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Effect of home vegetable gardening on the household availability of fruits and vegetables

Efeito do cultivo de hortas domiciliares sobre a disponibilidade domiciliar de frutas e hortaliças

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ABSTRACT

Objective

Evaluate the effect of planting herb or vegetable seeds and seedlings on the household availability of fruits and vegetables through an intervention study combining various actions (educational practices, home visits, and distribution of seeds and seedlings) for the promotion of fruit and vegetable consumption in multiple settings.

Methods

Data from 70 families were analyzed. Using the stratified sampling technique, the participant families were selected from a stratum within a population of 1,743 families living in three low-income communities in the city of *Rio de Janeiro*, Brazil. Three post-intervention groups were formed and compared: families that did not receive the seeds and seedlings during the intervention; families that received but did not plant the seeds and seedlings; families that received and planted the seeds and seedlings.

Results

Among the families that did not grow their own fruits and vegetables before the intervention, those that received and planted the seeds and seedlings achieved an increase in household availability of fruits and vegetables

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(Δ=+5.8 percentage points) up to three times higher (p<0.05) than that achieved by the families who did not receive the seeds and seedlings (Δ=+1.8 5 percentage points) and those that received but did not plant them (Δ=+2.3 percentage points). As for the families that grew their own fruits and vegetables before the intervention, the comparison between those that did not receive the seeds and seedlings, those that received and planted them, and those that received but did not plant them showed no differences in the household availability of fruits and vegetables.

Conclusion

The planting of the seeds and seedlings that they received by the families that did not grow their own fruits and vegetables before the intervention contributed to a significant increase in the household availability of fruits and vegetables.

Keywords: Evaluation Studies. Gardening. Health Promotion. Social Participation. Vegetables.

RESUMO

Objetivo

Analisar o efeito do plantio de sementes e mudas de temperos ou hortaliças sobre a disponibilidade domiciliar de frutas e hortaliças no âmbito de um estudo de intervenção. Este combinou diversas ações de promoção do consumo de frutas e hortaliças em múltiplos cenários, como práticas educativas, visitas domiciliárias, distribuição de sementes e mudas de temperos ou hortaliças.

Métodos

Foram analisados dados de 70 famílias selecionadas por meio de uma amostra estratificada. Esses dados permitiram inferir sobre o universo de 1 743 famílias que viviam em três comunidades de baixa renda da cidade do Rio de Janeiro. Três grupos definidos a posteriori foram comparados: *não receberam sementes e mudas durante a intervenção; receberam mas não plantaram as sementes e mudas; e receberam e plantaram as sementes e mudas.*

Resultados

Dentre as famílias que não cultivavam frutas e hortaliças antes da intervenção, aquelas que receberam e plantaram sementes e mudas atingiram um aumento na disponibilidade domiciliar de frutas e hortaliças (Δ=+5,8 pontos percentuais) até três vezes maior (p<0,05) do que os experimentados pelas famílias que não receberam sementes e mudas (Δ=+1,8 pontos percentuais) ou que receberam mas não plantaram (Δ=+2,3 pontos percentuais). Dentre as famílias que já possuíam frutas e/ou hortaliças plantadas antes da intervenção, ao comparar os diferentes grupos, não foram encontradas diferenças na disponibilidade domiciliar de frutas e hortaliças.

Conclusão

O plantio de sementes e mudas entregues às famílias que não cultivavam frutas e hortaliças antes da intervenção contribuiu para o efetivo aumento da disponibilidade domiciliar de desse tipo de alimento.

Palavras-chave: *Estudos de Avaliação. Cultivo de Alimentos. Promoção da Saúde. Participação Social. Hortaliças.*

INTRODUCTION

The contribution of fruit and vegetable to the prevention of chronic non-communicable diseases such as cardiovascular disease, cancer, diabetes, and obesity is well-documented in the literature, and the consumption of these foods has been widely recommended [1-3].

However, the accumulation of evidence and recommendations such as the daily consumption of a minimum of 400g of fruit and vegetable [3] are only the first step. This information alone cannot change the reality aiming for healthier dietary patterns. Thus, strategies that improve these feeding practices should be adopted and evaluated so that the most effective ones can be recommended.

Some studies have identified a positive relationship between the habit of growing fruits and vegetables at home or school and fruit and

vegetable consumption [4-7]. In the current scenario of broad social recognition of agricultural and environmental problems, growing herbs and fruits and vegetables in small spaces has been increasingly recommended [4-7]. Home/school/community fruit and vegetable gardens bring people closer to nature, add a ludic aspect to an activity that is associated with essential life resources, and enable rethinking the importance of foods in life. School fruit and vegetable gardens have led to a significant increase in fruit and vegetable consumption among children and adolescents [6,7] and their parents and also in the household availability [8]. Home and community fruit and vegetable gardening programs have also been developed worldwide and have received support from the United Nations [4]. This is due to the fact that these gardens ensure direct access to healthier foods such as fruit and vegetable and because they can alleviate the problem of limited access to affordable food [4-7].

An even more urgent need to intervene in very harsh realities from the socio-economic point of view has been consistently highlighted even in richer countries [9]. In Brazil, the consumption of fruit and vegetable does not reach even one-third of the minimum recommended daily intake of 400g. This situation is even worse among low-income families, for which the consumption has been below one-third of the minimum recommended since the 1970s [3,10-17]. As a result, there have been increased chances of the population developing diseases associated with the insufficient intake of fruits and vegetables, as well as a rise in health inequities due to the fact that impoverished populations are exposed to less adequate food patterns.

These challenges motivated us to conduct a study to evaluate the effectiveness of a strategy that combined several actions to promote fruit and vegetable consumption in multiple settings, including families living in low-income communities. This study evaluated the effects of planting herb or vegetable seeds and seedlings that were distributed during an intervention on household availability of fruits and vegetables.

