Cost-Effectiveness of Lifestyle and Structured Exercise Interventions in Sedentary Adults

Results of Project *ACTIVE*

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Background: Project *ACTIVE* was a randomized clinical trial comparing two physical activity interventions, *lifestyle* and traditional *structured* exercise. The two interventions were evaluated and compared in terms of cost effectiveness and ability to enhance physical activity among sedentary adults.

Design: This was a randomized clinical trial.

Setting/ Participants: The study included 235 sedentary but healthy community-dwelling adults.

Intervention: A center-based *lifestyle* intervention that consisted of behavioral skills training was compared to a *structured* exercise intervention that included supervised, center-based exercise.

Main Outcome Measures: The main outcome measures of interest included cost, cardiorespiratory fitness, and physical activity.

Results: Both interventions were effective in increasing physical activity and fitness. At 6 months, the costs of the *lifestyle* and *structured* interventions were, respectively, $46.53 and $190.24 per participant per month. At 24 months these costs were $17.15 and $49.31 per participant per month. At both 6 months and 24 months, the *lifestyle* intervention was more cost-effective than the *structured* intervention for most outcomes measures.

Conclusions: A behaviorally-based *lifestyle* intervention approach in which participants are taught behavioral skills to increase their physical activity by integrating moderate-intensity physical activity into their daily lives is more cost-effective than a *structured* exercise program in improving physical activity and cardiorespiratory health. This study represents one of the first attempts to compare the efficiency of intervention alternatives for improving physical activity among healthy, sedentary adults.

Medical Subject Headings: (MeSH): economics, exercise, health promotions, physical fitness, primary prevention, randomized controlled trials (Am J Prev Med 2000;19(1):1–8)

Introduction

A sedentary lifestyle is common in the United States, with as many as 30.9% of Americans being completely physically inactive.[1] Clinicians have long recognized the relationship between inactivity and morbidity and mortality. Inactivity results in excessive rates of chronic disease, including cancer,[2] diabetes,[3,4] and cardiovascular disease.[5–7] A recent Surgeon General's report[8] concluded that Americans can substantially improve their health and quality of life by including moderate amounts of physical activity in their daily lives. The report further notes that, for those who are already physically active, additional benefits can be achieved by further increases in physical activity.

Health care costs consume a significant proportion of our nation's economic resources. Several authors conclude that engaging in promotion and prevention activities will not only improve the health of the nation, but will also reduce the cost and utilization of health care services.[9–13] However, despite all of the discussion regarding the importance of physical activity, research

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is limited regarding the economic efficiency of different approaches for enhancing health through increasing physical activity. The literature yielded only six reports regarding the cost-effectiveness of exercise interventions.[13–18] One of these is a design paper,[13] one is an observational study,[17] and three are reports of simulation-based analyses.[14–16] Only one study reports a cost-effectivesness analysis conducted in conjunction with a randomized clinical trial of an exercise intervention.[18] The purpose of this report is to compare the cost-effectiveness of two interventions for enhancing physical activity among sedentary adults that were tested within a clinical trial.

Methods

Design

Project *ACTIVE* was a randomized clinical trial designed to evaluate the effectiveness of two intervention approaches to promote change in physical activity and cardiorespiratory fitness among healthy, sedentary adults.[19] Participants were randomized to a *lifestyle* intervention that consisted of behavioral skills training, or to a *structured* intervention that included supervised, center-based exercise. Both interventions were based on Social-Cognitive Theory[20] and the Transtheoretical Model of Behavior Change.[21,22] Participant outcomes were evaluated at 6 months and 24 months, and included a variety of measures of physical activity, cardiorespiratory fitness, cardiovascular disease, and psychosocial outcomes. The baseline characteristics, design, interventions, and 6-month outcomes are more fully described elsewhere.[19,22,23] With this paper we present our findings regarding the cost-effectiveness of the *lifestyle* and *structured* interventions at 6 months and at 24 months. Both 6- and 24-month results are presented, as they illustrate the extent to which the ordering of the efficiency of the interventions remains constant over time (i.e., if maintenance of behaviors over time is markedly different between the interventions, what may be more cost-effective at 6 months may be less so at 24 months). This cost-effectiveness analysis is based on post hoc estimates of the value of time and resources required to deliver the interventions.

