

Original Research

Repeated Exposure in a Natural Setting: A Preschool Intervention to Increase Vegetable Consumption

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ABSTRACT

Background Laboratory and home-based research suggest that repeated exposure to vegetables may increase consumption among children. Effectiveness of repeated exposure to vegetables has not been tested in a community-based preschool setting.

Objective This randomized controlled trial tested the hypotheses that children who are served unfamiliar vegetables repeatedly in the preschool lunch setting will increase consumption of them, and that consumption will be influenced by peer eating behaviors and parental feeding behaviors.

Subjects/setting Data were collected in two private preschools in a small northeastern city in 2007. Ninety-six children (aged 3 to 6 years) participated.

Design Schools were randomly assigned to condition. During the first 6 weeks, Preschool A served three vegetables at lunch on 10 separate occasions (ie, 30 days of exposure), while Preschool B continued routine practice. In the 7th week, schools reversed conditions and Preschool B served the vegetables for the next 6 weeks. Consumption data were collected daily in the intervention school and at baseline and post-intervention meals in the control school.

Primary outcomes/statistical analyses Analysis of variance was used to examine the effect of vegetable exposure on vegetable intake; multilevel models were used to examine the effect of peer eating behaviors and parental feeding practices on vegetable intake.

Results Repeated exposure did not increase vegetable consumption. Greater consumption by tablemates was a significant predictor of greater vegetable consumption;

across the three vegetables, 1 g of peer intake was associated with roughly a 1/2-g intake increase among the subjects. Overall, children demonstrated wide fluctuation in vegetable consumption from day to day, creating as much variability within subjects as between them.

Conclusions Further research should explore the conditions necessary for repeated exposure to increase vegetable consumption in preschool settings. Creating opportunities for young children to serve as peer models has promise as a strategy to promote vegetable consumption. *J Acad Nutr Diet.* 2012;112:230-234.

The first years of life are critical for development of life-long food preferences (1-4). Although there is evidence that food preferences are partially heritable, they are also malleable and can be shaped by the food environment (5). Repeated taste exposure to novel or disliked foods has been shown to increase children's willingness to eat them in some settings. Studies in which infants or children were repeatedly exposed to fruit and cheese (6), tofu (7), and sweet orange drinks (8) successfully increased liking for the target food.

Young children are often reluctant to eat vegetables, presumably because of their bitter taste (9). Some research, however, suggests that the strategy of repeated exposure to new vegetables can increase consumption. Three- to 5-year-old children given certain vegetables repeatedly by their parents at home increased their consumption of these vegetables (10). Researchers working with individual 5- to 7-year-old children in a school setting found similar results (4). A school cafeteria-based study examined the effect of serving new vegetables frequently to fourth and fifth graders and found that students reported greater liking of three of the four vegetables tested (vegetable consumption was not assessed) (11).

In addition to becoming familiar with new foods, family and social factors can influence children's willingness to try and eat vegetables (12-15). In one earlier study, a positive statement about the taste of an unfamiliar food by a peer increased the likelihood that young children would eat it (16,17). Peer intake has been shown to be a significant predictor of snack consumption among teens (18). Lowe and colleagues have shown that young children increase vegetable consumption after viewing videos of peers eating vegetables (19). Another study conducted more than 30 years ago found that preschool children, particularly younger preschoolers, increased their preference for vegetables after observing a peer eating them (14).

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Preschools are a promising venue for exposing young children to a variety of vegetables; however, it is unknown whether repeated exposure can be used effectively in this setting. The study aimed to test whether children in a community preschool would increase consumption of three unfamiliar or disliked vegetables after being offered each of them 10 times during lunch over a 6-week period. It was hypothesized that there would be an increase in vegetable consumption in the intervention group over time. A secondary aim was to examine the within-child variability in vegetable intake (day-to-day fluctuations) and to compare it to between-child variability. It was hypothesized that there would be significantly more between-child variability than within-child variability. Because preschool lunch occurs in the social context of the lunch table, this study also aimed to examine whether each child's vegetable intake is influenced by what his or her tablemates are eating. It was hypothesized that children seated with peers who ate larger amounts of the vegetables would, in turn, eat more of them. Finally, the study aimed to assess whether parental feeding behaviors, such as restricting children's intake, pressuring children to eat, or monitoring their eating influences their level of vegetable consumption. It was hypothesized that these parental feeding behaviors would have an undesirable effect on vegetable consumption.

