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Increasing Physical Activity in Patients With Asthma Through Positive Affect and Self-affirmation

A Randomized Trial

Carol A. Mancuso, MD; Tiffany N. Choi, RN; Heidi Westermann, MPH; Suzanne Wenderoth, MD; James P. Hollenberg, MD; Martin T. Wells, PhD; Alice M. Isen, PhD; Jared B. Jobe, PhD; John P. Allegrante, PhD; Mary E. Charlson, MD

Background: Patients with asthma engage in less physical activity than peers without asthma. Protocols are needed to prudently increase physical activity in asthma patients. We evaluated whether an educational intervention enhanced with positive-affect induction and self-affirmation was more effective than the educational protocol alone in increasing physical activity in asthma patients.

Methods: We conducted a randomized trial in New York City from September 28, 2004, through July 5, 2007; of 258 asthma patients, 252 completed the trial. At enrollment, control subjects completed a survey measuring energy expenditure, made a contract to increase physical activity, received a pedometer and an asthma workbook, and then underwent bimonthly follow-up telephone calls. Intervention patients received this protocol plus small gifts and instructions in fostering positive affect and self-affirmation. The main outcome was the within-patient change in energy expenditure in kilocalories per week from enrollment to 12 months with an intent-to-treat analysis.

Results: Mean (SD) energy expenditure at enrollment was 1767 (1686) kcal/wk among controls and 1860 (1633) kcal/wk among intervention patients ($P=.65$) and increased by 415 (95% CI, 76-754; $P=.02$) and 398 (95% CI, 145-652; $P=.002$) kcal/wk, respectively, with no difference between groups ($P=.94$). For both groups, energy expenditure was sustained through 12 months. No adverse events were attributed to the trial. In multivariate analysis, increased energy expenditure was associated with less social support, decreased depressive symptoms, more follow-up calls, use of the pedometer, fulfillment of the contract, and the intervention among patients who required urgent asthma care (all $P<.10$, 2-sided test).

Conclusions: A multiple-component protocol was effective in increasing physical activity in asthma patients, but an intervention to increase positive affect and self-affirmation was not effective within this protocol. The intervention may have had some benefit, however, in the subgroup of patients who required urgent asthma care during the trial.

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PATIENTS WITH ASTHMA ENgage in less physical activity than age-matched peers, thereby increasing risks for cardiovascular and other diseases.[1] Although most asthma patients have some exercise-induced bronchospasm,[2] participation in prudent exercise is recommended by the National Asthma Expert Panel.[3] Fortunately, there is now evidence that lifestyle activity such as daily walking can be effective.[4,5]

Increasing daily physical activity, however, requires conscious behavior change.[6] According to well-established psychosocial models, behavior change occurs by increasing knowledge of why the change is worthwhile,[7] by making a contract to do the behavior,[8] and by having social support that facilitates the behavior.[6,9] Another component is increasing confidence, or self-efficacy, by acknowledging prior successes and having physiological feedback showing that the behavior is effective.[7,9]

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Novel psychological techniques that may foster behavior change are increasing positive affect and self-affirmation. Inducing positive affect, such as from thinking up-

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lifting thoughts, increases connections between effort and outcome and increases persistence.[10,11] Reaffirmation by recalling proud achievements strengthens core values.[12] Thus, it is hypothesized that positive affect and self-affirmation foster adaptability and willingness to accept behavior change.[13,14]

The primary goal of this trial was to increase walking and exercise in asthma patients in the course of 12 months. Patients randomized to the control group received a multiple-component educational protocol consisting of making a contract to participate in a specific physical activity, increasing knowledge of exercise and asthma, and increasing self-efficacy through physiological feedback from a pedometer. Patients randomized to the intervention group received these same maneuvers plus were taught techniques to increase positive affect and self-affirmation.

