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Assessing school-based intervention strategies to foster the prevention of choking injuries in children: The results of the CHOP (CHOking Prevention) trial

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Abstract

There are few public health programs aimed at reducing choking injuries, even though choking is one of the leading causes of death among unintentional injuries in young children. We present the results from the CHOP (CHOking Prevention) project community intervention trial, which aimed to compare three different school-based intervention strategies for food choking prevention. The trial enrolled 41 educational facilities, which were randomized to one of three different intervention strategies to inform about prevention of food choking, or to serve as the control group. In strategy A, education was delivered directly to families, whereas in strategy B, education was delivered first to teachers and by them to families, and in strategy C, education was delivered only to healthcare coordinators in each school and by them to teachers and families. All educational interventions were delivered in the schools by experts and certified trainers. The participants were asked about sociodemographic information and completed questionnaires (pre-, post- and follow-up of intervention). Information from the postintervention and follow-up questionnaires was synthesized into four indicators to evaluate the effectiveness of each intervention strategy. Of the 1,426 participants, 298 were involved in strategy A, 474 in strategy B, 491 in strategy C and 163 in the control group. At postintervention, the scores of the indicators in each strategy significantly outperformed those of the control group, with adjusted $p < 0.05$. At follow-up, the distribution of the indicator scores of each strategy was found to be not significantly different compared to those of the control group ($p > 0.05$). The results of this study suggest that a sustainable school-based public health intervention mediated by teachers is effective as direct training for families in improving knowledge about food choking injury prevention. Nevertheless, further improvements could be made to increase long-term information retention.

KEYWORDS

children, choking prevention, CHOP, community intervention trial, foreign body, public health, school

1 | INTRODUCTION

Choking is one of the leading causes of death among unintentional injuries in young children and remains relevant until the age of 14 (Lorenzoni et al., 2018; Paulozzi et al., 2006). In recent years, the development of prevention strategies for nonfood choking injuries (e.g., toys) has resulted in a reduction in the occurrence of this type of injury (Cramer et al., 2019). However, the same cannot be stated for food-related choking injuries, which present an even more significant impact (van As et al., 2012). Nonetheless, there are few public health programs on this topic, and there is a need to develop prevention strategies for this issue. Indeed, food-related choking injuries in children are related to physiological characteristics that make them more prone to choking while eating (Passali et al., 2015), and with regard to chewing, the characteristics of food (size, shape, texture/consistency) make some food types difficult for younger children in particular. Thus, some foods can be swallowed before they have been sufficiently chewed, giving rise to the possibility of conforming to the pharynx, with a potential complete air blockage or of reaching the lower respiratory tract, with the consequent risk of infections. However, studies have shown that caregivers often lack knowledge about food choking and hazardous foods (Fano et al., 2019; Higuchi et al., 2013; Nichols et al., 2012), with many studies recommending the need for caregiver education (Rodriguez et al., 2017; Sih et al., 2012; van As et al., 2012). Data from the Susy Safe registry (The Susy Safe Working Group, 2012) agree in indicating that most choking injuries were due to a food item (The SuSy Safe Working Group, 2013). Forty percent of injuries occurred when children were eating without adult supervision, and for the remaining 60% where adult presence was recorded, children were served food that was prepared improperly (The Susy Safe Working Group, 2012). This suggests that caregivers lack sufficient knowledge about food choking hazards and the possibilities for reducing risk and managing a choking episode, thus demonstrating the need to develop food choking prevention strategies. The potential success of such strategies can be seen from studies conducted in Israel (Sadan et al., 1995) and in Crete (Karatzanis et al., 2007), which showed that a reduction in choking rates in children occurred after the implementation of educational programs for choking prevention.

In most of Europe and, in particular, in Italy, training on food choking prevention is currently performed voluntarily, and in particular, low-income families may suffer limited access to such training resources. This is also generally the case for many families with newborns or expecting children, as other costs may take priority. Ideally, caregivers should receive at least some training either before children are born or before weaning commences. This usually happens at approximately six months of age because children under the age of three are more likely to suffer from the most severe choking injuries (Paulozzi et al., 2006).