METHODS

Participants

Two private preschools in a small northeastern city were recruited for the study in 2007. Both schools serve the same university community, offer comparable financial aid to families, and are accredited by the National Association for the Education of Young Children. They both participate in the US Department of Agriculture's Child and Adult Care Food Program and provide all meals and snacks; no food is brought from home. The sample ($n=96$) included 54 male and 42 female students. These preschools primarily serve highly educated households; nearly all (93%) of the children had at least one parent with a bachelor's degree and 75% had at least one parent with a graduate or professional degree. Age ranged from 3 to 6 years old, but most (85%) children were 4 or 5 years old. Race/ethnicity was white (69%), Asian (8%), African American (5%), Hispanic (6%), and other (12%). There were no significant differences in any of the demographic variables or parent survey responses between the two schools. Parental written consent was obtained for 95% of the children enrolled in the schools. The new vegetables were served to all of the children in the classroom, but data were only collected from those with parental consent.

In order to detect a medium effect size between the two groups, a sample of 100 (two groups of 50) was required (20). The study as planned ($n=100$) was adequately powered to detect a medium effect size. Slight reduction of sample size ($n=96$) because of nonparticipating children left the study very slightly underpowered.

Measures

Before the intervention, parents were given The Child Feeding Questionnaire (CFQ) (21), which contains 31

items assessing perceived responsibility for child feeding, parent's perception of his or her own weight and child's weight, parent concern about child weight, and parental use of controlling child feeding practices. The CFQ has demonstrated strong reliability and has been validated in populations of parents of children and adolescents (21,22). At the same time, parents were given a list of eight vegetables and rated whether their child "likes it," "thinks it is okay," "dislikes it," "has not been offered it yet," or "refuses to try it." These data were used to choose the intervention vegetables. Cauliflower, snow peas, and green peppers emerged as the least well-known and well-liked vegetables among these children.

Design

In this randomized controlled trial, Preschool A was randomly assigned to the intervention first condition and Preschool B to the control/delayed intervention condition. Data were collected during a 12-week period, with each school receiving the intervention for 6 weeks. During the intervention, the children at Preschool A were served one of the new vegetables every day for 30 days in a 3-day cycle (eg, Monday, cauliflower; Tuesday, snow peas; Wednesday, green pepper) until they had received each vegetable a total of 10 times. Preschool B continued routine practices during the first 6 weeks of the study, and then switched conditions with Preschool A for the second 6 weeks (see the Figure).

Procedure

Each day, raw vegetables were purchased, washed, cut into bite-sized pieces, and placed in a snack-size plastic bag with student identification. All bags were weighed to the nearest gram and labeled. The servings (24 to 26 g) were consistent with recommendations for this age group (23). At lunch, all children were served the same meal and the teachers passed the vegetable bags to the children as part of serving the meal. All children were assigned a lunch table and ate at the same table each day. The preschool directors at both schools required the research study vegetables to be served in addition to (and not in place of) the produce in their Child and Adult Care Food Program reimbursable lunches. Teachers were instructed not to exert any pressure on the children to eat the vegetables; however, they were encouraged to discuss what they were eating, as is their normal practice (eg, "These peppers are green."). At the end of the lunch period, the teachers instructed students to put any waste back into the bags. Researchers picked up the bags later from the schools, weighed them, and calculated intake to the nearest gram.

Vegetable consumption was assessed unobtrusively each day during the intervention; however, researchers stayed during lunch to measure vegetable consumption and talk to the children at key points in the study, eg, Time 1: the first week of the study to provide baseline data for each vegetable; Time 2: the 6th week to provide post-intervention data for Preschool A and a second baseline for Preschool B; and Time 3: the 12th week to provide post-intervention data for Preschool B (see the Figure).

The protocol was approved by the Yale University Institutional Review Board.