METHODS

This study was approved by the institutional review board at the Weill Cornell Medical College–New York Presbyterian Hospital, and patients provided written informed consent. This trial was in response to an initiative from the National Heart, Lung, and Blood Institute to translate novel behavioral research to improve health behaviors in patients with cardiopulmonary disease and was conducted simultaneously with 2 other trials with patients with hypertension and coronary artery disease. All trials used the same protocols; detailed methods have been described previously.[15] In summary, for the asthma trial, adult primary care patients in New York City underwent screening by reviewing appointment schedules and medical records. Patients were eligible if they were at least 18 years of age, had mild to moderate persistent asthma, and spoke English. Patients were excluded if they had a severe or mobility-limiting comorbidity such as a musculoskeletal deficit precluding increased physical activity. At enrollment, patients completed standard questionnaires measuring asthma severity[16] and control,[17] use of asthma medications, knowledge of asthma self-management,[18] and asthma-related quality of life.[19] A portable spirometer was used to measure pulmonary function. Additional questionnaires were used to assess positive and negative affect,[20] depressive symptoms,[21] stress,[22] and social support.[23] Physical activity was measured with the well-established Paffenbarger Physical Activity and Exercise Index (hereinafter referred to as the Paffenbarger Index) measuring the following 3 domains of activity: number of blocks walked daily, number of flights of stairs climbed daily, and exercise/sports participation during the past week.[24] Physical activity was then converted into energy expenditure in kilocalories per week (to convert energy expenditure to kilojoules, multiply by 4.186) using a standard compendium of metabolic equivalents.[25]

Patients received a pedometer calibrated for weight and stride length. They practiced using the pedometer by walking up and down a corridor and then reported the number of steps recorded by their pedometer.[26] Patients were encouraged to wear the pedometer during the trial and record their numbers of steps.

Patients then were randomized to the control or the intervention group. We did not include a traditional control group because usual care has been shown to be ineffective in promoting and sustaining increased physical activity.[27-32] In the present trial, control subjects received a composite of several behavioral maneuvers that have been shown to improve diverse health behaviors such as physical activity and chronic disease self-management.[31,33] First, patients received a pedometer to provide physiological feedback. Second, they received an educational asthma workbook that we reviewed with them with emphasis on sections about physical activity and self-management.[34-36] Third, patients volunteered for an activity and signed a contract specifying how often and how much they would do. Walking was encouraged, and contracts were approved by patients' physicians. Patients rated their self-efficacy for fulfilling the contract.

Intervention patients received these maneuvers plus additional positive-affect and self-affirmation components. To foster positive affect, patients were asked what things made them feel uplifted just by thinking about them, such as a beautiful sunset, and they were encouraged to think of these things throughout the day. To increase self-affirmation, patients were asked what things they were proud of, such as completing a challenging work assignment, and they were encouraged to think of these achievements when fulfilling the contract. Intervention patients also were given a supplement to the workbook summarizing these techniques. At each follow-up, patients were asked how well they applied these techniques. Intervention patients also were mailed small gifts (eg, an umbrella and a desk clock) every 2 months to increase positive affect.[37]

During the subsequent year, all patients were telephoned every 2 months to complete the Paffenbarger Index and to report current self-efficacy for the activity, asthma status, pedometer readings, and how well they fulfilled their contract. During these follow-up calls, patients were encouraged to continue the activity, pedometer, and workbook and were asked whether they required any interval asthma care or hospitalizations or had any serious adverse events.

For both groups, closeout was the 12-month telephone contact, when patients again completed questionnaires about physical activity, asthma status, and psychosocial well-being and were asked global questions about using the pedometer and the workbook.

The primary outcome was the within-patient change in total energy expenditure from enrollment to 12 months measured in kilocalories per week using the Paffenbarger Index. A secondary outcome was the pattern of energy expenditure measured at each bimonthly follow-up call. We hypothesized that intervention patients would increase total energy expenditure more than controls.

