The Metabolic Fitness Program

LIFESTYLE MODIFICATION FOR THE METABOLIC SYNDROME USING THE RESOURCES OF CARDIAC REHABILITATION

Melvyn Rubenfire, MD; Lynette Mollo, NP; Sangeetha Krishnan, MS; Sandra Finkel, MPH; Martha Weintraub, ACSW, MPH, RD; Theresa Gracik, MBA; Daniel Kohn, BS; Elif A. Oral, MD

- **PURPOSE:** To describe and assess the effectiveness of a lifestyle intervention program (Met Fit) designed to treat the metabolic syndrome (MetSyn) in a cardiac rehabilitation setting.
- **METHODS:** Met Fit is a physician referred and patient pay ($350) program consisting of 12 weekly sessions of 45 minutes of exercise and 45 minutes of education with target exercise recommendations of 150 to 200 minutes weekly and 5% loss in body weight using a Mediterranean-style diet. Primary outcomes are compliance with program recommendations and secondary outcomes effecting MetSyn components.
- **RESULTS:** Patients (N = 126) were enrolled between June 2005 and July 2009 averaging 9 per class. Mean (SD) age was 51(12) years, body mass index 38(6.9) kg/m^2, high density lipoprotein-cholesterol for men 37(9.4) mg/dL and women 46(10) mg/dL, glucose 121(39) mg/dL, and homeostatic model assessment of insulin resistance 7.2(6.1). For the 93 (73.8%) patients for whom there was complete data, mean weight loss was 6.2(6.9) kg, 63.4% lost at least 4 kg, and 19.4% lost more than 5% of weight. Significant reductions were observed in the waist circumference and body fat, and systolic and diastolic blood pressure. Triglycerides decreased significantly in both diabetics and nondiabetics but glucose decreased significantly only in diabetics. At baseline, 51% had evidence of depression, which decreased to 24.7% at 12 weeks. At program completion, 18 patients (19.4%) no longer had the MetSyn and 39 (41.9%) lost at least 1 criterion ($P < .0001$).
- **CONCLUSIONS:** A 12-week patient-pay lifestyle interventional program conducted in a cardiac rehabilitation setting can result in a highly significant benefit to patients with the MetSyn.

K E Y W O R D S

cardiac rehabilitation

lifestyle

modification

medical fitness program

metabolic syndrome

Author Affiliations: Division of Cardiovascular Medicine, University of Michigan Medical School, Ann Arbor, Michigan.

Funding: Cardiovascular Medicine Preventive Cardiology Research Fund.

The authors declare no conflict of interest.

Correspondence: Melvyn Rubenfire, MD, 24 Frank Lloyd Wright Drive, Lobby A, Ste 3700, Ann Arbor, MI 48106 (mrubenfi@umich.edu).

DOI: 10.1097/HCR.0b013e318220a7eb

The metabolic syndrome (MetSyn), also known as the insulin resistance syndrome, afflicts millions of Americans. The prevalence is 20% to 30% of the United States population, increases with age, tracks with obesity, and is growing rapidly in adults and adolescents.[1-4] The metabolic syndrome is associated with an increased risk for diabetes (5-fold) and coronary disease (2-fold), cardiovascular and all cause mortality, as well as gallstones, asthma, sleep-disordered breathing, fatty liver, and some forms of cancer.[2,5,6] In a meta-analysis that included 172 573 individuals, Gami et al[7] found the MetSyn association with cardiovascular and all cause mortality (relative risk 1.78) remained after adjusting for traditional cardiovascular risk factors. These findings support a strategy for identification of MetSyn and modification of its components. Although the preferred treatment for the components of the MetSyn and diabetes is lifestyle

modification including exercise and nutrition therapy,[8-10] the challenge is the multitude of risk factors and the high prevalence of obesity and depression, each of which are difficult to approach in typically allotted office visits.[1,3,11] Furthermore, patients often struggle with adopting lifestyle changes; mere knowledge is not sufficient to result in change in behavior.[12]

The gold standard approach to lifestyle intervention was utilized in the NIH-sponsored Diabetes Prevention Program.[8] However, such an intervention requires assembly of new teams of health care providers. It has been difficult to translate the exciting positive message of this trial into clinical practice because of logistical and economic realities. We describe our experience with a pilot lifestyle intervention program designed specifically for patients with MetSyn (Metabolic Fitness Program [Met Fit]), which utilized the staff and facilities of a cardiac rehabilitation (CR) program.