This analysis offers the perspective of a practicing clinician interested in the most efficient approach to maximizing the health of patients. However, the results may also be of interest to payers, who are coming under increasing pressure to maintain the health of their enrollees and, thus, reduce utilization of health care services.[a]

[a]Cost analysis can be undertaken from a variety of perspectives, including those of the patient, clinician, hospital, payer, or society. It is necessary to specify the perspective of the analysis because of potential conflicts between individual, institutional, and societal interests. For example, in comparing the efficiency of different medical interventions, a patient will be most interested in improvements in health while minimizing his or her out-of-pocket expenditures. A payer is interested in controlling unnecessary utilization, but will not be concerned with out-of-pocket expenditures on the part of patients. How cost and outcomes are defined, then, will be a function of who pays and for whom the outcomes of an intervention are most salient.

Sample

Patients living within a 10-mile radius of the Cooper Institute in Dallas, Texas, were recruited to the study. Starting in January 1994, study participants were recruited into three successive cohorts, staggered at 6-month intervals. A variety of techniques was used to recruit participants, including mass media (print, radio, television), word of mouth, and recontacting volunteers from previous studies. To ensure an appropriate ethnic balance, a Community Advisory Council was established to assist in the development of special procedures for recruiting African-American and Hispanic participants from local community centers and churches.

Criteria for recruitment were: (1) aged 35 years to 60 years, (2) >140% of ideal body weight, and (3) a baseline energy expenditure value of <36 kcal/kg/day for men or <34 kcal/kg/day for women. Participants were excluded from the study if they: (1) were pregnant or planning to become pregnant during the study period; (2) consumed ≥3 drinks containing alcohol each day; (3) planned to move from the Dallas area during the next 24 months; (4) had a history of myocardial infarction, stroke, insulin-dependent diabetes mellitus, osteoporosis, or osteoarthritis; (5) used prescription medications that could impair exercise performance or tolerance; or (6) had a resting systolic blood pressure >160 mmHg or resting diastolic blood pressure >100 mmHg. If deemed eligible, subjects were randomized to either the *structured* intervention arm, or the *lifestyle* intervention arm.

The ethnic composition was 73% non-Hispanic Caucasian, 14% African American, 12% Mexican American, and 1% other. The mean education level was 16 years, with 88% employed full-time, 6% employed part-time, 3% housewives, and 3% unemployed or retired. Baseline analyses showed the control and intervention groups to be comparable on clinical chemistries, fitness performance, and energy expenditure.[19]

Written consent was obtained from all participants in accordance with the policy statement regarding the use of human subjects and informed consent for the American College of Sports Medicine. The study protocol was approved annually by the Institutional Review Board of the Cooper Institute. Written informed consent was obtained from each participant before initiating testing procedures and again before randomization.

Intervention

Study participants were randomized to one of two intervention arms. Both interventions were delivered in an intensive phase lasting 6 months. After 6 months, participants entered an 18-month tapered maintenance phase.

In the *lifestyle* intervention, participants were taught behavioral skills to increase their physical activity by integrating moderate-intensity physical activity into their daily lives. The *lifestyle* approach integrated behavior modification and cognitive-behavior modification techniques for behavior change, tailored to the participant's level of motivational readiness for change.[24] During the initial 6-month intensive phase, the *lifestyle* intervention was delivered in weekly small group meetings for weeks 1 through 16, and then biweekly for weeks 17 through 24. During these meetings, facilitators worked with participants on problem-solving and self-management skills. During the subsequent 18-month tapered phase, *lifestyle*

participants continued to meet regularly. For months 7 through 12, participants met monthly, every other month for months 13 through 18, and quarterly for months 19 through 24. During the tapered phase, *lifestyle* participants received a quarterly newsletter and a monthly calendar of activities.