The sample size was based on the primary outcome. According to prior longitudinal studies, SDs for weekly energy expenditure ranged from 200 to 350 kcal/wk,[38] and an increase in walking 6 or more blocks daily (approximately 336 kcal/wk) corresponds to decreased cardiovascular risk.[39] Conservatively using an SD of 450 kcal/wk, a goal to detect a difference between groups of 250 kcal/wk (approximately 4 blocks daily), an α value of .05, and a power of 90%, we required 68 patients per group. Based on prior studies showing that 73% to 90% of patients enrolled in physical activity trials maintained some increased activity at 3 to 6 months, we estimated that 80% would still be involved in the activity at 12 months.[27,28] We also considered a possible rate of loss to follow-up of 15%. Thus, 123 patients were required per group (246 in total).

Randomization was performed in permuted blocks by the study statistician (M.T.W.) and was concealed and verified at the trial conclusion. Patients were not blinded to the randomization group, and study personnel administering the enrollment, follow-up, and closeout interviews were not blinded. Spot checks were performed throughout the trial to ensure uniformity in enrollment and follow-up protocols.

The primary analysis was a multivariate linear regression model including variables moderately associated with the primary outcome in bivariate analyses and controlled for age, sex, and asthma control and severity. The variables that minimized the Akaike information criterion, which adjusts for overfitting, were retained in the final model.[40] An intent-to-treat analysis was used for patients without the closeout by carrying forward their last energy expenditure value. Few patients had missing closeout values, and

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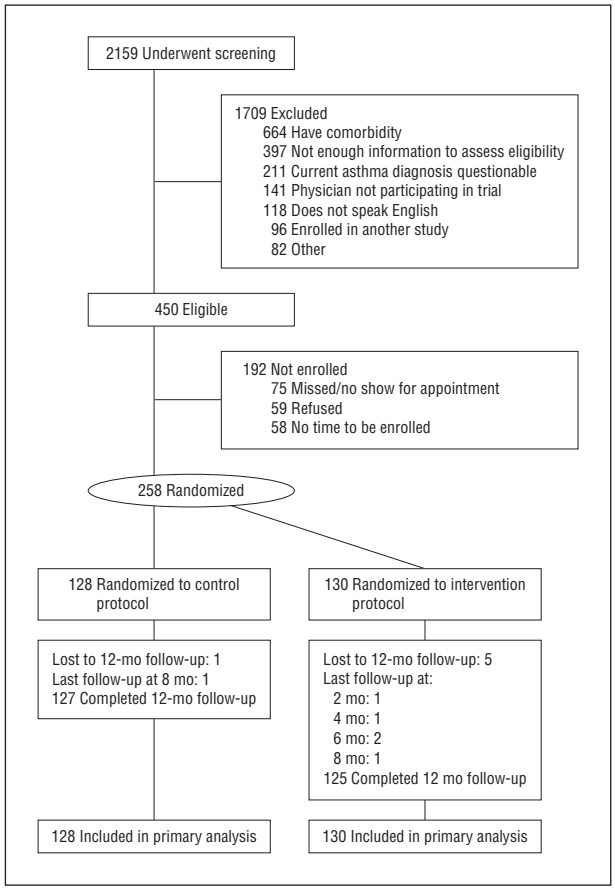

Figure 1. Flow diagram of study participants.

other imputation methods gave the same results. Secondary analyses assessed repeated measurement of energy expenditure every 2 months with a mixed-effects model with the energy expenditure value from each follow-up call as the dependent variable. Each patient constituted a random factor, and time from enrollment was a fixed-time variable. We also assessed values longitudinally at each follow-up with a linear mixed model using a flexible spline-based time component to discern the physical activity pattern over time. Analyses were performed using SAS software, version 5.[41]