METHODS

This is a community-based interventional study with before-after comparisons (without control communities). One of the intervention components included the promotion of home fruits and vegetables and herb gardening, which is the focus of analysis of this study. The unequal exposure of the families that participated in the intervention to the actions promoting home gardening allowed forming post-intervention groups without random allocation of participants. Three groups were formed as follows: families that did not receive the seeds and seedlings; families that received but did not plant the seeds and seedlings; and families that received and planted the seeds and seedlings.

The study population consisted of families living in three communities in the Western area of *Rio de Janeiro*, including children aged six and eight years in 2008 (five to seven years in 2007) and mothers who did not work outside the home. This stratum enabled overlapping the actions for promoting fruit and vegetables consumption, discussed below, considering that one of these actions would be implemented in public elementary and middle schools.

The sample size was determined using the stratified sampling technique with probability proportional to the number of families in each stratum (*i.e.*, in the micro-areas of each Family Health Units).

Of the 283 selected families, 207 answered the questionnaire at baseline. Seventy out of these 207 families answered the questionnaires and completed two protocols (pre- and post-intervention). To minimize the effect of dropouts, the sample weights were calibrated in order to ensure the power level of the final sample for statistical inferences. The family household natural weight (W_{ij}), which is

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given by the inverse of the household's probability of selection was multiplied by the calibration factor (g_{ij}), resulting in the household calibrated weight: $W_{ij}^{c} = W_{ij} \; x \, g_{ij} \; \forall \; ij \in d$, where *d* is the 12 post-stratification domains, *i.e.*, the micro-areas of each one of the three communities (5 in *Antares*, 5 in *Marias*, and 2 in *Cesário de Melo*). The calibration factors were estimated based on the post-stratification variables and the known population totals using regression equations. The distance function used in the equation is linear, and therefore there was no need to define limits to the calibration factors or weights since the calibration weights were not less than 1.

A more detailed description of the intervention has been previously reported [18]; thus it will be briefly described here. Figure 1 shows a schematic representation of how the intervention would ideally work, highlighting the elements that were evaluated in the present study.

Some activities had the support of the study project management team, but following the shared activity principle, the intervention was primarily based on the training of professionals and workers involved who could intervene in their own reality, considering the local resources and skills available.

A basic training course was offered to the Community Health Workers (CHWs), teachers, school cooks, and pedagogical coordinators of the schools involved in this study. It included activities to help raise awareness of CHWs and other local actors in order to multiply the actions in the community (*e.g.*, families and students). The course was offered to professionals of the three communities and was taught by dietitians, home economists, food engineers, agricultural engineer, and project team educators.

The course was composed of five modules and workload of 28 hours, which were defined according to the suggestions given by the CHWs, healthcare unit managers, teachers, and school cooks at the beginning of the study. The modules covered the following topics: cooking workshop; growing fruit and vegetable; use of the whole food; communication and health education tools; evaluation and planning.

The second module of the training course offered to the professionals and workers involved (*i.e.*, CHWs, teachers, and school cooks) was aimed at raising the participants' awareness to promote home and school fruit and vegetable gardening in the community. This module was offered at the *Escola Carioca de Agricultura Familiar* (a municipal school of urban agriculture in *Rio de Janeiro*), where the participants could visit the school vegetable gardens after participating in a discussion about urban agriculture and the main results of fruit and vegetable gardening obtained in the diagnosis made in this study based on the initial evaluation of families and schools.

During the visit, the following topics were addressed: "soils and composting – the importance of organic matter"; "home garden plants – species, annual gardening calendar, and seedling preparation"; and "garden pests – a new way to look at insects and their relatives". After the guided visit, the participants were grouped according to the community where they worked and lived to discuss possibilities, difficulties, and strategies to promote their consumption of fruits and vegetables.

At the end of this activity, seeds of cilantro, eggplant, and carrots and seedlings of vegetables and herbs (*e.g.*, basil, rosemary, and parsley) were distributed together with growing instructions and characteristics of the plants, roots, fruits and/or leaves. The participants were also given educational materials and brochures containing information about the topics addressed. The seeds and seedlings were also distributed during the community event held in each one of the three communities and in other opportunities such as the visits made by the field researchers to the participating families.

Data about food acquisition were gathered through a 30-day food record. The socio-demographic characteristics and exposure of the families to the interventions were collected using