In the *structured* intervention arm, participants received a typical exercise prescription as described by the American College of Sports Medicine,[25] involving an exercise intensity of 50%–85% of maximal aerobic power and exercise of 20 to 60 minutes duration at each session. During the first 6 months of the intervention, participants exercised at a state-of-the-art fitness facility, under the supervision of a health educator. Participants used a computer-based exercise logging system to record physical activities done during each session. At the end of the active phase, participants met with a staff person to review briefly plans for continued exercise. They were provided with a referral list of local fitness facilities, and were offered the opportunity to become a member of the Cooper Fitness Center. They were told that project staff would be available by telephone or appointment to answer any questions they might have with regard to their physical activity, and were given motivational readiness manuals, as described below. During the subsequent 18-month tapered phase, participants were invited to participate in quarterly activities. *Structured* group members also received a quarterly newsletter and a monthly calendar of activities.

Measures

Clinical outcome measures. All 235 participants who were successfully randomized returned for the 6-month assessment, and 190 returned for the 24-month assessment. We determined the incremental cost-effectiveness of each approach using a variety of outcome variables, including: (1) changes in energy expenditure from physical activity using the 7-day Physical Activity Recall or PAR[26]; (2) self-reports of time (hours per week) spent sitting, the number of flights of stairs climbed per day, and number of minutes walked per day; (3) peak VO_2 (mL/kg/min); (4) total treadmill time; (5) heart rate at a specified submaximal stage of the Bruce protocol graded exercise test[27]; (5) systolic and diastolic blood pressure; and (6) weight. The denominator of the cost-effectiveness ratios for each intervention group was the average change from baseline measures of these variables to 6 months, and also 24 months, adjusted for baseline values and other characteristics of the study participants. Variables selected for adjustment were chosen a priori. Numerous studies have shown these variables to influence cardiorespiratory fitness and physical activity.

Costs. The value of each cost component appears in Table 1 (6 months) and Table 2 (24 months). Research costs (such as laboratory evaluations and cardiovascular testing) and the value of the participants' time were not included in the analysis. Recruitment costs are also not included. Costs were discounted annually at a rate of 5%.

Personnel costs. Personnel costs were estimated by multiplying the amount of time dedicated to the intervention activities by an hourly wage and fringe rate. In selecting the professional disciplines to deliver the different interventions we matched the content of the intervention to the skills and training of the interventionists. For each of the three consecutive cohorts, the health educator involved with the *structured* intervention group was available 6 hours per day, 5 days per week for 6 months. The health educator supervised the activities of subjects during the intensive phase of the intervention. Before transition to the tapered maintenance phase, the health educator met with each participant for approximately 10 minutes to discuss plans for continuing his or her exercise over the remaining 18 months of the study period.

Three professionals experienced in the field of health promotion (an exercise psychologist, a clinical psychologist, and a nutritionist—the design team) collaborated on the development of the curriculum for the classes for the *lifestyle* intervention. Two of these individuals (the exercise psychologist and the nutritionist) along with a health educator (the delivery team), in consultation with the clinical psychologist, conducted the *lifestyle* classes. The intervention was delivered to each cohort during the intensive phase, in 20 one-hour classes. Eleven one-hour classes were delivered in the tapered phase. Responsibility for class preparation was rotated