RESULTS

Two hundred fifty-eight patients were enrolled from September 28, 2004, through July 5, 2007 (16 men were enrolled in addition to the projected sample size to match the percentage of men with asthma in this practice). Of these, 252 patients (97.7%) completed the 12-month closeout, and each of the remaining 6 patients had at least 1 follow-up (**Figure 1**). At enrollment, controls (n=128) and intervention patients (n=130) were comparable regarding demographic and clinical characteristics (**Table 1**). Similar percentages reported a history of exercise-related respiratory symptoms (53.9% and 55.4%; $P=.81$). For most controls (68.8%) and intervention patients (59.2%; $P=.11$) the activity contract was to walk several more blocks several times per week. Mean (SD) self-efficacy for fulfilling the contract was 8.2 (1.8) and 8.4 (1.7) ($P=.47$), respectively, on a scale of 0 (no confidence) to 10 (most confidence).

Table 1. Characteristics at Enrollment[a]

Variable	Control Group (n=128)	Intervention Group (n=130)	*P* Value
Age, mean (SD), y	42 (12)	42 (12)	.78
Women	73.4	76.2	.62
College graduates	60.2	62.3	.72
Never married	49.2	43.9	.39
Race[b]			
White	52.3	56.2	.84
African American	24.2	19.2	
Other	23.5	24.6	
Latino[b]	30.5	32.3	.75
Body mass index[c]			.51
Mean (SD)	30 (8)	29 (7)	
<25 (Normal weight)	32.8	30.0	.87
25 to <30 (Overweight)	25.0	32.3	
≥30 (Obese)	42.2	37.7	
Asthma duration, mean (SD), y	23 (14)	21 (15)	.14
Forced expiratory volume in 1 s, mean (SD)	88 (18)	92 (18)	.06
Current asthma medications			
None	4.7	6.2	.60
Inhaled β-agonist only	46.1	38.5	.22
Inhaled corticosteroid	45.3	48.5	.61
Leukotriene modifier	14.8	16.2	.77
Other[d]	2.3	4.6	.32
Long-term asthma severity[e]			.55
Mean (SD)	6 (5)	6 (4)	
<5	46.1	43.9	.42
5 to 9	32.8	42.3	
10 to 13	12.5	9.2	
≥14	8.6	4.6	
Short-term asthma control, mean (SD)[f]	1.5 (1.3)	1.3 (1.1)	.21
≤0.75	38.3	36.2	.82
0.75 to <1.50	20.3	26.9	
≥1.50	41.4	36.9	
Current smoker	10.9	10.8	.97
Any major comorbidity	11.7	10.0	.66
PANAS Positive Affect, mean (SD)[g]	36 (9)	35 (8)	.50
PANAS Negative Affect, mean (SD)[g]	19 (7)	20 (8)	.25
Depressive symptoms, mean (SD)[h]	6 (6)	6 (7)	.74
Perceived social support, mean (SD)[i]	80 (22)	77 (22)	.26
Perceived stress, mean (SD)[j]	15 (8)	15 (9)	.71

Abbreviation: PANAS, Positive and Negative Affect Schedule.
[a] Unless otherwise indicated, data are expressed as percentage of patients.
[b] Indicates self-described.
[c] Calculated as weight in kilograms divided by height in meters squared.
[d] Includes theophylline, cromolyn sodium, and ipratropium bromide.
[e] Calculated using the Severity of Asthma Scale (possible score range, 0-28). Higher scores indicate more severe asthma; 5-point increments correspond to clinically important differences.
[f] Calculated using the Asthma Control Questionnaire (possible score range, 0-6). Higher scores indicate less control, divided into 3 clinical categories.
[g] Possible score range for each subscale is 10-50. Higher scores indicate more of the attribute.
[h] Calculated using the Geriatric Depression Scale (possible score range, 0-30). Higher scores indicate more depressive symptoms.
[i] Calculated using the Medical Outcomes Study Social Support Scale (possible score range, 0-100). Higher scores indicate more support.
[j] Calculated using the Perceived Stress Scale (possible score range, 0-40). Higher scores indicate more stress.