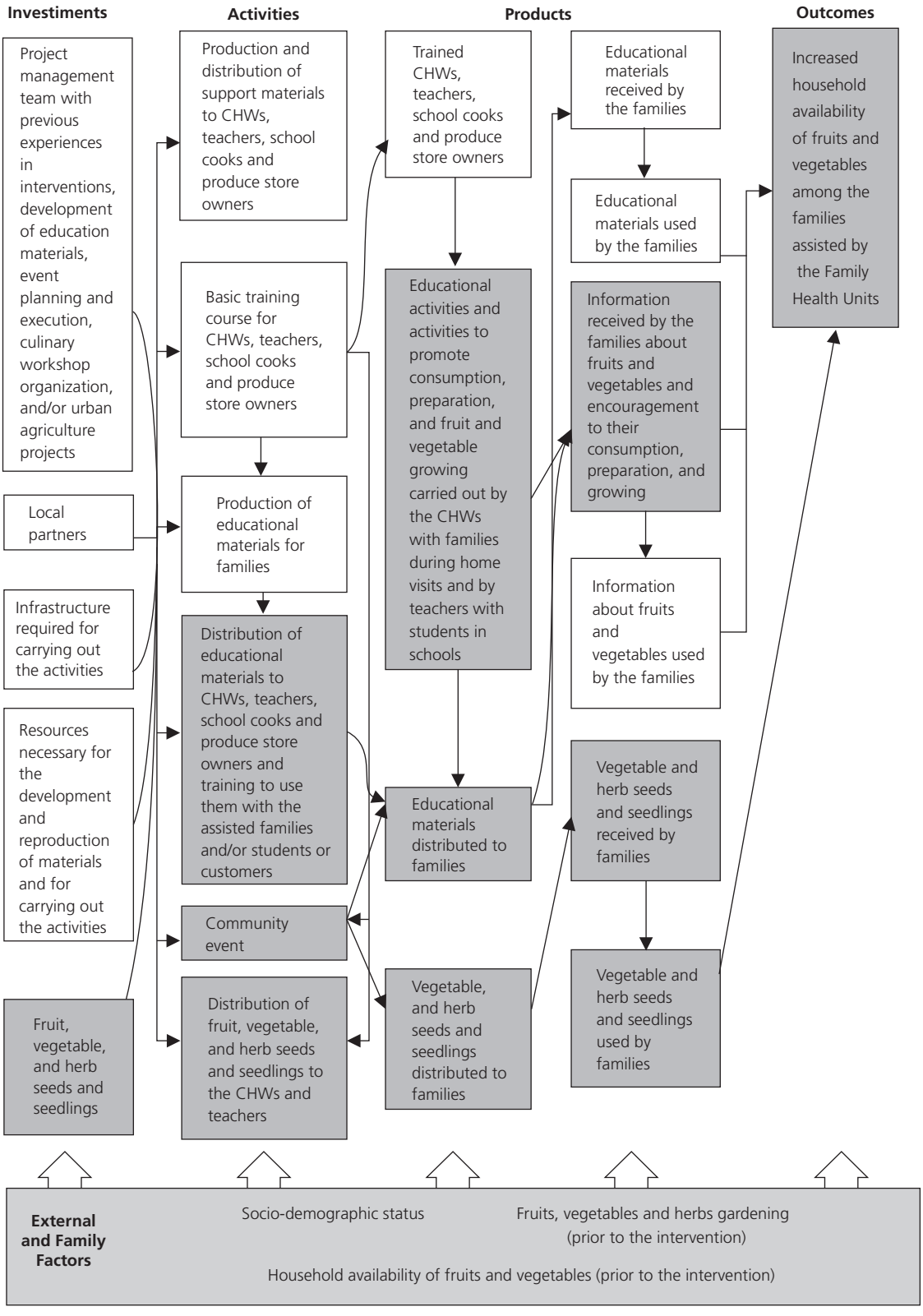

Figure 1. Logical model of the intervention to promote the consumption of fruits and vegetables highlighting the elements evaluated. Communities in the Western area of *Rio de Janeiro* (RJ), Brazil (2008-2009).

Note: CHW: Community Health Workers.

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structured questionnaires administered by trained researchers before and after the intervention. The families were instructed to record their daily food acquisition for 30 consecutive days describing in detail all foods they purchased (including beverages), foods that were donated to them, or foods they grew themselves. The records should include: quantity, unit of measure with weight or volume equivalents, the amount spent in Brazilian *Reais* (R$), and the purchase form and place, when appropriate. During the 30-day period, a field researcher made weekly home visits to the families and answered questions about completing the food record.

In order to determine the total calories acquired by the families, all foods recorded in the daily record book were coded according to a database established by the *Instituto Brasileiro de Geografia e Estatística* (IBGE, Brazilian Institute of Geography and Statistics) [10]; those that were not included in this database, were given new codes. A list of foods and food products (the same used by the IBGE) with corresponding codes to those mentioned above and containing the information about the nutritional composition of all food items was added to our data using the codes to estimate the amount of calories of each food.

The household availability of fruit and vegetable was defined as the amount of calories in the fruits and vegetables acquired by the families during 30 days, and it was considered as the outcome indicator. The socio-demographic status of the families was determined based on the household income, the respondent's level of education, and the number of children and family members.

The indicators of the scope of distribution and the use of the seeds and seedlings distributed to the families were used to form the three post-intervention groups (*i.e.*, those that did not receive the seeds and seedlings; those that received but did not plant the seeds and seedlings; and those that received and planted the seeds and seedlings), which contributed to the evaluation of the effect of growing the seeds and seedlings on the outcome of interest.

The present study was approved by the Research Ethics Committee of the *Secretaria Municipal de Saúde da cidade do Rio de Janeiro* (Municipal Secretariat of Health of *Rio de Janeiro*) (Protocol nº 120/07), and did not pose any risk to participants.

To estimate the total calories of the foods acquired by the families, the *Tabela Brasileira de Composição de Alimentos* (TACO, Brazilian Food Composition Table) [19], and, alternatively, the United States Department of Agriculture Food Composition Tables [20] were used.

The total amount of fruit and vegetable corrected for the total edible parts [19-21] was divided by the total adult equivalent units [22] to calculate the amount of fruit and vegetable per adult equivalent available in the household.

The Wald test [23] was used to determine whether the proportional distributions of the educational level categories of the respondents and the home visits to the families made by the CHWs differed between the intervention groups. This test was also used to compare the distribution of the socio-demographic variables of the samples before and after the intervention to verify selective loss of participants.

The first and second-order Rao-Scott adjustments to the Pearson's Chi-squared test [24] were used to evaluate the dichotomous variables, such as the number of family members categorized as less than five members and equal or greater than five members, and the presence or absence of children in schools participating in the intervention.

The differences in the relative percentage of calories in the fruits and vegetables in the total amount of calories acquired by the families and its variations between the pre-intervention and post-intervention periods and between the intervention groups were analyzed using log-linear model adjusting. A constant able to deviate the distribution to the right was added, allowing

adjustment of the models with non-negative responses [25,26]. The variation estimates were adjusted by the variable at baseline and by the variation in the number of total calories.