METHODS

The University of Michigan Health Care System (UMHS) provided a good environment to design and test Met Fit. Since about 50% UMHS CR participants have MetSyn, the staff has been educated and was prepared to participate.[13] Eligibility for Met Fit included at least 3 of the 5 criteria as listed in Table 1. Physician referral was required for Met Fit with the concept of a partnership between the program, the patient, and primary care physician, and to enhance the continuity of behavioral and medical recommendation.

Facilities and Personnel

Met Fit is housed in the UMHS Preventive Cardiology-Cardiac Rehabilitation suite that is centrally located for the referral base. The suite includes examination rooms, a clinical laboratory, stress testing, and a large conference room with 50-person seating capacity. The Phase III cardiac rehabilitation area used for exercise is 1961 sqft and includes standard exercise equipment, exercise mats, and an area with hardwood floor (596 sqft). All Met Fit staff are on-site cardiac rehabilitation and preventive cardiology employees working with flexible schedules.

Table 1 • Criteria for the Metabolic Syndrome

1. Central obesity with waist measured at the top of the right iliac crest with tape measure parallel to the floor: men ≥40 in, women ≥35 in, Asian Americans: men ≥35 in, women ≥31in
2. Fasting triglycerides ≥150 mg/dL; patients on drug treatment with fibrates or nicotinic acid should be presumed to have triglycerides ≥150 mg/dL and low high density lipoprotein-cholesterol.
3. Low high density lipoprotein-cholesterol: men <40 mg/dL, women <50 mg/dL
4. Blood pressure ≥130 mm Hg systolic or diastolic ≥85 mm Hg, or on any drug treatment for hypertension
5. Fasting glucose ≥100 mg/dL or diabetes

Initial Patient Assessment

Patients were informed that Met Fit was a new program and would evolve over time. Informed consent as approved by the University of Michigan Medical School institutional review board (IRBMED) was obtained on all patients.

The initial patient assessment scheduled after a 12-hour fast is summarized in Table 2. The nurse practitioner (NP) assessment (1 hour) included a history and physical, electrocardiogram (ECG), and administration of the Patient Health Questionnaire-9 (PHQ-9) to assess for depression.[14] The homeostatic model assessment (HOMA-IR) was used as a measure of insulin resistance [normal nondiabetic control male 1.73 ± 1.62, female 1.64 ± 1.11].[15] The NP reviewed the program content, staff responsibilities, and patient expectations. Patients were then seen by the exercise physiologist for a symptom limited treadmill exercise ECG, which was reviewed by the program cardiologist prior to patient participation.

Table 2 • Initial Patient Assessment

- Nurse practitioner assessment including medical history, physical examination, and review of records
- Exclusion barriers to participation
  - Cognitive
  - Orthopedic
  - <3 metabolic syndrome risk factors
- CV risk assessment with Framingham Risk Score
- Blood pressure
- Height/weight and body mass index
- Body fat analysis
- Waist circumference
- PHQ-9 depression score
- Symptom limited stress ECG
  - If significantly abnormal referred for stress imaging
- Laboratory testing (fasting)
  - Lipids
  - Glucose (Hgb A1c in diabetics)
  - Fasting insulin
  - Urinary microalbumin
- Dictated summary to referring physician

Program Duration and Cost

The program duration and content is summarized in Table 3. The basic program of 90 minutes per session is completed in 12 weeks. At week 11, the baseline assessment was repeated. A formal exit letter is sent to the referring physician and patient that includes the change from baseline measures, and recommendation for lifestyle and medication changes. The patient cost for the 12-week program is $350 paid prior to the 1st session, and can be refunded for medical reasons. The clinical and laboratory patient assessment and followup are billed to the 3rd party payer.

Exercise Content and Monitoring

Recommendations for exercise include 150 to 200 minute per week of a combination of moderate intensity aerobic, stretching, and resistance training (circuit training in the Fitness Center) with at least 3 and optimally 6 sessions lasting 20 to 60 minutes.[10,16,17] The weekly on-site 45-minute exercise portion of the program begins with an assessment of blood pressure, pulse, weight, and self-monitored blood glucose in diabetics. Participants are asked to keep a logbook of clinical variables, aerobic exercise equipment used, and total dedicated aerobic and resistance training. Exercise sessions include aerobic exercise (typically lasting 30 to 40 minutes), using equipment of participant choice, group circuit, exercise tubes, and free weight strength training followed by stretching. Exercise intensity was prescribed based upon the symptom-limited stress test and provided as 50% to 75% of predicted maximal heart rate and perceived exertion as moderately hard. Two exercise physiologists were available during each 45-minute exercise session to monitor safety, educate, and encourage participants. Formal exercise lectures included value and mechanics of exercise, strength training, and stretching; impact of heat and cold extremes; and recommendations for home, and other facilities.