Table 1. Components of the 6-month cost estimate by intervention arm

	Lifestyle	Structured
Intervention staff time		
Health educator		
Supervision in-center exercise	$ —	$ 36,235.44
Preparation for classes (cohort 1)	2,729.60	
Preparation for classes (cohorts 2 and 3)	589.79	
Classroom instruction	671.03	
Preparation of mail reminders	754.91	
Nutritionist		
Development of class content (cohort 1)	3,731.20	
Preparation for classes (cohorts 2 and 3)	806.21	
Classroom instruction	917.25	
Exercise psychologist		
Development of class content (cohort 1)	3,572.80	
Preparation for classes (cohorts 2 and 3)	771.98	
Classroom instruction	878.31	
Staff supervision	1,469.57	1,384.55
Clinical psychologist		
Development of class content (cohort 1)	1,488.60	
Monitor content delivery (cohort 1)	1,488.60	
Monitor content delivery (cohort 2)	496.20	
Monitor content delivery (cohort 3)	235.70	
Computerized tracking system		1,002.08
Curriculum materials		
Motivational readiness manuals	1,338.26	1,260.84
Lifestyle manual	847.00	
Digi-walkers	2,420.00	
Printing and postage		
Mail reminders	2,712.82	
General supplies	442.50	
Facilities	5,416.20	
Health club memberships		90,240.50
Total cost	33,778.53	130,123.41
Average cost per participant per month	46.53	190.24

Table 2. Components of the total 24-month cost estimate by intervention arm

	Lifestyle	Structured
Intervention staff time		
Health educator		
Supervision in-center exercise	$ —	$ 36,235.44
Preparation for classes (cohort 1)	2,729.60	
Preparation for classes (cohorts 2 and 3)	589.79	
Classroom instruction	671.03	
Preparation of mail reminders	754.91	
Nutritionist		
Development of class content (cohort 1)	3,731.20	
Preparation for classes (cohorts 2 and 3)	806.21	
Classroom instruction	917.25	
Exercise psychologist		
Development of class content (cohort 1)	5,493.26	
Preparation for classes (cohorts 2 and 3)	1,180.49	
Classroom instruction	1,344.57	
Staff supervision	5,805.75	5,469.74
Clinical psychologist		
Development of class content (cohort 1)	2,288.76	
Monitor content delivery (cohort 1)	2,288.76	
Monitor content delivery (cohort 2)	753.08	
Monitor content delivery (cohort 3)	362.39	
Computerized tracking system		1,704.15
Curriculum materials		
Motivational readiness manuals	1,338.26	1,260.84
Lifestyle manual	847.00	
Digi-walkers	2,420.00	
Printing and postage		
Mail reminders	4,152.93	
General supplies	855.75	
Facilities	10,474.38	
Health club memberships		90,240.50
Total cost	49,805.37	134,910.67
Average cost per participant per month	17.15	49.31

through the delivery team, with two interventionists assigned to each class. Staff estimate that, for the first cohort, each of the 31 classes required 8 hours on the part of the exercise psychologist and the nutritionist, and an additional 1.5 hours for the clinical psychologist to develop the class content. The clinical psychologist spent an additional 1.5 hours per class listening to audio tapes of the actual *lifestyle* sessions involving the first cohort of participants to provide feedback to the interventionist delivery team. For the first cohort, the health educator required approximately 8 hours to prepare for the classes. For the second and third cohorts, the intervention team estimates that approximately 80 minutes were required of each interventionist to prepare for each class. Additionally, the clinical psychologist provided 30 minutes of consultation for each class delivered to cohort 2, and 15 minutes of consultation per class for the duration of intervention activities with cohort 3. Before each *lifestyle* class, the health educator called all participants to remind them about the meeting. Those who did not attend received mailed notes summarizing the missed meeting. The reminders and follow-up required approximately 45 minutes of the health educator's time for each class.

For both intervention groups, we also estimated 10% effort on the part of the exercise psychologist in administrative oversight of the study staff related to the delivery of the intervention to study participants in both arms of the study (i.e., not related to data collection or other research activities). For this analysis, the value of her time was divided between *lifestyle* and *structured* groups, proportionate to the number of subjects in each arm.

The total value of personnel time was calculated as the product of the hourly rate (with a 29% fringe) and the total hours required to deliver the intervention. The hourly wage plus fringe rate for the health educator was $17.06. The hourly wage plus fringe rate for the nutritionist was $23.32. The hourly wage plus fringe rate for the exercise psychologist was $22.33, and for the consulting clinical psychologist the hourly wage plus fringe was $49.62.