The interaction between the fruit and vegetable growing before the intervention and the inclusion in each intervention group in terms of the outcome of interest were investigated by including an interaction parameter in the log-linear model and by a graphical analysis, using an interaction plot showing the interaction between the factors. Since both the model interaction parameter and the interaction plot revealed the presence of interaction, the estimates were stratified according to the status of the families in terms of fruit and vegetable growing before the intervention.

The total calories acquired by the families and the amount of calories in the fruits and vegetables were determined using Stata version 9.0 (StataCorp, College Station, Texas, United States of America). The other analyses were carried out in R language and environment using version 2.15.1 of R, a language and environment for statistical computing (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

It was found that one-third of families in the three communities grew fruits and/or vegetables before the intervention, especially fruits; vegetables were grown by less than one-tenth of the families. Approximately 60% of the families investigated received the seeds and seedlings distributed during the intervention, and the proportion of this exposure varied from approximately half to two-thirds of the families in the communities. However, the proportion of families that planted those seeds and seedlings varied, and it was higher in *Cinco Marias*, followed by *Antares* and was much lower in *Cesário de Melo* (Table 1).

Analyzing the data of the intervention groups that were formed based on the availability and planting of the seeds ad seedlings, it was found that families that received and planted the herb or vegetable seeds and seedlings differed from those in the other intervention groups in terms of the number of household members (there were more households with up to 4 members) and the respondent's level of education (there were more families with incomplete elementary and/or middle school). Income did not differ between the intervention groups (Table 2).

The exposure of the families to visits by the CHWs was similar between the groups that received the seeds and seedlings. The proportional distribution of the families that did not receive the herb or vegetable seeds and seedlings according to the frequency of CHW visits and their comments about fruit and vegetable differed significantly from the others. The families that did not receive the seeds and seedlings had lower frequency of home visits by the CHWs and comments about fruit and vegetable. As for the families with children attending participating schools, their exposure to the intervention actions carried out in those schools did not differ significantly between the groups, but it was a slightly lower in the group that received the seeds and seedlings (Table 2). The habit of growing fruit and vegetables before the intervention was higher in the families that did not receive the seeds and seedlings, but it did not differ significantly between the intervention groups (Table 2).

The interaction plot (Figure 2) shows that the habit of growing fruits and/or vegetables before the intervention was a modifier of the effect of the intervention. Among the families that grew fruits and/or vegetables before the intervention, the variation in the household availability of fruit and vegetable was similar among the groups that did not receive the seeds and seedlings and those that received and planted or did not plant the seeds and seedlings. On the other hand, among the families that did not grow fruit and vegetable before the intervention, those that received and planted the seeds and seedlings achieved an increase in the household availability

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Table 1. Socio-demographic characteristics, habit of growing fruits and vegetables, and scope of seeds and seedlings distribution and use of herb or vegetable seeds and seedlings per community. Western area of *Rio de Janeiro* (RJ), Brazil (2008-2009).

Average monthly household *per capita* income (R$)	*Antares* ($\hat{N}$=781)		*Cinco Marias* ($\hat{N}$=788)		*Cesário de Melo* ($\hat{N}$=781)		All communities ($\hat{N}$ =1,743)	
	119	(89;149)[a]	240	(191;289)[b]	119	(84;261)[a,b]	177	(150;204)
	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Number of household members								
4 or less	42.5	(16.5 ; 68.5)	41.0	(27.4 ; 54.6)	36.5	(4.7 ; 68.2)	41.2	(27.7 ; 54.8)
5 or more	57.5	(31.5 ; 83.5)	59.0	(45.4 ; 72.6)	63.5	(31.8 ; 95.3)	58.8	(45.2 ; 72.3)
Respondent's level of education	a		b		c			
Illiterate	6.3	(0.0 ; 16.8)	0.0		0.0		2.7	(0.0 ; 7.3)
Literate	4.3	(0.0 ; 12.1)	0.0		0.0		1.9	(0.0 ; 5.3)
Incomplete Elementary and/or Middle School	41.0	(18.9 ; 63.1)	71.2	(59.0 ; 83.3)	36.4	(4.7 ; 68.2)	54.5	(42.8 ; 66.1)
Complete Elementary and/or Middle School	26.4	(9.7 ; 43.2)	13.7	(3.4 ; 24.0)	21.9	(0.0 ; 51.2)	20.1	(10.8 ; 29.3)
Incomplete High School	4.3	(0.0 ; 12.1)	8.5	(1.8 ; 15.2)	21.9	(0.0 ; 51.2)	8.0	(2.5 ; 13.5)
Complete High School	17.7	(0.0 ; 37.7)	4.7	(0.0 ; 9.8)	19.8	(0.0 ; 46.7)	11.9	(2.4 ; 21.4)
College/University or Graduate School	0.0		1.9	(0.0 ; 5.5)	0.0		0.9	(0.0 ; 2.5)
Families that grew fruits before the intervention	4.1	(0.0 ; 11.5)[a]	54.5	(38.6 ; 70.4)[b]	51.1	(24.2 ; 78.0)[b]	31.6	(23.2 ; 40.0)
Families that grew vegetables before the intervention	9.8	(0.0 ; 20.6)	8.4	(0.4 ; 16.4)	14.6	(0.0 ; 40.4)	9.6	(3.1 ; 16.2)
Families that grew fruits and/or vegetables before the intervention	13.9	(0.8 ; 27.0)[a]	59.6	(44.0 ; 75.2)[b]	51.1	(24.2 ; 78.0)[b]	38.3	(28.7 ; 47.8)
Families that received herb or vegetable seeds and seedlings	54.5	(28.5 ; 80.5)	67.4	(52.4 ; 82.3)	48.7	(19.6 ; 77.7)	59.8	(45.9 ; 73.7)
Families that planted seeds and/or seedlings they received	29.4	(2.0 ; 56.8)	41.5	(20.2 ; 62.9)	8.5	(0.0 ; 24.1)	31.1	(15.9 ; 46.2)

Note: Different letters in the same row refer to the proportional distribution of categories of the variables and indicate statistically significant differences in the distributions between the communities. Values followed by different uppercase letters in the same row indicate statistically significant differences in the distributions between the communities. Same letters or absence of letters indicates that there were no statistically significant differences between the communities.

