Effects of Cardiorespiratory Fitness on Healthcare Utilization

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ABSTRACT

MITCHELL, T. L., L. W. GIBBONS, S. M. DEVERS, and C. P. EARNEST. Effects of Cardiorespiratory Fitness on Healthcare Utilization. *Med. Sci. Sports Exerc.*, Vol. 36, No. 12, pp. 2088–2092, 2004. **Background:** Prospective study examining the relationship between cardiorespiratory fitness level and incidence of medical treatments during a 1-yr period before each of two examinations. A subset was also evaluated to assess whether improvement in fitness affected incidence of treatments. **Methods and Results:** Part I: Six thousand six hundred seventy-nine healthy male subjects underwent medical examinations on two occasions, including a maximal exercise test. Division of subjects by fitness into quartiles (Q1 = low fitness through Q4 = high fitness) revealed an inverse relationship between fitness and outcome measures. Men in the low-fitness group had more office visits and overnight hospital stays than men in the high-fitness group (3.5% (Q1) vs 1.6% (Q4) men had 10+ office visits, and 10% (Q1) vs 5.0% (Q4) men had overnight hospital stays, $P < 0.0001$). These differences held after adjustment for potential confounding variables (age, follow-up yr, blood pressure, cholesterol, and smoking). Part II: Subjects in this subset ($N = 2974$) were evaluated to compare overnight hospital stays between low-fit men who remained low fit at the second examination, and low-fit men who became fit by the second examination. This cohort was divided into fitness tertiles (T1 = low fitness through T3 = high fitness). Those who improved their fitness by the time of the second examination had a decreased number of overnight hospital stays, compared with those who remained unfit at the time of the second examination (10.2% (T1 at second visit) vs 5.9% (T3 at second visit) had overnight hospital stays, $P < 0.03$). **Conclusions:** Men who maintain or become fit are less likely to have physician visits or overnight hospital stays, compared with men who are unfit.
Key Words: HEALTH ECONOMICS, EXERCISE, HEALTH COSTS

Physical activity has demonstrable beneficial effects on body mass index, hypertension, cholesterol, blood sugar, and even some forms of cancer (5,9,11, 13,16,17,19,24,25,27). In spite of the widespread knowledge of its numerous benefits, more than half of American adults do not achieve the level of physical activity recommended by the Centers for Disease Control and Prevention and the American College of Sports Medicine, and more than one fourth report no leisure-time physical activity (28).

National health expenditures are projected to total $3.4 trillion and reach 18.4% of Gross Domestic Product by 2013 (1). The Centers for Disease Control (CDC) and the Health Care Finance Administration (HCFA) have data regarding direct costs due to physician visits, hospitalization, and treatment (7). The financial burden of this cost is borne largely by company insurance premiums (21%), Medicare (22%), and direct out-of-pocket payments (56%) (7). Lowering these trends could provide cost savings for both the public and private sectors.

Various analyses have measured the relationship between exercise participation, absenteeism (20), healthcare costs (15), and productivity (26). These relationships have generally been analyzed as parts of broader health promotion programs (22,31). The efficacy of exercise alone has been more difficult to assess, and the results vary. Though the trend is generally favorable, results are less clear when evaluating its effectiveness in reducing direct healthcare costs. One difficulty is the fact that many studies examine reported participation versus functional capacity (i.e., measured fitness). To clarify this, we sought to analyze and answer the following questions: 1) Does fitness correlate with the incidence of healthcare treatments? and 2) if fitness improves, does the incidence of healthcare treatments decrease?

