RESEARCH ARTICLE

An Economic Evaluation of the Expanded Food and Nutrition Education Program

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ABSTRACT

Objective: To evaluate the New York State Expanded Food and Nutrition Education Program using economic methodology.

Design: Data were collected by nutrition educators in a pretest, posttest design with an epidemiological modeling approach to assess costs and estimate potential health benefits of the state program.

Setting: Cooperative Extension, 35 counties.

Participants: 5730 low-income participants.

Intervention: Series of 6 or more food and nutrition lessons.

Main outcome measures: Cost (program and participant); health benefits in quality adjusted life years (QALYs); and monetized benefits: society's willingness to pay for QALYs, and benefits of avoiding or delaying health care costs and loss of productivity.

Analysis: Cost-effectiveness estimated from behavior change and QALY weights. Cost–benefit ratios estimated from costs and monetized benefits. Sensitivity analyses provided ranges where lack of agreement exists around parameters' values.

Results: Cost was $892/graduate. Cost-effectiveness was 245 QALYs saved, at $20 863/QALY (sensitivity 42-935 QALYs, $5467-$130 311 per QALY). Societal willingness to pay benefit-to-cost ratio was $9.58:$1.00 (sensitivity $1.44-$41.92:$1:00); narrow governmental benefit-to-cost ratio was $0.82:$1.00 (sensitivity $0.08-$4.33:$1:00).

Conclusions and implications: Outcome data indicate that food and nutrition behavior changes resulting from the Program are likely to improve future health and reduce health care costs. Cost-effectiveness is estimated to be as great as for many current health interventions.

Key Words: cost-benefit analysis, cost-effectiveness, evaluation studies, low-income population, nutrition education

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INTRODUCTION

Community nutrition programs are designed to encourage participants to change food choice to improve health. Positive behavior change among graduates of the Expanded Food and Nutrition Education Program (EFNEP) and retention of this change over time has been reported.[1,2] But from an economic perspective, effectiveness tells only part of the story. Resources have competing uses, especially in the context of budget constraints. Economic evaluation methods can help direct societal resources to their most highly valued use. Cost analysis (CA) sheds light on the efficiency of a program, whereas cost-effectiveness (CEA) and cost-benefit (CBA) are of interest for cross-program comparisons of efficiency or effectiveness relative to cost.

Cost-effectiveness has become an established evaluation method for health care interventions. Studies of medical nutrition therapy report the impact of nutrition intervention on secondary prevention, for example, in diabetes or heart disease.[3,4] Prior to recent EFNEP studies, the only economic analyses reported in public health in the United States have been in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), where savings in Medicaid expenses were estimated with a combination of food

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assistance and nutrition education.[5,6] The more general application of CEA to public health interventions is increasingly common. An example is the World Health Report 2002,[7] which concludes that population-wide health education strategies to reduce cholesterol are cost-effective. In medicine and public health, CBA is not as well accepted as CEA because of objections to placing a dollar value on health.[8]

The need for economic evaluations of nutrition education programs has been noted for years.[9] Only 2 studies that report the economic impact of community-based nutrition education have been published in the peer-reviewed literature. Rajgopal et al reported $10.63 in estimated health benefits (future health care savings and avoiding or delaying loss of productivity) for every $1.00 spent in the Virginia EFNEP to avoid or delay diet-related conditions.[10] Burney and Houghton measured benefits in terms of savings in food expenditures, expected to increase food security, in EFNEP participants in Tennessee.[11] This randomized, controlled trial resulted in graduated participants reporting a decrease in family food expenditures of $124 to $234 over a year while still improving nutrition practices. Both of these studies, as well as the earlier WIC studies,[5,6] adopt narrow perspectives for the measurement of impact. Consequently, they omit important categories of costs and benefits that may be crucial determinants of societal decisions about allocating more resources to nutrition interventions.

EFNEP is delivered through Cooperative Extension in all US states and territories with federal, state, and local funding. It reaches over 150 000 low-income adults per year to assist them "in acquiring knowledge, skills, attitudes, and changed behavior necessary for nutritionally sound diets and to contribute to their personal development and the improvement of the total family diet and nutritional well-being."[12] Data that allow the costs of this and similar programs to be compared to their benefits are important for justification of funding, determination of priorities, and assessment of practices within a given program. The objective of this research was to conduct economic analyses of the New York State (NYS) EFNEP.

METHODS

We conducted CA, CEA, and CBA of the NYS EFNEP for federal fiscal year (FY) 2000. We followed standard practices[13] and recommendations of the Panel on Cost-Effectiveness in Health and Medicine,[14] experts in CEA convened by the US Public Health Service. In the primary analyses, costs and consequences of the intervention were measured from the societal perspective; secondary analyses were conducted using the narrower perspective adopted in previous studies.[5,6,10] During FY2000, 5730 adults graduated from the NYS EFNEP; all were included in the analyses. A graduate had participated in a minimum of 6 lessons and completed a pre- and post-education evaluation, which were the primary data sources used. Of the graduates, 38% were white, 34% Hispanic, 24% black, 3% Asian, and 1% Native American. This study was approved by the University Committee on Human Subjects, Cornell University.

Primary and secondary data sources were used to estimate costs or savings likely to accrue based on the extent of change related to food choice and food preparation behavior reported by participants. The evaluation was guided by a conceptual model (Figure) outlining the "event pathway,"[15] that is, the cascade of cost implications and health consequences.

