COST-EFFECTIVENESS OF MINIMAL CONTACT EDUCATION STRATEGIES FOR CHOLESTEROL CHANGE

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Objectives: To compare the effectiveness and cost effectiveness of minimal contact nutrition interventions that varied in intensity on lowering total blood cholesterol (BC) levels.

Design: A randomized trial in which public, work, religious, and medical sites were randomly assigned to one of six minimal-contact nutrition interventions for lowering total BC.

Setting: 36 public, work, religious, and medical sites in southern New England (total sites=144).

Participants: The number of eligible participants at baseline was 10,144, which included 1425 Hispanics, who were over-recruited for this study.

Intervention: One of six brief interventions was provided to participants: 1) feedback tip sheet only; 2) tip sheet plus Rate Your Plate (RYP); 3) tip sheet, RYP, plus Let's Eat Kit (LEK); 4) all written materials plus CD audio intervention (AUD); 5) all written materials plus counseling from a trained lay person (LAY-C); and 6) all written materials plus counseling by a nutritionist (NUT-C). The educational materials were adapted to be culturally and linguistically appropriate for a Hispanic audience, and the counselors for the Hispanic participants were bilingual.

Measures: Total blood cholesterol levels were measured using fingerstick methods at baseline, 3 months, and 12 months after the intervention.

Results: Blood cholesterol (BC) was significantly reduced from baseline to 12-month follow-up among most experimental groups. Only LAY-C and NUT-C conditions demonstrated significant BC reductions at three months. The BC change in the NUT-C group was statistically different from the feedback-only condition at three months only. At three-month followup, BC was reduced 1.6% for the total sample, 2.8% for participants with borderline-high BC levels, and 3.4% for participants with high BC. Generally, the two conditions receiving counseling resulted in the largest percentage changes in BC levels. When examining BC change data by ethnicity, Hispanic participants in the audio condition achieved the largest overall 12-month change (4%). Generally, total costs increased as the intensity of the experimental condition increased. When comparing 3-month and 12-month cost effectiveness, LAY-C and NUT-C were approximately the same, whereas LEK and AUD conditions tended to become more expensive than the other interventions.

Conclusions: Brief nutrition counseling is an effective component of BC reduction programs. Culturally tailoring programs can result in substantial reductions in BC among Hispanic participants. Overall, even the most expensive intervention was fairly inexpensive compared to other, more intensive clinical interventions. (*Ethn Dis*. 2006;16:443–451)

Key Words: Cholesterol, Cost Effectiveness, Minimal Contact Intervention, Nutrition Education, Randomized Trial

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INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death in the United States and cost the United States an estimated $329 billion dollars in 2002.[1] The relationship between high blood cholesterol (BC) and CVD is established,[2–5] and approximately half of US adults have elevated levels (>5.2 mmol/L or ≥200 mg/dL),[6,7] although total BC levels have been decreasing.[6–8] A 1% reduction in total BC has a corresponding 2%–3% reduction in risk for coronary heart disease.[9–12]

Addressing the BC problem should include population-based strategies that incorporate changes in diet.[9,13–16] Dietary change has a significant effect on BC levels[17] as well as other CVD risk factors.[9,18,19] A number of nutrition education interventions have been tested for lowering BC levels, and in general, more intensive interventions have had a greater effect.[20–31] Unfortunately, many of these interventions would be too resource intensive and expensive to implement widely on a population basis.

Design limitations of previous intervention studies preclude useful interpretation and extrapolation to community practice. Some studies involved only limited segments of the community (mainly White participants and/or those at high risk), had small sample sizes, and/or had contamination issues because of individual-level randomization designs.[32] Furthermore, many studies that have used multiple-component interventions were not designed to identify which component(s) or combinations of the intervention were most effective. Thus, additional research is needed to evaluate the cost-effectiveness of alternative modes of intervention delivery to determine which intervention components hold the most promise for public health.[33–35] The objectives of this study were to evaluate the relative effectiveness of a variety of minimal contact nutrition education interventions on lowering BC levels and to examine the cost-effectiveness of each type of intervention in a large, multisite study with a diverse group of participants.

