 7, 8, and 9 lower (t -values between 2.84 and 6.42, p -values below 0.05); Differences between baseline and intervention were significant for street food vendors 5 ($t = 2.08, p = 0.047$), 6 ($t = -4.43, p < 0.001$), 11 ($t = -2.45, p = 0.018$), and 12 ($t = 2.08, p = 0.040$)

Source(s): Authors' work

Figure 3. Satisfaction with the whole dish per SFV at baseline (dark color) and intervention (light color) Y-axis: 1 = very dissatisfied to 5 = very satisfied. X-axis: numbers of the SFVs

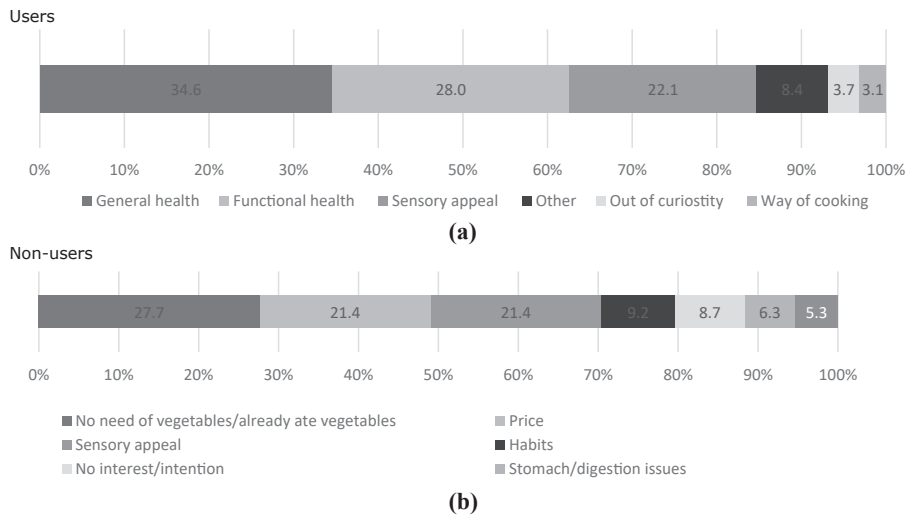


Figure 4.

Motivations of users ($N=358$) (A) for buying additional green leafy vegetables and of non-users ($N=206$) (B) for not buying them

Note(s): “Other” for users includes appearance of the dish, habits, outward appearance, traditional/culture, other health issues (e.g. diabetes, recommendation, medically advised), weight control). “Other” for non-users includes barriers related to food safety, availability, and health

Source(s): Authors’ work

3.4 SFV and vegetable supplier evaluation

Most SFVs indicated that buying, preparing and selling additional GLVs did not result in additional work (Tables 2 and 3). The SFVs that did perceive additional work, mentioned that buying and preparing GLVs was new to them, that they were not used to going to the market daily and that actively promoting vegetables required extra time. All SFVs indicated that

Table 2.

Perceptions of participating street food vendors and vegetable suppliers regarding extra work, leftovers and potential restrictions

	No	Yes
Extra work buying the additional vegetables	10	2
Extra work preparing the additional vegetables	9	3
Extra work selling the additional vegetables	10	2
Users have more leftover vegetables than non-users	12	0
Extra leftover vegetables at end of day compared to baseline	10	2

Source(s): Authors’ work

Table 3.

Potential restrictions for the green leafy vegetable suppliers participating in the study

	No	Yes
I have enough sourcing capacity to get additional vegetables	2	10
I have enough storage for additional vegetables	1	11
I can get all the additional vegetables at sufficient quality	0	12
I have to change something else	8	4

Source(s): Authors’ work

users did not have more leftover GLVs than non-users. Two SFVs had more leftover GLVs at the closing of business in the intervention period than in the baseline period.