The pathway begins with EFNEP education previously demonstrated to change behavior.[2] Epidemiologic and clinical evidence predicts these behavioral changes will reduce or delay the incidence of certain diet-related conditions, leading to improvements in life expectancy and quality. Each step of the pathway has economic implications. Program delivery involves resource and time costs. Behavioral changes could yield costs or savings for participants, depending on whether food expenditures increase or decrease as a result of a more healthful diet. Decreased incidence of diet-related conditions will reduce associated health care expenditures and productivity (human capital) losses. As shown in the last step, a complete evaluation would also recognize that increasing life expectancy affects future costs, for example, in both participant costs and health care. However, owing to data limitations, as is standard practice in many economic evaluations of health interventions, the analyses were unable to capture all of the effects on future costs.

Economic Analyses

Three types of economic evaluation were conducted—CA, CEA, and CBA. The primary analyses were from the comprehensive societal perspective, "which incorporates all costs and all health effects regardless of who incurs the costs and who obtains the effects."[16]

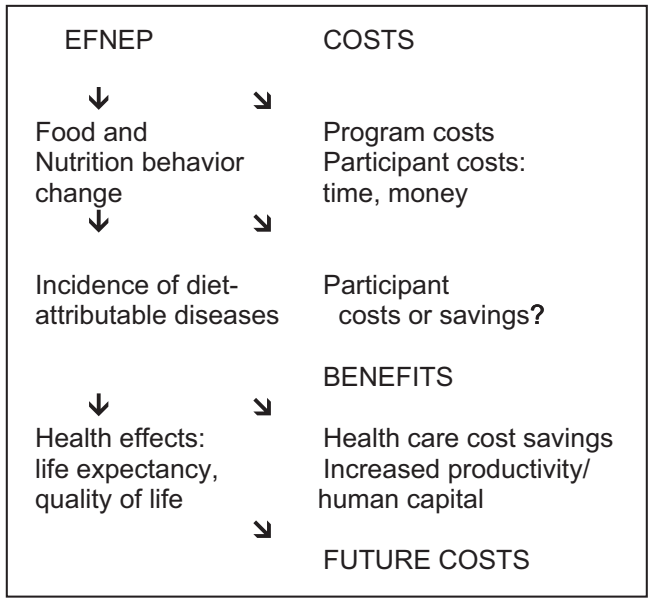

Figure. Event pathway for evaluation of the economic impact of EFNEP on the incidence of diet-attributable conditions.

Cost analysis. Cost analysis, the first step in both CEA and CBA, is a useful partial evaluation method in its own right. The costs of the program are estimated based on the concept of *opportunity costs*, that is, the value of inputs or resources that could have been employed elsewhere. When measuring costs from a societal perspective, the goal is to determine what society gives up in terms of foregone consumption of other goods and services.

Cost effectiveness analysis. This was a cost-utility analysis, a form of CEA where the effect of EFNEP was measured in a common metric based on people's utility levels or preferences for different health states. Utility is the preference of an individual for a particular health state. Utilities have been measured for different populations and resulting preference scores, which the authors used in this study, are available from the Harvard Center for Risk Analysis catalog.[17] This analysis compared the impact of EFNEP (post-education) to no program (pre-education). The authors applied results from studies in the scientific literature that report the effects of dietary behavior on health and life expectancy to estimate the impact of behavior change resulting from EFNEP on estimated years of life expectancy gained as a result of health improvements. Extending life in poor health is not equivalent to extending life in perfect health; therefore, this difference in quality of life expectancy was taken into account by applying published quality-adjusted life year (QALY) weights, ranging from 0 (death) to 1 (perfect health), for different health states to estimate number of QALYs saved.

Cost–benefit analysis. The CBA monetized health benefits. In principle, EFNEP yields benefits because improved nutritional practices lead to health improvements. Ideally, these benefits are measured by estimating societal willingness to pay for the improved health. By monetizing the benefits in the CBA, decision makers have a basis for determining where to use the available resources.

Two approaches were taken to monetize benefits. First, the authors used estimates suggesting that society is willing to pay at least $200 000 for each QALY saved.[18] In other words, even though improved health may cost so much in comparison to benefits received that benefits do not outweigh costs, society may still consider the investment worth the cost, because life is extended or quality of life is increased. Because these estimates are somewhat controversial, the authors conducted a cost-benefit analysis consistent with the narrower perspective in previous studies.[5,6,10] The authors used published data associated with avoiding or delaying medical costs and loss of productivity from related morbidity. The authors replicated the study of Rajgopal et al[10] for all conditions except hypertension, for which updated data were used.[19] This approximation provided a plausible lower estimate of the value of the health benefits.[8] Using this narrower approach, monetized benefits are limited to estimated actual costs and savings in health care and productivity rather than using a CEA and including society's willingness to pay for health improvements.

Program Costs

The direct, tangible costs consisted of the value of resources, including direct payments of real and in-kind dollars, used in program administration and implementation. Costs included salaries, wages, and benefits; facilities (office space and utilities); equipment, supplies and travel; and staff training. Because of distortionary taxation, raising $1.00 of revenue imposes more than $1.00 of costs on the economy, so the marginal excess burden of taxes needed to finance the program was assumed to be 17% of the total costs to the local program.[20]

Costs to participants are an important part of opportunity costs. Participants gave up time that could have been used in other valued ways such as work for wages, household work, or leisure activities. The value of participants' time was estimated by assuming 1-hour lessons (the usual length) multiplied by number of lessons and the minimum wage of $5.15.[14] Other costs to the participants, such as travel costs to the program sites, were not measured, as participants are normally reached either by the educator traveling to the participant's home or to a group of participants meeting for another reason, such as a welfare-to-work program.