METHODS

General Design

The Minimal Contact Education for BC Change (MC) project, an NHLBI-funded study, was conducted from July

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1992 until August 1997. The BC screenings were completed in four different sectors: 1) public sites (eg, shopping malls); 2) medical facilities (eg, clinics); 3) religious organizations; and 4) work sites. A total of 144 sites (36 of each site type) in southeastern New England were recruited by using rolling recruitment to control for seasonality effects. To minimize contamination, sites were randomized into one of six nutrition education interventions so that all participants at a given site were exposed to the same intervention. Data collection and BC screenings were conducted at baseline, 3 months, and 12 months after the intervention. All study intervention and evaluation materials were provided in English or Spanish based on the participant's preference. The Spanish-language materials were also developed to be culturally appropriate for the Hispanic population in southern New England.[36–38]

Randomized Intervention Conditions

Sites were randomized into six different experimental conditions that increased incrementally in intensity and cost.[36–40] The first three intervention levels included take-home written materials only, each one incrementally increasing in dose/intensity: 1) Cholesterol Result Form (CRF); 2) CRF + Rate Your Plate (RYP); and 3) CRF + RYP + Let's Eat Kit (LEK). The next three interventions included all of the written materials (CRF+RYP+LEK) plus counseling by one of the following approaches: 4) compact disc audio intervention (AUD); 5) lay-administered face-to-face counseling (LAY-C); and 6) nutritionist-administered counseling (NUT-C).

The CRF received by all groups is a one-page, two-sided handout on which project staff manually recorded the participants' BC level. This handout also outlined the National Cholesterol Education Program (NCEP) referral recommendations for each BC category (desirable, borderline, and high) and gave basic information about BC and diet. Rate Your Plate (RYP), received by groups 2–6, is a brief, self-scoring instrument for eating pattern assessment that focuses on food behaviors that contribute to fat, saturated fat, and cholesterol intake,[39] with a section for setting dietary change goals. The LEK,[38] received by participants in groups 3–6, consisted of a three-ring binder including a RYP and goal-setting pages that corresponded to the RYP food categories, with detailed information on food choices, label reading, dining out, etc, as well as healthful recipes. Participants in the counseling groups completed a RYP during registration, received their BC screening, and attended an educational session that differed according to condition. The audio (AUD) group listened to self-selected tracks from an audio compact disk containing educational information that corresponded to the RYP food categories, while they viewed a book of food photographs also corresponding to the RYP.[37] The LAY-C and NUT-C conditions received brief (10- to 12-minute) face-to-face counseling with either a lay counselor (LAY-C) who had been trained and certified by investigators or a nutritionist (NUT-C). The counseling used the LEK and focused on the participant's BC level and answers to the RYP.

Participants

Participant recruitment methods depended upon the type of site and included posters, flyers, face-to-face recruitment, table tents, etc. Targeted recruitment efforts also focused on enrolling Hispanic participants. The initial baseline sample included 10,144 participants with 7817 non-Hispanic White (NHW), 1425 Hispanic, 561 African American/Black, 102 Asian, and 109 Native American participants. (See Tables 1 and 2 for participant characteristics.)

Measures

Participants were assessed in person at baseline, 3 months, and 12 months after the intervention. The main outcomes for this paper are BC change and cost effectiveness. At baseline, all interested participants completed an informed consent form and a registration form to enroll in the study. The registration form included basic tracking and demographic information as well as questions regarding health behaviors/risk factors. Then each participant completed a written survey containing dietary and psychosocial questions. Participants had their weight measured, and then they received a BC screening. All participants received one of the six nutrition education interventions regardless of their BC level, as recommended by NCEP. This practice also negated the effect of regression to the mean on our study results.[41] At each follow-up assessment, participants completed a telephone survey followed by another in-person screening at the same site as baseline.

Total BC was measured by using the Boehringer Mannhiem Diagnostics Reflotron,[43] a portable desktop BC analyzer whose accuracy and utility in field studies has been demonstrated.[42–44] To ensure the accuracy and reliability of BC measurements, we developed intensive, strict internal and external quality control procedures in conjunction with a phase IV Centers for Disease Control

Table 1. Baseline demographic characteristics by experimental condition and by site type