$\hat{N}$: Estimate of the total number of families; 95%CI: 95% Confidence Interval.

of fruit and vegetable of up to three times higher (from 2.6 to 8.4%) (p<0.05) than the increase achieved by the families that did not receive the seeds and seedlings (from 3.4 to 4.5%) or that achieved by the families that received but did not plant the seeds and seedlings (from 3.4 to 4.8%). For this reason, a parameter of interaction between the habit of growing fruits and/or vegetables before the intervention and the intervention group of each family was incorporated into the adjusted models; the intervention effect estimates are shown in a stratified manner (Table 3).

Among the families that grew fruits and/or vegetables before the intervention, there was no difference in the household availability of fruit and vegetable before or after the intervention among the groups that did not received the seeds and seedlings and those that received and planted or did not plant them. The variations did not differ among these groups, even when adjusted to household availability at baseline, variation in total calories, respondent's level of education, and exposure of the families to other intervention actions (Table 3).

Table 2. Socio-demographic characteristics, home gardening practice before and after the intervention, and exposure to intervention actions other than planting seeds and seedlings per intervention groups. Western area of *Rio de Janeiro* (RJ), Brazil (2008-2009).

Average monthly household *per capita* income (R$)	Did not receive herb or vegetable SSds ($\hat{N}$=660)		Received SSds but did not plant them ($\hat{N}$=567)		Received and planted SSds ($\hat{N}$=307)	
	161	(106 ; 215)	149	(105 ; 193)	155	(131 ; 180)
	%	95%CI	%	95%CI	%	95%CI
Number of household members	a		a		b	
4 or less	41.6	(21.2 ; 62.1)	30.3	(11.0 ; 49.6)	75.4	(52.1 ; 92.7)
5 or more	58.4	(37.9 ; 78.8)	69.7	(50.4 ; 89.0)	24.6	(1.3 ; 47.9)
Respondent's level of education	a		a		b	
Illiterate	0.0		8.3	(0.0 ; 21.1)	0.0	
Literate	0.0		5.6	(4.3 ; 15.6)	0.0	
Incomplete elementary and/or middle school	43.6	(25.0 ; 62.2)	45.4	(25.6 ; 65.3)	78.8	(58.4 ; 99.1)
Complete elementary and/or middle school	24.4	(8.4 ; 40.3)	24.8	(6.5 ; 43.3)	16.4	(0.0 ; 34.7)
Incomplete high school	15.2	(1.9 ; 28.5)	5.3	(0.0 ; 12.0)	0.0	
Complete high school	16.8	(0.0 ; 35.4)	10.5	(0.0 ; 24.2)	0.0	
College/University or graduate school	0.0		0.0		4.8	(0.0 ; 14.1)
Families that grew F before the intervention	44.6	(26.7 ; 62.5)	23.6	(9.7 ; 37.5)	16.4	(0.0 ; 34.7)
Families that grew V before the intervention	11.3	(0.0 ; 23.7)	12.0	(0.0 ; 25.6)	8.2	(0.0 ; 22.9)
Families that grew F and/or V before the intervention	50.4	(31.7 ; 69.1)	33.0	(15.3 ; 50.6)	24.6	(1.3 ; 47.9)
Families with children attending schools that participated in the intervention	48.0	(28.8 ; 67.1)	72.0	(54.3 ; 89.8)	72.8	(47.3 ; 98.3)
Exposure of the families to the actions for the promotion of FV consumption carried out by the CHWs	a		b		b	
Families visited <1 per month; the CHW rarely/never mentioned FV	53.7	(34.4 ; 72.9)	32.7	(12.8 ; 52.6)	31.3	(6.4 ; 56.1)
Families visited <1 per month; the CHW sometimes mentioned FV	0.0		0.0		0.0	
Families visited <1 per month; the CHW always mentioned FV	3.8	(0.0 ; 10.7)	24.1	(4.0; 44.2)	30.2	(0.0 ; 62.6)
Families visited 1-3 times per month; the CHW rarely/never mentioned FV	14.8	(2.88 ; 26.7)	14.8	(2.7 ; 27.0)	29.5	(3.4 ; 55.7)
Families visited 1-3 times per month; the CHW sometimes mentioned FV	18.9	(0.2 ; 37.7)	0.0		0.0	
Families visited 1-3 times per month; the CHW always mentioned FV	4.8	(0.0 ; 13.5)	11.3	(0.0 ; 23.7)	4.1	(0.0 ; 11.9)
Families visited once per month; the CHW rarely/never mentioned FV	0.0		10.2	(0.0 ; 21.3)	0.0	
Families visited once per month; the CHW sometimes mentioned FV	0.0		0.0		4.8	(0.0 ; 14.1)
Families visited once per month; the CHW always mentioned FV	3.8	(0.0 ; 10.7)	6.8	(0.0 ; 15.8)	0.0	

Note: Different letters in the same row refer to the proportional distribution of categories of the variables and indicate statistically significant differences between the intervention groups. Same letters or absence of letters indicates that there were no statistically significant differences between the groups.

$\hat{N}$: Estimate of the total number of families; 95%CI: 95% Confidence Interval; F: Fruits; FV: Fruits and Vegetables; SSds: Seeds and Seedlings; CHW: Community Health Workers.

The estimates of the model adjusted to all of these variables, establishing worst and best case scenarios to other intervention actions, show that although receiving the seeds and seedlings (and the encouragement to plant them) did not exert effect on the families that grew fruits

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Table 3. Availability of fruits and/or vegetables* before and after the intervention, and its variation according to the intervention groups and the habit of growing fruits and/or vegetables before the intervention. Western area of *Rio de Janeiro* (RJ), Brazil (2008-2009).