Computerized tracking system. A computerized tracking system, e-log, was used by participants in the *structured* exercise intervention. E-log is a DOS-based computer program that allows individuals to track their daily workouts and personal progress. E-log currently sells for about $300, which we treat as a variable, start-up cost of the program. We estimate the cost of a personal computer to be $2000 (consistent with the cost of computer equipment at the time the study began). We treated the computer as a one-time, capital expenditure, and annuitized the value of this item using the method described by Shaffer and Haddix.[28] Over the 3-year period during which the study was conducted, the annuitized value of the computer was $1404.15.[b]

Curriculum materials. Subjects in the *lifestyle* intervention received a manual containing curriculum materials. The cost of color printing, a binder, and tabs to separate content by units was approximately $7 per participant. *Lifestyle* participants also received step counters, which provided feedback to them regarding their physical activity during the day. The cost of these step counters was $20 per participant.

Subjects in both interventions received five booklets describing the stages of motivational readiness, and strategies for moving forward in establishing and meeting exercise goals. The cost of printing and binding these booklets was $11.06 per participant.

Printing and postage. As previously noted, *lifestyle* participants in all three cohorts received a mailed reminder notice before each of the classes which they were scheduled to

[b]

$$C = \left[P - S \frac{1}{(1+r)^t} \right] [A(t, r)]^{-1}$$

$$A(t, r) = \left[1 - \frac{1}{(1+r)^t} \right] r^{-1}$$

where:

C = calculated equivalent annual cost of the computer
P = cost of purchasing the computer
S = discounted value of the computer after t years of useful service
r = discount rate of 5%
t = useful life of the computer, estimated to be 4 years
A (t,r) = annuity factor

attend. Printing and postage costs for these were $0.38 per participant per class. General office supplies cost an estimated $25 per month for the 36 months of the study.

Facilities. The facility costs for the *lifestyle* intervention include: (1) the depreciated value for class and office space, the value of which is estimated at $76 per month; (2) facility maintenance estimated at $45 per month; (3) utilities, estimated to be $85 per month; and (4) base telephone and long-distance telephone calls for three staff, estimated at $100 per month.

Health club membership fees. The value of the health care facility space used for the three consecutive cohorts of participants in the *structured* intervention is estimated from the cost of membership at the Cooper Institute Fitness Center for the 6-month period (or a $295 initiation fee plus a maintenance membership fee of $85 per month). At the conclusion of the 6-month intensive phase, participants were given the option of remaining at the Cooper Institute at their own expense. They were also provided with information regarding other local health club facilities in the area. However, this analysis does not take into consideration any out-of-pocket expenditures incurred by study participants.

Analysis

Analysis of covariance was used to compare the *lifestyle* and *structured* intervention groups' changes in physical activity and cardiorespiratory fitness at 6 months and 24 months. Several cost-effectiveness ratios were computed. Ratios of average dollars spent per average incremental improvement in outcome achieved were calculated for each outcome variable specified in the Measures section. The average cost of each intervention arm was calculated as the sum of the intervention cost components divided by the number of participants in the intervention arm. Incremental improvement is defined as the mean change score from baseline for each group, adjusted for baseline values of the outcome measure and other participant characteristics. Sensitivity analyses were conducted, assuming a lower health club membership cost and assuming an established program (i.e., eliminating start-up costs).

Results

The impact of the interventions on activity level and cardiorespiratory fitness are discussed in more detail elsewhere.[22–23] In summary, both *lifestyle* and *structured* intervention participants had significant and comparable improvements in physical activity and cardiorespiratory fitness from baseline to 24 months. The investigators found that, in previously sedentary healthy adults, a lifestyle physical activity intervention is as effective as a structured exercise program in improving physical activity, cardiorespiratory fitness, and blood pressure.[23]

Table 1 and Table 2 show the cost components, total cost, and average per participant cost for each intervention arm, for 6 months and 24 months, respectively. Ratios are reported in terms of the cost per month of participation in the study, **not** per month of operation of the program. The total cost of the *lifestyle* intervention at 6 months was $33,778.53, or $46.53 per participant per month. The *structured* intervention at 6 months was significantly more expensive, totaling $130,123.41 or $190.24 per participant per month. Similarly, the total cost of the *lifestyle* intervention at 24 months was $49,805.37 or $17.15 per participant per month. The *structured* intervention at 24 months was significantly more expensive, totaling $134,910.67 or $49.31 per participant per month.