Condition	CRF	RYP	LEK	AUD	LAY-C	NUT-C	*P* value*	TOTAL
n	1697	1774	1720	1637	1708	1608		10,144
Age (years)	50 (.38)†	48 (.37)	47 (.37)	49 (.38)	50 (.38)	49 (.39)	.0001	49 (.15)
Men	47%	41%	42%	42%	43%	39%	.001	42%
High school	51%	59%	58%	57%	62%	61%	.001	58%
Ethnicity								
White	72%	80%	77%	76%	86%	77%	.001	78%
Hispanic	21%	14%	20%	15%	5%	9%	.001	14%
Black	4%	3%	1%	7%	6%	12%	.025	6%
English language	75%	84%	80%	80%	93%	87%	.001	83%
Married	61%	60%	65%	59%	63%	58%	.001	61%
US-born	72%	80%	76%	78%	88%	83%	.001	79%
Parents US-born	62%	70%	68%	66%	77%	72%	.001	31%
Regular doctor	80%	79%	83%	81%	84%	84%	.001	82%

* *P* value was determined from analysis of variance and chi-squared tests (for categorical variables).

† Number in parentheses is the standard error of the mean.

CRF=Cholesterol Result Form; RYP=Rate Your Plate; LEK=Let's Eat Kit; AUD=compact disc audio intervention; LAY-C=all written materials and counseling from a trained layperson; NUT-C=all written materials and counseling by a nutritionist.

and Prevention standardized laboratory per National Institutes of Health guidelines.[45] Details on the quality control procedures are available from the authors upon request.

Statistical Analyses

All analyses were performed by using the Statistical Analysis Software (SAS) package version 8.2. First, exploratory analyses were performed with all variables. Next, change in BC was calculated for 3- and 12 month follow-up time periods by subtracting the follow-up value from the baseline value. Models were constructed to assess potential confound-

Table 2. Baseline risk characteristics by experimental condition

Condition	CRF	RYP	LEK	AUD	LAY-C	NUT-C	*P* value*	TOTAL
n	1697	1774	1720	1637	1708	1608		10,144
Mean BC	215 (1.2)†	215 (1.1)	214 (1.2)	213 (1.2)	216 (1.2)	216 (1.2)	NS	215 (.47)
BC category								
<200 mg/dL	38%	40%	39%	42%	37%	38%		39%
200–239 mg/dL	34%	33%	33%	32%	34%	33%	NS	33%
240 mg/dL	28%	27%	28%	26%	28%	29%		28%
Mean BMI	26.9 (.13)	26.8 (.13)	27.1 (.13)	26.9 (.13)	26.9 (.13)	26.9 (.14)	NS	26.9 (.05)
% Overweight‡	36%	35%	38%	39%	40%	37%	NS	37%
% Obese§	22%	22%	22%	21%	22%	23%	NS	23%
FHQ Summary Score	2.45 (.01)	2.43 (.01)	2.46 (.01)	2.40 (.01)	2.41 (.01)	2.36 (.01)	.0001	2.42 (.01)
Regular exercise	52%	55%	50%	55%	56%	54%	.005	54%
Family history CVD	18%	19%	20%	18%	19%	19%	NS	19%
Previous BC measure	71%	71%	71%	71%	76%	78%	.001	73%
Have high BC	34%	30%	30%	33%	35%	36%	.001	33%
Taking BC meds	7%	6%	5%	7%	7%	6%	NS	6%
Have high BP	22%	19%	18%	21%	22%	24%	.001	21%
On high BP meds	18%	15%	14%	17%	17%	20%	.001	17%
Smoker	15%	15%	16%	13%	14%	13%	NS	15%
History of stroke	2%	1%	1%	2%	2%	1%	NS	2%
Had heart attack	7%	6%	7%	7%	8%	8%	NS	7%
Have diabetes	6%	4%	5%	5%	5%	5%	.02	5%

* *P* value was determined from analysis of variance tests (chi-squared tests for categorical variables).

† Number in parentheses is the standard error of the mean.

‡ BMI $\geq$25 kg/m^2 (but <30 kg/m^2).

§ BMI $\geq$30 kg/m^2.