Table 3 • Met Fit Program Content

Week 1
- 45-minute orientation, introduction to staff and patients, introductory lecture and 45-minute introduction to use of exercise equipment

Week 2 though week 10
- 45-minute group discussion/lectures: 5 nutrition, 3 stress/behavior, 1 exercise
- 45 minute of exercise (stretch, resistance, and aerobic circuits) with education during session
- Free use of fitness center daily through week 12
- Patient maintains weight, blood pressure, exercise log

Week 11
- Repeat of baseline assessment
- Review of results
- 45-minute exercise session

Week 12
- 45-minute exercise session
- Good and welfare session
- Written summary to physician with copy to patient

Nutrition Content and Monitoring

The nutrition component of Met Fit is based on a Mediterranean food pattern, designed to give participants the information needed to optimize their nutrition choices for weight loss, improved blood lipid and glucose levels, blood pressure, and decrease in insulin resistance.[18-20] Participants are encouraged to set a 6-month weight loss goal of 7% to 10% of their current body weight if appropriate, as this degree of weight loss has been found to correlate with significant reduction in cardiometabolic risk factors.[17] Nutrition data were collected at entry and on completion of the program using The Diet Habit Survey[21] or a food frequency assessment focusing on a Mediterranean eating pattern.

During the 12 weeks, there are 5 nutrition classes using the interactional model. The first class focuses on learning the tools to design a Mediterranean-style meal plan for meals high in fiber, low in saturated fats, and moderate in monounsaturated fats, including adequate protein, calcium, and antioxidants with approximately 1600 calories per day. Information is also provided for appropriate intake for participants requiring a higher energy intake and those few requiring a lower energy intake.

Additional classes included information and discussion about reducing sodium, label reading, dining out, and menu planning. One entire class and portions of several others focus on the emotional barriers to lifestyle change and emphasized strategies to increase awareness of emotional needs and how they can influence food choices. Each class had participant interaction with discussions of strategies for overcoming barriers.

Behavioral/Stress Reduction Content and Assessment

The behavioral/stress management component is designed to inform participants of how psychosocial distress can increase risk factors for CVD and MetSyn and the potential for and barriers to success.[22,23] Three lectures given on physiology of stress and relaxation deal with resistance to change, productive goal setting, and using imagery to support goals.[24,25] Participants learn several mindfulness practices, such as body scan and mindfulness meditation, deep

breathing, breath-focused meditation, and guided imagery. The discussion period of each class allows participants to discuss ways stress affects their life and their personal struggles in achieving their goals in the program, and for the group to support one another and propose ways to overcome obstacles.

Considering the relationship between depression and obesity, the MetSyn, and adverse life style, we use the validated Patient Health Questionnaire-9 (PHQ-9) to detect depressive symptoms (1-4 normal, 5-9 possible depression, 10-14 high probability of depression, >14 high probability of major depression). Fourteen patients admitting to clinical depression or a PHQ-9 score more than 14 were referred to their primary care physician.

As seen in Table 3, the clinical reassessment occurred at week 11 so as to provide results and establish future goals for participants at week-12. The results for the group are discussed at week 12 in a "good and welfare session," which is intended to give feedback to participants from staff and from participants to staff.

Statistical Methods

Continuous variables were expressed as mean ± SD, and categorical variables as percents. Two sample *t* tests and analysis of variance were used to assess differences in baseline characteristics between those who attended the week 11 evaluation and those who did not, as well as the diabetics and nondiabetics. Changes between baseline and 11-week data were compared using a paired *t* test and χ^2 analysis and McNemar's exact tests. A $P < .05$ was used to determine statistical significance. All analyses were performed using SAS V9.1, SAS Institute Inc, Cary, NC.

RESULTS

Patients (N = 126) with MetSyn were enrolled in 14 classes between June 2005 and July 2009 (averaging 9 per class, range 2-17). All 5 components of MetSyn were present in 16.7%, 4 components in 37.3%, and 3 components in 46%. Ninety-seven percent had central obesity, 69.8% elevated triglycerides, 65.9% low high density lipoprotein-cholesterol, 65.9% elevated BP or treated hypertension, and 71.4% impaired fasting glucose or diabetes. Coronary artery disease was present in 4 (4.3%) of referred patients, and an additional 2 were diagnosed during their program, following which they returned when approved by their physician.

