Randomized Trial Testing the Effect of Peer Education at Increasing Fruit and Vegetable Intake

David B. Buller, Calvin Morrill, Douglas Taren, Mikel Aickin, Lee Sennott-Miller, Mary Klein Buller, Linda Larkey, Carlos Alatorre, Thomas M. Wentzel

Background: **The National Cancer Institute recommends that Americans eat at least five daily servings of fruits and vegetables. National strategies to increase consumption may not reach minority and lower socioeconomic populations. In a randomized trial, peer education was tested for effectiveness at increasing fruit and vegetable intake among lower socioeconomic, multicultural labor and trades employees.** ***Methods:*** **Employees (n = 2091) completed a baseline survey and received an 18-month intervention program through standard communication channels (e.g., workplace mail, cafeteria promotions, and speakers). Ninety-three social networks (cliques) of employees were identified, which were pair matched on intake. At an interim survey (during months 8 and 9), 11 cliques no longer existed and 41 matched pairs of cliques containing 905 employees remained, with one clique per pair being randomly assigned to the peer education intervention. Employees who were central in the communication flow of the peer intervention cliques served as peer educators during the last 9 months of the intervention program. Fruit and vegetable intake was measured with 24-hour intake recall and with food-frequency questions in baseline, outcome (i.e., at 18 months), and 6-month follow-up surveys. All *P* values are two-sided.** ***Results:*** **By use of multiple regression, statistically significant overall effects of the peer education program were seen in the intake recall (increase of 0.77 total daily servings; *P*<.0001) and the food-frequency (increase of 0.46 total daily servings; *P* = .002) questions at the outcome survey. The effect on the total number of servings persisted at the 6-month follow-up survey when measured by the intake recall (increase of 0.41 total daily servings; *P* = .034) but not the food-frequency (decrease of 0.04 total daily servings; *P* = .743) questions.** ***Conclusions:*** **Peer education appears to be an effective means of achieving an increase in fruit and vegetable intake among lower socioeconomic, multicultural adult employees. [J Natl Cancer Inst 1999;91:1491–500]**

Several health authorities recommend that Americans eat at least five daily servings of fruits and vegetables, and the National Cancer Institute has been prominent in this list with its Five a Day for Better Health Program. These foods seem to confer protection against several forms of cancer (e.g., colon/rectum [if adequate bread/cereal fiber is consumed], prostate, and breast cancers) and other diseases *(1–7)*, but Americans consume fewer servings than recommended *(8)*. National efforts to increase consumption relying on mass media messages, point-of-purchase promotions, and product labeling may not reach important subpopulations, like minority and lower socioeconomic adults who currently consume fewer servings than white and more affluent Americans *(8)*. This study evaluated a peer health education program to improve fruit and vegetable intakes of lower socioeconomic, multicultural labor and trades employees at workplaces in two southwestern U.S. cities.

Peer health education is commonly used to communicate health information to underserved populations *(9,10)*. Peer health educators are effective because they alter the normative and communica-

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Affiliations of authors: D. B. Buller, AMC Cancer Research Center, Denver, CO; C. Morrill (Department of Sociology), D. Taren (Nutrition and Physical Acitivity Unit, Arizona Prevention Center), L. Sennott-Miller (College of Nursing), T. M. Wentzel (Arizona Cancer Center), University of Arizona, Tucson; M. Aickin, Center for Health Research, Kaiser Permanente Northwest Division, Portland, OR; M. K. Buller, Department of Technology Transfer, Partners for Health Systems, Inc., Denver; L. Larkey, Women's Cancer Prevention Research Initiative, Arizona Cancer Center, University of Arizona; Phoenix; C. Alatorre, Statistical and Mathematical Sciences, Lilly Research Laboratories, Eli Lilly & Co., Indianapolis, IN.

Correspondence to: David B. Buller, Ph.D., AMC Cancer Research Center, 1600 Pierce St., Denver, CO 80214 (e-mail: bullerd@amc.org).

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tion environment in informal social groups *(11,12)*. Members of social groups demonstrate their commitment to the group *(13–15)* and maintain the group's identity *(16)* by conforming to the new health norms advocated by peer educators. Peer educators also marshal social support that helps others to overcome barriers to healthy behavior and reinforces decisions to adopt the healthy behavior. Other adults also may reciprocate peer educators' expression of support by adopting their recommendations for healthy behavior *(17)*. Finally, peer educators serve as informal opinion leaders who improve the quantity of messages about healthy behavior *(18)*, tailor messages to the unique needs and culture of a social group *(11,19,20)*, and stimulate a classic diffusion of innovation process *(18)*. The group processes promoted by peer education can produce changes that are longer lived than changes created by individual decision processes because the group's social support and norms are more resistant to change than the individual's beliefs and attitudes *(14,15,21)*.

Our intervention method by peer education was evaluated on a lower income, multicultural population in the southwestern United States, a population that often has less information about cancer and nutrition *(22–25)*. Many people in this population hold labor and trades, blue-collar occupations (53% of Hispanics in U.S. work force; 52% of Hispanics in Arizona work force), particularly the men (64% of Hispanic males in U.S. work force; 62% of Hispanic males in Arizona work force) *(26)*. Informal social networks at work provide important information and social support for employees *(27–30)*, and community-based peer educators have delivered advice to people while at work *(11)*. Work site peer education should overcome barriers to wellness activities for these employees, such as shorter break times, less flexible hours, offsite and multiple work areas, and uneven English usage.

SUBJECTS AND METHODS

The effectiveness of a peer health education program deployed along with a work site Five a Day Education Program using standard formal communication channels (e.g., workplace mail, cafeteria promotions, and speakers) was evaluated in a multicultural population of employees with lower socioeconomic status. Measures of fruit and vegetable intake and related awareness and opinions following the intervention and at a 6-month follow-up survey are compared with a group of employees who re-

Table 1. Means and standard deviations (SDs) and percentages for job and sociodemographic characteristics of employees in the baseline sample, in the study cohort, and serving as peer educators

	Baseline sample (n = 2091)	Study cohort (n = 905)	Peer educators (n = 42)
Job characteristics			
Years at the job, mean (SD)	9.56 (7.34)	10.28 (6.94)	9.23 (7.28)
Hours worked in the last wk, %			
<20 hr	8	7	7
20–40 hr	79	79	67
>40 hr	13	14	26
Hours worked in last week, mean (SD)			
At work place	20.37 (17.96)	20.50 (18.16)	21.43 (19.39)
Away from work place	16.28 (18.17)	16.54 (18.45)	17.19 (20.10)
Shift, %			
Day	84	82	86
Evening	9	10	9
Night and rotating shifts	7	8	5
Sociodemographic characteristics			
Smoking status, %			
Nonsmoker	70	71	74
Smoke cigarettes, cigars, pipe	27	26	24
Use chewing tobacco or snuff	2	2	2
Smoke and chew tobacco	<1	<1	0
Personal history of cancer, %	6	5	10
Respondent's ethnic origin, %			
White/Anglo	46	47	36
Hispanic*	42	43	53
Native American/American Indian	4	3	7
Black/African American	7	6	2
Other group	1	<1	2
Place of birth, %			
In the United States	90	92	93
Outside the United States (including Puerto Rico)	10	8	7
Ethnic/racial pride (1 = extremely proud; 5 = not proud and feels negative toward ethnic group, mean (SD)	1.58 (0.87)	1.54 (0.84)	1.54 (0.78)
Contact with Mexico (1 = lived in Mexico for ⩾1 y; 5 = no exposure/communications with people in Mexico), mean (SD)	3.51 (1.29)	3.63 (1.28)	3.50 (1.10)
Ethnic identification (1 = very Anglo; 5 = very [ethnic group]), mean (SD)	1.99 (0.97)	2.05 (0.93)	2.64 (1.79)
Age, y, mean (SD)	43.13 (10.07)	42.13 (9.23)	40.67 (7.22)
Respondent's education, %			
Did not attend school	<1	0	0
11th grade or less	16	14	10
High school graduate	34	36	36
Trade, technical, or vocational education beyond high school	7	8	14
Some college, without receiving a degree	27	24	21
2-y college degree (A.A.)	10	11	19
4-y college degree (B.A. or B.S.) or postgraduate education	5	6	0
Refused to answer	1	<1	0
No. of people living in household, including self, mean (SD)	3.40 (1.67)	3.40 (1.63)	3.38 (1.34)
Family composition, %			
Live alone	11	<1	5
Live with children only	3	3	5
Live with adults only	32	36	33
Live with children and adults	54	60	57
Marital status, %			
Married/cohabiting	72	75	76
Widowed	2	1	0
Divorced or separated	16	15	17
Never married	9	9	7
Refused to answer	<1	0	0
Sex, %			
Male	74	75	71
Female	26	25	29