The shared behavioral maneuvers were equally administered in both groups; that is, most patients in both groups received bimonthly follow-up calls and reported wearing the pedometer, fulfilling the contract, and reading the workbook (**Table 2**). Pedometer use was greatest at 2 months,

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Table 2. Administration of Behavioral Components[a]

Component	Control Group	Intervention Group	*P* Value
Received 5-6 follow-up telephone calls[b]	90	90	.97
Wore pedometer at any time during trial[c]	92	90	.73
Pedometer helped perform activity[d]	73	79	.27
Fulfilled contract, mean (SD)[c,e]	3.4 (1.0)	3.6 (0.9)	.10
Workbook helped perform activity[d]	88	92	.40
How well implemented, mean (SD)[c,e]			
Positive-affect thoughts	NA	3.9 (0.8)	
Self-affirmation thoughts	NA	3.6 (0.9)	
No. of gifts received[c,f]			
5-6	NA	66	
1-4	NA	32	
0	NA	2	

Abbreviation: NA, not applicable.
[a] Unless otherwise indicated, data are expressed as percentage of patients.
[b] Includes a maximum of 6, excluding closeout.
[c] Reported during bimonthly follow-up calls.
[d] Reported at closeout.
[e] Possible responses range from 1 (not at all) to 5 (completely).
[f] Includes a maximum of 6.

Table 3. Energy Expenditure from the Paffenbarger Physical Activity and Exercise Index at Enrollment and Closeout

	Mean (SD) Energy Expenditure, kcal/wk		
	Enrollment	Closeout	Within-Patient Change
Control group	1767 (1686)	2182 (1725)	415 (1938)[a]
Intervention group	1860 (1633)	2258 (1760)	398 (1462)[b]
Between-group difference	93 (1660)[c]	77 (1742)[d]	16 (1715)[e]

SI conversion factor: To convert kilocalories to kilojoules, multiply by 4.186.
[a] $P=.02$.
[b] $P=.002$.
[c] $P=.65$.
[d] $P=.72$.
[e] $P=.94$.

which coincided with the peak of self-efficacy for the activity (9.2 [1.5]). Most intervention patients reported thinking the positive-affect and self-affirmation thoughts and receiving the mailed gifts. The most common reason for not receiving a gift was that there was no one at home at the time of mail delivery to receive the package. At closeout, 82.4% of controls and 85.4% of intervention patients ($P=.53$) reported currently fulfilling their contract completely or to some extent.

Energy expenditure at enrollment was comparable between groups (**Table 3**). Most expenditure was derived from walking, with only 39.8% of controls and 48.5% of intervention patients participating in any sports/exercise ($P=.16$).[1] Variables associated with more energy expenditure at enrollment were younger age, male sex, being a college graduate, and lower body mass index.[26] The longitudinal pattern of energy expenditure was similar for both groups (**Figure 2**).

The primary outcome—the mean within-patient change in energy expenditure from enrollment to 12 months—increased by 415 (95% CI, 76-754; $P=.02$) kcal/wk in controls and 398 (95% CI, 145-652; $P=.002$) kcal/wk in intervention patients, with no difference between groups ($P=.94$). This was above the threshold for a clinically important difference (336 kcal/wk) for both groups but was not different between groups (Table 3). An increase of 336 kcal/wk or more was reported by 44.5% of controls and 49.2% of intervention patients ($P=.45$).

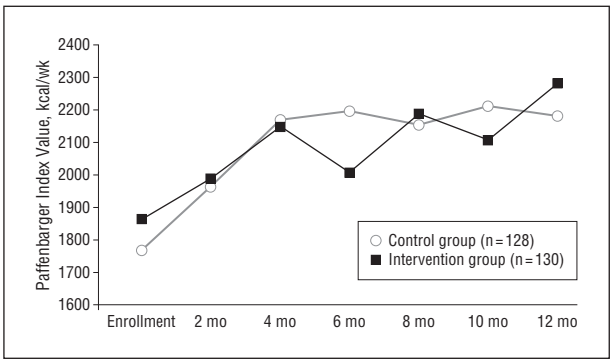

Figure 2. Paffenbarger Physical Activity and Exercise Index values at each follow-up for the entire sample.