The baseline clinical variables in the 126 patients who began the program and the 93 patients for whom there was complete followup data are presented in Table 4. There was no difference between groups. More than 90% of participants were obese (≥30 kg/m^2). The lipids are characteristic of patients with MetSyn. The mean fasting insulin and HOMA-IR were markedly elevated. Fasting insulin in nondiabetics (23.0 ± 18.8 mmol/mL) was similar to that in the noninsulin dependent diabetics (25.2 ± 16.6 mmol/mL) ($P = .53$), whereas the HOMA-IR was significantly higher in noninsulin dependent diabetics (9.2 ± 7.0 mU·mmol/L^2) than nondiabetics (6.2 ± 5.5 mU·mmol/L^2) ($P = .01$).

The mean PHQ-9 score was 5.6 ± 4.3 with range 0 to 21. A moderate probability of depression (score >9) was present in 22.2% and a major depressive disorder (score >14) in 7.1% of patients.

The mean (SD) session attendance for the 126 patients was 7.9 (3.1) and median [IQ] 8 (6-10). Attendance averaged 82% during the first 6 weeks and 50% in the last 6 weeks. There was no difference in the attendance of the exercise or education sessions based upon gender, age, depression scores, employment or marital status, baseline body mass index (BMI), or between the 126 who entered the program and the 93 who attended the week 11 reassessment. Patients with 4 or more MetSyn criteria were more likely to complete more than 50% of sessions, odds ratio 2.27 (95% CI 1.013-5.071, $P = .046$). Table 4 summarizes the changes in clinical parameters from baseline to week-11 in the 93 who completed the reassessment.

Medication use at entry and followup is presented in Table 5. The only significant change in medication during the program was a decrease in use of antidepressants and anxiolytics, which was at the discretion of the referring physician or patient. The dose of antihypertensive drugs were reduced in 2 patients, statin dose increased in 2 patients, and metformin dose increased in 2 patients.

Mean weight loss was 6.2 ± 6.9 kg and 63.4% lost at least 4 kg; 19.4% lost more than 5% and 1.1% lost more than 10% of their body weight. Significant reductions were observed in the waist measurement in men (decrease 1.7 ± 2.2 in) and women both (decrease 1.4 ± 2.7 in) as well as body fat composition (decrease 1.0% ± 2.6%.) The significant decrease in the waist circumference in nondiabetic females ($P = .0006$) was not observed in the diabetic females ($P = .1409$).

The decrease in systolic blood pressure (BP) (~8 mm Hg) and diastolic BP (~4 mm Hg) were significant in both nondiabetics and diabetics and was comparable in those treated and not treated with antihypertensive drugs. Fasting blood glucose decreased

Table 4 • Biometrics, Laboratory Results, and Metabolic Syndrome Criteria at Baseline and Followup, M ± SD or n (%)