CRF=Cholesterol Result Form; RYP=Rate Your Plate; LEK=Let's Eat Kit; AUD=compact disc audio intervention; LAY-C=all written materials and counseling from a trained layperson; NUT-C=all written materials and counseling by a nutritionist; BC=blood cholesterol; BMI=body mass index; FHQ=food habits questionnaire; CVD=cardiovascular disease; BP=blood pressure.

ing variables and the main effects. Initially, the change variable for the 3-month followup was examined by sociodemographic and risk factor variables by using independent sample *t* tests or analysis of variance to assess for possible confounders. Potential confounding variables (those variables that were different by condition) were added to the basic model in this procedure if after inclusion of the variable in the model, the parameter estimate for condition changed by more than ±10%.[46]

Next, main effects were tested with both 3- and 12-month follow-up values by constructing mixed regression models, which account for both fixed and random effects, by using the PROC MIXED procedure. The site variable was entered into each model as a random effect to account for intraclass correlation, and experimental condition was entered as a fixed main effect. Baseline BC level, age, sex, and ethnicity were included as covariates, as was use of BC-lowering medication at baseline. No statistical variation in BC was found due to Reflotron lot and test date, so statistical adjustment in the final model was not deemed necessary.

Finally, we computed cost analysis figures for each minimal contact intervention, including costs for participant screening and education in year 2000 dollars. See Harrow et al[40] for further details. Briefly, screening costs included all supplies for measuring BC, height and weight equipment, and screening staff time. The screening cost was $7.08 per person. Educational costs differed by condition and included just the costs for reproduction of the materials (CRF, RYP, LEK, audio CDs) as well as counseling staff time for the LAY-C and NUT-C conditions, but not materials development and design costs. The cost-effectiveness ratio was then computed as the total cost per participant incurred by a given condition minus the cost for the "control" condition of feedback only (condition 1) divided by the difference in BC change between the condition in question and condition 1.

RESULTS

Response to Followup

At the three-month followup, 90% of participants completed the telephone survey, and 81% completed the BC screening. At 12 months, 84% and 76% of participants were followed by phone and at the screening, respectively. Response rates were lower for Hispanic compared with NHW participants. Participants who did not complete either phone or in-person screening differed from those we were able to contact and were more likely to have both parents foreign-born; not be married; speak a language other than English at home; be born outside the United States; be overweight or obese; be non-White; have less education; have a BC reading <200 mg/dL; be <40 years old; have a lower fat intake based on food habits questionnaire (FHQ) score; have a regular doctor; exercise regularly; have had their BC previously measured; not have been previously told that they have high blood BC; not have diabetes; and not have had a stroke. Differences between those lost to followup at 12 months and study completers were similar to those noted above.

Sample

Demographic characteristics of the sample are provided in Tables 1 and 2. Overall, participants in this project had a mean age of 49 years, a mean BC in the borderline high category (215 mg/dL), and a mean body mass index (BMI) in the overweight range (26.9 kg/m^2). Almost 60% were women, 58% had a high school education or less, 61% were married, and 82% reported having a doctor for regular health care. Based on participant self-report, 54% reported exercising regularly, 18% were smokers, 19% had a family history of CVD, 33% had high BC, 6% took BC medications, 21% had high blood pressure (BP), and 17% took high BP medications.

Main Outcomes

Overall, mean BC tended to decrease significantly for all conditions over the course of the study; the magnitude of which was higher for those with elevated baseline BC. Changes in BC for 3- and 12-month followup among the total sample, as well as those with borderline and high BC levels, are reported in Table 3 adjusted for age and sex. At three months, significant BC changes were found for only the two counseling conditions (LAY-C and NUT-C), whereas significant BC changes from baseline to 12 months were found for the RYP, LEK, AUD, and NUT-C conditions. Among those participants with elevated baseline BC levels, significant decreases in BC were found at both 3- and 12-month followup time points for all experimental conditions.

The participants with elevated BC levels who received nutritional counseling achieved significantly more change in BC at 3-month followup as compared to those who received CRF only. No other statistically significant differences were found among experimental conditions. Also, no statistically significant differences were seen among experimental groups in BC change at 12 months.

As would be expected from a minimal contact approach, BC reductions were modest. In the total sample, a BC reduction of 1.6% was found for the NUT-C condition, whereas all other conditions showed reductions of <1%. For those having a baseline BC level 200–239 mg/dL, a mean 2.8% reduction was seen at three months, but only 1.7% by 12 months. For those with baseline BC levels ≥240 mg/dL, the average BC change over three months was 3.4%, which increased to 5.2% by 12 months. Generally, the two conditions that received counseling resulted in the largest change in BC levels.