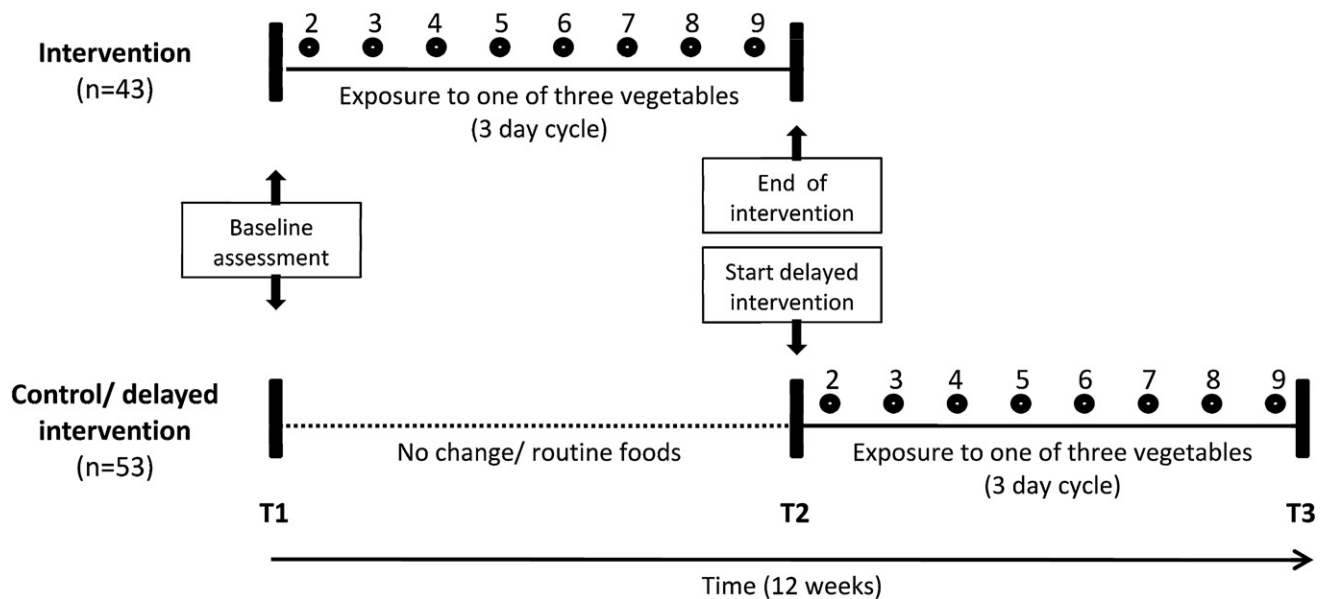


Figure. Study design for repeated exposure to increase vegetable consumption among preschoolers in a natural setting ($n=96$). Each exposure circle in the graph represents 3 consecutive days on which the three different vegetables were served.

Statistical Analysis

A 2 (time) \times 2 (condition) mixed factorial analysis of variance was used to test whether vegetable consumption increased over time in the intervention group vs the control group. For these analyses, the Time 1 and Time 2 data from Preschool A was compared to Time 1 and Time 2 data from Preschool B (ie, when it served as the control condition). Further analyses were conducted using the consumption data from both schools during their intervention weeks (excluding the measurements that were done with the researchers present). To test whether peer eating behavior and parent feeding practices predicted children's consumption of vegetables, multilevel regression models were estimated. All analyses were carried out using Stata statistical software (version 11, 2009, StataCorp LP, College Station, TX).

RESULTS

Willingness to Try a New Vegetable

Data from 96 children were analyzed. Willingness to try eating a vegetable was defined as eating at least 3 g and the proportion of time children were willing to try each vegetable was calculated. During the first and last weeks of each intervention when researchers were present, between 43% (cauliflower at Time 2) and 61% (snow peas at Time 1) of children were willing to try the vegetables. During lunches without researchers present (exposures two through nine), approximately half of the students were willing to try each of the vegetables at least three times (43% for cauliflower, 50% for snow peas, and 54% for peppers). Willingness to eat one vegetable was associated with willingness to try the others. Children's overall intake of each of the three vegetables was significantly associated with their intake of the others (cauliflower/snow peas, $r=.39$; cauliflower/peppers, $r=.25$, and snow peas/peppers, $r=.42$, all $P<0.05$).

Effect of Multiple Exposures to New Vegetables

The mixed factorial analysis of variance produced a significant time \times condition interaction on consumption averaged across all three vegetables, but not in the expected direction: Preschool B (control school) showed an increase and Preschool A (experimental school) showed a decrease between Times 1 and 2; $F(1,88)=10.81$, $P=0.002$. At baseline, average vegetable consumption was 10.7 g (standard deviation [SD]=8.5 g) at Preschool A and 6.2 g (SD=6 g) at Preschool B. At the end of the intervention, the average vegetable consumption was 8.5 g (SD=6.8 g) at Preschool A and 7.5 g (SD=7.4 g) for Preschool B. Follow-up analyses of variance were run for each vegetable separately. For snow peas, there was no significant change in the intervention or control group over time. For cauliflower, there was a decrease in the mean intake by about 4 g in the intervention group ($F[1,82]=7.67$, $P=0.007$) and no change in the control group. Finally, for peppers, the intervention group intake did not change, and there was an increase in the control group ($F[1,68]=8.99$, $P=0.004$).

Variability of Vegetable Intake over Time

Closer examination of the variability in vegetable intake from day to day revealed that individual children vary significantly in how much of the same food they eat from one eating occasion to the next. The variability of intake for the same child over time was compared to the variability of intake between the children and, surprisingly, the variability within students was nearly as high as the variability between. The amount of variance between subjects ranged from 57% to 62%, and, conversely, the proportion of variance within subjects across time ranged from 38% to 43% across the three vegetables.