From a public health perspective, in the presence of a lack of compulsory prenatal classes or postnatal training opportunities for new parents, the identification of sustainable and effective educational strategies is a priority. Under the hypothesis that a school-based intervention may represent the most realistic way to reach as many families as possible for a community-based training program, the CHOP (CHOking Prevention) project (Lorenzoni et al., 2019) was conducted.

What is known about this topic?

- Choking injuries in children pose a severe public health burden.
- Choking injuries are predictable and preventable through ad hoc prevention programs.
- No specific public health programs targeted to choking injuries prevention have been developed.

What this paper adds?

- **A school-based public health intervention has been found to be effective in improving the knowledge about choking injuries prevention.**

It is worth pointing out that to the best of our knowledge, the CHOP study is the first in the field aimed at testing a school-based intervention strategy for preventing food choking injuries specifically aimed at children's caregivers.

In this paper, we report the results of the CHOP study by comparing three different school-based intervention strategies among themselves and with a control group with regard to food choking prevention.

2 | METHODS

2.1 | Study design

The CHOP project was designed as a community intervention trial to compare three different school-based intervention strategies and is described elsewhere (Lorenzoni et al., 2019); trial profile is reported in Figure 1. The project delivered education on primary and secondary food choking prevention under the umbrella topic of nutrition education. The CHOP project was approved by the "Comitato etico per la Sperimentazione clinica della Provincia di Padova" (Prot. Num. 4277/U6/17).

2.2 | Participants

The trial enrolled 41 educational facilities (nurseries, kindergartens and primary schools). Fifty schools were assessed for eligibility but six of fifty refused to participate, so the initial sample consisted of 44 educational facilities. However, three of forty-four schools withdrew the consent after the randomization was done (Figure 1). The eligibility criteria for school participation are detailed elsewhere (Lorenzoni et al., 2019).