Program Outcomes

For the CEA and CBA, the authors estimated EFNEP's impact on final health outcomes. The immediate impact was based on self-reported food and nutrition behavior pre- and post-education. The distal impacts were based on current literature that reported the relationship of the behavior to disease incidence. Implementation steps are summarized in this formula[10]: ***OUTCOME*** = ([A] number of graduates x [B] incidence of the condition x [C] incidence attributable to diet x [D] percentage of graduates practicing optimal food and nutrition behaviors related to avoiding or delaying the condition) x [E] impact of dietary change assessed using the EFNEP Evaluation Reporting System.[21] In the absence of a long-term, prospective, randomized, controlled trial, the formula takes an epidemiological modeling approach to estimate outcomes of the EFNEP intervention, a common practice for economic evaluations where clinical trials are impractical.[14]

The incidence of the condition [B] and the incidence attributable to diet [C] (Table 1) were gleaned from the published literature.[22-36] To the extent possible, the authors used lifetime risk, or cumulative incidence for the incidence rates. When this was not available, it was approximated. For example, lifetime risk was unavailable for type 2 diabetes, so risk was estimated using the decade of life with the highest prevalence. Lifetime risk would be higher since diabetes is increasing,[37] but this estimate was closer than a prevalence rate collected at an arbitrary time.

Table 1. Cost Effectiveness Analysis of the New York State Adult EFNEP (n = 5730)

Condition*	Incidence Rate (%)	Diet-Attributable Risk (%)	Graduates with Optimal Nutrition Behaviors† (%)	Graduates Accruing Benefits (n)	Present Value of Quality of Life Adjustment[17]‡	Total Quality of Life Benefits in QALYs§
Heart disease[27,28]	32.0	30	0.26	1.44	0.7827	1.13
Stroke[26,32]	5.0	27	3.65	2.82	1.0915	15.97
Hypertension[25,26,36]	90.0	45	3.65	84.65	1.6965	143.60
Colorectal cancer[30,31]	5.6	12	0.52	0.2	1.8834	0.38
Osteoporosis[38,39,59]	33.0	15	7.71	21.88	0.9298	20.34
Obesity[34,55]	35.6	50	0.49	4.98	6.2827	31.31
Diabetes[33,34]	22.0	51	0.47	3.03	2.3387	7.08
Foodborne illness[24]	2.8	100	14.55	23.35	0.9817	22.92
Low birthweight infants[29]	7.3	74	2.30	10.03	0.2500	1.86
Common infant diseases[22]	68.0	22	3.61	119.95	0.0100	0.31
TOTAL QALYs						244.91

EFNEP indicates Expanded Food and Nutrition Education Program.

*References for incidence rate and diet-attributable risk for each condition are noted.

†"Optimal nutrition behaviors" were reached when a participant reported changes in every assessment item related to avoiding or delaying a particular condition (Table 2).

‡Quality of life adjustment is based on the Harvard Center of Risk Analysis CEA Registry[17] of cost-per-QALY ratios indicating people's preferences for different health states.

§Quality of life benefits accrue in quality adjusted life years (QALYs) for each condition according to the behavior change reported pre- to post-EFNEP education.

Osteoporosis was a special case. Because lifetime risk was unavailable, the authors used cumulative incidence of vertebral fractures as a conservative estimate.[38] Diet-attributable risk was estimated based on research suggesting that 60%-80% of osteoporosis is attributable to genetics and body mass index[39]; and cross-sectional studies of non-athletes indicating a contribution of muscle strength to bone density in the range of 9%-38%.[40] Assuming these values are additive, less than 30% of bone density would be attributable to diet. The authors used the midpoint of the range (15%), then they applied outer limits of 0% and 30% in sensitivity analyses, as described in the following section.

The investigators used assumptions of other nutrition cost-benefit studies[10] and sorted conditions into 3 categories: directly life-threatening, for which incidence could be delayed by improved diet; not directly life-threatening, but chronic; and acute, with only a one-time cost. For the first group, the authors assumed a 5-year delay, because behavior change would be retained at least 5 years,[1] and based years of condition on difference between average age of onset and death.

The treatment effect [D] was measured by assessing self-reported behaviors of participants as reported on a behavior checklist in a pre- and post-education comparison, along with dietary intake collected via a 24-hour recall. Dietary data were analyzed using the Evaluation Reporting System 4,[21] the evaluation method required by USDA for evaluation of EFNEP. Checklist items have been shown to have acceptable validity (as compared to the Partial Healthy Eating Index) and internal reliability (α = .72) (J. Anliker, W. Willis, R. Cox, oral presentation, Dallas, TX, September 13, 2001). Five checklist questions related to food practices that pertain specifically to the health conditions studied were selected (Table 2). Participants responded on a 5-point scale reporting relative frequency of practicing the behavior ("almost always" to "do not do"). For a given condition, an individual identified as practicing optimal nutrition behavior reported practicing behavior(s) related to the prevention of that condition "sometimes," "seldom," or "never" pre-education and "most of the time" or "almost always" post-education. Hence, a participant who met the guidelines prior to education was not counted as having changed and benefit accrued. To take a conservative approach, change had to occur with *every* item related to the particular condition for a participant to be identified as having reached "optimal behavior." In addition, the participant had to report dietary intake (food or nutrient) below the then-current recommendation (2000 Dietary Guidelines for Americans)[41] at entry and

Table 2. Criteria Used to Assess Behavior Change Pre- and Post-EFNEP Education for Each Related Disease State or Condition Investigated in the Economic Analyses