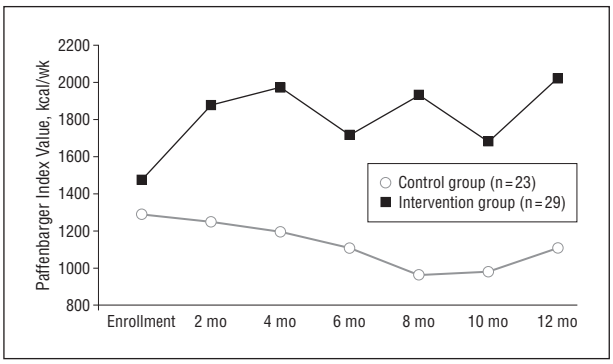

Figure 3. Paffenbarger Physical Activity and Exercise Index values at each follow-up for patients who required urgent care for asthma or any hospitalization during the trial.

Fifty-two patients (23 controls and 29 intervention patients; $P=.39$) reported interval medical care during the trial. Among these, energy expenditure decreased by 198 kcal/wk for controls but increased by 552 kcal/wk for intervention patients ($P=.05$) (**Figure 3**).

In multivariate analysis, increased mean energy expenditure was associated with less social support at enrollment, decreased depressive symptoms from enrollment to closeout, and being in the intervention group for those requiring interval medical care during the trial (**Table 4**). Receiving more follow-up telephone calls, fulfilling the contract more often, and using the pedometer also were associated with increased energy expenditure.

In a mixed-effects model with each bimonthly Paffenbarger Index value as the dependent variable, increased energy expenditure was associated with time of follow-up ($P<.001$) for both groups. Using a spline model with an adaptive slope, energy expenditure increased from enrollment to 4 months and then continued at a stable level to 12 months ($P=.02$). This pattern was the same for both groups.

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Table 4. Variables Associated With Increased Energy Expenditure From Enrollment to Closeout From the Paffenbarger Physical Activity and Exercise Index

Variable	Bivariate Analysis		Multivariate Analysis[a]	
	Estimate, kcal/wk	*P* Value	Estimate, kcal/wk	*P* Value[b]
Intervention group	−16	.94	−257	.28
Less social support at enrollment	+11	.02	+11	.04
Decrease in depressive symptoms from enrollment to closeout	+57	.01	+66	.02
Required interval medical care[c]	−233	.38	−761	.04
Required interval medical care for intervention group[c]	+164	.63	+879	.07
Received more follow-up telephone calls[d]	+237	.02	+336	.09
Fulfilled contract more often[d]	+379	<.001	+292	.02
Pedometer helped fulfill contract[e]	+340	.02	+342	.02

[a] Adjusted for age, sex, asthma severity, and asthma control at enrollment and closeout.
[b] Calculated using a 2-sided test.
[c] Includes any urgent care for asthma or any hospitalization.
[d] Reported during bimonthly follow-ups.
[e] Reported at closeout.

At closeout, asthma remained well controlled or improved in 68.4% of patients and asthma-related quality of life stayed the same or improved in 81.2%. In addition, 50.4% thought the trial made their asthma better, 49.6% thought it had no effect, and none reported it made their asthma worse. There were no differences between groups for these assessments.

Regarding adverse events, 29 controls (22.7%) and 36 intervention patients (27.7%; $P=.35$) had a serious adverse event during the trial, defined as any event that required emergency department care or hospitalization or any musculoskeletal complaint that required care in any setting. Forty-four events occurred in controls and 69 in intervention patients ($P=.12$); no events were attributed to the trial.