Table. Linear mixed effects regression models predicting vegetable intake in preschoolers from school, sex, peer intake, and parent attitudes (n=96)

| | Cauliflower | | Snowpeas | | Peppers | |
|-----------------------------|-------------|---------|----------|---------|---------|---------|
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| School B | -2.155 | -1.664 | -1.792 | -0.387 | 0.413 | 0.601 |
| Girls | 2.153* | 1.495 | 2.558* | 3.761* | -0.241 | 0.610 |
| Average peer intake | 0.157* | 0.216** | 0.098 | 0.163* | 0.189** | 0.185* |
| Child Feeding Questionnaire | | | | | | |
| Restriction | | -1.138 | | -0.864 | | -1.315 |
| Pressure | | -0.302 | | -0.135 | | -0.277 |
| Monitoring | | -0.538 | | 0.502 | | 1.330 |
| Constant | 3.953 | 3.954 | 3.712 | 0.310 | 4.616 | 3.332 |
| n (tables) | 21 | 20 | 21 | 20 | 21 | 20 |
| n (students) | 94 | 71 | 94 | 71 | 94 | 71 |
| n (observations) | 677 | 508 | 668 | 499 | 679 | 512 |
| R ² (table) | 0.74 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 |
| R ² (total) | 0.08 | 0.12 | 0.07 | 0.08 | 0.01 | 0.05 |

*P<0.05.
**P<0.01.

Determinants of Vegetable Intake

In order to examine the effect of parent feeding practices and peer eating behavior on vegetable intake, multilevel regression models were used (see the Table). The model controlled for school and sex and included the Restriction, Pressure, and Monitoring subscales of the CFQ and the average intake of the other children at each table. There was a significant positive association between the average intake of a student's tablemates and the student's own intake. Across the three vegetables, 1 g of peer intake was associated with roughly a 1/5-g intake increase among the subjects. None of the CFQ subscales were associated with vegetable intake.

DISCUSSION

The efficacy of increasing children's consumption of new vegetables through repeated exposure has been demonstrated in researcher-directed laboratory studies and parent-directed home interventions (4,10,11). This study was the first to test the effectiveness of this intervention by delivering it to young children in a community-based preschool setting. Even though an increase in vegetable consumption was not observed, the findings shed light on important elements of the intervention that must be adapted to community settings and the circumstances that may increase vegetable consumption in this age group.

In previous research, the children were required to taste the food each time it was served. In contrast, children in schools are not required to taste everything they are offered; in fact, requirements like this are discouraged (24). Therefore, a 10-exposure paradigm in a school setting will likely result in fewer than 10 tastings, as was the case in the present study. It is possible that continuing exposure for several months might be necessary to achieve the needed number of tastings of the new food.

These findings suggest that assessing average intake for a given child may not be meaningful; eg, a child may

eat very little on one day, and a much larger portion on the next. This variability in consumption may be due to many factors, such as current hunger, mood, or attention on competing activities. Parents and caregivers often stop offering children healthy foods once they have been rejected a few times (25,26); however, the findings from this study suggest that they should not give up so easily. It may help to recognize that individual variability is common in this age group and that refusal to eat a particular food on one day may not translate to future refusal. Approximately half the children in this study were willing to try the vegetable of the day at least one third of the time. This suggests that they did not try it once and refuse to eat it again; rather, they were willing to keep giving it another try.

In predicting vegetable intake, there was a significant peer effect, such that a child's consumption was associated with the average intake of the other children at his or her table. These findings may be interpreted as a result of nonrandom seating of good eaters, or may be causal; sitting with one or more good eaters may "raise the bar" and produce improved intake in other children at the table. The latter interpretation is supported by research showing the effects of peer modeling or peer influence in both adolescents (18) and young children (14,16,17,19). This strategy deserves further study, as it may hold promise for grouping children thoughtfully in preschool settings to capitalize on this positive peer influence.

This study was subject to a number of limitations. First, despite the fact that schools were matched on important characteristics and there were no demographic differences or differences in parent report of vegetable liking between groups, there were differences in vegetable consumption at baseline. In addition, it was not possible to provide vegetables in lieu of regular snacks; rather, it was required that they be served with the lunch, which included a competing second vegetable. Further, as reasonably expected, schools did not require children to try a bite of each vegetable. Mere exposure by

looking at the novel foods does not change preference for the food (27). It is also possible that a greater number of exposures are necessary for children to accept vegetables in this setting. Finally, results of this study are not generalizable to the general population of preschool children; both schools serve families with highly educated parents with either current or future income well above the national median.

CONCLUSIONS

This study demonstrated variability in daily vegetable consumption among preschoolers. This finding suggests that preschool teachers (and parents and caregivers) should continue to offer new and disliked vegetables to children, with the understanding that current rejection of vegetables does not necessarily indicate future rejection. More research is needed to understand the conditions under which repeated exposure can be used effectively in the preschool setting to increase vegetable consumption; the number of exposures may need to be increased and children may need more encouragement to taste the vegetables each day. Tablemates at preschool have a significant positive effect on consumption of vegetables. The strategic placement of "good eaters" across lunch tables in preschool classrooms represents a promising strategy for increasing vegetable consumption, and should be tested.

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