(Table continues)

Table 1 (continued). Means and standard deviations (SDs) and percentages for job and sociodemographic characteristics of employees in the baseline sample, in the study cohort, and serving as peer educators

	Baseline sample (n = 2091)	Study cohort (n = 905)	Peer educators (n = 42)
Spouse's employment status, %			
Employed	75	75	85
Unemployed	25	25	15
Spouse's ethnic origin, %			
White/Anglo	47	46	48
Hispanic*	42	41	40
Native American/American Indian	3	2	6
Black/African American	6	6	3
Other group	2	5	3
Annual household income, in dollars, mean (SD)	33 739 (16 170)	34 855 (15 864)	35 064 (15 443)

*Hispanic employees self-identified as "Hispanic/Mexican(-American)/Chicano/Cuban(-American)/Latino/Central American/Latin American/Puerto Rican" or reported a mixed-race ancestry that included one of these groups.

ceived only the work site Five a Day Education Program through standard formal communication strategies. Analyses of recruitment procedures, measures of intervention procedures, tests of the effects of the intervention on a secondary measure of stage of change in intake, and analysis of the role of social network characteristics on trial outcomes are reported elsewhere *(31,32)* because the scope of data collected on trial procedures and outcomes was too large to be included in a single manuscript. All of the methods used in this randomized trial to evaluate the peer education program are described below.

Employee Population and Baseline Sample

Labor and trades blue-collar employees from 10 public employers (two county governments, two city governments, two public universities, two community colleges, and two public school districts) in Tucson and Phoenix, AZ, were recruited to the study from facilities management, automotive and fleet services, communications, water services, food services, housekeeping/laundry, groundskeeping, parks and recreation, custodial services, solid waste, and streets and transportation departments. Recruitment occurred by formal work group to obtain collections of employees who had regular informal contact on a weekly basis with one another. Senior managers identified work groups and secured access to them. Supervisors were ineligible to participate so that we could control for the effects of formal authority among participants.

One hundred twenty-six work groups containing 2530 eligible employees agreed to participate in a baseline survey that was completed with 2091 employees (83%). *See* Fig. 1 for trial flow chart. The university's institutional review board approved all trial procedures and classified the project procedures as exempt. Interviewers read a written consent statement to all employees, and employees' consent to participate was obtained before the baseline interview was conducted. The majority of the employees completing the baseline survey were male, married, moderately educated, and middle-aged. The size of their families was slightly larger than the national average, and they had low to middle household incomes (many with multiple income earners). Tobacco use was slightly higher than the national adult average. The employees exhibited a range of ethnic identifications; most were white or Hispanic. Almost all Hispanic employees were born in the United States, had limited contact with Mexico, and identified somewhat with the Anglo culture, yet they reported a great degree of ethnic pride. Employees spent a large amount of work time off-site; some of these employees worked fewer than 40 hours and, in total, averaged nearly 10 years at their current job (Table 1).

Experimental Design and Procedures

The peer education program was tested with a randomized design with the use of preintervention and postintervention measures of fruit and vegetable intake and related beliefs and attitudes (Fig. 1). Employee recruitment and the baseline survey were performed from May 1993 to February 1994.

General Five a Day Program. Beginning in 1995, an 18-month General Five a Day Program was delivered to all employees at each work site regardless of job type through formal work site communication channels (mail, posters, cafeteria promotion, and guest speakers). Research staff supplied managers (e.g., communications, wellness, and cafeteria) with printed program materials from the National Cancer Institute's Five a Day for Better Health Program; managers distributed the materials through company mail and posted them in workplaces and cafeterias; and research staff visited work sites to measure program implementation and to solve problems. Process measures confirmed that nearly 200 000 intervention items were used.[1] Guest speakers were identified by research staff who assisted managers with scheduling and conducting speaker sessions at the work sites. Program themes across the 18-month General Five a Day Program were rotated in 6-month intervals; program activities occurred every other month.

This program provided a baseline awareness level of the National Cancer Institute's Five a Day for Better Health Program that was equalized in intervention and control work groups prior to launching the peer education program. It provided a non-peer-based intervention to the control groups to eliminate the potential of a Hawthorne effect (i.e., changes observed in response to peer education are not due simply to being treated but rather to the nature of the intervention). It also increased employer and employee participation by ensuring that all employees received some nutrition education.

Identifying, matching, and randomizing informal social networks. The unit of matching and randomization was the informal social network of employees, specifically cliques. Cliques are informal networks in which members interact more with each other than surrounding people within their work groups *(33)*. The request for applications from the National Cancer Institute under which this project was funded required that applicants project sample size based on an increase of 0.50 daily servings of fruits and vegetables, which the National Cancer Institute's staff had selected as a meaningful level of dietary change. To detect this level of dietary change, we determined that 40 matched pairs of informal social networks were required to achieve statistical power at 0.80, with an alpha (α) criterion of 0.05 (two-tailed).

Network data were collected via a sociometric question in which respondents were asked to name up to eight co-workers in their work group with whom they talked. Respondents were then asked to rate each named person on five social-tie dimensions (using 5-point scales): 1) contact frequency (never, rarely [once or twice a year], sometimes [once or twice a month], often [once or twice a week], or very often [once or twice a day]), 2) personal relationship (acquaintance, friend, good friend, close friend, or very close friend), 3) frequency of health- and diet-related conversations (never, rarely, sometimes, often, or very often), 4) respect for co-worker's opinions about health-related information (very little, little, some, much, or very much), and 5) frequency of eating lunch together (never, rarely, sometimes, often, or very often).

Multistage social network analysis detected 93 cliques in person-to-person data matrices on contact frequency, with the use of sorting algorithms in UCINET software *(34)* (Fig. 1). A clique was formally defined as an informal referent group in which co-workers were no more than two social-tie lengths (e.g., friends of friends) away from one another. (Cliques defined by direct ties only yielded groups that were too small.) When multiple overlapping cliques existed, the clique with the most members was selected; if multiple "largest" cliques of the same size were detected, the clique with the highest density was selected. Density is a measure of strength of social ties in a group, operationalized for the purposes of this study as the mean rating for each social-tie dimension within each clique *(35)*. At baseline, the median clique size was 11 (range = 5–18; 25th–75th percentile = 10–13).