COMMENT

A multiple-component protocol aimed at increasing lifestyle physical activity in asthma patients resulted in clinically important increases in energy expenditure after 12 months. These gains were achieved without worsening asthma, and in most cases asthma improved. These findings are clinically relevant because they address a dilemma faced by asthma patients: although patients acknowledge that physical activity is beneficial for cardiovascular health, many avoid it for fear it will exacerbate respiratory symptoms.[42,43] This trial is the first to apply several tenets of health behavior theory to address this critical yet largely overlooked dilemma for asthma patients.

We did not find that the intervention was more effective than the control protocol. Possible reasons for this may be characteristics of both protocols. For example, it is possible that the intervention simply was not an effective mediator of behavior change in our relatively healthy young patients with stable asthma. It also is possible that the methods we used to foster positive affect and self-affirmation were not ideal for this sample and that other techniques would have been more effective. With regard to the control protocol, it is likely that not having a traditional control group but rather having a multiple-component background protocol was particularly effective in our sample. We chose this comprehensive control protocol because multiple studies have shown that meaningful increases in physical activity do not occur in the absence of specific interventions.[27-32] In a previous 12-month observational study performed in the same medical practice as this trial, energy expenditure increased by only 162 kcal/wk in healthy patients in the absence of any intervention.[30]

Thus, both groups in the current trial received behavioral maneuvers that, although not previously tested in asthma patients, are well-established facilitators of behavior change that exceed usual practice.[44] We believe these maneuvers were effective in both groups and most likely dwarfed effects of the intervention. There are several possible reasons for the particular effectiveness of these maneuvers in our sample. First, because our patients had few comorbidities and were not coping with multiple health concerns, they probably were better able to focus on the maneuvers we presented to them. Second, our sample consisted predominately of young adults who probably were better able to master all proactive maneuvers such as managing the contract and using the pedometer and workbook. In addition, younger adults typically engage in more diverse lifestyle activities and thus have more opportunity to incorporate physical activity into daily routines. For example, we encouraged integrating physical activity into workplace functions, commuting, and recreational activities with children. Finally, some physical activities, such as exercising with others and in health clubs, are more socially acceptable for younger individuals. We also encouraged these activities to simultaneously derive reinforcement from others. Thus, our multiple-component control protocol administered to both groups was particularly well suited to younger patients with fewer comorbidities and potentially overshadowed the positive-affect and self-affirmation intervention.

For some patients, specifically those who required medical care during the trial, the intervention potentially had an incremental benefit. Possible reasons for this

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may be that positive affect and self-affirmation buffer patients from the psychological consequences of acute illness and help prevent abandoning elective healthy behaviors during periods of medical adversity.

In the multivariate analysis, we found that using the pedometer, fulfilling the contract, and receiving more telephone contacts were associated with more activity. Patients reported that the pedometer provided information about actual activity level and motivated them to match, and preferably exceed, this level each day. Thus, by providing real-time feedback, the pedometer increased self-efficacy for the activity. These findings confirm other trials that showed pedometers were associated with increased walking, even among those who were previously sedentary.[45,46] Our trial also confirms previous studies that demonstrated the effectiveness of setting goals, making a contract, and using follow-up telephone calls to promote physical activity.[44,47,48]

Of the patient characteristics we considered, less social support at enrollment was associated with greater increases in physical activity. A reason for this counterintuitive result may be that having more social support often is accompanied by having more obligations to provide support to others. This hypothesis is endorsed by a previous finding that having extensive family obligations, which was common in our predominately young female population, was a barrier to exercise, whereas having more personal time was a facilitator.[42] Of the other characteristics we studied, a decrease in depressive symptoms from enrollment to closeout was associated with increased physical activity, most likely because depressive symptoms affect the motivation to exercise and the ability to self-manage asthma.[49]

