ENDURANCE EXERCISE TESTING
IN WOMEN WITH
SYSTEMIC LUPUS ERYTHEMATOSUS

by

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Chapter I

Introduction

Systemic lupus erythematosus (SLE) is a chronic, systemic disease that affects approximately one in every 2200 persons. SLE strikes in disproportionate numbers in women of childbearing age. Two of the most common manifestations of SLE -- fatigue and joint pain -- may contribute to a cycle of physical deconditioning and increasing functional impairment even when the disease is quiescent, as illustrated by the diagram in figure 1.

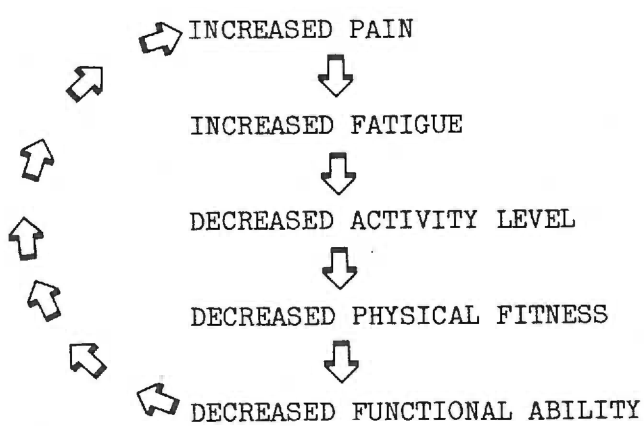


Figure 1: Cycle of Physical Deconditioning

Because of recent societal attention and focus on the importance of physical fitness for the population in general, persons with a chronic illness such as SLE are increasingly requesting advice regarding the feasibility and safety of engaging in exercise programs. Studies have been done that attempt to document the benefits of exercise, and in particular endurance training, in persons with other chronic illnesses including cardiovascular disease, chronic lung disease, and rheumatoid arthritis. To date, no studies have documented the safety of strenuous exercise in persons with SLE.

The possibility exists of increased cardiovascular and pulmonary disease among persons with SLE; therefore, health care providers are uncertain as to what advice to give their clients. Clients, then, either choose sedentary lifestyles or engage in exercise which may be unsafe. This study, then, asked the question, "Is it safe for persons with unexacerbated SLE to exercise?"

Nursing characteristically seeks to expand patients' lifestyle options to maximize wellness within limitations brought about by disease processes such as SLE. Any new knowledge regarding the safety of exercise in persons with SLE will assist nurses and other healthcare providers in giving the best possible advice to their patients with SLE. Advice given to patients with the overall goal of maximum patient wellness, may also serve to increase patient satisfaction with healthcare and increase the credibility of the nursing practice.

Review of Literature

The review of literature will discuss several topics which relate to the question, "Is it safe for persons with SLE to exercise?" These include: (1) SLE, (2) exercise in rheumatic disease, (3) exercise in cardiopulmonary disease and (4) stress testing.

SLE

This section will include a brief overview of SLE: its epidemiology, pathophysiology, clinical features, diagnosis, treatment and prognosis and some manifestations of SLE that relate to exercise.

Epidemiology. According to incidence and prevalence studies in the United States cited by Rothfield (1985), approximately one person per 2200 population has SLE; and there are between six and eight new cases annually per 100,000 population. SLE has a striking predilection for females over males (9:1) and for black females over white females (3:1). While SLE can occur at any age, the mean age of diagnosis is 30 years (Rothfield, 1985).

Pathophysiology. SLE is a complex disease process involving the immune system. The exact etiology of SLE is not known; however immunologic abnormalities result in proliferative antibody production directed not against foreign substances, but against some of the body's own tissues. In SLE, the body is either unable to differentiate between its own and foreign antigens, or fails to limit the production of autoantibodies if they occur. This process is known as autoimmunity. When autoantibodies and autoantigens join together, they are known as immune complexes. In persons with SLE, increased immunoglobulin synthesis and autoantibody production promote the constant formation of immune complexes which may then become deposited in virtually any organ of the body and thereby initiate inflammation or injury (Koffler and Bresecker 1983; Weidermann and Tappeiner, 1984; Zvaifler and Woods 1985).