	Overall group (N = 126)	Patients completing 3-month program (n = 93)		
		Baseline	Week 11	P[a]
Age, y	51.3 ± 11.8			
Females, %	85 (67.5)			
Weight, lbs	240.7 ± 48.5	240 ± 47.9	232.8 ± 47.1	<.0001
Body mass index, kg/m^2	38.1 ± 6.9	38.1 ± 6.6	36.7 ± 6.2	<.0001
Systolic BP, mm Hg	122.3 ± 16.1	124.5 ± 15.5	116.2 ± 15.9	<.0001
Diastolic BP, mm Hg	72.9 ± 9.3	72.9 ± 9.3	68.1 ± 8.7	<.0001
Average waist circumference: Males, in	49 ± 5.4	49.1 ± 5.4	47.4 ± 5.1	.0001
Average waist circumference: Females, in	45.7 ± 6	45.8 ± 6	44.2 ± 5.9	.0002
Body composition, % fat[b]	44.3 ± 6.9	43.9 ± 6.8	42.8 ± 7.1	.0003
Total cholesterol, mg/dL	193.5 ± 48.7	193.6 ± 50.4	189 ± 51.5	.1419
Triglycerides, mg/dL	237.4 ± 221.9	244 ± 244.6	199.3 ± 121.5	.0262
LDL-C, mg/dL	106 ± 36.5	105 ± 36.7	106.4 ± 37.8	.8233
HDL-C (males), mg/dL	37.1 ± 9.4	37.3 ± 9.2	35.3 ± 7.9	.0534
HDL-C (females), mg/dL	45.9 ± 10.6	45.6 ± 10.5	45.4 ± 10.2	.8282
Fasting glucose, mg/dL	121.1 ± 38.9	122.4 ± 43	113.5 ± 33.4	.0068
Fasting insulin, μmol/mL	23.7 ± 18	23.2 ± 13.8	22.6 ± 13.5	.5252
HOMA IR, mU · mmol/L^2	7.2 ± 6.1	7.0 ± 5.2	6.6 ± 5.4	.4065
HS-CRP	5.7 ± 5.5	5.6 ± 5.6	5.4 ± 5.9	.9623
PHQ-9 score	5.6 ± 4.3	5.5 ± 4.3	3.5 ± 3.9	<.0001
Metabolic syndrome criteria, number (%) meeting each				
Abdominal obesity (>40 in men, >35 in women)	123 (97.6)	91 (97.8)	88 (94.6)	.1052
Triglycerides (>150 mg/dL)	88 (69.8)	63 (67.7)	52 (55.9)	<.0001
HDL-C (<40 mg/dL in men; <50 mg/dL women)	83 (65.9)	65 (69.9)	63 (67.7)	.0001
Blood pressure (>130/85 mm Hg)	83 (65.9)	63 (67.7)	56 (60.2)	<.0001
Fasting glucose (>100 mg/dL or diabetes)	90 (71.4)	69 (74.2)	51 (54.8)	<.0001
Number of metabolic syndrome criteria				
0	0 (0)	0 (0)	3 (3.2)	<.0001
1	0 (0)	0 (0)	4 (4.3)	
2	0 (0)	0 (0)	11 (11.8)	
3	58 (46)	38 (40.9)	26 (28)	
4	47 (37.3)	38 (40.9)	39 (41.9)	
5	21 (16.7)	17 (18.3)	10 (10.8)	

Abbreviations: BP, blood pressure; C, cholesterol; HDL, high density lipoprotein; HOMA-IR, homeostatic model assessment of insulin resistance, HS-CRP, high sensitivity C-reactive protein; LDL, low density lipoprotein; PHQ-9, Personal Health Questionnaire-9.
[a]Comparison of characteristic at baseline vs study end in patients who completed the program.
[b]Bioelectrical impedance, Tanita Body Composition Analyzer Model TBF-360 (Tanita Corporation of America, Inc., Arlington Heights, IL).

significantly, but only in diabetics (baseline 153 ± 60 mg/dL vs 131 ± 44 mg/dL, $P = .009$). The triglycerides decreased significantly with a similar magnitude in nondiabetics and diabetics, but there was no change in total, low density lipoprotein-cholesterol (LDL-C) or HDL-C. There was no change in insulin level, HOMA-IR, or hs-CRP in either noninsulin-dependent diabetics or nondiabetics.

There was a 2.0 ± 3.5 unit reduction in the PHQ-9 depression scores ($P < .0001$). At baseline, 51% had some evidence of depression, which decreased to 24.7% at 12 weeks, and 5 of the 14 patients with a PHQ-9 score more than 9 at baseline (moderate probability of depression) had a score less than 9 at program completion ($P < .0001$ for each).

At program completion, 18 patients (19.4%) no longer had MetSyn, 39 (41.9%) lost at least 1 criterion ($P < .0001$), and 41 (44%) continued to have the same number of criteria. There was a significant increase in aerobic and resistance training sessions, defined as at least 2 other than the Met Fit 45 minute weekly session. Only 26% of patients regularly performed aerobic activity at baseline, which increased to 65.6% at 12 weeks ($P = .02$); whereas, 11.8% regularly performed strength training at baseline and 47.3% at 12 weeks ($P = .01$).

Table 5 • Medication Use at Baseline and 12 Weeks (n = 93)

	Baseline	12 weeks
Antiplatelet	44 (47.3%)	45 (48.4%)
Diuretic	18 (19.4%)	20 (21.5%)
β-blocker	33 (35.5%)	28 (30.1%)
ACEi or ARB	44 (47.3%)	44 (47.3%)
Statin	39 (41.9%)	39 (41.9%)
Other lipid-lowering agents	6 (6.6%)	5 (5.4%)
Hypoglycemic oral drugs	33 (35.5%)	30 (32.3%)
Insulin	7 (7.5%)	7 (7.5%)
Thyroid	18 (19.4%)	19 (20.4%)
Anxiolytic	10 (10.8%)	6 (6.5%)[a]
Antidepressant	25 (26.9%)	14 (15.1%)[a]
Antiasthmatic	14 (15.05%)	16 (17.2%)

Abbreviations: ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker.
[a]Difference baseline versus 12-week assessments ($P < .05$).