METHODS

Subjects and design. The Institutional Review Board of the Cooper Aerobics Center evaluated the investigative proposal for this study as part of its ongoing oversight of the Aerobics Center Longitudinal Study database, and gave its approval. Informed consent for laboratory evaluation and exercise treadmill testing was obtained from all subjects. Subjects for this study were selected from male patients seen at the Cooper Clinic in Dallas, TX. Each completed a detailed medical history, and of 13,344 potential subjects, 10,245 qualified by completing two clinical exams. Subjects underwent an in-depth, physician-conducted medical evaluation at both visits, including a comprehensive review of

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their current and past medical/surgical history, medications, family history, and lifestyle habits. A complete physical examination was performed (including sigmoidoscopy for those above 40 yr of age). All had laboratory studies (including lipid panel, glucose, chemistries, liver function studies, kidney function studies, complete blood count, urinalysis, prostate-specific antigen, and stool cards for bleeding) and anthropometry. All underwent a maximal-effort exercise treadmill test using a modified Balke protocol. If a prospective participant was found, by this evaluation, to be healthy, then he was followed longitudinally. Exclusion criteria included: abnormal resting or exercise electrocardiograms, diabetes, history of heart attack, stroke, cancer, and >80 yr at baseline. Additionally, patients who did not achieve 85% maximal heart rate were excluded from the trial, as they may have had preexisting disease or been on medication that affected heart rate (e.g., beta blockers). Such individuals may have had conditions associated with a poorer treadmill test performance and higher incidence of healthcare treatment during the study period. The remaining 6679 men (mean ± SD, 44.8 ± 9.1 yr, range 20–79 yr, BMI 26.4 ± 3.0 $kg \cdot m^{-2}$) included in the investigation were predominantly Caucasian (97%), educated, white collar/professional, and apparently healthy. Each completed two examinations at the Cooper Clinic in Dallas between 1970 and 1989.

A baseline assessment was performed after informed consent was obtained. After completion of their medical evaluation, participants underwent a maximal graded exercise test. Technicians administering the test followed a standardized protocol (modified Balke). Speed was 88 $m \cdot min^{-1}$, and grade was 0% for the first minute. The grade was increased by 2% after the first minute, and 1% each minute thereafter until 25 min. After 25 min, the grade remained the same, and speed was increased 5.4 $m \cdot min^{-1}$ each minute until test termination. Patients were encouraged to give maximal effort. Total treadmill test time (s) was used for the fitness assessment. Patients were divided into quartiles based on their measured fitness (part I). A subset of the cohort was analyzed to assess the effects of improved fitness (between the first and second examinations) to incidence of overnight hospital stays. Participants in this subset were divided into tertiles based on their measured fitness (part II).

Part I. Level of fitness for each quartile was defined by time to exhaustion on the treadmill and age (20–39, 40–49, 50–59, and 60+ yr) at the baseline examination. The least fit men were classified as quartile 1 (Q1), whereas the most fit men were classified as quartile 4 (Q4). The average (±SD) interval between examinations was 4.9 ± 4.1 yr (range, 1–18 yr). Estimated $\dot{V}O_2$ was calculated using standard American College of Sports Medicine metabolic equations for treadmill speed and grade. These values, as well as other characteristics of the subjects at baseline, are presented in Table 1.

Part II. For the second portion of this investigation, a subset of men were divided according to their fitness level into tertiles (T), again based on time to exhaustion on the treadmill test. Terciles were used because of a smaller sample size, as well as the observation that <4% of this cohort fell into the "true" high-fit group. After completion of the initial examination, subjects were divided into tertiles as follows: T1 (20%, low fit), T2 (40%, moderate fit), and T3 (40%, high fit). The average (±SD) interval between examinations was 4.9 ± 4.1 yr (range, 1–18 yr). At the time of the second examination, subjects were again divided into fitness tertiles using the same definitions. The survey instrument described below was used to compare the number of overnight hospital stays between those men who remained low fit (T1) at the second examination, and those men who had been initially low fit (T1) but became fit (T3) by the second examination.

Survey instrument. The history form provided data on health risks, lifestyle, family history, and other illnesses. The history contained the following questions:

1. How many times in the past 12 months have you seen a physician for:

a. Routine check-ups: 0, 1, 2–5, 6–10, >10.

TABLE 1. Characteristics of study participants according to fitness level.