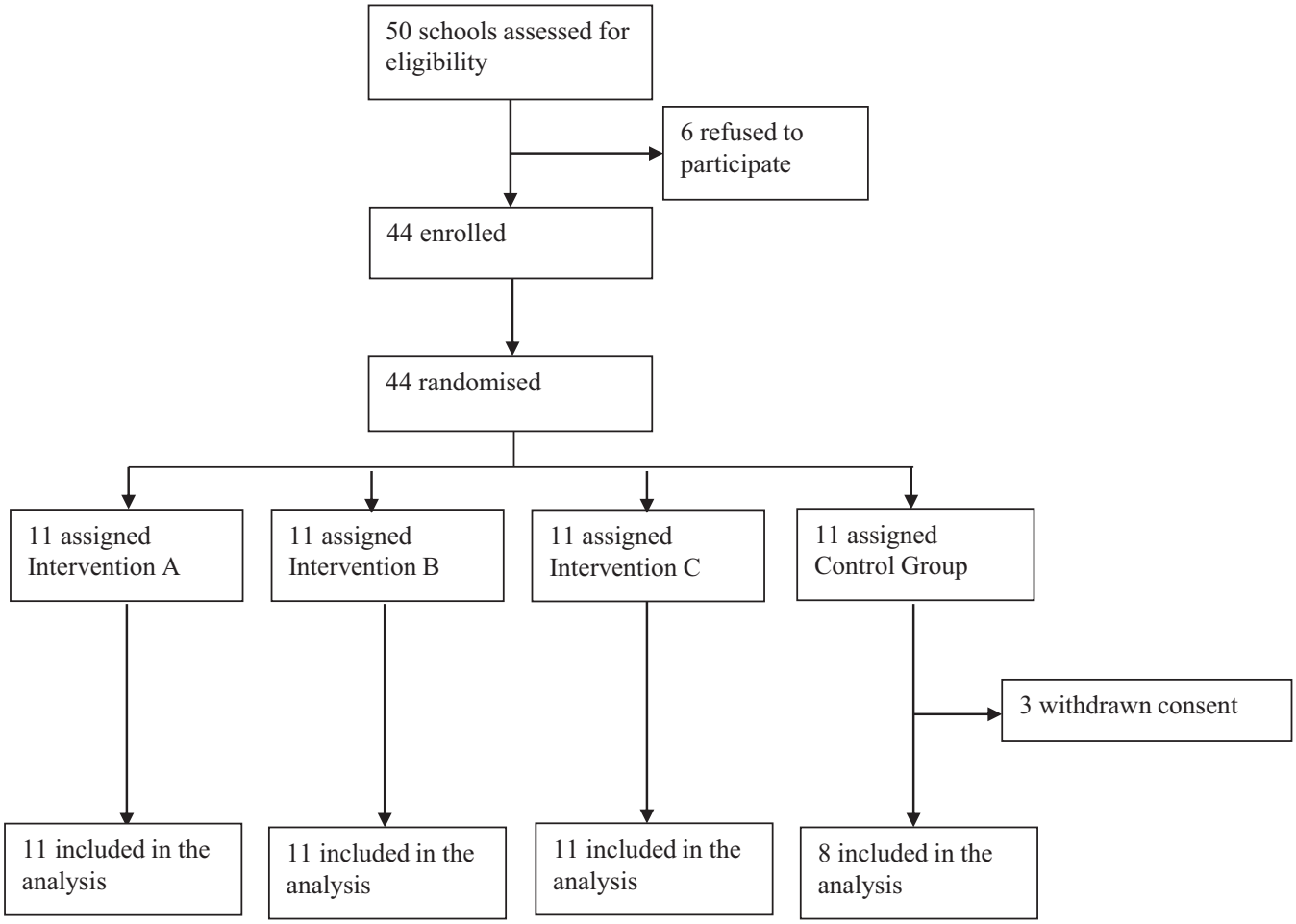

FIGURE 1 Trial profile

Study participants were informed about the nature and the scope of the study by study coordinators. If they agree to participate, they must provide written informed consent in accordance with Ethical Committee (EC), using an EC approved informed consent form, including the consent for the use and processing of their personal details.

2.3 | Randomisation and masking

The educational facilities were stratified such that each stratum included one nursery, one kindergarten and one primary school. Each stratum was then randomized to one of three different intervention strategies or the control group.

Participants and trainers were not blinded to strata allocation, but those in charge of data analyses and interpretation of results were blinded.

2.4 | Procedures

Figure 1 summarizes the three educational intervention strategies (A, B, C), which were delivered by experts and certified trainers. All strategies delivered the same educational intervention material, which is detailed elsewhere (Lorenzoni et al., 2019); however, in brief, it included the following:

- A lecture on the primary prevention of food choking (see below) given by experienced trainers.
- Training on maneuvers to dislodge foreign bodies (secondary prevention) illustrated by trainers certified by the Italian Society of Pediatric Emergency Medicine (SIMEUP).
- Distance education via a massive open online course (MOOC) to reinforce the lecture content.

2.5 | Outcomes

Details regarding data collection and the indicators of intervention strategy performance are detailed elsewhere (Lorenzoni et al., 2019). In brief, all participants completed a sociodemographic questionnaire (gender, age, marital status, educational level, employment and any experience with a choking episode), a baseline questionnaire before the intervention, two identical questionnaires immediately after (post) and one month after (follow-up) the educational interventions, and a pass/fail skills test on secondary prevention training.

The indicators of the performance of each intervention strategy (A, B, C) were determined based on some of the responses within the questionnaires (post- and follow-up). Four indicators (1–4, Table 1) consisting of sets of questions were calculated for the postintervention and follow-up stages of each strategy using weighted scoring, as shown in Table 1.

2.6 | Statistical analysis

The indicators are reported as the mean (±standard deviation). For each indicator, Wilcoxon–Kruskal–Wallis tests were performed for each strategy compared to the control group. To properly account for the multiplicity of testing, the p-values were adjusted based on the Benjamini–Hochberg procedure (Benjamini & Hochberg, 1995). Furthermore, linear regression models were estimated, one for each indicator, at both study stages (post and follow-up) to adjust the strategy effects, accounting for potential confounders, in particular for sociodemographic characteristics and baseline knowledge regarding choking prevention. All analyses were performed using the R system (R Development Core Team, 2015).