DISCUSSION

We have demonstrated that a lifestyle intervention program designed to reduce cardiovascular risk in patients with MetSyn can be successfully developed and implemented using the preexisting structure of cardiac rehabilitation. By utilizing CR staff and facilities, we were able to provide a 12-week program at a reasonable cost to the patient ($350). The fee structure covered expenses for staff, facility, administrative support, educational materials, and marketing. There was excellent acceptance and cooperation for referral of patients from primary care, cardiology, endocrinology, and gynecology. Patient pay did not create an obstacle for the acceptance and growth of the program.

The results were obtained in a cohort with a distribution of the MetSyn criteria similar to published experience,[3,4,6] but our population was significantly enriched with stage III obesity (BMI >40 kg/m^2) reflecting a referral bias within our network. Despite the simplified nature of contact with the program educators and the enrichment of our population by more severe obesity, the percentage of patients who completed the program and the clinical results obtained for weight loss and blood pressure are highly encouraging to consider wider applicability of our approach.[8-10]

The program as designed and implemented should be possible in the majority of cardiac rehabilitation programs. The 2007 guidelines of the American Heart Association and the American Association of Cardiovascular and Pulmonary Rehabilitation suggests that "all cardiac rehabilitation/secondary prevention programs should contain specific core components that aim to optimize cardiovascular risk reduction, foster healthy behaviors and compliance to these behaviors, reduce disability, and promote an active lifestyle for patients with cardiovascular disease."[24] Although weight loss is the dominant factor that reduces incident diabetes in "prediabetics," there is a significant contribution of exercise if sufficient amounts are maintained over time.[25]

Depression rather than anxiety is more prevalent in MetSyn[26] but each can prompt stress-triggered behaviors such as overeating and alcohol consumption. Depressive symptoms were reduced considerably despite a reduction in use of antidepressants and anxiolytics (Tables 4 and 5).

There are several limitations for the generalization and application of our results including the absence of a control group, patient self-report for compliance with diet and exercise, and the lack of postprogram follow-up data. The attendance and completion rates were less than optimal, but not unlike cardiac rehabilitation.

The optimal duration for a lifestyle modification program is not known and studies are inconsistent. In a review of published controlled studies, the effects of exercise training on diabetic glycolic and blood pressure control did not correlate with duration of the intervention.[9] We decided on a 12-week program to minimize cost and to optimize compliance. Furthermore, 3 months of CR impacts CV risk factors and outcomes.[24]

Few studies are available to compare to Met Fit results. The HERITAGE study was designed to assess if genetics, race, gender, age, and other variables modify the benefit of an intense 6 month exercise program.[27] There was improved fitness with the 6-month intervention, but shorter periods were not tested.[28] Of the 105 participants with MetSyn at baseline, 30.5% were no longer classified as having MetSyn after the exercise training program.[29] In another controlled study[30] of 103 men and women aged 55 to 75 years designed to assess the effects of exercise on cardiovascular risk factors, 42% had MetSyn at baseline, and mean BMI was 29.4 kg/m^2. The active group included supervised exercise for 1 hour 3 days weekly for 26 weeks while maintaining their normal weight. At 6 months, 17.7% of the exercise and 15.1% of the control group no longer had MetSyn, whereas 7.6% of the controls and no exercisers developed it.[30] In comparison, our 12-week study emphasized education, diet with weight loss targets, and stress reduction, and once weekly 45 minute supervised exercise session on site. The mean baseline BMI was 38.1 kg/m^2 and 34% were morbidly obese. At 12-weeks 19% no longer had MetSyn.