Clinical Features. Clinical features at the onset of SLE vary with each individual as well as does the course of the disease. In general, symptoms may include moderate to severe fatigue, weight loss, fever, joint pain and/or swelling, lesions or abnormalities of the skin, hair, or mucous membranes, pleural effusion, pericarditis, nephritis, organic brain syndrome, peripheral neuropathy, eye changes, menstrual abnormalities, stillbirths, miscarriages, hepatomegaly and splenomegaly.

In general, SLE can affect the skin, kidneys, circulation, intestines, pancreas, spleen, liver, thyroid, thymus, eyes, parotid glands, central nervous system, heart, lungs, reproductive organs and blood (Rothfield, 1985).

Diagnosis. The diagnosis of SLE is made when a person meets four or more of the following eleven criteria (Rodnan and Schumacher 1983, p.211):

(1) Malar Rash
(2) Discoid Rash
(3) Photosensitivity
(4) Oral Ulcers
(5) Arthritis
(6) Serositis
(7) Renal disorder
(8) Neurologic disorder
(9) Hematologic disorder
(10) Immunologic disorder
(11) Autoantibody

These criteria were revised in 1982 by the Diagnostic and Therapeutic Criteria Committee of the American Rheumatism Association (ARA). Definitions of these criteria can be found in Appendix A. Studies have found the eleven criteria to be highly specific. One such study conducted by Pasas, Wong, Peterson, Testa and Rothfield (1985) applied both the original and revised criteria to 207 persons with rheumatic diseases other than SLE. They found the 1982 criteria to be 99.5% specific, a modest improvement over the original criteria which were 97.6% specific.

Treatment. Treatment for SLE includes rest when the disease is active, sunscreens, physical therapy for muscle weakness and deformities, and topical steroids. Drug treatment for SLE is usually aimed at relief of symptoms, alteration of the immune system and prevention of future abnormalities and includes nonsteroidal antiinflammatory drugs (NSAIDs), steroids, antimalarials, and immune modulating drugs.

Prognosis. The prognosis for persons with SLE has improved dramatically in recent years. Schur (1985) points out that persons with SLE were given only a 50% chance of surviving four years in 1956; whereas today, they have a better than 90% chance of surviving at least ten years. This improved prognosis is attributable to earlier diagnosis, recognition of many mild cases and better treatment options for both SLE and its complications (Schur, 1983).

Musculoskeletal Manifestations. SLE can directly or indirectly lead to joint problems which may be a deterrent to physical activity and lead to decreased physical fitness and function. In SLE, joints, especially of the fingers, hands, wrists and knees are often painful, swollen or diseased, presumably because of immune complex deposits. Indeed, 78-95% of persons with SLE have joint complaints which are usually polyarticular, episodic, and nondeforming 85-90% of the time (Rothfield, 1985; Stevens, 1983).

Treatment for SLE can lead to other musculoskeletal problems. Miescher and Beris (1984) believe that is rarely possible to control SLE without the use of steroids. Steroids can cause unwanted weight gain, muscle atrophy and osteoporosis, which in turn, can lead to increased stress on the joints and loss of normal function and alignment.

Fatigue and Depression. As stated earlier, fatigue and depression are two complaints which are found frequently in persons with SLE. Fatigue can lead to a decrease in activity level and a continuing downward spiral of physical fitness in persons with SLE. This process can both lead to and be compounded by depression.

Rothfield (1985) found that 76% of 209 patients complained of fatigue at the time of diagnosis, with an additional 5% complaining of fatigue soon after diagnosis. Liang, et al. (1984) noted fatigue, loss of physical function, independence and social interaction to be prominent in 76 women with active SLE, and further noted a positive correlation between loss of social activity and depression as measured on the Minnesota Multiphasic Personality Inventory.