The cliques were pair matched on the basis of the clique-level average total daily consumption (servings) of fruits and vegetables, stage of readiness to increase fruit and vegetable consumption, clique density, co-worker and management support for health, perceived self-efficacy for increasing fruit and vegetable consumption, proportion of Hispanic employees, proportion of female employees, and clique size from the baseline survey. One clique within each pair was randomly assigned to the intervention group receiving the Five a Day Peer Education Program plus the General Five a Day Pro-

Fig. 1 ***(see facing page).*** Flow of cliques (informal social networks) and employees in randomized trial. p = pairing; r = randomization. [1]Seventy-five employees in cliques randomly assigned to the General Five a Day Program were removed from the trial at the interim survey (74 had left cliques; one became a supervisor). [2]Sixty-four employees in cliques randomly assigned to the Five a Day Peer Education Program were removed from the trial at the interim survey (63 had left cliques; one became a supervisor). [3]Eighteen employees in cliques randomly assigned to the General Five a Day Program were lost to the study and withdrawn from the trial at the outcome survey because they left the employer and could not be located. [4]Eighteen employees in cliques randomly assigned to the Five a Day Peer Education Program were lost to the study and withdrawn from the trial at the outcome survey because they left the employer and could not be located. [5]Twenty-one employees in cliques randomly assigned to the General Five a Day Program were lost to the study and withdrawn from the trial at the 6-month follow-up survey because they left the employer and could not be located. [6]Fourteen employees in cliques randomly assigned to the Five a Day Peer Education Program were lost to the study and withdrawn from the trial at the 6-month follow-up survey because they left the employer and could not be located.

gram, and the other was randomly assigned to the control group receiving only the General Five a Day Program. Matching and randomization were performed by the project biostatistician, who had no contact with peer educators.

After initial randomization, pairs were inspected for physical proximity to each other. Randomization within seven pairs where cliques were in close physical proximity was adjusted to eliminate diffusion of peer education into the control group. At the end of the study, only five employees had moved from one clique to another (one by interim survey, two by outcome survey, and two by follow-up survey). In self-report measures of contact with co-workers, only seven employees at the outcome survey and 10 employees at the 6-month follow-up reported talking with employees from another clique. The average proportion of cross-clique contacts per clique reported by employees at the outcome survey was 0.006 and 0.007 at follow-up. Thus, there was almost no opportunity for diffusion. In the analysis, these employees were retained as members of their original baseline cliques.

Rematching at interim survey. During months 8 and 9 of the General Five a Day Program, work groups were recontacted (following matching and randomization), and an interim survey was performed with employees in the cliques. Eleven cliques were removed from the trial that no longer existed, whose employees refused to participate further, or in which no employee would serve as a peer educator. As a result, six cliques were re-matched and re-randomized. In addition, 140 employees were removed from the trial prior to the interim survey because they no longer were members of the cliques. Also, four did not complete the interim survey but returned to the study at the outcome or follow-up surveys. Thus, at the interim survey and just prior to the beginning of the Five a Day Peer Education Program, 41 cliques with 395 employees were assigned to receive this intervention, 41 cliques with 371 employees were assigned to serve as controls (Fig. 1), and one extra clique remained unmatched and was not randomized. Employees' membership in their clique and clique assignment to study condition were fixed at the interim survey, and attempts were made to complete the outcome and follow-up surveys with all clique members, even those who left the clique and/or employer.

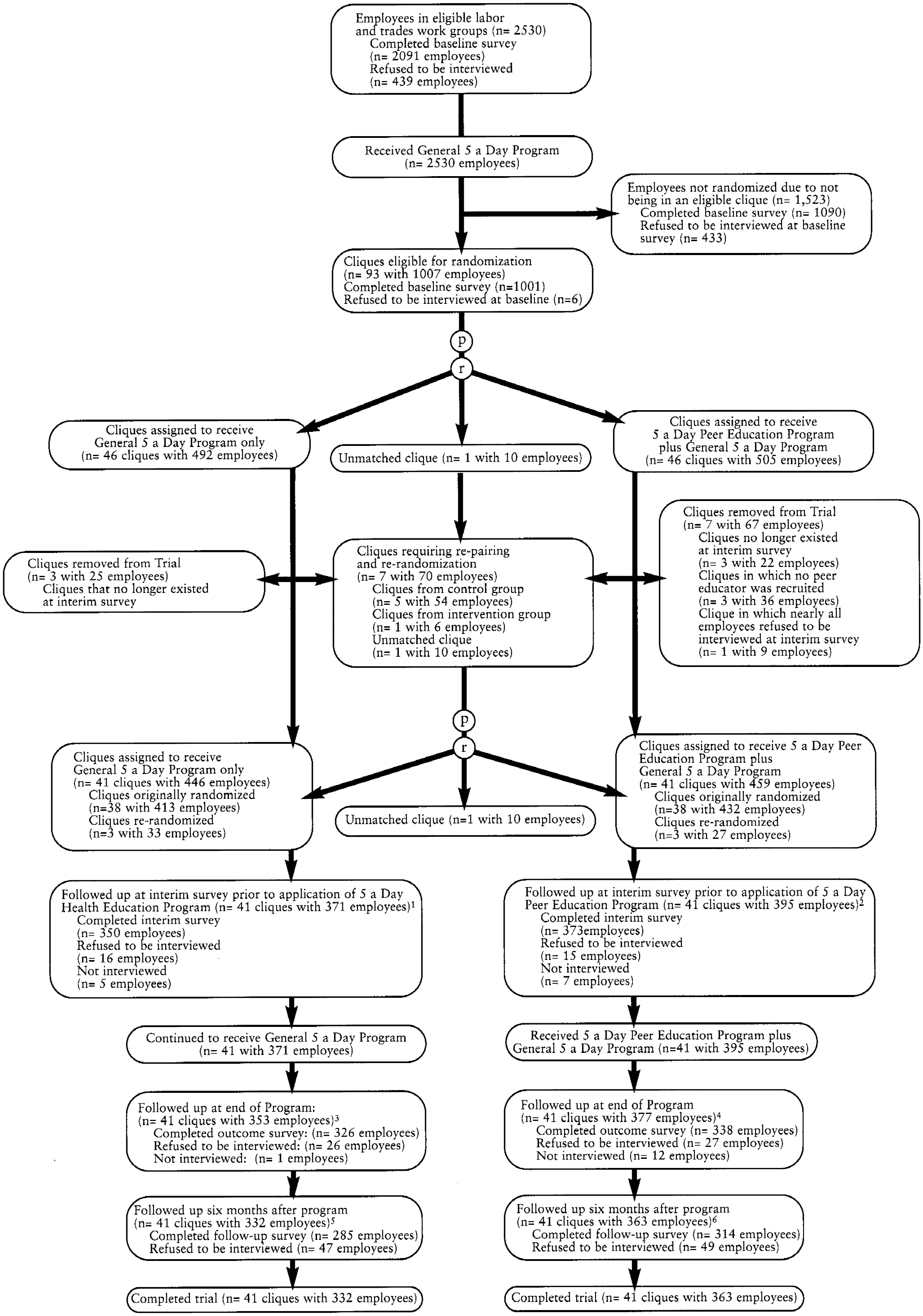
Five a Day Peer Education Program. This program was implemented during the last 9 months of the General Five a Day Program. Three months before implementation, an employee in each intervention clique was recruited to be a peer educator. These employees were highly central within the clique in terms of communication ties and flow. As such, they were skilled at communication, had strong relationships with their co-workers, were capable of accessing all co-workers, and could be opinion leaders in the group. Centrality was measured with the use of a "peer index" at baseline, calculated as a combination of "betweenness centrality," i.e., the ability to intercept or to modify information in a clique assessed as the probability that any one individual is connected to two other members who are not directly connected *(36);* "degree centrality," i.e., social prominence or status indicated by the number of times a person was named by other clique members *(36);* and "average strength of tie," i.e., the mean rating on each social tie context received by each person. The peer index was the grand mean of the rank of each clique member on these measures relative to other clique members. Researchers first contacted the employee with the highest peer index for recruitment. If that employee declined, the one with the second highest peer index was recruited and so on. The majority of the peer educators had either the highest (38% in Tucson and 21% in Phoenix) or the second highest (56% in Tucson and 37% in Phoenix) peer indices. Employees were ineligible to be peer educators if their supervisor objected to them serving as one or they planned to take a leave of absence or retire before the final survey. Peer educators shared many of the demographic characteristics with the study cohort, although their education and age ranges were more restricted and there were more Hispanics than in the study cohort (Table 1).