The relative contribution of weight loss by decreasing energy intake and type, and frequency and intensity of exercise will need to be assessed in appropriate future trials. Compared to moderate continuous exercise, intense interval training is equally effective at lowering BP, weight, and body fat, but has a better effect on insulin signaling in fat and skeletal muscle, blood glucose, adipose tissue lipogenesis, and vascular endothelial function.[31]

The prevalence and contribution of increased weight (obesity/overweight), hypertension, physical inactivity, and other risk factors modifiable by behavioral lifestyle change continues to increase in the United States over the past 20 years.[32] Yet the health care system is not organized to deliver adequate therapies to effectively modify lifestyle. Changing lifestyle to induce weight loss, particularly in the obese, requires education, experience, feedback, and reinforcement over time, as well as attention to gender, age, education, and ethnic and socioeconomic factors.[33-36] Whether a lifestyle intervention program targeting MetSyn would be cost-effective is not known. However, impaired fasting glucose, which is found in at least 1/3rd of persons with MetSyn, has been shown to add >$5000 per annual age/gender-adjusted per-person medical cost.[37]

The developing United States health care bill encourages shifting spending from high cost diagnostic and treatment strategies to identifying high-risk patients and providing practical prevention efforts. The Met Fit program fulfills the criteria for a "well-defined package of preventive services that are effective and offer good economic value."[38] Whether programs such as Met Fit will yield net savings and improve cardiovascular outcomes will require controlled trials comparing several paradigms of content and duration. Until those results are available, the Met Fit approach would appear to be a prudent alternative to standard care for both patients and insurers who share the common goals of reducing the cardiovascular and metabolic risks, and reduce health care costs over time.

—Acknowledgements—

We thank Ronda Barnes, Kristen Edrozo, Carla Vorndran, and Patrick Walden for the contributions to the Metabolic Fitness Program.

References

1. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults. *JAMA.* 2002;287:356-359.
2. Grundy S. Metabolic syndrome pandemic. *Arterioscler Thromb Vasc Biol.* 2008;28:629-636.
3. Wildman RP, Muntner P, Reynolds K, et al. The obese without cardiometabolic risk factor clustering and the normal weight with cardiometabolic risk factor clustering. *Arch Intern Med.* 2008; 168:1617-1624.
4. Li C, Ford ES, Zhao G, Mokdad AH. Prevalence of pre-diabetes and its association with clustering of cardiometabolic risk factors and hyperinsulinemia among U.S. adolescents: National Health and Nutrition Examination Survey 2005-2006. *Diabetes Care.* 2009;32:342-347.
5. Grundy SM, Brewer HB, Cleeman JI, Smith SC, Lenfant C. Definition of metabolic syndrome. Report of the National Heart, Lung, and Blood Institute/American Heart Association Conference on Scientific Issues Related to Definition. *Circulation.* 2004;109:433-438.
6. Malik S, Wong ND, Franklin SS, et al. Impact of the metabolic syndrome on mortality from coronary heart disease, cardiovascular diseases, and all causes in United States adults. *Circulation.* 2004;110:1245-1250.
7. Gami AS, Witt BJ, Howard DE, et al. Metabolic syndrome and risk of incident cardiovascular events and death: a systematic review and meta-analysis of longitudinal studies. *J Am Coll Cardiol.* 2007;49:403-414.
8. Knowler WC, Barrett-Connor E, Fowler SE, et al: Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med.* 2002;346:393-403.
9. Marwick TH, Hordern MD, Miller T, et al. Exercise training for type 2 diabetes mellitus. Impact on cardiovascular risk. *Circulation* 2009;119;3244-3262.
10. Lavie CJ, Milani RV. Cardiac rehabilitation and exercise training programs in metabolic syndrome and diabetes. *J Cardiopulm Rehab* 2005;25:59-66.
11. Kinder LS, Carnethon MR, Palaniappan LP, King AC, Fortmann SP. Depression and the metabolic syndrome in young adults; Findings from the Third National Health and Nutrition Examination Survey. *Psychosom Med.* 2004;66:316-322.
12. Dowell AC, Ochera JJ, Hilton SR, et al. Prevention in practice: results of a 2-year follow-up of routine health promotion interventions in general practice. *Fam Pract.* 1996;13: 357-362.
13. Draper T, Rubenfire M, Salmon R, et al. The prevalence of metabolic syndrome in cardiac rehabilitation patients. *J Am Coll Cardiol.* 2007;49:389A.
14. Sptizer RL, Kroenke K, Williams JBW, et al. Validation and utility of a self-report Version of PRIME-MD. The PHQ Primary Care Study. *JAMA.* 1999;282;1737-1744.
15. Wallace TM, Levy JC, Matthews DR. Use and abuse of HOMA modeling. *Diabetes Care.* 2004;27;1487-1495.
16. Eriksson KM, Westborg CJ, Eliasson MCE. A randomized trial of lifestyle intervention in primary healthcare for the modification of cardiovascular risk factors. The Björknäs study. *Scan J Pub Health.* 2006;34:453-461.
17. Knowler WC, Barrett-Connor E, Fowler SE, et al. Diabetes Prevention Program Research Group: reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med.* 2002;346:393-403.
18. Schröder H, Marrugat J, Vila J, et al. Adherence to the traditional Mediterranean diet is inversely associated with body mass index and obesity in a Spanish population. *J Nutr.* 2004; 134:3355-3361.
19. Estruch R, Martinez-Gonzalez MA, Corella D, et al. Effects of a Mediterranean-style diet on cardiovascular risk factors: a randomized trial. *Ann Intern Med.* 2006;145:1-11.
20. Martinez-Gonzalez MA, de la Fuente-Arrillaga C, Nunez-Cordoba JM, et al. Adherence to Mediterranean diet and risk of developing diabetes: prospective cohort study. *BMJ.* 2008;336(7657): 1348-1351.
21. Connor SL, Gustafson JR, Sexton G, et al. The Diet Habit Survey: a new method of dietary assessment that relates to plasma cholesterol changes. *J Am Diet Assoc.* 1992;92:41-47.