	Fitness Quartile			
	1	2	3	4
Subjects (*N*)	1694	1649	1667	1669
Age (yr)	5.4 ± 9.1	45.3 ± 9.1	45.1 ± 9.2	44.1 ± 9.0
Peak treadmill duration (min)	12.7 ± 2.5	16.8 ± 1.9	20.0 ± 1.9	24.9 ± 2.7
Estimated $\dot{V}O_2$, ($mL \cdot kg^{-1} \cdot min^{-1}$)	33.0	39.5	43.9	51.0
BMI ($kg \cdot m^{-2}$)	28.3 ± 4.1	26.5 ± 3.1	25.7 ± 2.6	24.3 ± 2.3
Total cholesterol				
($mmol \cdot L^{-1}$)	5.68 ± 1.02	5.53 ± 1.02	5.40 ± 0.99	5.21 ± 0.94
($mg \cdot dL^{-1}$)	(220.0 ± 39.4)	(214.0 ± 39.4)	(208.7 ± 38.2)	(201.7 ± 36.4)
HDL cholesterol				
($mmol \cdot L^{-1}$)	1.08 ± 0.28	1.14 ± 0.29	1.12 ± 0.31	1.34 ± 0.32
($mg \cdot dL^{-1}$)	(41.9 ± 10.9)	(43.9 ± 11.2)	(46.7 ± 12.0)	(51.8 ± 12.4)
Triglyceride				
($mmol \cdot L^{-1}$)	1.84 ± 1.22	1.54 ± 1.01	1.33 ± 0.91	1.02 ± 0.56
($mg \cdot dL^{-1}$)	(164.4 ± 108.2)	(137.0 ± 89.5)	(118.1 ± 80.9)	(90.5 ± 50.0)
Fasting glucose				
($mmol \cdot L^{-1}$)	5.55 ± 0.55	5.49 ± 0.54	5.44 ± 0.49	5.39 ± 0.48
($mg \cdot dL^{-1}$)	(99.9 ± 10.0)	(98.9 ± 9.8)	(98.0 ± 8.9)	(97.2 ± 8.7)
Blood pressure (mm Hg)				
Systolic	123.2 ± 13.2	120.7 ± 13.1	120.3 ± 12.9	120.3 ± 13.1
Diastolic	82.8 ± 9.6	81.0 ± 9.4	80.0 ± 9.4	78.7 ± 8.4
Current smoking (%)	25	15	11	5.30

TABLE 2. Incidence of healthcare utilization for 1-yr low-fit (Q_1), moderate-fit (Q_2–Q_3), and high-fit (Q_4) men.

	Incidence of Physician Attended Office Visits					Incidence of Overnight Hospital Stays				
	0	1	2–5	6–10	>10	0	1–3	4–7	8–14	>14
Fitness quartile										
Q_1 (N = 1694)	23.3	25.1	42.1	6.0	3.5	90.1	5.2	2.9	1.2	0.6
Q_2 (N = 1649)	25.0	29.2	38.0	4.5	3.3	92.7	3.6	2.8	0.6	0.4
Q_3 (N = 1667)	27.2	28.5	37.4	4.7	2.2	92.6	5.5	1.4	0.4	0.1
Q_4 (N = 1669)	32.1	29.8	32.8	3.7	1.6	95.2	3.2	1.1	0.4	0.2

Values expressed as percentage of group.

b. Medical treatment: 0, 1, 2–5, 6–10, >10.

2. Were you hospitalized for at least one night during the last year?

a. No.

b. Yes: 1–3, 4–7, 8–14, >14.

Statistical analysis. Data were analyzed using the SAS statistical program (Cary, NC), and contiguous tables were used to assess differences in health outcomes between fitness level categories. To compare average physician office visits and overnight hospital stays, we used the mean for each category. For example, if a patient reported 2–5 visits to the doctor, the designation for office visits would be 3.5. For patients in the highest category (>X), we assigned it as X+1. The study period was the 1-yr interval before the most recent evaluation. A test for trend examined the strength of the dependent variables across fitness categories. All data were corrected for potential confounding variables (smoking, cholesterol, and blood pressure), with P values reflecting two-tailed tests. Those values below 0.05 were considered statistically significant. An estimate of financial burden was made for overnight hospital stays using data from National Health Statistics Group indicator tables ($1127 per day) (18).