Peer educators attended a 16-hour training program conducted by the researchers over an 8-week period. This training program used presentations, group discussions, and role playing to cover a range of topics: *(a)* the health benefits of eating fruits and vegetables; *(b)* cultural trends in dietary practices; *(c)* methods of incorporating the topic of fruits and vegetables in informal communication at work, gaining compliance, and motivating behavior change; and *(d)* peer educators' role and responsibilities as peer educators in the study. Peer educators were told that the project expected them to spend about 2 hours per week discussing eating fruits and vegetables with co-workers. Peer educators were taught five persuasive communication strategies (foot-in-the-door, fear appeal, benefits, peer pressure, and questioning) and ways to initiate informal conversations about fruits and vegetables (e.g., noticing what a co-worker brought for lunch; using a media story as a segue into a Five a Day conversation; and hosting contests, potluck meals, and group discussions) in one-on-one interactions, small group discussions, or presentations at safety or staff meetings. Peer educators were not involved in the implementation of the General Five a Day Program described earlier. While peer educators' focus was to be on co-workers in their cliques, they were not discouraged from talking with employees outside them.

Peer educators *(a)* kept records of contacts with co-workers, *(b)* attended monthly 2-hour in-service training session with researchers to review activities, solve problems, and discuss special topics, and *(c)* spoke by telephone monthly with researchers about their progress. Logs of contacts with co-workers kept by peer educators and questions posed to co-workers at the outcome and follow-up surveys confirmed that they regularly discussed eating fruits and vegetables with co-workers and attempted to influence them to eat more of these foods *(32).*[1] For example, peer educators recorded more than 9000 contacts with co-workers, and 95% of employees surveyed in intervention cliques reported having a discussion about fruits and vegetables and receiving printed Five a Day materials from the peer educators.

Printed Five a Day materials were prepared by the researchers to be used by peer educators with their co-workers. The *Five a Day Guidebook* contained nine themed booklets, collected in a three-ring binder for storage, which peer educators distributed one a month. They contained culturally and regionally appropriate nutrition information (e.g., recipes and foods used in the Anglo and Mexican diets in Arizona, monthly listing of in-season Arizona-grown fruits and vegetables, Spanish translations and summaries, Mexican holidays and events, and Mexican-American and Anglo characters) to influence knowledge, attitudes, stages of change, skills, and barriers (e.g., general availability, cost, time, and satisfaction with taste) for eating fruits and vegetables. Features included articles and reports, a question-and-answer column, photonovella (continuing melodrama in photographs like a comic strip about a peer educator, co-workers, and family members), low-literacy graphics and stories, calendar of seasonal fruits and vegetables, activities for children, recipes and regional foods, and tips and facts. Four issues of *The Five a Day Way* newsletter directed employees to program events at their work sites and were distributed by peer educators every other month. Peer educators also provided one item each month (e.g., water bottle, recipe books, sample produce, and vegetable seeds) to help co-workers practice dietary skills, but these items were not used as incentives for any action. Peer educators distributed printed materials as intended, and employees read and often discussed these materials with co-workers and family members.[1]

Peer educators were paid $1800 for time spent in training, traveling to training, distributing materials, talking with co-workers for about 2 hours per week, and keeping daily logs of their contacts (approximately 165 hours). It is a common practice to pay lay advisors *(20).* Two peer educators were lost during the intervention; one was reassigned to another work group, and the other quit being a peer educator. Two replacement peer educators with high centrality


Employees in eligible labor and trades work groups (n= 2530)
Completed baseline survey (n= 2091 employees)
Refused to be interviewed (n= 439 employees)
Received General 5 a Day Program (n= 2530 employees)
Employees not randomized due to not being in an eligible clique (n= 1,523)
Completed baseline survey (n= 1090)
Refused to be interviewed at baseline survey (n= 433)
Cliques eligible for randomization (n= 93 with 1007 employees)
Completed baseline survey (n=1001)
Refused to be interviewed at baseline (n=6)
p
r
Cliques assigned to receive General 5 a Day Program only (n= 46 cliques with 492 employees)
Unmatched clique (n= 1 with 10 employees)
Cliques assigned to receive 5 a Day Peer Education Program plus General 5 a Day Program (n= 46 cliques with 505 employees)
Cliques removed from Trial (n= 3 with 25 employees)
Cliques that no longer existed at interim survey
Cliques requiring re-pairing and re-randomization (n= 7 with 70 employees)
Cliques from control group (n= 5 with 54 employees)
Cliques from intervention group (n= 1 with 6 employees)
Unmatched clique (n= 1 with 10 employees)
Cliques removed from Trial (n= 7 with 67 employees)
Cliques no longer existed at interim survey (n= 3 with 22 employees)
Cliques in which no peer educator was recruited (n= 3 with 36 employees)
Clique in which nearly all employees refused to be interviewed at interim survey (n= 1 with 9 employees)
p
r
Cliques assigned to receive General 5 a Day Program only (n= 41 cliques with 446 employees)
Cliques originally randomized (n=38 with 413 employees)
Cliques re-randomized (n=3 with 33 employees)
Unmatched clique (n=1 with 10 employees)
Cliques assigned to receive 5 a Day Peer Education Program plus General 5 a Day Program (n= 41 cliques with 459 employees)
Cliques originally randomized (n=38 with 432 employees)
Cliques re-randomized (n=3 with 27 employees)
Followed up at interim survey prior to application of 5 a Day Health Education Program (n= 41 cliques with 371 employees)1
Completed interim survey (n= 350 employees)
Refused to be interviewed (n= 16 employees)
Not interviewed (n= 5 employees)
Followed up at interim survey prior to application of 5 a Day Peer Education Program (n= 41 cliques with 395 employees)2
Completed interim survey (n= 373employees)
Refused to be interviewed (n= 15 employees)
Not interviewed (n= 7 employees)
Continued to receive General 5 a Day Program (n= 41 with 371 employees)
Received 5 a Day Peer Education Program plus General 5 a Day Program (n=41 with 395 employees)
Followed up at end of Program: (n= 41 cliques with 353 employees)3
Completed outcome survey: (n= 326 employees)
Refused to be interviewed: (n= 26 employees)
Not interviewed: (n= 1 employees)
Followed up at end of Program (n= 41 cliques with 377 employees)4
Completed outcome survey (n= 338 employees)
Refused to be interviewed (n= 27 employees)
Not interviewed (n= 12 employees)
Followed up six months after program (n= 41 cliques with 332 employees)5
Completed follow-up survey (n= 285 employees)
Refused to be interviewed (n= 47 employees)
Followed up six months after program (n= 41 cliques with 363 employees)6
Completed follow-up survey (n= 314 employees)
Refused to be interviewed (n= 49 employees)
Completed trial (n= 41 cliques with 332 employees)
Completed trial (n= 41 cliques with 363 employees)

scores were trained to continue the intervention with minimal disruption.