Table 3. Mean blood cholesterol change (standard error) in mg/dL at 3- and 12-month follow-up measurements by experimental condition for full sample and baseline blood cholesterol category after adjusting for age and sex

	Experimental Condition					
	CRF	RYP	LEK	AUD	LAY-C	NUT-C
Full sample (*N*=10,144)						
n	1697	1774	1720	1637	1708	1608
3 month change	−0.6 (1.4)‡	−2.5 (1.4)	−0.9 (1.4)	−2.0 (1.3)	−2.9 (1.4)*	−4.5 (1.4)*†
12 month change	−2.1 (1.4)	−5.0 (1.4)*	−3.1 (1.4)*	−4.6 (1.4)*	−2.4 (1.4)	−4.0 (1.4)*
Baseline BC 200–239 mg/dL (*n*=3369)						
n	579	579	576	525	587	523
3 month change	−3.9 (1.6)*‡	−5.9 (1.7)*	−5.0 (1.6)*	−6.2 (1.5)*	−6.7 (1.5)v	−8.4 (1.6)*‡
12 month change	−6.3 (1.8)*	−10.8 (1.8)*	−8.6 (1.8)*	−9.7 (1.8)*	−7.3 (1.8)*	−8.5 (1.8)*
Baseline BC >240 mg/dL (*n*=2810)						
n	471	487	474	428	482	468
3 month change	−7.2 (1.8)*‡	−8.1 (1.8)*	−10.6 (1.8)*	−8.9 (1.8)*	−11.1 (1.8)*	−10.9 (1.8)*‡
12 month change	−10.0 (2.3)*	−15.2 (2.3)*	−13.2 (2.3)*	−17.2 (2.2)*	−14.8 (2.2)*	−14.6 (2.3)*

* Significantly different from zero.
† Different from condition 1.
‡ Different from condition 6.
CRF=Cholesterol Result Form; RYP=Rate Your Plate; LEK=Let's Eat Kit; AUD=compact disc audio intervention; LAY-C=all written materials and counseling from a trained layperson; NUT-C=all written materials and counseling by a nutritionist; BC=blood cholesterol.

Table 4 presents the results by ethnicity for NHW and Hispanic participants. Among NHW participants, only the NUT-C condition demonstrated statistically significant BC reductions at three months, while at 12 months, the RYP, LEK, AUD, and NUT-C conditions demonstrated statistically significant BC reductions, which is similar to the full sample. For Hispanic participants, the AUD and NUT-C conditions demonstrated statistically significant BC reductions at three months, while those in the AUD condition were the only Hispanic group to show durable BC change over the 12-month follow-up period. Hispanic participants in the AUD, LAY-C, and NUT-C conditions demonstrated statistically significant BC reductions compared to the CRF-only condition at three months, while no difference in BC change by condition was observed for NHW participants during this time period.

Cost-effectiveness analysis (CEA) data are presented in Tables 5a and 5b. Costs generally increase as intervention intensity increases, with the NUT-C condition costing more than the other conditions. However, in terms of total dollars spent per unit change (mg/dL) in BC level, the CRF condition (group 1) and the LEK condition (group 3) were the most expensive, with RYP, LAY-C, and NUT-C being the most cost-effective at three months. When considering educational costs only (without the costs of the cholesterol screening), however, the lower intensity interventions of CRF and RYP were more cost-effective. In the 12-month analyses, the NUT-C and LAY-C conditions had the highest costs per unit decrease in cholesterol level. For educational costs only, the costs per unit change (mg/dL) increased steadily as amount of contact increased. Finally,

Table 4. Blood cholesterol change (SE)¶ (adjusted for age and sex) by experimental condition for non-Hispanic White and Hispanic participants

	Experimental Condition					
Condition	CRF	RYP	LEK	AUD	LAY-C	NUT-C
3 month change¶	+5.1 (2.8)‡§‖	−2.1 (3.1)	−1.0 (2.7)	−6.1 (2.9)*†	−7.2 (3.8)†	−7.2 (3.5)*†
12 month change¶	+.0 (2.4)‡	−2.4 (2.8)	−1.1 (2.5)	−8.1 (2.8)*†	+4.2 (1.5)	+.2 (3.4)

* Significantly different from zero.
† Different from Condition 1.
‡ Different from Condition 4.
§ Different from Condition 5.
‖ Different from Condition 6.
¶ BC change scores presented in mg/dL.
CRF=Cholesterol Result Form; RYP=Rate Your Plate; LEK=Let's Eat Kit; AUD=compact disc audio intervention; LAY-C=all written materials and counseling from a trained layperson; NUT-C=all written materials and counseling by a nutritionist; BC=blood cholesterol.