Availability*	Families that grew fruits and/or vegetables before the intervention					
	Did not receive herb or vegetable seeds and seedlings		Received but did not plant the seeds and seedlings		Received and planted the seeds and seedlings	
	Mean	(95%CI)	Mean	(95%CI)	Mean	(95%CI)
Before†	2.8	(1.6 ; 5.0)	1.6	(0.7 ; 3.6)	3.6	(1.8 ; 7.2)
After†	5.1	(3.3 ; 8.0)	4.7	(1.9 ; 12.0)	4.7	(3.1 ; 7.1)
Variation[1]	2.3	(1.1 ; 3.6)	2.2	(0.4 ; 4.1)	1.6	(-0.3 ; 3.6)
Variation[2]	2.8	(1.3 ; 4.4)	2.4	(0.5 ; 4.4)	1.6	(-0.4 ; 3.8)
Variation[3]	3.0	(1.2 ; 4.9)	2.1	(0.3 ; 3.9)	2.5	(0.4 ; 4.8)
Variation[4]	4.9	(2.0 ; 7.9)	3.9	(0.8 ; 7.1)	4.3	(0.8 ; 8.1)
Availability*	Families that did not grow fruits and/or vegetables before the intervention					
	Did not receive herb or vegetable seeds and seedlings		Received but did not plant the seeds and seedlings		Received and planted the seeds and seedlings	
	Mean	(95%CI)	Mean	(95%CI)	Mean	(95%CI)
Before†	3.4	(1.6 ; 7.1)[a]	3.4	(2.0 ; 5.7)[a]	2.6	(1.3 ; 5.3)[a]
After†	4.5	(2.9 ; 7.0)[a]	4.8	(3.0 ; 7.7)[a]	8.4	(6.9 ; 10.2)[b]
Variation[1]	1.8	(0.0 ; 3.7)[a]	2.3	(1.0 ; 3.6)[a]	5.8	(4.4 ; 7.3)[b]
Variation[2]	2.3	(0.1 ; 4.5)[a]	2.9	(1.2 ; 4.7)[a]	6.0	(4.5 ; 7.5)[b]
Variation[3]	3.3	(0.1 ; 6.7)[a]	3.5	(0.7 ; 6.6)[a]	6.1	(3.6 ; 8.7)[b]
Variation[4]	5.1	(0.5 ; 10.2)[a]	5.4	(1.6 ; 9.5)[a]	8.0	(4.4 ; 11.9)[b]

Note: Different letters in the same row refer to the proportional distribution of categories of the variables and indicate statistically significant differences in the distributions between the intervention groups (among the groups that were formed according to the habit of growing fruits and vegetables before the intervention). [1]Adjusted to the variation in total calories and to household availability at baseline; [2]Adjusted to the variation in total calories, to household availability at baseline, and level of education (fixed as complete or incomplete elementary and/or middle school); [3]Adjusted to the variation in total calories, to household availability at baseline, and level of education (fixed in complete or incomplete elementary and/or middle school), and exposure of families to other intervention actions, fixed in the worst case scenario (*i.e.*, family without children attending a school that participated in the intervention and that was visited less than once a month by the community health workers, and, when visited, the Community Heark Workers rarely or never mentioned fruits and vegetables); [4]Adjusted to the variation in total calories, to household availability at baseline, and level of education (fixed in complete or incomplete elementary and/or middle school), and exposure of families to other intervention actions, fixed in the worst case scenario (*i.e.*, family without children attending a school that participated in the intervention and that was visited less than once a month by the community health workers, and, when visited, the CHWs rarely or always mentioned fruits and vegetables).*Amount (%) of total calories in the fruits and vegetables acquired by the families; †Adjusted to the total calories.
95%CI: 95% Confidence Interval.

and/or vegetables before the intervention, the other actions contributed significantly to increase the variation in the household availability of fruit and vegetables. The exposure to the other actions, even when more limited, was fundamental to contribute to increase the participation of fruit and vegetable in the families' diet. The effect of planting the seeds and seedlings on the families that did not grow fruit and vegetable before the intervention was quite significant. The families that received and planted the seeds and seedlings had a significantly higher variation in the household availability of fruit and vegetable than that of the families that did not receive the seeds and seedlings or that received but did not plant them, even after adjusting the model to the level of education and exposure to other intervention actions ($p<0.05$) (Table 3).

Even when the exposure to other interventions was fixed in a worst case scenario, characterized by the absence of children attending schools that participated in the intervention and low frequency of CHW visits and comments about fruit and vegetable during the visits, there was a significant increase in the variation of the participation of fruit and vegetable