Outcome and Follow-up Surveys and Measures

An outcome survey was performed with employees in the cliques at the conclusion of intervention activities, and a follow-up survey was conducted 6 months afterwards by trained interviewers, some of whom were bilingual (English and Spanish). Interviews were conducted with employees individually, face-to-face, and during work time at the work site, with the approval of the employers (Fig. 1). We were unable to locate and interview 36 employees at the outcome survey and another 35 employees at the follow-up survey who had left the employer, so they were removed from the analysis. Thus, 41 cliques with 363 employees completed the trial in the intervention group and 41 cliques with 332 employees completed the trial in the control group (Fig. 1).

Survey questions assessed job and sociodemographic characteristics, co-worker and management support for healthy behaviors, sources of health information *(37)*, self-efficacy expectations, attitudes toward cancer prevention, personal and family histories of cancer *(38)*, and acculturation. Interviewers were unaware of the assignment of a clique to intervention or control condition. Measures of and evaluation of peer educator activities were asked at the end of the surveys, after all outcome measures had been obtained.

Measures used in the analyses reported here included an item measuring awareness of the Five a Day Program (i.e., Had employees heard of the Five a Day for Better Health Program?—"yes" or "no") and an item assessing knowledge of the recommendation to eat five servings of fruits and vegetables daily *(24)*. Attitudes toward fruit and vegetable consumption written for this study were measured with the use of 5-point Likert-type agree/disagree items. The primary measure of daily fruits and vegetables intake was a 24-hour intake recall on which interviewers recorded each food item eaten (as reported by an employee), the portion size, and the number of times each food item was eaten during the previous 24 hours *(39)*. When probing for portion size, interviewers used 8- and 16-ounce glasses and half- and one-cup bowls. Research staff converted the interviewers' reports to servings of fruits and vegetables. Measures were created of the number of servings of fruits, vegetables, fruit juices, and in total consumed during the last 24 hours, excluding olives, avocados, coconut, fried potatoes, French fries, and cranberry juice (which is not 100% fruit juice) per the National Cancer Institute's guidelines. Seven food-frequency questions assessed consumption of 100% orange or grapefruit juice, other 100% fruit juices, green salad (with or without other vegetables), French fries or fried potatoes, other potatoes (e.g., baked, boiled, and mashed), vegetables not counting potatoes and green salads, and fruit not counting fruit juices, which provided a secondary measure of daily intake over a typical month *(8)*.

Statistical Analysis

The analysis was based on clique-level averages of the outcome measures, since clique was the unit of randomization. Pairing of cliques was also included in the design of the analysis based on clique-level average total daily consumption (servings) of fruits and vegetables, stage of readiness to increase fruit and vegetable consumption, clique density, co-worker and management support for health, perceived self-efficacy for increasing fruit and vegetable consumption, proportion of Hispanic employees, proportion of female employees, and clique size from the baseline survey. All outcomes were analyzed with the use of the following method: First, the difference in outcome between baseline and outcome surveys was computed for each intervention clique, d_1, and each control clique, d_0. Second, the difference between these changes, $dd = d_1 - d_0$, was computed within each matched pair of cliques, yielding 41 outcome values. Finally, the analytic model was simple linear regression, $dd = \alpha + \beta d_0 + e$, where e is assumed to have a mean of zero and be independent of d_0, and d_0 is centered at its mean. Including the d_0 term is a way of controlling for the regression to the mean phenomenon; in fact, this analysis is a variant of the conditional change model *(40)* that is widely recommended for studies of change. The parameter measuring effect is α, which would be zero if the only effect on difference between change (dd) were regression to the mean (β). The customary .05 (two-sided) criterion was used for assessing statistical significance. This analysis procedure was planned in the original study protocol and was the basis for the sample size determination.

RESULTS

Comparison of Employees in Clique and Employees Not in Cliques

Compared with those not in eligible cliques, employees in the 93 eligible cliques at baseline *(a)* were less likely to agree that what they eat or drink is one of the most important things that affects how healthy they are (two-tailed $P = .004$); *(b)* ate fewer total daily servings of vegetables, not counting potatoes and green salads ($P = .001$); *(c)* received more health information from people with whom they work ($P = .012$); *(d)* were more likely to agree that drinking alcohol does not increase their risk of getting cancer ($P = .016$); *(e)* had spent more years at their job ($P = .002$); *(f)* had higher annual household incomes ($P<.0001$); and *(g)* had less contact with Mexico ($P = .014$). In addition, compared with those not in eligible cliques, more of the employees in the eligible cliques *(h)* were born in the United States ($P = .001$); *(i)* had a high school education or a trade, technical, or vocational education ($P = .010$); and *(j)* were male ($P = .018$). No general selection bias was evident: Having more information from people at work and being more acculturated and affluent might facilitate the peer education intervention, but believing that diet is less important for good health, believing that alcohol and cancer are related, having lower baseline fruit and vegetable intake, and being male may impede its success.

Immediate Changes in Awareness, Attitudes, and Dietary Behavior

The intervention and control cliques were at substantially the same levels of all of the outcome measures at baseline (Table 2). The largest statistically significant differences were that employees in the intervention cliques thought that an appropriate number of daily servings of fruits and vegetables was about 0.20 lower than did the control cliques. Also, according to both the intake recalls and food-frequency questionnaire, the reported total daily servings were lower among the intervention than the control cliques (by 0.23 and 0.20 servings, respectively).

Intervention effects at the outcome survey are shown in Table 3 under the α column (left side). Statistically significant overall effects of 0.77 ($P<.0001$) and 0.46 ($P = .002$) increases in total daily servings were seen in the intake recall and food frequency, respectively. The largest component of the effect was in daily servings of fruit (0.41 and 0.25), while a statistically significant effect for juices (0.10 and 0.01) could not be declared. Servings of vegetables showed intermediate effects (0.26 and 0.19) that were statistically significant only by the food-frequency measure.

The number of daily servings considered appropriate by the intervention cliques increased by 0.82. Furthermore, there was a 15% effect in increasing awareness of the Five a Day Program. Among the diet-related attitudes, there were a number of statistically significant intervention effects. Levels of confusion about what to eat went down (−0.20), whereas beliefs that food is important to health and to the individual rose (0.14 and 0.18, respectively). Finally, the intervention produced a large (0.88) increase in the feeling that there was information about healthy eating at work, but no effect was detected in attitude toward the difficulty of obtaining fruits and vegetables at work.

Overall, 11 of the 15 outcome measures showed statistically significant intervention effects in the expected direction of increase in intake.