The methods for sample size estimation are detailed elsewhere (Lorenzoni et al., 2019).

Trial registration number: NCT03218618.

TABLE 1 Indicator topics, questions, and weighted scores used to assess the CHOP choking educational intervention strategies

Indicator	Topic	Question	Weighted score
1	Risk perception	Are magnets, if swallowed in numbers greater than one, dangerous?	0.15
		What objects are most frequently involved in foreign body injuries?	0.35
		What objects cause the most serious and fatal injuries?	0.35
		Why are button batteries dangerous if ingested?	0.15
2	Rules for food preparation	When should it be assumed that a child has inhaled a foreign body, and what should be done?	0.1
		What size should food be prepared to?	0.1
		How should we prepare and cook meat and fish to reduce the risk of choking and injury?	0.3
		How should you cut wurstel and hot dogs?	0.3
		What should children do during meals and when eating?	0.1
		Do particular food preparation techniques help to reduce the risk of choking?	0.1
3	Ability to recognize hazardous foods	Which food represents a high risk of choking to children?	0.4
		Why is food of a round shape hazardous?	0.4
		Why do we have to give babies nuts in a ground form incorporated into other foods with a soft consistency (e.g., yogurt)?	0.1
		At what age can children be given candies and sweets?	0.1
4	Epidemiological knowledge	Do you know the reason why children are at risk of choking?	0.33
		At what age are children at highest risk of choking?	0.33
		How many deaths per year are estimated to result from foreign body injuries in EU countries in children between 0 and 14 years of age?	0.33

2.7 | Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

3 | RESULTS

3.1 | Sociodemographic characteristics

Table 2 presents the essential sociodemographic characteristics of the study sample. Of the 1,426 participants, 298 were involved in strategy A, 474 in strategy B, 491 in strategy C and 163 in the control group. Most participants were female and were aged 36–45 years old. Most participants had at least secondary education and were office workers, with a relevant presence of unemployed people. Notably, a relevant number of participants affirmed having

TABLE 2 Characteristics of the participants by strategy (A, B, or C) and the control group. Data are percentages (absolute numbers)

	N	Strategy A (*N* = 298)	Strategy B (*N* = 474)	Strategy C (*N* = 491)	Control group (*N* = 163)
School type	1,311				
Nursery		38% (112)	31% (146)	40% (196)	27% (13)
Preschool		40% (119)	32% (152)	25% (122)	25% (12)
Primary school		22% (67)	37% (176)	35% (173)	48% (23)
Gender	1,116				
Female		82% (213)	92% (366)	87% (289)	63% (79)
Male		18% (48)	8% (33)	13% (42)	37% (46)
Age	1,115				
>45		18% (46)	24% (96)	27% (90)	17% (21)
18–35		26% (68)	27% (106)	29% (97)	42% (52)
36–45		56% (148)	49% (194)	44% (145)	42% (52)
Marital status	1,110				
Single		4% (11)	12% (46)	12% (38)	38% (48)
Married		83% (213)	75% (298)	75% (248)	41% (51)
Widowed		0% (0)	1% (4)	1% (3)	0% (0)
Divorced		4% (10)	4% (14)	3% (9)	7% (9)
Domestic partner		9% (24)	9% (35)	10% (32)	14% (17)
Educational level	1,110				
University		55% (143)	31% (122)	47% (154)	30% (38)
Primary education		1% (3)	2% (8)	1% (2)	0% (0)
Secondary education		43% (112)	67% (267)	53% (174)	70% (87)
Job	938				
Manager		3% (7)	0% (1)	3% (7)	2% (2)
Office worker		43% (102)	40% (130)	46% (124)	45% (49)
Independent contractor		29% (68)	13% (41)	19% (50)	14% (15)
None		22% (52)	42% (136)	28% (75)	26% (29)
Worker (factory)		3% (7)	5% (15)	5% (13)	14% (15)
Choking episodes in children	1,004				
Yes		17% (41)	25% (87)	16% (50)	14% (16)
No		83% (199)	75% (256)	84% (257)	86% (98)

experienced a choking episode involving their children (from 25% to 14% by strategy).