Six SFVs indicated positive customer reactions to additional GLVs, whereas the rest used more neutral statements, such as “my customers accepted the additional vegetables”, or indicated that only part of their customers were willing to buy additional GLVs. At the end of the intervention, all SFVs indicated to continue selling additional GLVs, of which six as an option and six as a standard part of each dish.

Most of the vegetable suppliers indicated to have enough capacity to source additional GLVs of sufficient quality and to store them, if demand from SFVs would increase (Tables 2 and 3). Four suppliers mentioned they would have to make changes related to the selling location (increase in size, move), to lowering prices and to urging supplying farmers to improve the quality of offered GLVs.

3.5 Availability of the additional GLVs post intervention

Six to eight weeks after the intervention, six SFVs were still selling additional GLVs as in the intervention and three SFVs were still selling, but not daily. Three SFVs did not sell additional GLVs anymore, because it was too much work to buy, prepare and sell them. SFVs that were still selling additional GLVs, offered these also to other dishes, because of customer demand. They used the same portion size as in the intervention. Six SFVs indicated to still sell the additional GLVs for 50 Naira. Of these, four indicated to make a profit and two to break-even. One of the two SFVs with a price of 100 Naira during the intervention was still selling additional GLVs and still had a price of 100 Naira and two SFV changed the price from 50 to 100 Naira after the intervention. Two of these three indicated to make a profit and one to break-even.

4. Discussion

Our study showed that almost half of the customers of twelve SFVs in Lagos purchased additional GLVs with their swallow or rise dish when being informed about the potential health benefits of vegetable consumption. The customers paid a commercially viable price for these additional GLVs. Six to eight weeks after the intervention, nine SFVs still offered additional GLVs. This shows the potential of increasing vegetable intake through street foods in Lagos, Nigeria. Lion *et al.* (2018) also showed that people started adding GLVs to their stews to increase their iron intake after receiving information about the GLVs' health consequences. We found that health-related aspects, such as good for the body and nutrients, were important drivers for buying additional GLVs with street foods, which is in line with health being one of the main motives for vegetable consumption at home in Nigeria (Raaijmakers *et al.*, 2018; Snoek *et al.*, 2022). Thus, educating consumers on potential health benefits of vegetable consumption could be an interesting option to increase vegetable consumption both in- and out-of-home.

4.1 Dish satisfaction remains high or increases when adding an additional portion of GLVs

Satisfaction with a dish with additional GLVs increased from that without additional GLVs ($\Delta M = 0.3$). However, the size of increase was not that high, as the average respondents' satisfaction score of a dish without additional GLVs was already close to the top end of the applied Likert scale, so a higher score for a dish with additional GLVs was more difficult to achieve. The satisfaction scores are also supported by the finding that none of the SFVs reported leftovers on the plates of the consumers. Interestingly, we did see a difference between the types of dish. Satisfaction with a rice dish significantly increased when it included additional GLVs, however, the size of the increase was limited ($\Delta M = 0.1$). Dish

satisfaction of swallow dishes remains high. Customers were more likely to buy additional GLVs with a swallow dish than with a rice dish. This could be due to a rice dish with GLVs being more perceived as innovative, because having vegetables with rice dishes was uncommon, whereas having vegetables with swallow dishes was common. More insight into the underlying reasons is needed to improve acceptance of additional vegetables with swallow and rice dishes.

In other health-related fields, such as food safety, consumers develop personal relationships with their food vendors to help ensure quality (Hollinger and Staatz, 2015). This would potentially suggest that regular customers would be more induced by the SFV to buy additional vegetables than irregular customers. However, we did not find significant differences in patronization frequency between users and non-users. Further studies are needed to identify if this is due to the fact that only twelve SFVs were included in our study or that the impact of the SFV–customer relationship differs for additional vegetables to street foods.