Table 2. Clique-level means (standard deviations) on awareness of Five a Day Program, knowledge, diet-related attitudes, and fruit and vegetable consumption at baseline, outcome, and follow-up survey for 41 clique pairs

	Mean (standard deviation)					
	Baseline survey		Outcome survey		6-mo follow-up survey	
Measure	Control	Intervention	Control	Intervention	Control	Intervention
Awareness: Heard of Five a Day for Better Health Program*	0.16 (0.13)	0.17 (0.14)	0.81 (0.17)	0.97 (0.07)	0.86 (0.16)	0.97 (0.06)
Knowledge regarding No. of servings of fruits and vegetables a person should eat each day for good health	3.12 (0.83)	2.93 (0.69)	3.30 (0.61)	3.92 (0.67)	3.40 (0.64)	3.72 (0.72)
Diet-related attitudes						
There is so much advice about healthy ways to eat and drink that I don't know what is good or bad.†	3.25 (0.48)	3.17 (0.52)	3.01 (0.67)	2.73 (0.55)	2.87 (0.59)	2.64 (0.63)
What I eat and drink is one of the most important things that affects how healthy I am.†	4.27 (0.29)	4.28 (0.28)	4.34 (0.32)	4.49 (0.32)	4.33 (0.34)	4.42 (0.27)
Eating fruits and vegetables is important to me.†	4.43 (0.26)	4.32 (0.23)	4.40 (0.35)	4.47 (0.25)	4.39 (0.35)	4.39 (0.27)
There is a lot of information where I work about eating healthy.†	2.33 (0.79)	2.23 (0.60)	2.77 (0.67)	3.55 (0.53)	2.72 (0.72)	2.98 (0.54)
It's hard for me to get fruits and vegetables when I am at work.†	2.56 (0.69)	2.69 (0.57)	2.71 (0.79)	2.74 (0.78)	2.71 (0.85)	2.62 (0.66)
24-h intake recall						
Total daily servings	3.55 (1.16)	3.32 (0.88)	3.79 (1.14)	4.33 (0.88)	3.64 (1.48)	3.81 (1.01)
Daily fruit servings	1.01 (0.47)	0.78 (0.39)	0.99 (0.53)	1.17 (0.58)	1.01 (0.80)	0.84 (0.49)
Daily vegetable servings	1.97 (0.88)	1.97 (0.68)	2.22 (0.86)	2.49 (0.74)	2.09 (0.84)	2.33 (0.72)
Daily juice servings	0.57 (0.43)	0.56 (0.41)	0.58 (0.41)	0.67 (0.39)	0.54 (0.39)	0.64 (0.43)
Food frequency						
Total daily servings	3.00 (0.73)	2.80 (0.64)	3.48 (1.17)	3.74 (0.85)	3.47 (1.16)	3.24 (0.64)
Daily fruit servings	1.00 (0.35)	0.83 (0.27)	1.11 (0.49)	1.18 (0.31)	1.11 (0.52)	0.96 (0.32)
Daily vegetable servings	1.34 (0.38)	1.34 (0.36)	1.58 (0.67)	1.77 (0.59)	1.56 (0.67)	1.49 (0.47)
Daily juice servings	0.66 (0.27)	0.64 (0.23)	0.80 (0.37)	0.79 (0.36)	0.67 (0.39)	0.72 (0.33)

*Awareness measured as no (0) or yes (1).

†Opinions measured on 5-point scale from strongly disagree (1) to strongly agree (5).

Persistence of Changes in Awareness, Attitudes, and Dietary Behavior

The 6-month follow-up study showed a general persistence of the intervention effects (α column, right side, Table 3), although of reduced magnitude. The statistically significant increases in total number of daily servings persisted when measured by intake recall (0.41; $P = .034$) but not by food-frequency questionnaire (−0.04; $P = .743$). The effect on servings of fruits largely vanished, while the effect on servings of vegetables seemed to remain constant when measured by intake recall (0.24), although not by food-frequency questionnaire (−0.08). Both knowledge of the Five a Day Program and an opinion about appropriate number of servings per day showed persistent but smaller effects (9% and 0.51, respectively).

The same pattern was evident among the diet-related attitudes—persistence but shrinkage of short-term effects. The one exception was the appearance of a perception that fruits and vegetables were easy to get at work being more prevalent in the intervention than control groups.

At the end of the 6-month follow-up, statistically significant intervention effects persisted in six of the 15 outcome measures, and one new effect (perception that fruits and vegetables are easy to get at work) emerged. All of these effects were in the expected direction.

DISCUSSION

Peer education was effective at achieving dietary change among the lower socioeconomic, multicultural adult employees. Its effects were on par with changes produced by another peer education Five a Day intervention conducted with women in a food-assistance program (+0.56 servings) *(41)* and exceeded improvements by an intervention with the use of telephone counseling and mailings (+0.34 servings) *(42)*. Peer education also seemed to influence diet more broadly (increasing fruit and vegetable, not just fruit, intake) than a European work site program employing tailored printed materials, also with predominantly male employees *(43)*. Finally, the changes produced by the peer education program were larger than those achieved by a community campaign in Australia *(44)*. However, our changes may appear larger because they were estimated from a small defined work site population, most of whom were exposed to the program, rather than from an entire community. All of these projects increased awareness and/or knowledge of the recommendation to increase fruit and vegetable intake and improved attitudes in support of eating these foods.

As we anticipated, the dietary changes produced by the peer education program persisted beyond the conclusion of the intervention. Two previous trials on fruit and vegetable programs using peer education *(41)* and interpersonal contact from a telephone counselor *(42)* also showed that changes persisted. Theoretically, peer education achieves persisting change because it alters social group norms that continue to influence individuals after the program is completed. However, recidivism was also evident in our follow-up survey, as witnessed in the telephone-based Five a Day Program *(42)* and in other nutrition and weight-loss programs *(45–50)*. The effects of peer education interventions may not last indefinitely, and strategies are needed to maintain these changes over longer periods *(51)* without

Table 3. Regression coefficients (β columns) and intervention effects (α columns) plus associated standard deviations (SDs) of the estimate and two-tailed *P* values from the model comparing outcome and 6-month follow-up surveys with baseline survey (n = 41 clique pairs) on awareness of Five a Day Program, knowledge, diet-related attitudes, and fruit and vegetable consumption

	Outcome survey			6-mo follow-up survey		
Measure	β coefficient at baseline*	α intervention effect†	R^2‡	β coefficient at baseline*	α intervention effect†	R^2‡
Awareness: Heard of Five a Day for Better Health Program§	−0.97 (0.13), .000	0.15 (0.02), .000	0.60	−1.95 (0.11), .000	0.09 (0.02), .000	0.64
Knowledge regarding No. of servings of fruits and vegetables a person should eat each day for good health	−0.78 (0.18), .000	0.82 (0.13), .000	0.32	−1.00 (0.12), .000	0.51 (0.11), .000	0.63
Diet-related attitudes						
There is so much advice about healthy ways to eat and drink that I don't know what is good or bad.‖	−1.06 (0.16), .000	−0.20 (0.08), .024	0.53	−0.99 (0.20), .000	−0.15 (0.11), .163	0.39
What I eat and drink is one of the most important things that affects how healthy I am.‖	−0.69 (0.13), .000	0.14 (0.05), .010	0.42	−0.75 (0.12), .000	0.08 (0.05), .107	0.50
Eating fruits and vegetables is important to me.‖	−1.00 (0.15), .000	0.18 (0.05), .001	0.54	−0.93 (0.14), .000	0.11 (0.05), .040	0.53
There is a lot of information where I work about eating healthy.‖	−0.78 (0.17), .000	0.88 (0.09), .000	0.36	−0.75 (0.15), .000	0.38 (0.10), .000	0.39
It's hard for me to get fruits and vegetables when I am at work.‖	−0.74 (0.28), .011	−0.10 (0.11), .387	0.34	−1.22 (0.16), .000	−0.21 (0.10), .035	0.60
24-h intake recall						
Total daily servings	−0.83 (0.10), .000	0.77 (0.17), .000	0.62	−0.93 (0.10), .000	0.41 (0.19), .034	0.68
Daily fruit servings	−1.09 (0.17), .000	0.41 (0.09), .000	0.51	−0.93 (0.09), .000	0.06 (0.08), .453	0.72
Daily vegetable servings	−0.85 (0.13), .000	0.26 (0.15), .075	0.51	−0.91 (0.13), .000	0.24 (0.15), .117	0.54
Daily juice servings	−0.91 (0.13), .000	0.10 (0.07), .175	0.55	−0.80 (0.11), .000	0.11 (0.06), .068	0.57
Food frequency						
Total daily servings	−0.90 (0.14), .000	0.46 (0.14), .002	0.50	−1.13 (0.12), .000	−0.04 (0.12), .743	0.70
Daily fruit servings	−1.24 (0.15), .000	0.25 (0.06), .000	0.65	−1.00 (0.12), .000	0.03 (0.06), .666	0.62
Daily vegetable servings	−0.84 (0.17), .000	0.19 (0.09), .047	0.38	−1.04 (0.14), .000	−0.08 (0.08), .302	0.60
Daily juice servings	−0.83 (0.17), .000	0.01 (0.06), .806	0.38	−1.06 (0.16), .000	0.07 (0.06), .246	0.55