Cardiac Manifestations. There are reports in the literature of increased cardiac disease among persons with SLE. Rosner et al. (1982) did a multi-center followup study on 1103 patients with SLE in order to determine the various causes of death in this population. These researchers noted that 3% of their sample died because of myocardial infarction -- double the expected number in the normal population. Rothfield (1983) reported that death from myocardial infarction due to inflammation of the coronary arteries is rare but that death from myocardial infarction was the most frequent cause of death in persons who had SLE for ten to twenty years.

A study by Hosenpud et al. (1984) disclosed a 38% incidence of cardiac perfusion abnormalities in 26 subjects with SLE who were asymptomatic with respect to cardiac complaints. These researchers studied 25 female and one male employing Thalium stress testing and M-mode echocardiography. The researchers were unable to differentiate between small and large vessel disease using these methods. They further noted that it was not known how indicative these perfusion abnormalities were of hemodynamically significant epicardial coronary disease in this population.

Haider and Roberts compared coronary artery segments of 21 females and one male with SLE with thirteen controls at necropsy (1981). Those with SLE were found to have 13% of vessels narrowed 76 to 100% (0% in controls) and 20% of vessels narrowed 51-75% (6% in controls). Ten of the 22 persons with SLE had one or more of four major coronary arteries narrowed 76-100%.

In a study by Rothfield (1985), 25% of patients with SLE had pericarditis and 30% had systolic murmurs (1985). Ito et al. (1979) performed electrocardiograms, external carotid pulse tracings and chest xrays on 48 subjects with SLE. Cardiovascular abnormalities were found in 94%, pericardial effusion being the most frequent abnormality (45.8%) and hypertension being the second (27.1%). Other abnormalities were: left ventricular hypertrophy (21.3%), T-wave abnormalities (25.5%), ST depression >.1mv (17%), arrhythmias or conduction block (14.9%), supraventricular premature contractions (8.5%), atrial fibrillation, supraventricular tachycardia and AV block (each 4.3%). and atrial standstill (2.1%).

Bidani, Roberts, Schwartz and Lewis (1980) performed imunopathologic studies on ten autopsied SLE cadavers. They noted pericardial lesions (60%), vascular lesions (60%), myocardial pathology (60%), pericarditis (40%) and valvular lesions (30%). In addition, 80% had documented non-specific ST-T changes and cardiomegaly before death.

The exact mechanism behind these reported increases in cardiovascular disease in persons with SLE is not known. Bidani and others (1980) concluded that immune reactants could be demonstrated in the cardiac tissues of the majority of patients with severe, active and fatal SLE. Haider and Roberts (1981) noted that the higher frequency of pericardial and valvular involvement found in those with severest narrowing suggests a causative immunologic factor. Rothfield (1983) noted that in mouse models, diet-induced atherogenesis could be accelerated by higher circulating immune complex levels. Aldersberg, Schaefer and Drachman (1950) found that cortocosteroids could induce hyperlipidemia and hypercholesterolemia, thus implicating the role of prednisone in the development of cardiovascular disease.

Spiera and Rothenberg (1983) reported on four patients with SLE who suffered myocardial infarction at an early age. All had been on corticosteroids for nine or more years. Three died and of the two who were autopsied, both had atherosclerosis of their coronary arteries, while neither had evidence of arteritis or immune complexes in their coronary arteries. These same authors, however, also note no cases of myocardial infarction under age 35 in 500 persons receiving corticosteroids for inflammatory bowel disease. Thus they offer this theory: In SLE, the coronary arteries are damaged by immune complexes; in the presence of hypertension (aggravated by corticosteroids), atheromatous deposits can more readily occur; myocardial infarction can then ensue.

Because of the preceding reports of increased cardiac abnormalities and cardiac risk factors among persons with SLE, the safety of strenuous exercise in this population is in question.