	Diseases/Conditions									
Behavior Change Criteria	**Heart Disease[51]***	**Stroke[52]**	**Hyper-tension[52]**	**Colorectal Cancer[53]**	**Osteo-porosis[54]**	**Obesity[55]**	**Diabetes[56]**	**Foodborne Illness[57]**	**Low Birth-Weight Infants[58]**	**Infant Diseases[22,50]**
Behavior checklist items										
Prepare food without salt	X	X	X							
Trim fat from meat	X			X		X	X			
Think about healthful food choices	X	X	X	X	X	X	X			
Meat/dairy sitting out $>$ 2 hrs								X		
Thaw food at room temperature								X		
Dietary intake standards										
Fruits/vegetables $\geq$ 5 servings	X	X	X	X		X				
Dairy $\geq$ 2 servings					X					
Carbohydrates $\leq$ 250 g							X			
$\leq$ 30% fat	X			X		X				
$\geq$ 20 g fiber	X			X		X	X			
Calcium $\geq$ 800 mg		X	X		X					
Kcal $-$20% [†]						X	X			
$>$ 2100 Kcal[‡]									X	
Nondietary variables										
"Yes" for pregnant									X	
"Yes" for nursing[§]										X

EFNEP indicates Expanded Food and Nutrition Education Program.

*Cited references provide data supporting the use of the variables to assess diseases/conditions.

[†]Energy decrease of 20% indicated negative energy balance to promote weight loss.

[‡]Additional energy needs during pregnancy are approximately 300 Kcal/day,[58] and the average nonpregnant woman in the age range served by EFNEP needs at least 1800 Kcal/day to maintain weight, thereby resulting in $>$2100 Kcal to decrease risk of low birth weight in pregnancy.

[§]If "yes" for nursing, protection against commonly occurring diseases of infancy (otitis media, gastroenteritis, viral infections) was assumed.

reach or exceed the recommendation at exit. Standards used to assess dietary intake are listed in Table 2.

For the CEA, the impact was expressed in terms of QALYs saved, where [E] was the present value of QALYs saved that were appropriate for each condition. Using total program cost, the authors estimated cost per QALY saved. Two different methods were used to monetize benefits and provide CBAs. The first took a broad societal approach—society's willingness to pay for health improvements as expressed through QALY. This approach was made by monetizing the present value of the benefits (QALYs) using a published summary value.[18] The second CBA took a narrow approach by monetizing impact, where [E] was the present value of benefits, that is, the product of the medical costs per year of condition (direct benefit) and the cost of avoiding lost work days (indirect benefit). Costs related to the condition were taken from the literature, discounted to the year of the study (2000), in other words, since they occurred at different times, they were adjusted to the equivalent value at the time of the study. A discount rate of 5% was used for both QALYs saved and monetized benefits accrued in the future. This rate takes into account time value of money, with the expectation that benefits are worth more if experienced sooner.

Sensitivity analyses are conducted where there is lack of agreement about some parameters' values, which may substantially impact outcomes,[14] for example, the relative degree to which genetics, body mass index, physical activity, and diet contribute to osteoporosis. Three parameters were included in this analysis. First, retention rate of dietary behaviors were assumed to occur in only 25% of those making behavioral changes, rather than in 100%.[42] Second, outer limits of 0% and 30% were applied for diet-attributable risk of osteoporosis. Third, a discount rate of 5% was applied for the initial calculations, and then rates of 0%, 3%, and 7% were included in the sensitivity analyses, as is standard practice in economic analyses.[14,43]

RESULTS

Cost Analysis

The total costs for the adult EFNEP for FY2000 were $5 111 544, about 1.5 times the total federal allocation to NYS, with the additional coming from in-kind and direct funding received from local and state governments and in-kind support from other agencies. The mean cost per graduate was $849 (range $512 - $3270), depending on the site (percentiles: 10^{th} = $592, 50^{th} = $1041, 90^{th} = $2142). This cost included $715 per graduate in direct costs. When the societal perspective is taken, other costs must be added, including an average of $43 in participant costs (mean of 8.3 hours in class at minimum wage of $5.15), plus marginal excess burden of $125 (17% of direct costs). The breakdown of total costs included 58% for personnel; 13% for facilities (space and utilities); 5% for equipment, supplies, and travel; and 5% for staff training.

Cost Effectiveness Analysis

The variables in Table 1 were used for the CEA to determine QALYs. The present value of quality of life adjustment was used to determine value of benefits for each condition. The program saved an estimated 245 QALYs (Table 1). Sensitivity analyses were applied: (a) discount rates of 0%, 3%, and 7% yielded 816, 376, 168 QALYs, respectively; (b) diet-attributable risk of osteoporosis adjusted to 0% or 30% resulted in 225 and 265 QALYs, respectively; and (c) if only 25% of the participants retained dietary changes for 5 years, QALYs decreased to 61. Combining these sensitivity analyses resulted in a range of 42 - 935 QALYs saved. Compared to the alternative of no program, and considering only the program's direct costs of $5 111 544, the NYS EFNEP was estimated to have an incremental cost-effectiveness ratio of $20 871 per QALY saved (sensitivity $5467 - $130 311).

Cost-benefit Analyses

For the first CBA, using society's willingness to pay, the authors estimated that the 245 QALYs saved are worth $49 million to society. Using this approach to value the benefits leads to a benefit-to-cost ratio of $9.58:$1.00 (sensitivity $1.44-$41.92:$1.00).

For the second CBA, direct and indirect benefits of health improvements are found in Table 3. The benefit-to-cost ratio for the 10 health outcomes assessed was $0.82:$1.00. We applied sensitivity analyses as follows: (a) discount rates of 0%, 3%, and 7% yielded ratios of $2.48:$1.00, $1.15:$1.00, and $0.63:$1.00, respectively; (b) diet-attributable risk of osteoporosis adjusted to 0% or 30% yielded ratios of $0.35:$1.00 and 1.29:$1.00, respectively; and (c) if only 25% of participants retained their reported dietary changes for 5 years, the ratio dropped to $0.20:$1.00. Combining these sensitivity analyses yielded a range of $0.08-$4.33:$1.00. This narrow approach has been criticized because it is not tightly linked to what society is willing to pay to improve health.