Table 5a. Cost-effectiveness analysis (CEA) including total and education costs per participant by experimental condition as well as total costs per unit change in blood cholesterol (mg/dL) at 3-month and 12-month followup

Condition	Total Cost Per Person*	Educational Cost Per Person†	Change BC (mg/dL)	Total Cost ($/mg/dL)‡	Educational Cost ($/mg/dL)§
Cholesterol Result Form	$ 7.13	$ .05			
3-month change:			−.60	11.90	.08
12-month change:			−2.1	3.39	.02
Rate Your Plate	$ 7.38	$ .30			
3-month change:			−2.50	2.95	.12
12-month change:			−5.0	1.48	.06
Let's Eat Kit	$11.33	$ 4.25			
3-month change:			−.90	12.59	4.72
12-month change:			−3.1	3.65	1.37
Audio w/photo book	$14.64	$ 7.56			
3-month change:			−2.00	7.32	3.78
12-month change:			−4.6	3.18	1.64
Lay counselors	$13.73	$ 6.65			
3-month change:			−2.90	4.73	2.29
12-month change:			−2.4	5.72	2.77
Nutritionists	$21.72	$14.64			
3-month change:			−4.50	4.83	3.25
12-month change:			−4.0	5.40	3.66

* Includes cost of cholesterol screening ($7.08 per person) and educational costs.
† Includes cost of education only.
‡ Computed by dividing total costs (column 1) by cholesterol change.
§ Computed by dividing educational costs (column 2) by cholesterol change.

the interventions were more cost-effective for participants with increased baseline BC. For example, 12-month CEA based on educational costs for those receiving counseling by a nutritionist was $1.72 per mg/dL decrease in BC for participants between 200 and 239 mg/dL and $1.01 for those with BC ≥240 mg/dL.

DISCUSSION

Before discussing the results, we briefly address limitations of the present study. The sample used for these analyses was not random; the data presented are from participants who volunteered to participate in the cholesterol education and screening program. However, sites were randomized, and a number of different site types were selected for the study to maximize generalizability, which improves inference and increases the representative nature of the sample. We were able to adequately over-recruit Hispanics (14% in this study) compared to the general Hispanic population as represented in the Rhode Island (9%) and Massachusetts (7%) 2000 Census, and Hispanic participants were representative of Hispanic subgroups in this region.[47] More than 60% of the overall study sample had BC levels ≥200 mg/dL, which was consistent with national trends at the time.[6]

This study avoided many of the limitations noted in previous studies by involving a diverse sample, including a large sample size from many different types of sites, maintaining a high proportion of participants throughout follow-up, including participants with desirable and borderline as well as high BC levels, and using a group randomized design. Moreover, this study is one of a very few that presents detailed cost-effectiveness data for type of nutrition education interventions.

This large-scale, multiple-site study has yielded interesting findings regarding population-level BC change, which have implications for future BC intervention strategies. Study results indicate that brief counseling by a nutritionist generally resulted in the largest 3- and 12-month BC changes. This intervention resulted in BC reductions of ≈2% at 12 months for the full sample, 4% at 3 months and 12 months for participants with baseline BC 200–239 mg/dL, and 4% and 7% at 3 and 12 months, respectively, for those with baseline BC levels >240 mg/dL. Our findings are consistent with those of other studies that used brief counseling by nutritionists and found a 3% reduction at 12 months, but for a substantially smaller sample.[33] Other studies have shown BC reductions of up to 9% in the highest BC category, but they involved much more expensive, lengthy, intensive interventions.[25,34,48] Thus, minimal contact nutrition interventions can be useful in lowering BC levels, primarily among those with elevated levels. Moreover, minimal contact nutrition education can be cost-effective. Our most expensive intervention, at ≈$22 for the NUT-C condition, was less expensive than the $50 per person costs found in other studies[33,49] Yet the interventions in our study were

Table 5b. Cost-effectiveness analysis (CEA) for participants with elevated baseline cholesterol including total and education costs per participant by experimental condition as well as total costs per unit (mg/dL) change in blood cholesterol for 3-month and 12-month follow-up time periods