Pulmonary Manifestations. The literature reports an increase in pulmonary abnormalities among persons with SLE. Rothfield (1983) stated that pleuro-pulmonary manifestations were present in 46% of a sample of patients with SLE during the course of their disease, and that 20% had pleural effusion and 22% had pleuritic rub at time of diagnosis. Gibson, Edmonds and Hughes

(1977) noted a 50% prevalence of pleuritic pain, 50% prevalence of breathlessness and 80% prevalence of pulmonary function abnormalities in their sample of thirty patients with SLE.

Lung involvement in SLE may occur because of deposition of immune complexes in the pulmonary interstitium, thus causing interstitial pneumonitis and chronic dyspnea on exertion and general decreased pulmonary function tests (Rothfield, 1985). Another type of lung involvement in SLE is termed "shrinking lung" and is explained by Rothfield (1983) as follows. Pleural adhesions form which cause chest pain on inspiration (pleurisy). The person with chest pain, therefore, breathes more shallowly and experiences disuse phenomenon due to pain. As a result, the vital capacity of the lung decreases.

Limitations in lung function are capable of limiting the capacity to exercise. They may also contribute to symptoms which in turn may influence whether or not a person chooses to exercise.

While the preceding studies point out an increased prevalence of cardiac and pulmonary abnormalities in persons with SLE, they do not address the current concern. All of these studies, have involved persons with symptomatic, long term, progressive or fatal disease. They often involve subjects who developed SLE before modern treatments were available, and most make no mention of other important variables such as concurrent diagnoses or cardiac and pulmonary risk factors such as cigarette smoking. The question of the safety of endurance exercise in persons with no known cardiopulmonary abnormality remains unanswered. It is this population that nurses are most likely to be counseling regarding exercise.

Exercise in Rheumatic Disease

Advice regarding SLE and exercise is general and somewhat ambiguous. Steinberg (1985) stated that persons with SLE should exercise vigorously but not when their disease is active and not to the point of exhaustion. He recommended curtailing activities and resting when the disease is active. Schur (1983) recommended that persons with SLE participate in a regularly scheduled exercise program which increases and maintains strength, endurance and muscle tone. Rodnan and Schumacher (1983) recommended weight bearing exercise in persons with SLE to prevent osteoporosis. The development of osteoporosis is encouraged by reduced physical activity and steroid medications (Miescher and Beris, 1984). This advice is based on logic and experience; however no research studies are known which support or refute the advisability of exercise in persons with SLE.

One study looked at the effect of diet, exercise and sleep on circulating immune complex (CIC) levels in seven subjects with SLE (Isenberg, Crisp, Morrow, Newham, and Snaith, 1981). Although exercise was one of the variables, their main focus was on reliability of CIC levels. After three minutes of exercising at two-thirds maximum heart rate by age, CIC levels increased in four control subjects (without SLE) and in 3 of 7 subjects with SLE. Although CIC levels are used as markers of clinical activity in SLE, other studies have failed to show a correlation between CIC levels and disease activity in SLE.

The majority of research studies on exercise in rheumatic diseases has been with diseases other than SLE. The first studies were conducted by Swedish investigators, Ekblom, Lövgren, Alderin, Fridström, and Sätterström (1974; 1975). The first study (1974) documented lower physical performance levels in 31 females with rheumatoid arthritis (RA) compared to a control group of five females without RA. Tests included bicycle ergometry, an 850 meter walk, stair climb, step test, and test of muscular strength. The question was raised, "Is the low physical performance due to disease or inactivity?" These same researchers conducted a six month followup study on 23 patients with RA who underwent five weeks of physical conditioning (1975). They found that subjects who continued to exercise on their own for six months maintained or improved on their exercise endurance, walk times, etc., while those who stopped training did not. On followup, these researchers also noted that those in the physical training group had no worse joint status. Four of 13 had returned to full time work. There were many positive comments regarding good effects of exercise on functional status and attitudes.

Nordemar, Ekblom, Zachrisson and Lundqvist (1981), compared 23 subjects with RA who had been given physical training for 4-8 years to a control group with equal disease severity that did not exercise. They noted significantly less progress of X-ray changes in the joints of the exercising patients compared with control patients. They also noted better disease outcome with less sick leave in the active group. Nordemar (1981) in this same group, reported higher capacity for activities of daily living among the active group and more complaints of weakness and joint discomfort in the untrained group.