Both approaches to CBA represent only a portion of the benefits that are expected from the program and that have been observed in other types of studies.[11,44]

DISCUSSION

Community nutrition programs designed to prevent disease are presumed to be less costly, both in actual dollars expended and as quality of life gained, than treatments after diseases have occurred. Previous evaluations of EFNEP indicate that over time participants retain improvements in food and nutrition behavior reported at graduation.[1,2] Additional evidence of improvement in resource management practices[11] and personal and family well-being has also been demonstrated.[2] All of this evidence points to the effectiveness of EFNEP. But effectiveness alone does not fully ad-

Table 3. Benefits of the New York State Adult EFNEP Based on a Narrow Governmental Perspective* (n = 5730)

	Direct Benefits†		Indirect Benefits‡		Total Benefits
Condition	Present Value of Healthcare Benefits	Total Direct Benefits	Present Value of Lost Earnings	Total Indirect Benefits	
Heart disease	$ 1169	$ 1683	$1076	$ 1549	$ 3233
Stroke	21 878	86 421	3234	12 774	99 195
Hypertension	892	75 503	2304	195 022	270 525
Colorectal cancer	27 068	5457			5457
Osteoporosis	109 070	2 386 353			2 386 353
Obesity	11 989	59 753	201	1000	60 753
Diabetes	75 918	229 986	420	1273	231 259
Foodborne illness	31 272	730 264	2645	61 777	792 041
Low birthweight infants	37 613	279 227			279 227
Common infant diseases	1642	50 857			50 857
TOTAL BENEFITS					$4 178 899

EFNEP indicates Expanded Food and Nutrition Education Program.

*This perspective bases benefit on published data associated with avoiding or delaying medical costs and loss of productivity from morbidity related to each condition.

†Direct benefits are gained from avoiding or delaying medical costs.

‡Indirect benefits are gained from avoiding lost work days.

dress the economic question of benefit vs cost. To estimate dollars saved or lost, several states have undertaken EFNEP CBAs.[10,11] Doing so is seen as a means of evaluating program effectiveness, as well as a means of communicating the program's value to Congress in an effort to increase funding,[10] but the narrow perspective used provides incomplete guidance for societal decisions about the program.

The standard approach in economic evaluation is to complete a Reference Case Analysis, in other words, using a standard set of methods to make results comparable among studies, adopting the perspective of society as a whole. The broad societal perspective means all costs, effects, and benefits should be incorporated into the analyses, no matter who pays the costs or receives the benefits.[15] This broad perspective is consistent with the goal that the economic evaluation should provide guidance to policy makers on allocation of resources among EFNEP, other food and nutrition programs, and other uses. The authors first looked at costs using cost per graduate as a measure of efficient use of resources, since these could be employed elsewhere. The authors then conducted a CEA to take the societal perspective assessing program benefits as measured by people's preferences for different health states. Finally, benefits were monetized in 2 ways, first with a willingness-to-pay approach so benefits represented the broader societal perspective, and then with the narrower governmental perspective, which includes only a subset of program costs. This narrow perspective is appropriate if the only goal is to help governmental decision makers weigh costs to taxpayers against benefits to participants.[10]

It is important to keep in mind that programs in different locations and analyses using different assumptions would be expected to provide quite variable results. These economic evaluations of the NYS EFNEP conducted from the broad societal perspective were quite favorable, suggesting that the investment of resources in EFNEP is a good investment for society as a whole, but it has a lower return from the narrower perspective of government budgets.

The results indicate that EFNEP's cost effectiveness compares well to other health interventions, saving a sizable number of QALYs as compared to no program. Considering only direct costs, EFNEP is estimated to have an incremental cost-effectiveness ratio of $20 871 per QALY saved. A study by Plans-Rubio estimated the effectiveness of cardiovascular disease prevention and found that dietary intervention cost $57 175 to $62 154 per life year gained.[45] The Harvard Center of Risk Analysis CEA Registry contains a League Table of over 600 cost-per-QALY ratios.[17] The NYS EFNEP is at least as cost-effective as many of these current health interventions. Using societal willingness to pay to save a QALY, the estimated benefits of EFNEP far exceed the costs ($9.58:$1.00). However, the secondary analyses using a narrower perspective found costs exceeded potential savings. It should be stressed that it is not necessary that an intervention yield cost savings to have a favorable economic evaluation. Instead, the standard approach of CEA and CBA compares the additional costs of an intervention to the value of the health gains, measured in QALY or monetary units.[13,14] Practical examples of the use of CEA and CBA in health policy making include the World Health Organization's use of CEA[7] and the US Office of Management and Budget's use of CBA.[17]

When these methods are applied, the CEA and CBA here support the conclusion that societal resources devoted to EFNEP are in a highly valued use.

The only other reported study that estimates health benefits from a community-based nutrition education program without food assistance is the Virginia EFNEP study, which used only the narrow governmental perspective and did not include cost to participants.[10] The Virginia benefit-to-cost ratio was $10.64:$1.00. The difference between NYS and Virginia is accounted for in 3 ways: the differences in the assumptions and methodology used, relative cost differences, and differences in benefits accruing to the respective program. Two-thirds of the difference between the 2 states' outcomes, using the narrow governmental approach, can be accounted for by different assumptions, in terms of lifetime risk, diet-attributable risk, and present value of benefits. Recalculating Virginia's benefit-to-cost ratio using the authors' assumptions and sensitivity analyses from the present study results in a ratio of $3.84:$1.00 (sensitivity = $0.43 - $19.10). In addition, Virginia used only post-education dietary intake, comparing it to recommended levels, rather than assessing pre- to post-education change. If NYS benefits are recalculated using only post-education dietary intake data, the benefit-to-cost ratio more than doubles, from $0.82 to $1.86:$1.00. Differences in methodology therefore account for a large part of the difference in the benefit-to-cost ratios reported for the 2 states. However, the NYS benefit is still below that of Virginia, which indicates a need to look more closely at programmatic issues.