4.2 Socio-demographics and motivations are among the drivers of buying additional GLVs with street foods

Users were on average higher educated and older than non-users. Other literature confirmed that vegetable consumption increases with age (Stadlmayr *et al.*, 2023). However, the review study of Stadlmayr and colleagues focusing on factors affecting fruit and vegetable consumption of adults in sub-Saharan Africa found no association between educational level and vegetable consumption. A study conducted in adults living in urban Mozambique found that vegetable consumption was lower in higher educated adults. It was speculated that this group is more likely to work outside the home and prefer food that is ready to eat (Padrão *et al.*, 2012). Our study took place in the out-of-home environment focusing on ready to eat foods, this might be the reason why we found a positive association. In line with a meta-review of African studies which did not find clear gender differences in vegetable intake (Mensah *et al.*, 2021), we did not find a difference in the proportion of female and male customers that selected additional GLVs. This was also supported by Stadlmayr *et al.* (2023). Additionally users show that they mainly chose the additional vegetables due to health benefits. Literature shows that health is one of the main drivers for vegetable consumption (e.g. Raaijmakers *et al.*, 2018; Snoek *et al.*, 2022).

4.3 COVID-19 crisis and season

The study was conducted in August and September 2020 during the COVID-19 pandemic. The study started about two months after a lock-down in Lagos ended, during which many businesses including SFVs had been closed. This might have resulted in income loss for people, also for those that buy street foods. On the one hand, this could have had a negative impact on people's willingness to buy additional GLVs. On the other hand, this might have triggered extra attention to the need to eat healthy, which could have resulted in a positive impact on people's willingness to buy additional GLVs. Indeed, Iheme *et al.* (2020) found that urban Nigerians considered consumption of vitamin C rich fruits and vegetables to be protective against COVID-19.

The study was conducted for five weeks in the wet season, with some days with a lot of rain. On such days, total customer numbers were lower than on dryer days. Not all SFVs had sufficient shelter to protect customers against the rain. Thus, we expect that the total number of customers was lower than it would have been in the dry season. We do not, however, expect that an average user would make a different decision in the dry season compared to in the wet season, if other circumstances would be similar (e.g. price). So, although the number of users might differ between seasons, we expect the percentage of users to be similar in different seasons.

4.4 Impact on vegetable consumption and implications for health

Consumption of sufficient vegetables contribute to preventing obesity and reducing the risk of developing chronic diseases and nutrient deficiency (Aune *et al.*, 2017; Yahia, 2017; WHO, 2003). However, current vegetable intake of urban Nigerians is below recommended levels (Afshin *et al.*, 2019; Olatona *et al.*, 2018; Olawuyi and Adeoye, 2018). The increased vegetable intake of SFV customers could potentially reduce the health risks of many urban Nigerian since street food consumption is common.

At the same time, an increased intake of GLVs could also result in increased risk of food borne disease through higher intake of microbial or chemical hazards present in these GLVs. Such hazards could be present due to improper practices used during cultivation, storage, processing and preparation (Erhirhie *et al.*, 2020; Pepple, 2017; Omojokun, 2013). This food safety aspect was outside the scope of our study. But, when designing regional or national policies to increase vegetable consumption, such potential food safety implications should also be considered.

With over 50 respondents for most SFVs and around 85% of customers visiting the SFVs at least several times a week, we expect that our consumer sample is representative of all consumers visiting the participating twelve SFVs. Although our street food consumer sample has similar demographics as those of Bamiro (2012) and Leshi and Leshi (2017), with the majority being male, between 30 and 40 years old and having secondary education, not all groups are equally covered. Efforts should be made to also reach other groups, for example younger people. Younger groups might be better reached in locations near schools and in neighborhood settings (Westbury *et al.*, 2021) or by improved alignment of the intervention with young people's perception of health benefits of vegetables or type of dish.

Participation of twelve SFVs was sufficient to reach our study aim but care should be taken in extrapolating the results of our study to customers of other SFVs in Lagos, in other cities in Nigeria, or in other countries. The number of SFVs is insufficient to draw conclusions about potential SFV related causes for differences in the percentage of users between SFVs. However, observed differences between SFVs in, for example, type of dish, price of additional GLVs, location and customers, can be used to develop directions for upscaling to other SFVs in Lagos, other Nigerian cities and other countries.