3.2 | Baseline knowledge

Preintervention questionnaires (Table 3) were used to depict the baseline knowledge of all participants regarding choking injuries. A high percentage of participants correctly answered questions regarding why children are at risk of choking (90.5%) and whether they considered themselves to know food preparation techniques that can help to reduce the incidence of choking (88%). More than one-third of the participants did not correctly answer questions relating to the age at which children are at highest risk of choking and the objects that most often cause choking. More than half of the participants did not know the extent of the choking burden in children in the EU.

3.3 | Skills test

All participants in strategies A and C passed the skills test, and 98% of those in strategy C passed. Of the teachers and health-care workers who had to complete the skills test prior to being able to teach families (i.e., strategies B and C), 100% and 97% in strategy B and strategy C, respectively, passed the test.

TABLE 3 Baseline knowledge (preintervention) regarding choking injuries. Data are percentages (absolute numbers)

Questions	*N*	
Do you know the reason why children are at risk of choking?		
Right answer	1,038	90.5 (939)
Wrong answer		9.5 (99)
At what age are children at risk of choking?		
Right answer	1,026	61 (624)
Wrong answer		39 (402)
Do particular food preparation techniques help to reduce the risk of suffocation?		
Yes	957	88 (842)
No		12 (115)
Do you know the extent of the problem of foreign body injuries in Europe?		
Yes	1,035	26.5 (274)
No		73.5 (761)
How many deaths per year are estimated to result from foreign body injuries in EU countries in children between 0 and 14 years of age?		
Right answer	920	45 (412)
Wrong answer		55 (508)
Which objects/foods most often cause choking?		
Right answer (nuts/candies/baby carrots)	1,356	63 (849)
Wrong answer		37 (507)

3.4 | Post intervention

The resulting postintervention indicator scores for each strategy and the control group are shown in Table 4. The scores of the indicators for each strategy significantly outperformed those of the control group. In multivariable analysis, being allocated to one of the strategies was found to be associated with a significantly higher score for all indicators compared to being allocated to the control group (Table 5), except for the "rules for food preparation" indicator (strategy A was not associated with a higher indicator score) and the epidemiological knowledge indicator (strategies B and C were not associated with a higher indicator score).

Tables S1–S7 present the distribution of the postintervention indicator scores by the sociodemographic characteristics of the participants assessed at baseline.

3.5 | Follow-up to intervention

Table 6 shows the follow-up indicator scores for all strategies and the control group. The distribution of the indicator scores for each strategy was found to be not significantly different compared to those of the control group, except for the "risk perception" indicator (p-value 0.004 for each strategy compared to the control group). Such results were confirmed by the multivariable analysis (Table 7). Tables S8–S14 present the distribution of the follow-up indicator scores by the sociodemographic characteristics of the participants assessed at baseline.

4 | DISCUSSION

The present study compared the effectiveness of three school-based intervention strategies aimed at teaching caregivers how to prevent food choking injuries in childhood. Although choking injuries are a relevant public health burden and although the need to develop primary prevention strategies in the field (e.g., recommendations for food preparation, interventions aimed at teaching the parents of young children how to prevent food choking injuries) has been claimed, initiatives are sparse. Caregivers show poor knowledge regarding the most hazardous food items and how to prepare them to minimize the risk of choking in young children. Consistent with the literature in the field (Fano et al., 2019), at the preintervention stage, even though more than 90% of participants had some knowledge of why children are at risk of choking, nearly 40% of participants had an incorrect understanding of the age at which children are at highest risk of choking and the objects that are the most hazardous.