Other Benefits Not Captured In These Analyses

The results presented here are clearly underestimates of the benefits that would be expected to accrue from EFNEP participation. The conservative approach used does not estimate more modest benefits expected from less than optimal dietary changes or benefits that accrue only after the participant leaves the program. Additional expected outcomes were not assessed, for example, improvement in the dietary intake of other family members, improved management of household budget,[11] impact of increased family meals,[46,47] improvements in other health habits (eg, exercise), or the impact of personal empowerment of participants[12] and of staff.[48] In addition, no estimates were made of benefits accruing from other programs to which families were referred, particularly food assistance programs. During the study year, 4553 referrals were made to other programs for low-income audiences, greatly increasing the exposure of participants to consequent benefit flows from programs such as WIC and Food Stamps. Amplification of benefits expected is exemplified by WIC CBA reporting savings of $1.77-$3.13 for every dollar spent.[6]

Strengths and Limitations of the Data

This study included a large, multiethnic sample of low-income adults in EFNEP for at least 6 lessons. EFNEP in NYS focuses on individualized instruction rather than on a standard curriculum for all participants, yet it is evaluated using the standard national evaluation.[21] Even so, although actual lessons delivered may not address all evaluation items, economic results were favorable.

One limitation of the study was the limited data available, specifically the small number of items to measure each construct. The evaluation instrument is brief to limit respondent burden. For research purposes, this brevity limits the possibility of triangulation for validation. Also, in some cases items available do not represent the variable of choice. For example, level of dietary saturated fat is more important than total fat for heart disease risk, but only total fat is available in the nutrient database. Only two 24-hour recalls (pre and post) were available, so day-to-day variation was not assessed.

A second limitation is the potential impact of social desirability and/or lack of knowledge on participant responses. Data were self-reported with no biomarkers, and participants may have reported practicing better behaviors than they actually were. Rohs et al reported that pre-intervention data may be skewed because the participant thinks he or she is practicing more desirable behavior than he or she is.[49] Once knowledge and skills are gained, reported practices more closely reflect true practice, and hence the behavior change calculated from pre- and post-intervention data underestimates actual change. This underestimation would translate to a higher benefit-to-cost ratio than reported.

A final limitation is that the authors have not considered participants' future costs. EFNEP may have implications for future costs that arise with improvements in life expectancy. The Panel on Cost-Effectiveness in Health and Medicine recommends that economic evaluations "include the net costs of health care and non-health consumption during years of life added by the intervention."[14] The treatment of future costs in economic evaluations has been controversial, however, leading the Panel to further suggest that it may be appropriate to omit future costs because of measurement problems and unresolved theoretical issues. Especially for sensitivity analysis, future work should consider whether the results of the CBA and CEA are sensitive to the inclusion of participants' future costs.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Economic analyses have implications for funding decisions and program management at every level. While EFNEP was the program investigated here, other nutrition education programs can use similar methodology to leverage funding and to use available funds more effectively.

Federal Level

The education provided by EFNEP directly supports current goals of both the US Department of Agriculture and the US Department of Health and Human Services, as indicated in the Dietary Guidelines for Americans[41] and Healthy People 2010.[50] Data showing that there are actual quality of life and monetary benefits to EFNEP provides an incentive to Congress to increase funding. It is important for experts designing these studies to base analyses on data that are supported by the body of scientific knowledge and that are reasonable. Overvaluation of programs may lead to benefit-to-cost ratios that are so high that they lack apparent credibility. Simultaneously, programs can be undervalued if they are too narrowly focused or if advocates do not make it clear that benefits accrue that have not been captured in a given analysis (eg, food security benefits beyond those addressed in the present study and health benefits to other family members).

State Level

Analyses of program effectiveness using economic studies have potential for upper level management of nutrition programs—state level management for government funded programs, or corporate level management in the private sector. Results provide data for advocating for more money and for making decisions regarding budgetary allocations to local programs.

Local Level

Economic analyses can also be used by local programs to analyze their own costs relative to other sites, providing data that can improve programming and management. Likewise, nutrition educators can use the benefits portion of the study in marketing. Though they already have other productivity measures (eg, number of graduates, pre to post behavioral outcomes), accrued benefits estimated in this study give a unique perspective, in real terms, of the number of lives being affected and the size of the impact. In addition, educators are eager to learn more about peer programs that have the highest economic benefit to assist them in improving program management and delivery to more successfully impact the lives of participants. In NYS, educators and administrators are involved in leveraging county and state funds for programs. Being able to articulate the success of the work in terms of monetized benefits will assist them in this effort.