We found that energy expenditure increased during the first several months and then was sustained at a relatively constant level to closeout. In another trial to increase physical activity, researchers found an initial increase in energy expenditure, but then a gradual decline to closeout.[47] In that trial, the frequency of follow-up telephone calls decreased over time compared with our trial, in which the frequency was maintained until closeout. This finding supports the psychosocial principle that sustained behavior change requires ongoing counseling and support.[50] Another possible reason for sustained activity in our trial was that patients chose their own activity goal based on what they thought was prudent and practical. In contrast, in the other trial, all patients were assigned the same goal of meeting national exercise guidelines. Perhaps a better way to meet guidelines is to incrementally increase activity based on evidence of success, such as from daily pedometer readings.[51]

This trial has several limitations. First, our study design precludes our ability to conclude whether positive-affect and self-affirmation interventions are effective without other behavioral maneuvers. Second, this study was conducted in an urban primary care practice with patients with minimal comorbidities and mild to moderate asthma and may not be generalizable to patients in different settings with more severe disease. Third, the same study personnel administered the follow-up calls to maintain continuity and therefore were not blinded to randomization group and any protocol-specific issues. Fourth, although we used a well-established and widely used scale to measure physical activity, this scale relied on self-report and may have been subject to overreporting or underreporting.

In summary, a composite of several behavioral maneuvers was effective in increasing physical activity in patients with stable asthma. Physical activity increased to 4 months and was sustained through closeout at 12 months. These gains were achieved without exacerbating asthma. An intervention to increase positive affect and self-affirmation was not effective in increasing physical activity above the control protocol but may have had an incremental benefit in patients who required interval medical care during the trial.

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Author Affiliations: Departments of Medicine, Hospital for Special Surgery (Dr Mancuso) and Weill Cornell Medical College–New York Presbyterian Hospital (Drs Mancuso, Wenderoth, Hollenberg, and Charlson and Mss Choi and Westermann), and Departments of Health and Behavioral Studies, Teachers College, and Sociomedical Sciences, Mailman School of Public Health, Columbia University (Dr Allegrante), New York, New York; Departments of Statistical Sciences (Dr Wells) and Psychology (Dr Isen) and Johnson Graduate School of Management (Dr Isen), Cornell University, Ithaca, New York; and National Institutes of Health, Bethesda, Maryland (Dr Jobe).
Correspondence: Carol A. Mancuso, MD, Hospital for Special Surgery, 535 E 70th St, New York, NY 10021 (mancusoc@hss.edu).
Author Contributions: Dr Mancuso had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design*: Mancuso, Hollenberg, Isen, Jobe, Allegrante, and Charlson. *Acquisition of data*: Mancuso, Choi, Westermann, Wenderoth, Hollenberg, and Charlson. *Analysis and interpretation of data*: Mancuso, Westermann, Hollenberg, Wells, Isen, and Charlson. *Drafting of the manuscript*: Mancuso, Wenderoth, and Wells. *Critical revision of the manuscript for important intellectual content*: Mancuso, Choi, Westermann, Hollenberg, Wells, Isen, Jobe, Allegrante, and Charlson. *Statistical analysis*: Mancuso, Hollenberg, Wells, and Isen. *Obtained funding*: Mancuso, Allegrante, and Charlson. *Administrative, technical, or material support*: Mancuso, Westermann, Wenderoth, Hollenberg, Allegrante, and Charlson. *Study supervision*: Mancuso, Hollenberg, and Jobe.
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Additional Contributions: B. Robert Meyer, MD, and the physicians and patients at the Cornell Internal Medicine Associates at the Weill Cornell Medical College participated in this study. Mary Murray-Weir, PT, MBA, Hospital for Special Surgery, assisted in categorizing physical activities. William M. Briggs, PhD, New York Methodist Hospital, Brooklyn, New York, and Bohumir Prikryl, MS, Weill Cornell Medical College, assisted in managing databases.

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