4.5 Implications for SFV business

Most SFVs and vegetable suppliers in our study indicated not to have problems to source and store an additional amount of GLVs. A few vegetable suppliers indicated that they might need to change location or increase their location's size. Probably, each SFV and vegetable supplier answered these questions with different amounts in mind, because the total amount of additional GLVs was not specified. The amount of our twelve SFVs was only a fraction of the total amount of GLVs sold in Lagos. If many more SFVs decide to sell additional GLVs, total demand for GLVs might increase substantially and problems might arise in availability of GLVs of adequate quality, in transport, or in storage, which should be considered when upscaling.

Following Plaisier *et al.* (2019), we actively involved SFVs in deciding upon the intervention. This also helped to balance project activities with daily SFV business activities, to get commitment of SFVs and to manage expectations. To balance risks due to the intervention with a sustainable business case, purchase costs of additional GLVs were reimbursed to the SFVs during the study period, but costs of other ingredients used in the vegetable stew and SFV time effort were not compensated. Because 75% of the SFVs continued to sell additional GLVs after the intervention, this participatory approach seemed to have worked well in our study.

To reduce potential noise, we aimed to have all SFVs using the same price of 50 Naira for one portion of additional GLV, which was agreed upon in the inception phase assuming it would cover all costs and a reasonable profit margin. However, two SFVs decided to set it at 100 Naira, claiming 50 Naira did not cover their additional costs. Given that these two SFVs had lower than average costs per kg GLVs (Table 1), other ingredients of the vegetable stew might have been a reason to increase the price. Regardless, the percentage of users of these two SFVs did not differ from that of the other SFVs. This shows that even at a higher price, a large percentage of street food consumers was willing to buy additional GLVs.

5. Conclusion

This study showed that when SFVs in Lagos promoted potential health benefits of vegetables to their customers, almost half of the customers were willing to buy additional GLVs with existing street foods at a commercially viable price. Informing consumers on the potential health benefits of vegetables and offering these in street food dishes is an interesting option to increase the consumption of vegetables. Dish satisfaction remained high or increased depending on the dish type to which GLVs were added to.

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Source(s): Authors adaptation of the leaflet, 'Why you must eat green leafy vegetables every day' by Snoek et al. (2022)

Figure A1.
Flyer used during the
intervention

Table A1.
Average weight per
day and price per kg
additional green leafy
vegetable purchased
over four intervention
days, and average start
time of selling and
selling time for street
food vendors with
swallow and rice dish

Appendix 2

Street food vendor	Weight (g)	Price (naira/kg)	Start time selling	Selling time
<i>Swallow dish</i>				
1	1,919	685	12:44	4:05
4	1,625	938 ^b	12:50	5:11
5	1,561	466	14:50	5:09
7	2,750	553	12:45	4:09
8 ^a	2,295	481	12:44	4:05
10	1,687	593	11:27	5:51
Swallow dish average	1,973	619	12:36	4:57
<i>Rice dish</i>				
2	2,165	438	7:09	3:55
3	1,788	308	12:44	3:32
6	1,570	681	9:37	6:25
9 ^a	3,667	291	7:05	1:58
11	2,550	397	12:44	3:32
12	1,488	674	9:37	6:25
Rice dish average	2,205	465	9:39	4:36
Total average	2,089	542	11:07	4:47
Note(s): ^a Street food vendors 8 and 9 charged 100 Naira for additional GLVs, the rest 50 Naira				
^b The high price was due to a last minute, occasional purchase from a road vendor				
Source(s): Authors' work				