Future Research

Reports of economic analyses of community-based nutrition education programs have been limited, and more are needed to assure that programs receive the support needed to meet public needs. Future studies should use CEA to compare different management styles, staffing structures, and program delivery methods to determine the most cost-effective and guide management decisions and resource allocation. Well-validated assessment tools, with a larger number of variables than in the present study, should be used. Additional controlled trials, beyond that of Burney and Houghton,[11] are needed to provide an additional level of rigor.[16]

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REFERENCES

1. Nierman LG. A longitudinal study of the retention of foods and nutrition knowledge and practices of participants from the Michigan Expanded Food and Nutrition Education Program [dissertation]. East Lansing, MI: Michigan State University; 1986.
2. Arnold CG, Sobal J. Food practices and nutrition knowledge after graduation from the Expanded Food and Nutrition Program (EFNEP). *J Nutr Educ*. 2000;32:130-138.
3. Franz MJ, Splett PL, Monk A, et al. Cost-effectiveness of medical nutrition therapy provided by dietitians for persons with non-insulin-dependent diabetes mellitus. *J Am Diet Assoc*. 1995;95:1018-1024.
4. Delahanty LM, Sonnenberg LM, Hayden D, Nathan DM. Clinical and cost outcomes of medical nutrition therapy for hypercholesterolemia: a controlled trial. *J Am Diet Assoc*. 2001;101:1012-1023.
5. Montgomery DL, Splett PL. Economic benefit of breast-feeding infants enrolled in WIC. *J Am Diet Assoc*. 1997;97:379-385.
6. United States Department of Agriculture, Food and Nutrition Service. *Savings in Medicaid Costs for Newborns and Their Mothers from Prenatal Participation in the WIC Program*. Washington, DC: United States Department of Agriculture, Food and Nutrition Service; 1992.
7. World Health Organization. *The World Health Report 2002: Reducing Risks, Promoting Healthy Life*. Geneva, Switzerland: World Health Organization; 2002.
8. Kenkel D. On valuing morbidity, cost-effectiveness analysis, and being rude. *J Health Econ*. 1997;16:749-757.
9. Brun JK. Where are we going? *J Am Diet Assoc*. 1987;87:S81-S82.
10. Rajgopal R, Cox RH, Lambur M, Lewis EC. Cost-benefit analysis indicates the positive economic benefits of the Expanded Food and Nutrition Education Program related to chronic disease prevention. *J Nutr Educ Behav*. 2002;34:26-37.
11. Burney J, Houghton B. A nutrition education program that demonstrates cost-benefit. *J Am Diet Assoc*. 2002;102:39-45.
12. Cooperative State Research Education and Extension Service, US Department of Agriculture. *Expanded Food and Nutrition Education Program (EFNEP)*. Available at: http://www.csrees.usda.gov/nea/food/efnep/efnep.html. Accessed February 22, 2008.
13. Drummond MF, O'Brien B, Stoddart GL, Torrance GL. *Methods for the Economic Evaluation of Health Care Programmes*. 2nd ed. New York, NY: Oxford University Press; 1997.
14. Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. *Cost-Effectiveness in Health and Medicine*. New York, NY: Oxford University Press; 1996.
15. Torrance GW, Siegel JE, Luce BR. Framing and designing cost-effectiveness analysis. In: Gold MR, Siegel JE, Russel LB, Weinstein