*Values in columns = coefficient at baseline (SD of the estimate), two-tailed *P* value.

†Values in columns = intervention effect (SD of the estimate), two-sided *P* value. Intervention effects are changes in servings for 24-hour intake recall and food-frequency measure.

‡Coefficient of determination.

§Awareness measured as no (0) or yes (1).

‖Opinions measured on 5-point scale from strongly disagree (1) to strongly agree (5).

producing fatigue and boredom that diminish returns *(52)*.

Peer educators were selected in this program on the basis of their centrality in the communication flow within cliques, a more formal, empirical assessment of the "natural helping ability" criteria used to identify lay health advisors in other programs *(20,53,54)*. Peer educators had sufficient regular contact with a large proportion of clique members to deliver the intervention effectively and were respected by co-workers for their opinions and therefore could be opinion leaders. And, by being central within social networks, peer education was implemented in the primary context in which social support is given and received *(9)*, group norms develop *(28)*, and opinion leadership functions *(18)*.

The method of peer education in this program in which education was provided only by lay people and only informally is only one form of peer education. It is an informal counseling function similar to that defined by Eng and Young *(9)* from the vantage point of being "paraprofessionals" *(10,54)*. Payment was provided to compensate peer educators for time in training, for travel, for interacting with researchers, for keeping records, and for adding a new task to their job.

The conclusions about the effectiveness of peer-led nutrition education in the workplace is limited to nonmanagerial and labor and trades employees. It is not clear from this evaluation whether it will be successful in other work environments, where people from different levels of the authority structure work together in the same groups, i.e., executives, managers, professional staff, and secretaries *(28,55)*.

A second limitation is that fruit and vegetable intake was measured through self-reports rather than by direct inspection of food consumption *(56)*. Self-reports can be biased by demand effects (employees knew that the goal was to increase their intake and therefore reported it) and social desirability tendencies (employees may have felt they looked more attractive by agreeing with the interviewers). Food-frequency questionnaires are more prone to bias than 24-hour intake recalls *(57)*. The increase on both measures and the fact that the 24-hour recall showed larger changes in intake and detected the persisting but smaller change at follow-up suggest that the improvements in consumption estimated by our measures were real.

Another limitation is that group-level estimates of intake for each clique from the 24-hour intake recalls were derived from measures of a single day at each survey, which inflated the variation in the observed group means. We were limited to a single-day measure to obtain permission from employers to interview employees on work time to improve response rates. One analysis *(58)* did show that averaging 24-hour intake recalls across members of a group, as we did, produced lower variation in group-level means than would have been observed had the average been based on individuals.

The unique aspects of this study—the focus on potentially overlooked workers, the participation of predominantly men in a nutrition peer education program, a design using careful randomization of informal social networks as the unit of analysis, and the collection of follow-up data—make it an important contribution to the literature on lay health advisors. While the dietary changes could be considered small, a dose–response relationship has been observed between fruit and vegetable intake and reduction in the risk of cancer *(1,59)*, so incremental increases of this size should have a meaningful public health impact. Peer education can be applied in many circumstances, including the work environment, where informal groups of individuals are present and significantly influence the behavior of their members.

REFERENCES

(1) Block G, Patterson B, Subar A. Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. Nutr Cancer 1992;18:1–29.

(2) Krebs-Smith SM. Progress in improving the diet to reduce cancer risk. Cancer 1998;83:1425–32.

(3) Negri E, La Vecchia C, Franceschi S, D'Avanzo B, Parazzini F. Vegetable and fruit consumption and cancer risk. Int J Cancer 1991;48:350–4.

(4) Steinmetz KA, Potter JD. Vegetables, fruit, and cancer. I. Epidemiology. Cancer Causes Control 1991;2:325–57.

(5) Steinmetz KA, Potter JD. Vegetables, fruit, and cancer. II. Mechanisms. Cancer Causes Control 1991;2:427–42.

(6) La Vecchia CL, Decarli A, Pagano R. Vegetable consumption and risk of chronic disease. Epidemiology 1998;9:208–10.

(7) Zeigler RG. Vegetables, fruits and carotenoids and the risk of cancer. Am J Clin Nutr 1991;53:251S–9S.

(8) Subar A, Heimendinger J, Patterson BH, Krebs-Smith SM, Pivonka E, Kessler R. Fruit and vegetable intake in the United States: the baseline survey of the Five A Day for Better Health Program. Am J Health Promot 1995;9:352–60.

(9) Eng E, Young R. Lay health advisors as community change agents. Fam Commun Health 1992;15:24–40.

(10) Eng E, Parker E, Harlan C. Lay health advisor intervention strategies: a continuum from natural helping to paraprofessional helping. Health Educ Behav 1997;24:413–7.

(11) Eng E. The Save Our Sisters Project. A social network strategy for reaching rural black women. Cancer 1993;72(3 Suppl):1071–7.

(12) Parker EA, Schulz AJ, Israel BA, Hollis R. Detroit's East Side Village Health Worker Partnership: community-based lay health advisor intervention in an urban area. Health Educ Behav 1998;25:24–45.

(13) Festinger L. A theory of social comparison processes. Hum Rel 1954;7:117–40.

(14) Allen VL, Wilder DA. Social comparison, self evaluation, and conformity to the group. In: Suls JM, Miller RL, editors. Social comparison processes: theoretical and empirical perspectives. New York (NY): Hemisphere; 1977. p. 187–208.

(15) Schacter S. Deviance, rejection, and communication. J Abnorm Soc Pysch 1951;46:190–207.

(16) Turner JC. Towards a cognitive definition of the social group. In: Tajfel H, editor. Social identity and intergroup relations. Cambridge (U.K.): Cambridge University Press; 1982. p. 15–40.

(17) Hirsch BJ. Social networks and the coping process: creating personal communities. In: Gottlieb BH, editor. Social networks and social support. Beverly Hills (CA): Sage; 1981. p. 149–69.

(18) Rogers E. Diffusion of innovations. New York (NY): Free Press; 1995.

(19) Bird JA, Otero-Sabogal R, Ha N, McPhee SJ. Tailoring lay health worker interventions for diverse cultures: lessons learned from Vietnamese and Latina communities. Health Educ Q 1996;23(Suppl):S105–S122.