Appendix 3

	Swallow dish			Rice dish			Chi-square: Total swallow sample vs Total rice sample
	Total	Non-users (N = 90)	Users (N = 170)	Chi-square: Stew dish: Non- users vs Users	Non-users (N = 116)	Users (N = 188)	
Gender							
		Male	73.5				
		Female	26.5				
Educational level		Primary school	13.5				
		Secondary school	46.2				
		Polytechnic: school	11.5				
		Polytechnic: OND	11.5				
Age		University (BSc)	9.6				
		Post-University (MSc or PhD)	2.7				
		None	3.1				
		Do not want to answer	1.9				
		18-29 years	17.7				
		30-39 years	32.7				
		40-49 years	25.0				
		50-59 years	15.4				
		60 years and older	5.4				
		Do not want to answer	3.8				

(continued)

Vegetable
consumption
through street
food

Table A2.
Socio-demographics of
respondents in the
intervention period per
swallow and rice dish,
and non-user and
user (%)

	1	2	3	4	5	6	7	8	9	10	11	12
	Street food vendor											
Gender												
Male	91.1	49.0	72.3	86.0	78.6	70.0	79.2	84.0	76.4	17.1	80.4	76.4
Female	8.9	51.0	27.7	14.0	21.4	30.0	20.8	16.0	23.6	82.9	19.6	23.6
Educational level												
Primary school	13.3	25.5	17.0	9.3	25.0	4.0	3.8	10.0	12.7	26.8	4.3	1.8
Secondary school	48.9	43.1	57.4	51.2	57.1	40.0	35.8	48.0	56.4	41.5	63.0	43.6
Polytechnic: OND	17.8	21.6	17.0	4.7	14.3	20.0	18.9	4.0	10.9	9.8	8.7	14.5
Polytechnic: HND	4.4	3.9	2.1	25.6	3.6	4.0	18.9	8.0	3.6	4.9	10.9	12.7
University (BSc)	8.9	3.9	2.1	7.0	0.0	28.0	13.2	18.0	3.6	4.9	6.5	21.8
Post-University (MSc or PhD)	4.4	0.0	4.3	2.3	0.0	2.0	7.5	0.0	0.0	0.0	2.2	1.8
None	2.2	2.0	0.0	0.0	0.0	2.0	1.9	2.0	7.3	12.2	4.3	0.0
Do not want to answer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	5.5	0.0	0.0	3.6
Age												
18-29 years	24.4	19.6	27.7	20.9	14.3	28.0	13.2	14.0	25.5	19.5	60.9	16.4
30-39 years	26.7	37.3	38.3	37.2	17.9	18.0	43.4	32.0	32.7	31.7	28.3	52.7
40-49 years	26.7	25.5	23.4	20.9	39.3	36.0	30.2	18.0	29.1	19.5	10.9	20.0
50-59 years	20.0	15.7	8.5	16.3	17.9	12.0	13.2	8.0	5.5	19.5	0.0	9.1
60 years and older	2.2	0.0	2.1	4.7	10.7	6.0	0.0	8.0	0.0	9.8	0.0	0.0
Do not want to answer	0.0	2.0	0.0	0.0	0.0	0.0	0.0	20.0	7.3	0.0	0.0	1.8
Customer patronization frequency at SFV												
Daily	71.1	96.1	76.6	51.2	82.1	64.0	35.8	14.0	58.2	41.5	56.5	64.8
Several times per week (2-6)	15.6	2.0	6.4	30.2	10.7	28.0	43.4	46.0	25.5	36.6	39.1	29.6
Once a week	4.4	0.0	2.1	9.3	0.0	0.0	17.0	18.0	7.3	7.3	0.0	1.9
Less than once a week	2.2	0.0	2.1	2.3	3.6	0.0	0.0	16.0	1.8	9.8	0.0	0.0
It is the first time I eat here	6.7	2.0	12.8	7.0	3.6	8.0	3.8	6.0	7.3	4.9	4.3	3.7
Source(s):	Authors' work											

Table A3.
Socio-demographics of
respondents in the
intervention study per
street food vendor (%)