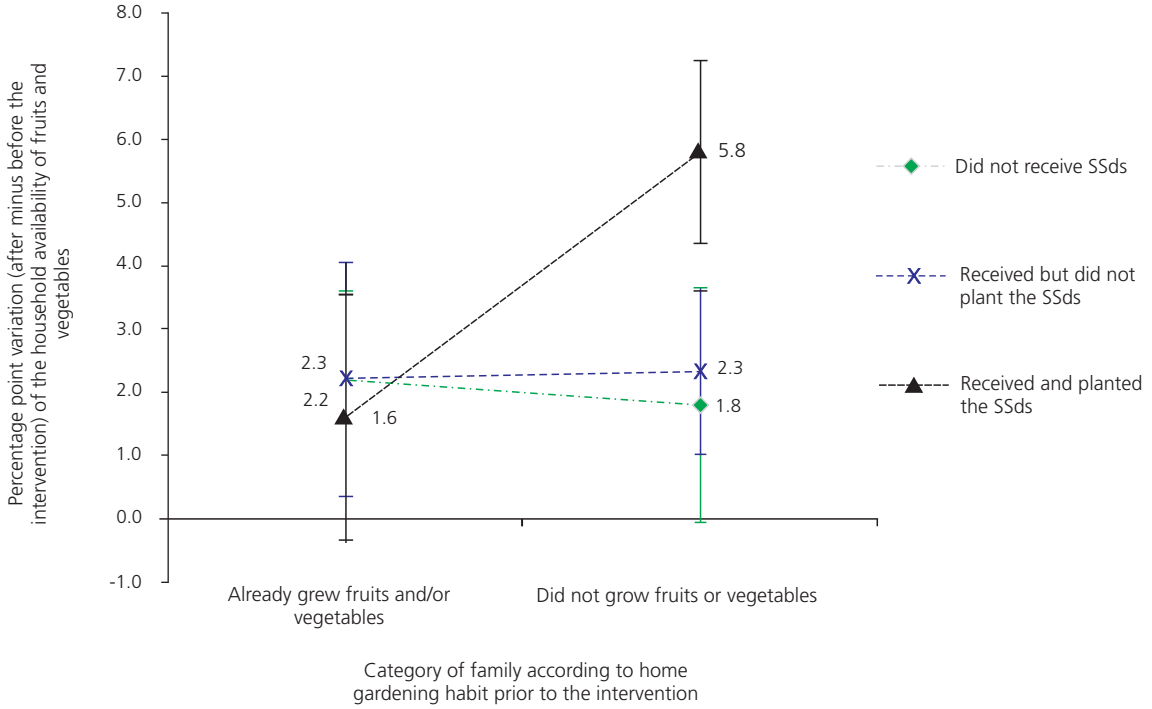

Figure 2. Percentage point variation (before and after the intervention) of the household availability of fruits and vegetables according to the home gardening habit per intervention groups. Western area of *Rio de Janeiro* (RJ), Brazil (2008-2009).

Note: Estimates adjusted to the household availability at baseline and to the variation in the total calories.

SSds: Seeds and Seedlings.

in the families' diet due to the planting of the seeds and seedlings received. Similarly, the increase resulting from planting the seeds and seedlings was significant among the families that were exposed to other intervention actions, leading to an increase in the availability of household fruit and vegetable (Table 3).

It is important to highlight that the distribution of the seeds and seedlings alone did not significantly change the variation in the participation of fruit and vegetable in the families' diet (Table 3). Therefore, some possible factors that could be related to the planting of seeds and seedlings were investigated. The adjustment of the parametric and non-parametric models showed that the exposure to the CHW visits and/or to the schools that participated in the intervention did not influence the decision about whether or not to plant the seeds and seedlings. The only factor that showed significant (p<0.05) differences was the number of household members. The chance of smaller families (with four or fewer members) planting the seeds and seedlings they received was significantly higher (*Odds Ratio*=7.5; CI95%=7.3–7.7) than that of families with five or more members.

DISCUSSION

The results obtained indicated that the planting of the seeds and seedlings by the families that did not grow fruit and vegetable before the intervention contributed significantly to the increase in the participation of fruit and vegetable in their diet. On the other hand, such effect was not observed among the families that grew fruits and/or vegetables before the intervention; probably due to the fact that the seeds and seedlings distributed were just additional plants in their vegetable garden and did not make a big difference in their daily lives. Therefore, other components of the intervention, such as the

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actions in the schools and the CHW visits, were of great importance to the families that grew fruits and/or vegetables at their homes. This is due to the fact that without these actions the effect on these families would probably have been very little or nonexistent since the intervention would be limited to planting the seeds and seedlings.

As for the families that did not grow fruit and vegetable before the intervention, in addition to planting the seeds and seedlings they received, the exposure to other actions, observed by the presence of children attending participating schools and more frequent CHW visits, magnified the effect on the household availability of fruit and vegetable. This finding shows the importance of investing in multicomponent interventions in multiple settings to magnify the effects and to increase the chances of producing effects in situations where one of the actions is not performed or is ineffective.

The potential of the fruit and vegetable home gardens as a strategy to promote the consumption of these foods has been increasingly reported in the literature, and the findings have consistently shown that it is a very effective strategy. However, most studies address the evaluation of interventions to promote school vegetable gardens [27]. There are very few studies evaluating home fruit and vegetable gardens [5,7,27]; moreover, among them there are even fewer studies on the effect of these gardens on the consumption of fruit and vegetable [5], and there are no studies on the impact on the household availability of fruit and vegetable.

There are many distinctive characteristics in the different settings in which people live, which make the circumstances under which an intervention will be implemented even more complex and diverse, affecting its impact. Therefore, interventions that encompass different dimensions and settings of life can increase the possibility of affecting reality [28].

An extensive literature exists regarding fruit and vegetable promotion through interventions with multiple components and strategy actions [29,30]. However, most of them address a single setting, especially schools and work environments [29,30]. There is a limited number of studies examining different settings, including a few pilot studies and study projects [31,32]. Krølner *et al*. [32] conducted a study combining school and community-based actions and emphasized that this setting integration is crucial to promote more favorable conditions to increase fruit and vegetable consumption. In the present study, combined with the planting of herb or vegetable seeds and seedlings, the exposure of families to the actions carried out in schools and healthcare services (CHW visits with comments about fruit ad vegetable) produced an effect able to increase household availability of fruit and vegetable by eight percentage points. To better contextualize the magnitude of this effect, since the average relative participation of fruit and vegetable in the total calories acquired by Brazilian families in 2008-2009 was 2.8% [22], more than half of the population could meet the recommendation if there was an effect similar to that found in the present study; the total fruit and vegetable calories would change from 2.8% to 10.8%. This does not mean that the same actions carried out in this intervention would be able to produce similar effects on other circumstances and contexts, but an effect of such magnitude would be at least desirable to meet the WHO recommendations, considering the Brazilian situation described in the last *Pesquisa de Orçamentos Familiares* (Family Budget Survey) [22].