RESULTS

Part I: effect of fitness on healthcare utilization. The most fit group was less likely to require a physician attended office visit during 1 yr ($P < 0.0001$). Those reporting "no physician-attended office visits" were 23.3% (Q1), 25.0% (Q2), 27.12% (Q3), and 32.1% (Q4). Those reporting one medical treatment were similarly grouped, with 25.1% (Q1), 29.2% (Q2), 28.5% (Q3), and 29.8% (Q4) (Table 2). However, as the incidence of medical treatments increased to more than one, those in the low-fit group were more likely to receive medical treatment than those in the high-fit group (test for trend: $P < 0.0001$). For example, only 1.5% of the patients in Q4 received more than 10 medical treatments, compared with 3.5% in Q1 (Table 2).

The majority of the study population required no overnight hospital stays (90.1% (Q1), 92.17% (Q2), 92.6% (Q3), and 95.2% (Q4). However, low-fit subjects were more likely than high-fit subjects to stay in a hospital for at least one night during the study period 5.2% (Q1) and 3.2% (Q4) (Table 2). The average overnight stays (per 1000 person-years) were 390/1000 (Q1), 310/1000 (Q2), 240/1000 (Q3), and 210/1000 (Q4); $P < 0.0001$ (Fig. 1). These associations did not change when adjusted for age, follow-up years, and previously mentioned potential confounding variables.

Part II: effect of improved fitness on overnight hospital stays. Chi-square analysis across dependent variables revealed an inverse relationship between improved fitness and overnight hospital stays. When the subset was analyzed before taking into account improved fitness, subjects exhibited a pattern similar to that reported in part I. The least fit (T1, 10.3%) were more likely to require a overnight hospital stay than the most fit (T3, 5.6%) (Table 3). Of those who remained low fit by the second evaluation (44% of the group), 10.2% stayed in a hospital for one or more nights, whereas only 5.9% of those who became fit (56% of the group) stayed in a hospital overnight during the study year; $P < 0.0001$ (Table 3). After adjustment for age, follow-up years, blood pressure, lipid fractions, and smoking, average nights in a hospital (per 1000 person-years) were 372/1000 for those who remained low fit, and 197/1000 for those who improved fitness ($P = 0.03$; Fig. 1).

DISCUSSION

We found that cardiorespiratory fitness is inversely related to healthcare utilization in men. Using data from the National Health Statistics Group, fit men (part I) as well as those who become fit (part II) exhibit healthcare utilization trends that would amount to approximately a 53% reduction in direct healthcare costs (from overnight stays in a hospital). Previous studies evaluating the financial effect of fitness on healthcare utilization have been done as parts of larger studies assessing work site health promotion programs. Ours is the first performed at a freestanding clinic to evaluate healthy subjects from a variety of occupations.

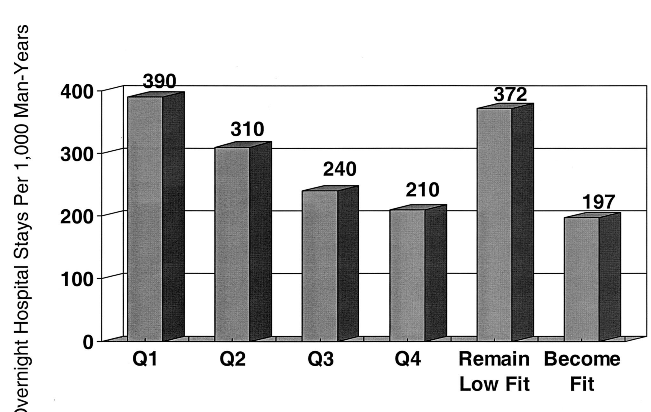

FIGURE 1—Overnight hospital stays (per 1000 person-years), adjusted for age and follow-up years. Q1–Q4 represent the increasing levels of fitness (part I). Data on the right represent subset of men who either remain unfit or become fit (part II).