Condition		Total Cost Per Person*	Educational Cost Per Person†	Change BC (mg/dL)	Total Cost ($/mg/dL)‡	Educational Cost ($/mg/dL)§
Chol Result Form		$ 7.13	$ .05			
3-month change	(200–239 mg/dL)			−3.9	1.83	.01
	(≥240)			−7.2	.99	.01
12-month change	(200–239 mg/dL)			−6.3	1.13	.01
	(≥240)			−10.0	.71	.01
Rate Your Plate		$ 7.38	$ .30			
3-month change	(200–239 mg/dL)			−5.9	1.25	.05
	(≥240)			−8.1	.91	.04
12-month change	(200–239 mg/dL)			−10.8	.68	.01
	(≥240)			−15.2	.48	.02
Let's Eat Kit		$11.33	$ 4.25			
3-month change	(200–239 mg/dL)			−5.0	2.27	.85
	(≥240)			−10.6	1.07	.40
12-month change	(200–239 mg/dL)			−8.6	1.32	.49
	(≥240)			−13.2	.86	.32
Audio w/photo book		$14.64	$ 7.56			
3-month change	(200–239 mg/dL)			−6.2	2.36	1.22
	(≥240)			−8.9	1.64	.85
12-month change	(200–239 mg/dL)			−9.7	1.51	.78
	(≥240)			−17.2	.85	.43
Lay counselors		$13.73	$ 6.65			
3-month change	(200–239 mg/dL)			−6.7	2.05	.99
	(≥240)			−11.1	1.24	.60
12-month change	(200–239 mg/dL)			−7.3	1.88	.91
	(≥240)			−14.8	0.93	.45
Nutritionists		$21.72	$14.64			
3-month change	(200–239 mg/dL)			−8.4	2.59	1.74
	(≥240)			−10.9	1.99	1.34
12-month change	(200–239 mg/dL)			−8.5	2.56	1.72
	(≥240)			−14.6	1.49	1.01

* Includes cost of cholesterol screening ($7.08 per person) and educational costs.
† Includes cost of education only.
‡ Computed by dividing total costs (column 1) by cholesterol change.
§ Computed by dividing educational costs (column 2) by cholesterol change.

still able to achieve BC reductions comparable to those found in other studies.[21,48]

Among the intervention components, behavioral counseling was more effective than other commonly used interventions (including feedback only and self-help educational materials alone) as has been found by other researchers.[28] Feedback alone is insufficient in lowering BC, as demonstrated in this study and in other research[50]; however, the addition of a brief counseling session to existing screening programs may be a cost-effective way to improve reductions in BC levels.

Study results indicate that brief counseling by a nutritionist generally resulted in the largest 3- and 12-month BC changes.

Hispanic participants seemed to benefit the most from face-to-face counseling (at least in the short term) and from the audio intervention in the long term. Comprehensive, formative research with ethnically diverse populations[36] is critical in targeting nutrition education,[51] and we believe that the careful cultural tailoring of the audio intervention[37] contributed to the substantial, stable impacts on BC demonstrated with the Hispanic participants in the present study. In addition, the audio intervention may have been more effective than the written educational materials alone because little reading was required, which may have benefited Hispanic participants with limited literacy. Moreover, Hispanic participants were significantly less likely to have had their BC previously checked (48% compared to 79% of NHW participants), which suggests that they were

less likely to have received previous education related to lowering BC, and thus the nutrition education we provided may have been particularly helpful to these participants.

While the resulting BC reductions achieved in the current study may appear to be modest numerically at the individual level, the impact of these changes at the population level could be dramatic[14,48,52] because of the potential to reach large numbers with these minimal interventions. Moreover the potential morbidity impact of the BC reductions we demonstrated, if sustained, would be considered significant at a population level, as a BC reduction of 1% can translate into a 2%−3% reduction in CHD incidence and mortality.[9,53] To put this in perspective, every 1% reduction in CHD, saves the United States ≈$1.3 billion.[1] Thus, even small BC reductions can have huge associated public health cost savings.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This research suggests that BC screening and brief education are useful at the population level for lowering BC levels and that brief counseling by nutritionists or lay counselors can be a cost-effective component of the screening process. In addition, interventions that are culturally tailored for Hispanic participants can be quite successful at lowering BC levels.

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