Table 3 provides the average incremental cost per incremental unit of improvement, at 6 months and 24 months respectively, in the outcome variables considered within this study. The analyses demonstrate that, given the cost definitions outlined in the Measures section, at 6 months and 24 months, the *lifestyle* intervention is not only comparable to the *structured* intervention in improving physical activity and fitness, but also the *lifestyle* intervention is clearly more cost-effective.

Sensitivity analyses were conducted around a variety of the underlying cost assumptions. The results of these are presented in Table 4. First, the comparative cost-effectiveness of the two arms may be influenced by the fact that much effort was devoted to program and curriculum development activities for the *lifestyle* intervention. Thus, we reassessed the cost-effectiveness of the two arms assuming an established curriculum. Under this assumption, the hours devoted to content development with the first cohort would be reduced to the same amount of time required to prepare for the classes delivered to the second and third cohorts. The input of the clinical psychologist would be reduced to approximately 15 minutes of consultation per class. Under these assumptions, the total cost of the intervention at 6 months would be reduced to $21,880.31 or $30.14 per *lifestyle* participant per month. At 24 months, the total cost of this intervention would be $36,968.22, or $12.73 per participant per month. Under the assumption of an established program, the *lifestyle* intervention was more cost-effective for all outcomes at 6 months. With the exception of reducing the number of hours the participants spent sitting, the *lifestyle* intervention was also more cost-effective for all outcomes at 24 months.

Second, the comparative cost-effectiveness of the two intervention arms is heavily influenced by the 6-month health club membership fee; therefore a sensitivity analysis was conducted around this variable. We varied the membership fee, using the median value of the range of fees obtained from other health clubs in the same geographic area. These included the local YMCA, which has an initiation fee of $100 and a maintenance fee of $39 per month, or $56 per month for the first 6-month period. Larry North, another health facility in the location, costs $50 per month with no initiation fee.

Table 3. Average incremental cost per average unit of improvement at 6 and 24 months by intervention arm for the primary outcome variables of physical activity and cardiorespiratory fitness

Outcome variable	6 month Lifestyle @ $46.53 per mo.	6 month Structured @ $190.24 per mo.	24 month Lifesetyle @ $17.15 per mo.	24 month Structured @ $49.31 per mo.
Energy expenditure[a] (kcal/kg/day)	1.53	1.34	0.84	0.69
$ per mo. per add'l kcal/kg expended per day	$ 30**	$142	$ 20	$ 71
Moderate activity[a] (kcal/kg/day)	1.60	0.88	0.93	0.33
$ per mo. per add'l kcal/kg expended per day	$ 29	$216	$ 18	$149
Hard activity[a] (kcal/kg/day)	0.47	0.74	0.40	0.80
$ per mo. per add'l kcal/kg expended per day	$ 99	$257	$ 43	$ 62
Sitting[a] (hours/week) time	5.27	6.88	1.18	6.85
$ per mo. per hour reduction in sitting time per week	$ 9	$ 28	$ 15	$ 7
Walking[a] (minutes/day)	19.80	16.52	13.07	26.75
$ per mo. per add'l minute walked each day	$ 2	$ 12	$ 1	$ 2
Stair climbing[a] (flights/day)	2.15	1.01	2.56	2.29
$ per mo. per add'l flight of stairs climbed per day	$ 22	$188	$ 7	$ 22
VO_{2peak}[a] (ml/kg/min)	1.58	3.64	0.77	1.34
$ per mo. per add'l ml/kg/min increase in VO_{2peak}	$ 29	$ 52	$ 22	$ 37
Treadmill time[a] (min)	0.46	0.92	0.23	0.37
$ per mo. per add'l minute on the treadmill	$101	$207	$ 75	$133
Submaximal heart[a] rate (beats/min)	4.75	10.22	2.62	4.88
$ per mo. per add'l beat/minute reduction in heart rate	$ 10	$ 19	$ 7	$ 10
Systolic blood pressure[a] (mmHg)	3.2	1.8	3.63	3.26
$ per mo. per add'l mmHg reduction in systolic blood pressure	$ 15	$106	$ 5	$ 15
Diastolic blood pressure[b] (mmHg)	2.2	2.2	5.38	5.14
$ per mo. per add'l mmHg reduction in diastolic blood pressure	$ 21	$ 86	$ 3	$ 10
Weight[c] (kg)	0.6	1.3	0.05	−0.69
$ per month per add'l kg of weight lost (gained)	$ 78	$146	$343	($71)