TABLE 3. Incidence of overnight hospital stays associated with a change in fitness.

Fitness Tercile	Any	1–3	4–7	8–14	>14
First exam					
T_1 (N = 595)	10.30	5.30	3.20	1.20	0.70
T_2 (N = 1190)	7.50	4.50	2.10	0.60	0.30
T_3 (N = 1189)	5.60	3.80	1.30	0.40	0.20−
Second exam					
Remain low fit ($T_1 \rightarrow T_1$, N = 262)	10.20	6.60	2.30	0.40	0.80
Become fit ($T_1 \rightarrow T_2$, T_3, N = 333)	5.90	4.10	1.60	0.30	0.00

Values expressed as percentage of group.

The consequences of a sedentary lifestyle are well documented relative to cardiovascular disease and all-cause mortality (3,4,12,21). Blair et al. showed (4) that the majority of the benefits from exercise were achieved in groups developing moderate levels of fitness, with only modest gains to be expected with higher levels of fitness. Our data show a similar trend for fitness and healthcare utilization.

A question remains. Is someone healthy because they are fit, or fit because they are healthy? Blair et al. (2) demonstrated associations between changes in treadmill time and changes in coronary heart disease risk factors in middle-aged men (an improvement in treadmill time being associated with improved risk factors) (2). A similar trend has been noted in studies comparing fitness to obesity and diabetes (29,30). It is estimated that each 1-min improvement in treadmill tie attenuates weight gain in men and women, as well as age-related weight gain in healthy middle-aged adults (8). These changes in fitness and their influence on risk factors occur in as little as 6 months for participants reaching the levels of physical activity recommended by the CDC and American College of Sports Medicine (10). This may explain some of the decrease in healthcare utilization we observed.

Several reports have examined the effect of work site fitness and wellness programs on healthcare utilization (6,14,31). Yen et al. (32) reported average annual medical costs (based on a variety of measurements) to be $67–$778 higher for high-risk versus low-risk employees. Although these data are favorable, employer-funded programs may include a degree of participation bias, as many offer incentives to participants for reporting or achieving certain healthcare/participation goals. Although the benefits are real, they may not reflect purely voluntary participation. To better establish a causal effect, one would need to assess whether or not improved fitness reduced healthcare utilization (4). Our subset indicated that improved fitness is associated with a concomitant reduction in overnight hospital stays. Using an estimate of $1127 per overnight hospital stay (18), this would suggest a savings of $197,225, comparing the group that remained unfit to the group that improved fitness (372 overnight hospital stays/1000 person-years vs 197 overnight hospital stays/1000 person-years). Given the escalating costs of national health expenditures, the potential for financial savings, both for the public and private sectors, is significant.

A limitation of our study is the patient population. Study participants were all male, 97% Caucasian, and had a higher socioeconomic and educational level than the general population; this might limit the generalizability of the results. Others have reported similar occurrences in blue-collar workers, suggesting this is a general trend (23). Nonetheless, studies should be performed on other populations (i.e., various ethnic groups and women). Another limitation of the study is that healthcare utilization data is self-reported, and therefore subject to recall errors. However, the time frame involved for recall is a 12-month period, which we believe minimizes this problem.

We believe our study has strengths not found in previous analyses. Most studies to date have been employer-sponsored, with the potential for participation bias noted previously. Additionally, our study is not limited to individuals in a single industry or work force.

A criticism of previous studies has been a lack of precise outcome measures. We have kept our outcome definitions specific (i.e., physician office visits and overnight hospital stays). Our data support the idea that maintaining fitness and improving fitness (in those who are low fit) yields both personal (diminished need for medical attention) and economic (diminished healthcare costs) benefits.

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