In the present study, the socio-demographic status, defined according to the number of household members, also significantly contributed to the decision about whether or not to plant the seeds and seedlings. For smaller families, a condition that in the context of the communities investigated was associated with better socioeconomic status [smaller families had a significantly higher *per capita* income ($p<0.05$); an average of R$87.59 more than that of larger families – results not shown], the chance of planting the seeds and seedlings they received

was significantly higher when compared to that of the households with five or more members. Despite the large number of reports in the literature of positive effects of home/school/community vegetable gardens on fruit and vegetable consumption [5-7,27], evidence on the decision to plant is still limited and is primarily restricted to studies carried out in African and Asian countries, marked by extreme situations or almost extreme poverty and food shortages. Thus, the main motivation of the families and government of those countries and supranational organizations to invest in home vegetable gardens results from the urgent need to reduce food insecurity [4]. Other motivations, such as environmental concerns [33,34], have been described in less favorable settings. On the other hand, lower socioeconomic status and the lack of space, time, and/or ability to plant are seen as barriers to grow a home garden [33,34].

The exposure of families to CHW visits did not increase their chance to plant the seeds and seedlings they received because even when the visits were frequent, fruit and vegetable was not frequently mentioned. Therefore, it would be essential that CHWs are aware of the importance to motivate families to plant, considering that planting the seeds and seedlings significantly contributed to the increase in household availability of fruit and vegetable among the families that started growing these foods due to the intervention. An effective training of the CHWs to encourage and support families to plant could help them overcome, collaboratively and communally, the barriers they face, particularly those that live in more adverse socio-economic conditions. Considering that in many municipalities, the *Estratégia Saúde da Família* (Family Health Strategy) is focused on populations living in the most adverse socio-demographic situations, this recommendation also contributes to promote equity [35]. Finally, it is suggested that effective multicomponent initiatives be developed in different realities in order to increase fruit and vegetable growing among families, especially those with low socio-economic status.

In addition to the analysis of the determinants of fruits, herbs, or vegetable gardening (which was not directly addressed in this study), it would be important to evaluate other effects of this practice related to food and other events of interest. Clayton [33] indicates some approaches that can contribute to this understanding. Investigating people's attitudes toward their gardening, the author found that there is recognition of the social and environmental value of gardens and home gardens, and that it is therefore positively associated with a greater concern for the environment and socialization. On the other hand, when growing edible or non-edible plants for commercial purposes, this relationship can differ greatly. Lourenço [36] showed that agricultural workers from the hillside area of *Rio de Janeiro* rarely consume the fruit and vegetable they grow. The authors added that growing a specific type of vegetables reduces the diversity of the most commonly available foods, making families to avoid consuming what they grow and see often. Moreover, the changes in the relationship between people and their produce, the environment, and the fruits of nature is evident in the sense of nostalgia for the old growing practices and eating habits, as reported by agricultural workers who see home gardening today as a purely commercial activity.

Forming heterogeneous post-intervention groups, *i.e.*, without random allocation of the families to the groups, could introduce bias into the analysis if the groups differed with regard to characteristics that were associated with the event of interest. As a result, some characteristics of the families that could affect the outcome and differ between the groups, such as level of education, were included in the adjusted models to minimize the effects that would not be attributed to the planting of herb or vegetable seeds and seedlings. The same procedure was adopted for the variables related to the exposure to other intervention actions.

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Although the high participant dropout rates were considered an important limitation, the comparison between the initial sample (dropout rate of only 27% equivalent to 2%, considering an oversampling of 25%) and final sample (dropout rate of 66%) showed that they did not differ in terms of socio-demographic characteristics (results not shown). Furthermore, the final sample size did not change the 90% power and the maximum error (5%) of the estimate of the difference between the pre and post-intervention data. However, to retain the representativeness of the sample, the sample weights were calibrated as a function of the dropouts so that the estimates would still represent the known population totals.

Only a little over half of the families studied received herb or vegetable seeds and seedlings, which seems to be a limitation of the intervention. However, this fact allowed the investigation of different degrees of exposure to the intervention, stratifying the analysis and comparing different scenarios resulting from the implementation of the intervention.

CONCLUSION

The promotion of home herb or vegetable gardens through the distribution of seeds and seedlings contributed to the increase of the household availability of fruits and/or vegetables among families who did not grow fruit and vegetable before the intervention and planted the seeds and seedlings they received. However, this increase was not statistically significant among the families that grew fruits and/or vegetables before the intervention. The chance of planting the herb or vegetable seeds and seedlings distributed was significantly higher among the families with better socio-demographic status. The presence in the family of children attending schools that participated in the intervention and the CHW visits also magnified the effect of planting the herb or vegetable seeds and seedlings.

The combination of multicomponent intervention actions (*e.g.*, home visits, educational activities, seeds and seedlings distribution) in multiple settings (*e.g.*, family, school, produce stores) involving different sectors (health, education) resulted in a positive effect of the intervention on the household availability of fruit and vegetable among the families investigated, even under circumstances where one of the actions had no effect (*e.g.*, planting of seeds and seedlings among families that grew fruits and/or vegetables before the intervention) or where the scope of seed and seedling distribution or participation in one of the actions was small (*e.g.*, families that received but did not plant the seeds and seedlings). Therefore, it is important to encourage the implementation and evaluation of similar interventions that encompass different circumstances under which the actions would be effective, combining different settings and action components.

CONTRIBUTORS

The author FS GOMES contributed to the study conception and design, and data collection, analysis and interpretation, the author GA SILVA contributed to the study conception and design and data interpretation, and the author IRR CASTRO contributed to the study conception and design, and data collection and interpretation.

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