[a]mean change scores adjusted for baseline values, cohort, and sociodemographics
[b]mean change score adjusted for baseline values, age, gender, BMI, and smoking status
[c]mean change score adjusted for baseline values, age, gender, and smoking status
**incremental cost per each unit of measure gained (or lost) as a result of the intervention
mo., month; add'l, additional.

Bally's costs $45 per month with no initiation fee. The cost-effectiveness of the *structured* approach for each outcome variable was determined using the value of $50/month, which reduced the total *structured* intervention costs at six months to $73,512.91 or $107.48 per participant per month. At 24 months, the total cost of this intervention would be $78,300.17, or $28.62 per participant per month. Under the assumption of a less expensive health club membership, the *lifestyle* intervention was more cost-effective for all outcomes at 6 months. At 24 months, the *lifestyle* intervention remained more cost-effective for the majority of variables. However, the *structured* intervention was more efficient in producing the outcomes of: (1) increased vigorous activity, (2) reduced time spent sitting, (3) reducing submaximal heart rate, and (4) increasing peak VO_2.

Discussion

With few exceptions, the data demonstrate that, at 6 months and 24 months, the *lifestyle* intervention is more economically efficient in achieving improvements for the outcome variables examined within this trial. Although reducing the assumed cost of health club memberships resulted in a reversal of the rankings in a few variables, the magnitude of the differences was generally very small.

The results of the study demonstrate that *lifestyle* physical activity counseling is as effective as the *structured* exercise program, and that the *lifestyle* approach is generally more economically efficient in achieving the desired increases in physical activity and cardiorespiratory fitness among healthy sedentary adults. Further efficiency in the *lifestyle* intervention may be realized by substituting master's or doctorally-prepared interventionists with highly trained bachelor's-level health educators. The value of computer hardware is likely to be lower in today's dollars. However, lowering hardware costs to current values would not alter the findings of this report. Assuming that future comparable programs are replicated in settings comparable to the study site, aside from reducing the health club membership fees, opportunities for increasing efficiency in the *structured* intervention are limited. However, if exercise programs

Table 4. Sensitivity analyses regarding 6 and 24 month cost-effectiveness ratios, assuming an established lifestyle curriculum and an alternative health club facility membership fee for structured program participants