22. Das S, O'Keefe JH. Behavioral cardiology: recognizing and addressing the profound impact of psychosocial stress on cardiovascular health. *Curr Atheroscler Rep.* 2006;8:111-118.
23. Prochaska JO, DiClemente CC. Stages and processes of self-change of smoking: toward an integrative model of change. *J Consult Clin Psychol.* 1983;51:390-395.
24. Balady GJ, Williams MA, Ades PA, et al. Core components of cardiac rehabilitation/secondary prevention programs: 2007 Update. *Circulation.* 2007;115:2675-2682.
25. Hamman RF, Wing RR, Edelstein SL, et al. Effect of weight loss with lifestyle intervention on risk of diabetes. *Diabetes Care.* 2006; 29:2102-2107.
26. Skilton MR, Moulin P, Terra JL, Bonnet F. Associations between anxiety, depression, and the metabolic syndrome. *Biol Psych.* 2007;62:1251-1257.
27. Bouchard C, Leon AS, Rao DC, et al. The HERITAGE Family Study: aims, designs, and measurement protocol. *Med Sci Sports Exerc.* 1995;27:721-729.
28. Skinner JS, Jaskólski A, Jaskólski A, et al. Age, sex, race, initial fitness, and response to training: the HERITAGE Family Study. *J Appl Physiol.* 2001;90:1770-1776.
29. Katzmarzyk PT, Leon AS, Wilmore JH, et al. Targeting the metabolic syndrome with exercise: evidence from the HERITAGE Family Study. *Med Sci Sports Exerc.* 2003;35:1703-1709.
30. Stewart KJ, Bacher A, Turner K, et al. Exercise and risk factors associated with metabolic syndrome in older adults. *Am J Prev Med.* 2005;28:9-18.
31. Tjonna AE, Lee SJ, Rognmo O, et al. Aerobic interval training versus continuous moderate exercise as a treatment for the metabolic syndrome. *Circulation.* 2008;118:346-354.
32. Lloyd-Jones, Adams R, Carnmethon M, for the Writing Group Members. Heart Disease and Stroke Statistics 2009 Update. *Circulation.* 2009;119;e21-e181.
33. Hollis JF, Gullion CM, Stevens VJ, et al. Weight loss during the intensive intervention phase of the Weight-Loss Maintenance Trial. *Am J Prev Med.* 2008;35:118-126.
34. Jakicic JM, Marcus BH, Gallagher KI, et al. Effect of exercise duration and intensity on weight loss in overweight, sedentary women: a randomized trial. *JAMA.* 2003;290:1323-1330.
35. Svetkey LP, Erlinger TP, Vollmer WM, et al. Effect of lifestyle modifications on blood pressure by race, sex, hypertension status, and age. *J Hum Hypertens.* 2005;19:21-31.
36. Svetkey LP, Stevens VJ, Brantley PJ, et al. for the Weight Loss Maintenance Collaborative Research Group. Comparison of strategies for sustaining weight loss. The Weight Loss Maintenance Randomized Controlled Trial. *JAMA.* 2008;299:1139-1148.
37. Nichols GA, Arondekar B, Herman WH. Medical care costs one year after identification of hyperglycemia below the threshold for diabetes. *Am J Manag Care.* 2008;14:791-798.
38. Woolf SH. A closer look at the economic argument for disease prevention. *JAMA* 2009;301:536-538.