MC, eds. *Cost Effectiveness in Health and Medicine*. New York City, NY: Oxford University Press; 1996.
16. Tolley GS, Kenkel DS, Fabian R. *Valuing Health for Policy: An Economic Approach*. Chicago, IL: Chicago University Press; 1994.
17. Harvard Center for Risk Analysis. *CUA Database, Standardizing the methods and practices of cost-effectiveness analysis*. Available at: http://www.tufts-nemc.org/cearegistry/. Accessed February 22, 2008.
18. Hirth RA, Chernew ME, Miller E, Fendrick AM, Weissart WG. Willingness to pay for a quality adjusted life year: in search of a standard. *Med Decis Making*. 2000;20:332-342.
19. Peterson C. Treatment of hypertension is steeped in controversy. *Managed Healthcare*. 1999;9(2):53-55.
20. Ballard CL, Shoven JB, Whalley J. General equilibrium computations of the marginal welfare costs of taxes in the United States. *Am Econ Rev*. 1985;75:128-138.
21. United States Department of Agriculture. *Supporting Documentation for ERS4*. Available at: http://www.csrees.usda.gov/nea/food/efnep/ers/ers4.html. Accessed April 8, 2008.
22. Beaudry M, Dufour R, Marcoux S. Relation between infant feeding and infections during the first six months of life. *J Pediatr*. 1995;126:191-197.
23. Cames OR, Cheung LWY, Lieberman E. The role of lifestyle in preventing low birth weight. *Future Child*. 1995;5:121-138.
24. Buzby J, Roberts T, Lin Jordan CT, MacDonald JM. Bacterial foodborne disease: medical costs and productivity losses. *Agri Econ Report*. 1996;741:69-71.
25. Hypertension Prevention Collaborative Research Group. Effects of weight loss and sodium reduction intervention on blood pressure and hypertension incidence in overweight people with high-normal blood pressure. The Trials of Hypertension Prevention, phase II. *Arch Intern Med*. 1997;157:657-667.
26. Harsha DW, Lin PH, Obarzanek E, Karanja NM, Moore TJ, Caballero B. Dietary approaches to stop hypertension: a summary of study results. DASH Collaborative Research Group. *J Am Diet Assoc*. 1999;99:S35-S39.
27. Lloyd-Jones DM, Larson MG, Beiser A, Levy D. Lifetime risk of developing coronary heart disease. *Lancet*. 1999;353:89-92.
28. Hu FB, Rimm EB, Stampfer MJ, Ascherio A, Spiegelman D, Willett WC. Prospective study of major dietary patterns and risk of coronary heart disease in men. *Am J Clin Nutr*. 2000;72:912-921.
29. National Center for Health and Statistics Centers for Disease Control and Prevention. *Child and Infant Health*. Available at: http://www.cdc.gov/nchs/fastats/infant_health.htm. Accessed February 22, 2008.
30. Slattery ML. Diet, lifestyle, and colon cancer. *Semin Gastrointest Dis*. 2000;11:142-146.
31. American Cancer Society. *Cancer Facts and Figures 2001*. Available at: http://www.cancer.org/docroot/STT/content/STT_1x_2001_Facts_and_Figures.pdf.asp. Accessed February 22, 2008.
32. American Heart Association. 2002 Heart and Stroke Statistical Update. Dallas, TX: American Heart Association; 2001.
33. Hu FB, Manson JE, Stampfer MJ, et al. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *N Engl J Med*. 2001;345:790-797.
34. Centers for Disease Control and Prevention. National Diabetes Fact Sheet. Available at: http://www.cdc.gov/diabetes/pubs/estimates.htm#prev. Accessed February 22, 2008.
35. NHANESIII. NHANESIII: Prevalence of BMI, overweight and obesity: United States, 1960-1994. Available at: http://www.cdc.gov/nchs/data/nhanes/overweight.pdf. Accessed February 22, 2008.
36. Vasan RS, Beiser A, Seshadri S, et al. Residual lifetime risk for developing hypertension in middle-aged women and men: The Framingham Heart Study. *JAMA*. 2002;287:1003-1010.
37. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA*. 1999;282:1523-1529.
38. Cummings SR, Black DM, Rubi SM. Lifetime risks of hip, Colles', or vertebral fracture and coronary heart disease among white postmenopausal women. *Arch Intern Med*. 1989;149:2445-2448.
39. Seeman E, Hopper JL, Young NR, Formica C, Goss P, Tsalamandris C. Do genetic factors explain associations between muscle strength, lean mass, and bone density? A twin study. *Am J Physiol*. 1996;270:E320-E327.
40. Snow CM, Shaw JM, Matkin CC. Physical activity and risk for osteoporosis. In: Marcus R, Feldman D, Kelsey J, eds. *Osteoporosis*. San Diego, Calif: Academic Press, Inc.; 1996.
41. US Department of Agriculture, Department of Health and Human Services. *Nutrition and Your Health: Dietary Guidelines for Americans*. Washington, DC: US Department of Agriculture, Department of Health and Human Services; 2000.
42. Cox RH, Rajgopal R, Lewis EC, Lambur MT. *Manual for Conducting Cost-Benefit Analysis of EFNEP*. Blacksburg, Va: Virginia Cooperative Extension, Virginia Polytechnic Institute; 2000.
43. Weinstein MC, Siegel JE, Gold MR, Kamlet MS, Russell LB. Recommendations of the Panel on Cost-Effectiveness in Health and Medicine. *JAMA*. 1996;276:1253-1258.
44. Dickin KL. *The Work Context of Community Nutrition Educators: Relevance to Work Attitudes and Program Outcomes*. Ithaca, NY: Cornell University; 2003.
45. Plans-Rubio P. Cost-effectiveness of cardiovascular prevention programs in Spain. *Int J Technol Assess Health Care*. 1998;14:320-330.
46. National Center on Addiction and Substance Abuse at Columbia University. CSA national survey of American attitudes of substance abuse VI: Teens. Available at: http://www.casacolumbia.org/absolutenm/templates/ChairmanStatements.aspx?articleid=240&zoneid=31. Accessed February 22, 2008.
47. Gillman MW, Rifas-Shiman SL, Frazier AL, et al. Family dinner and diet quality among older children and adolescents. *Arch Fam Med*. 2000;9:235-240.
48. Taylor T, Serrano E, Anderson J. Management issues related to effectively implementing a nutrition education program using peer educators. *J Nutr Educ*. 2001;33:264-292.
49. Rohs FR, Langone CA, Coleman RK. Response shift bias: a problem in evaluating nutrition training using self-report measures. *J Nutr Educ*. 2001;33:165-170.
50. US Department of Health and Human Services. *Healthy People 2010: Understanding and Improving Health*. 2nd ed. Washington, DC: US Government Printing Office; 2000.
51. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Third Report of the National Cholesterol Education Program (NCEP) (Adult Treatment Panel III) Final Report. *Circulation*. 2002;106:3143-3421.
52. Lenfant C, Chobanian AV, Jones DW, Roccella EJ. Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7): Resetting the hypertension sails. *Hypertension*. 2003;41:1178-1179.
53. Schottenfeld D, Winawer SJ. Cancers of the large intestine. In: Schottenfeld D, Fraumeri JFJ, eds. *Cancer Epidemiology and Prevention*. 2nd ed. New York, NY: Oxford University Press; 1996;813-840.
54. Heaney RP. Nutrition and risk for osteoporosis. In: Marcus R, Feldman D, Kelsey J, eds. *Osteoporosis*. San Diego, Calif: Academic Press, Inc.; 1996;483-509.
55. Foreyt JP, Poston WS. Consensus view on the role of dietary fat and obesity. *Am J Med*. 2002;113:S60-S62.
56. Diabetes Prevention Research Group. The Diabetes Prevention Program (DPP) description of lifestyle intervention. *Diabetes Care*. 2002;25:2165-2171.
57. US Department of Agriculture, Food Safety and Inspection Service. Foodborne illness: what consumers need to know. Available at: http://www.fsis.usda.gov/Fact_Sheets/Foodborne_Illness_What_Consumers_Need_to_Know/index.asp. Accessed February 22, 2008.
58. American Dietetic Assocation. Position of the American Dietetic Association: nutrition and lifestyle for a healthy pregnancy outcome. *J Am Diet Assoc*. 2002;102:1479-1490.
59. Rodriguez-Martinez MA, Garcia-Cohen EC. Role of Ca(2+) and vitamin D in the prevention and treatment of osteoporosis. *Pharmacol Ther*. 2002;93:37-49.