Overall, the present results showed the effectiveness of the three intervention strategies in improving knowledge regarding food

TABLE 4 Distribution of the indicators in the intervention groups (strategies A, B, C) and in the control group. The indicators for the intervention groups (strategies A, B, C) refer to the assessment performed immediately after the educational intervention. Data are the mean ± standard deviation

	N	Strategy A (*N* = 298)	Strategy B (*N* = 474)	Strategy C (*N* = 491)	Control group (*N* = 163)	*p*-value (A versus controls)	*p*-value (B versus controls)	*p*-value (C versus controls)
Risk perception	948	0.9 ± 0.2	0.9 ± 0.2	0.9 ± 0.1	0.7 ± 0.2	.001	.001	.001
Rules for food preparation	1,020	0.93 ± 0.11	0.96 ± 0.07	0.97 ± 0.07	0.88 ± 0.17	.03	.001	.001
Ability to recognize hazardous foods	1,031	0.97 ± 0.08	0.95 ± 0.11	0.98 ± 0.06	0.59 ± 0.10	.001	.001	.001
Epidemiological knowledge	842	0.7 ± 0.2	0.6 ± 0.2	0.6 ± 0.2	0.5 ± 0.2	.001	.02	.05

TABLE 5 Adjusted analysis of the indicators (each strategy vs. the control group). The indicators for the intervention groups (strategies A, B, C) refer to the assessment performed immediately after the educational intervention. Each model was adjusted for all the sample characteristics reported in Table 1, but only variables with a significant effect ($p < .05$) are reported in the table

	Estimate	Standard error	*p*-value
Risk perception			
Strategy A	0.174	0.038	<.001
Strategy B	0.208	0.037	<.001
Strategy C	0.217	0.037	<.001
Gender: Male	−0.039	0.019	.04
Educational level: Primary school	−0.115	0.049	.018
Educational level: Secondary school	−0.007	0.014	.623
Rules for food preparation			
Strategy A	0.014	0.020	.47
Strategy B	0.045	0.019	<.001
Strategy C	0.050	0.019	<.001
Ability to recognize hazardous foods			
Strategy A	0.405	0.021	<.001
Strategy B	0.386	0.021	<.001
Strategy C	0.415	0.021	<.001
Educational level: Primary school	−0.103	0.029	<.001
Educational level: Secondary school	−0.003	0.008	.7175
Children had choked: No	0.023	0.009	.007
Epidemiological knowledge			
Strategy A	0.243	0.078	.001
Strategy B	0.144	0.077	.062
Strategy C	0.149	0.078	.055

choking injury prevention immediately after the administration of the educational intervention. It is difficult to discuss the present results in terms of the literature in the field because only a few similar studies have been published, with those studies involving different types of educational interventions and different measures for assessing the effectiveness of the intervention (Karatzanis et al., 2007; Sadan et al., 1995). In Israel, a public campaign that addressed foreign body aspiration and that was administered to the general population through the media seemed to result in a 35% reduction in the incidence of foreign body aspiration (Sadan et al., 1995). A study performed in Crete showed a reduction in the rate of bronchoscopies to remove a foreign body from the airways after the administration of an educational intervention to the general population (Karatzanis et al., 2007). All such studies were uncontrolled. In contrast, the present study was designed as a randomized trial that did not aim and that did not make it possible to assess the long-term

TABLE 6 Distribution of the indicators in the intervention groups (strategies A, B, C) and in the control group. The indicators for the intervention groups (strategies A, B, C) refer to the assessment performed one month after the educational intervention. Data are the mean ± standard deviation

	N	Strategy A (*N* = 298)	Strategy B (*N* = 474)	Strategy C (*N* = 491)	Control group (*N* = 163)	*p*-value (A versus. controls)	*p*-value (B versus. controls)	*p*-value (C versus. controls)
Risk perception	717	0.9 ± 0.2	0.9 ± 0.2	0.9 ± 0.2	0.7 ± 0.2	.004	.004	.004
Rules for food preparation	750	0.91 ± 0.09	0.94 ± 0.08	0.93 ± 0.11	0.88 ± 0.17	.4	.6	.4
Ability to recognize hazardous foods	776	0.57 ± 0.09	0.58 ± 0.07	0.57 ± 0.08	0.59 ± 0.10	.4	1	.5
Epidemiological knowledge	502	0.5 ± 0.1	0.5 ± 0.2	0.5 ± 0.1	0.5 ± 0.2	.2	.933	.5