(20) Brownstein JN, Cheal N, Ackerman SP, Bassford TL, Campos-Outcult D. Breast and cervical cancer screening in minority populations: a model for using lay health educators. J Cancer Educ 1992;7:321–6.

(21) Festinger L, Schacter S, Back K. Social pressures in informal groups. New York (NY): Harper; 1950.

(22) Cotugna N, Subar AF, Heimendinger J, Kahle L. Nutrition and cancer prevention knowledge, beliefs, attitudes, and practices: the 1987 National Health Interview Survey. J Am Diet Assoc 1992;92:963–8.

(23) Harnack L, Block G, Subar A, Lane S. Cancer prevention-related nutrition knowledge, beliefs, and attitudes of U.S Adults: 1992 NHIS cancer epidemiology supplement. J Nutr Educ 1998;30:131–8.

(24) Krebs-Smith S, Heimendinger J, Patterson B, Busbar A, Kessler R, Pivonka E. Psychosocial factors associated with fruit and vegetable consumption. Am J Health Promot 1995;10:98–104.

(25) Perez-Stable EJ, Otero-Sabogal R, Sabogal F, Napoles-Springer A. Pathways to early cancer detection for Latinas: en acción contra el cáncer. Health Educ Q 1996;23(Suppl):S41–S59.

(26) U.S. Bureau of the Census. 1990 Census of population, social and economic characteristics. Washington (DC): U.S. Department of Commerce; 1990.

(27) Suarez L, Lloyd L, Weiss N, Rainbolt T, Pulley L. Effect of social networks on cancer-screening behavior of older Mexican-American women. J Natl Cancer Inst 1994;86:775–9.

(28) Ibarra H. Structural alignments, individual strategies, and managerial action: elements toward a network theory of getting things done. In: Nohria N, Eccles RG, editors. Networks and organizations: structure, form and action. Cambridge (MA): Harvard Business School Press; 1992. p. 165–187.

(29) Morrill C. The executive way: conflict management in corporations. Chicago (IL): University of Chicago Press; 1995.

(30) Guidry JJ, Aday LA, Zhang D, Winn RJ. The role of informal and formal social support networks for patients with cancer. Cancer Pract 1997;5:241–6.

(31) Morrill C, Buller DB, Buller MK, Larkey LL. Toward an organizational perspective on identifying and managing formal gatekeeping. Qualitative Sociol 1999;22:51–72.

(32) Larkey LK, Alatorre C, Buller DB, Morrill C, Buller MK, Taren D, Sennott-Miller L. Communication strategies for a dietary intervention in a worksite peer education intervention. Health Educ Res. In press 1999.

(33) Rogers EM, Kincaid DL. Communication networks: toward a new paradigm for research. New York (NY): Free Press; 1980.

(34) Borgatti S, Freeman LC, Everett M. UCINET, version 5. Natick (MA): Analytic Technologies Software; 1998.

(35) Fernandez R, Morrill C. Do you influence me the way I think you influence me? Unreciprocated and gendered influence in social networks. Paper presented at the Conference on Power and Gender, February 1996, Stanford Business School, Stanford, CA.

(36) Freeman LC. Centrality in social networks: conceptual clarification. Social Networks 1979;1:215–39.

(37) Buller DB, Callister M, Reichert T. Skin cancer prevention by parents of young children: health information sources, skin cancer knowledge, and sun-protection practices. Oncol Nurs Forum 1995;22:1559–66.

(38) Buller D, Modiano MR, Guernsey de Zapien J, Meister J, Saltzman S, Hunsaker F. Predictors of cervical cancer screening in Mexican American women of reproductive age. J Health Care Poor Underserved 1998;9:76–95.

(39) Serdula M, Coates R, Byers T, Mokdad A, Jewell S, Chavez N, et al. Evaluation of a brief telephone questionnaire to estimate fruit and vegetable consumption in diverse study populations. Epidemiology 1993;4:455–63.

(40) Plewis I. Analysing change. Chichester (U.K.): John Wiley & Sons; 1985.

(41) Havas S, Anliker J, Damron D, Langenberg P, Ballesteros M, Feldman R. Final results of the Maryland WIC 5-A-Day Promotion Program. Am J Public Health 1998;88:1161–7.

(42) Marcus AC, Heimendinger J, Wolfe P, Rimer BK, Morra M, Cox D, et al. Increasing fruit and vegetable consumption among callers to the CIS: results from a randomized trial. Prev Med 1998;27:S16–S28.

(43) Brug J, Steenhuis I, van Assema P, de Vries H. The impact of a computer-tailored nutrition intervention. Prev Med 1996;25:236–42.

(44) Dixon H, Borland R, Segan C, Stafford H, Sindall C. Public reaction to Victoria's "2 Fruit 'n' 5 Veg Every Day" campaign and reported con-

sumption of fruit and vegetables. Prev Med 1998;27:572–82.

(45) Hennrikus DJ, Jeffery RW. Worksite intervention for weight control: a review of the literature. Am J Health Promot 1996;10:471–98.

(46) Selbst M, Bell MM, Thome MJ. The impact of a cholesterol screening and intervention program among unskilled and semiskilled workers. Am J Health Promot 1992;6:261–3.

(47) Briley ME, Montgomery DH, Blewett J. Worksite nutrition education can lower total cholesterol levels and promote weight loss among police department employees. J Am Diet Assoc 1992;92:1382–4.

(48) Stunkard AJ, Cohen RY, Felix MR. Weight loss competitions at the worksite: how they work and how well. Prev Med 1989;18:460–74.

(49) Kern PA, Trozzolino L, Wolfe G, Purdy L. Combined use of behavior modification and very low-calorie diet in weight loss and weight maintenance. Am J Med Sci 1994;307:325–8.

(50) Winkleby MA, Taylor CB, Jatulis D, Fortmann SP. The long-term effects of a cardiovascular disease prevention trial: the Stanford Five-City Project. Am J Public Health 1996;86:1773–9.

(51) Abrams DB, Follick MJ. Behavioral weight-loss intervention at the worksite: feasibility and maintenance. J Consult Clin Psychol 1983;31:226–33.

(52) Wang VL, Ephross PH, Green LW. The point of diminishing returns in nutrition education through home visits by aides: an evaluation of EFNEP. Health Educ Monogr 1975;3:70–88.

(53) Israel BA. Social networks and social support: implication for the natural helper and community level interventions. Health Educ Q 1985;12:65–80.

(54) Jackson EJ, Parks CP. Recruitment and training issues from selected health advisor programs among African Americans: a 20-year perspective. Health Educ Behav 1997;24:418–31.

(55) Kanter RM. Men and women of the corporation. New York (NY): Basic Books; 1977.

(56) Glanz K, Sorensen G, Farmer A. The health impact of worksite nutrition and cholesterol intervention programs. Am J Health Promot 1996;10:453–70.

(57) Sawaya AL, Tucker K, Tsay R, Willett W, Saltzman E, Dallal GE, et al. Evaluation of four methods for determining energy intake in young and older women: comparison with doubly labeled water measurements of total energy expenditure. Am J Clin Nutr 1996;63:491–9.

(58) Basiotis PP, Welsh SO, Cronin FJ, Kelsay JL, Mertz W. Number of days of food intake records required to estimate individual and group nutrient intakes with defined confidence. J Nutr 1987;117:1638–41.

(59) World Cancer Research Fund, American Institute of Cancer Research (AICR). Food, nutrition, and the prevention of cancer. Washington (DC): AICR; 1997.

NOTES

[1] Buller DB, Buller MK, Larkey L, Sennott-Miller L, Taren D, Aickin M, et al.: unpublished data.

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