Outcome variable	6 month Lifestyle @ $30.14 per mo.	6 month Structured @ $107.48 per mo.	24 month Lifestyle @ $12.73 per mo.	24 month Structured @ $28.62 per mo.
Energy expenditure[a] (kcal/kg/day)	1.53	1.34	0.84	0.69
$ per mo. per add'l kcal/kg expended per day	$20**	$ 80	$ 15	$ 41
Moderate activity[a] (kcal/kg/day)	1.60	0.88	0.93	0.33
$ per mo. per add'l kcal/kg expended per day	$19	$122	$ 14	$ 87
Hard activity[a] (kcal/kg/day)	0.47	0.74	0.40	0.80
$ per mo. per add'l kcal/kg expended per day	$64	$145	$ 32	$ 36
Sitting[a] (hours/week) time	5.27	6.88	1.18	6.85
$ per mo. per hour reduction in sitting time per week	$ 6	$ 16	$ 11	$ 4
Walking[a] (minutes/day)	19.80	16.52	13.07	26.75
$ per mo. per add'l minute walked each day	$ 2	$ 7	$ 1	$ 1
Stair climbing[a] (flights/day)	2.15	1.01	2.56	2.29
$ per mo. per add'l flight of stairs climbed per day	$14	$106	$ 5	$ 12
VO_{2peak}[a] (ml/kg/min)	1.58	3.64	0.77	1.34
$ per mo. per add'l ml/kg/min increase in VO_{2peak}	$19	$ 30	$ 17	$ 21
Treadmill time[a] (min)	0.46	0.92	0.23	0.37
$ per mo. per add'l minute on the treadmill	$66	$117	$ 55	$ 77
Submaximal heart[a] rate (beats/min)	4.75	10.22	2.62	4.88
$ per mo. per add'l beat/minute reduction in heart rate	$ 6	$ 11	$ 5	$ 6
Systolic blood pressure[b] (mmHg)	3.2	1.8	3.63	3.26
$ per mo. per add'l mmHg reduction in systolic blood pressure	$ 9	$ 60	$ 4	$ 9
Diastolic blood pressure[b] (mmHg)	2.2	2.2	5.38	5.14
$ per mo. per add'l mmHg reduction in diastolic blood pressure	$14	$ 49	$ 2	$ 6
Weight[c] (kg)	0.6	1.3	0.05	−0.69
$ per month per add'l kg of weight lost (gained)	$50	$ 83	$255	($41)

[a] mean change scores adjusted for baseline values, cohort, and sociodemographics
[b]mean change score adjusted for baseline values, age, gender, BMI, and smoking status
[c]mean change score adjusted for baseline values, age, gender, and smoking status
**incremental cost per each unit of measure gained (or lost) as a result of the intervention
mo., month; add'l, additional.

were to be incorporated into an HMO setting, HMO subsidization could result in significant cost savings for one or both interventions.

The reader is cautioned to keep in mind that the results reported here do not address reductions in morbidity over the life of the subjects. Reduced morbidity and a consequent reduction in health care expenses in the *structured* intervention could offset additional costs incurred during the intervention period. Limitations in generalizability beyond similar settings/populations must also be considered. It is also important to consider regional variations in the cost of space. Finally, the reader should consider the fact that this cost analysis is based on post hoc estimates of the value of time and resources required to deliver the interventions and, thus, may be subject to error that would not have occurred had such data been gathered concurrently with the conduct of the study.

Our cost-effectiveness analysis cannot answer the question of whether investment in physical activity interventions is a wise use of health care dollars. The evidence for such a statement needs to come from either cost-benefit analyses or league tables comparing cost-effectiveness ratios for all other preventive interventions that have become standard practice. A cost benefit analyses would require valuing all inputs and outcomes in economic terms, and determining if a net benefit is realized. The method for assigning dollar values to physical activity and cardiovascular health outcomes is not clear and, thus, we can make no statements regarding net economic benefits to society from participation in either physical activity intervention. Comparison of cost-effectiveness ratios in league tables would require that the perspective of the study, definition of costs, duration of intervention, duration of measurement, and the outcomes measured be comparable among all studies. This clearly is not the case in the current prevention literature. All that can be determined from the current study is the comparative ranking in efficiency of intervention approaches in producing the study outcomes. Additional research is needed to answer questions regarding the efficiency of physical activity interventions relative to other preventive measures typically employed in primary care settings.

According to the recent Surgeon General's report on physical activity and health,[8] promoting a more active

lifestyle is of great importance to the health of the nation. Determining the most clinically effective and cost-effective approach to increasing activity among sedentary individuals is necessary for developing a comprehensive national initiative for better health through physical activity. This study represents one of the first attempts to assess the efficiency of intervention alternatives for achieving those ends.

Conclusion

A behaviorally-based *lifestyle* intervention approach in which participants are taught behavioral skills to increase their physical activity by integrating moderate intensity physical activity into their daily lives is generally more cost-effective than a *structured* exercise program in improving physical activity and cardiorespiratory health.

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