TABLE 7 Adjusted analysis of the indicators (each strategy vs. the control group). The indicators for the intervention groups (strategies A, B, C) refer to the assessment performed one month after the educational intervention. Each model was adjusted for all the sample characteristics reported in Table 1, but only variables with a significant effect ($p < .05$) are reported in the table

	Estimate	Standard error	*p*-value
Risk perception			
Strategy A	0.175	0.047	<.001
Strategy B	0.178	0.046	<.001
Strategy C	0.174	0.046	<.001
Gender: Male	−0.090	0.027	<.001
Job: Office worker	−0.079	0.058	.173
Job: Independent contractor	−0.073	0.059	.217
Job: None	−0.157	0.061	.010
Rules for food preparation			
Strategy A	−0.019	0.021	.37
Strategy B	0.015	0.020	.47
Strategy C	0.006	0.020	.76
Ability to recognize hazardous foods			
Strategy A	0.006	0.018	.732
Strategy B	0.012	0.018	.510
Strategy C	0.010	0.018	.589
Marital status: Married	−0.028	0.015	.065
Marital status: Widowed	−0.097	0.077	.210
Marital status: Divorced	−0.069	0.024	.004
Marital status: Domestic partner	−0.044	0.018	.020
Epidemiological knowledge			
Strategy A	0.039	0.049	.43
Strategy B	−0.003	0.048	.95
Strategy C	0.010	0.049	.84

effectiveness (i.e., reduction in choking cases) of the interventions tested. Furthermore, it did not involve the general population because the educational intervention was specifically aimed at children's caregivers.

Another important study finding is that the participants showed poor knowledge retention at the intervention follow-up. There is a need to identify methods that facilitate the retention of information, particularly information pertaining to this topic; in this regard, the issue is not whether or not information is delivered directly to caregivers but the information itself. For example, data can be presented visually and/or in different situations (posters in doctors' offices, adverts in magazines, school leaflets, etc.). The fact that the participants both increased their knowledge and retained information on risk perception but to a lesser

degree on hazardous food suggests that the material on the former may have been more successfully arranged and/or more clear or understandable.

4.1 | Study limitations

Analyzing the scores of each indicator individually, the lowest scores for all strategies were for indicator 4 (epidemiological knowledge). In addition to the general difficulties in managing epidemiological concepts for people who have not been specifically trained in this matter, this highlights how caregivers did not gain a good understanding of the information delivered, with the exception of those in strategy A, in which information was delivered directly to them. The scores for all strategies were not different from the control group at the follow-up stage. The participants did not retain information on basic epidemiology, such as the reason why children are at risk of choking and the most susceptible ages. When information involves data on practical aspects relating to daily life, such as food preparation or the identification of hazardous food, many people gain a better understanding of such topics, which are directly related to their daily life, such as cooking, identifying hazardous objects (e.g., batteries) and helping their children if in distress. Nevertheless, further improvements could be made to increase long-term information retention, eventually providing follow-up classes.

Furthermore, the study did not involve parent-to-be. It would be useful to inform parents about choking prevention before introduction of solids, e.g., during prenatal classes. However, a school-based intervention is the most suitable way to reach as much families as possible, since prenatal training is not compulsory and it has been shown to be less frequently attended by migrants' mother-to-be (Boerleider et al., 2013).

5 | CONCLUSIONS

The issue of food choking injuries in children is often neglected in public health strategies, and worldwide, only a few initiatives have been conducted to reduce food choking injuries. The results of this study suggest that a sustainable school-based public health intervention mediated by teachers is as effective as direct training for families in improving knowledge regarding food choking injury prevention. Such an approach would be a working model to be extended at the national level, not leaving the education on such a relevant public health topic to the caregivers' initiative.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

AUTHORS CONTRIBUTIONS

DG study design and conceptualization; CL, DA data analysis, GL interpretation of results and draft of the work; SB data collection; GM substantial revision of the work.

DATA AVAILABILITY STATEMENT

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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