Norwegian rheumatologists, Bjorholt et al. (1982) reviewed available literature and set guidelines for training in rheumatic disease. They listed precautions for RA, ankylosing spondylitis, Reiter's disease, gout and juvenile arthritis. In general, they advocated training but cited the need for controlled studies with objective methods of measuring joint function and work capacity in patients with arthritis to record the value or possible disadvantages of physical activity.

More recently, Beals et al. (1985) measured exercise endurance and physical fitness levels in patients with RA and osteoarthritis (OA), and attempted to determine whether short term, strenuous, non-weight bearing exercise exacerbated joint symptoms. They conducted a 12 week training program with 21 female subjects with RA. Eleven subjects exercised three times per week for 15, 25, or 35 minutes duration, while six women served as controls. All exercisers improved in aerobic capacity, exercise time, and joint counts and had self described improvement in joint pain and fatigue. Joint symptoms were monitored and thermography performed after one of the exercise sessions. It was concluded that neither joint inflammation nor joint symptoms increased after any one session of strenuous, non-weight bearing exercise.

Perlman, Connell, Alberti, Conlon and Mueller (1985) reported that subjects with RA were able to participate in a vigorous exercise program without adverse joint effects and noted that a combined exercise and problem solving program provided psychological benefits to the subjects. Minor, Hewitt and Kay (1986) concluded that endurance exercise in the form of walking or pool exercise did not result in significant changes in joint count, morning stiffness, grip strength, walking time or pain; although improvements were noted in walking time, morning stiffness, pain and grip strength. Young and Minor (1986) studied the efficacy of physical conditioning programs in 61 persons with RA and OA. Physical conditioning consisted of pool exercise or walking programs for one hour three times per week. The investigators noted improved endurance in the exercise group after 12 weeks as compared to a control group which did only range of motion exercise three times per week. Both groups were randomly assigned.

In summary, vigorous exercise has been found to be safe and beneficial in persons with rheumatoid arthritis and osteoarthritis. Although exercise is thought to be beneficial for persons with SLE there are a lack of studies documenting its safety and efficacy in this group. Before recommending vigorous endurance exercise, health providers need guidelines regarding the safety of such recommendations.

Exercise in Chronic Disease

Researchers have begun to assess the contribution of physical fitness to the health status of persons with chronic diseases. Questions frequently asked are (1) can persons with specific chronic diseases improve their physical fitness? and (2) what influence does exercise have on the individual's disease course and overall health status and function?

Exercise and Cardiac Disease. There have been several studies of exercise in persons who have had myocardial infarction (Kennedy et al. 1973; Kentala 1972; Bruce, Frederick, Bruce, and Fisher 1976). Kentala (1972) evaluated the effects of 12 months of supervised physical training in 158 male patients with recent myocardial infarction. Physical working capacity was found to be higher and body fat by skinfold was found to be lower among those who were more compliant with the exercise schedule. Kentala found that exercise was not a factor in reducing mortality in this group.

Kennedy et al. (1973) studied eight males with stable angina pectoris who exercised at 75-85% of maximum pulse rate three times per week for one year. They found that five of eight patients had an increased exercise tolerance. The authors noted that the three who had minimal or no change had irregular attendance at the exercise sessions. No increase in coronary collateral circulation as measured by angiography was noted. All experienced a decrease in angina and an increase in self esteem and a more positive attitude towards their work and disability.

Oldridge, LaSalle and Jones (1980) evaluated 28 female cardiac patients who were referred to a supervised exercise rehabilitation program. Participants exercised three times per week for 30 to 40 minutes of treadmill or ergometry and 20 to 30 minutes of volleyball. Exercise tolerance and maximum heart rate improved and all patients claimed they were better able to carry out activities of daily living with greater self assurance and fewer problems than before entering the program. The investigators stressed the importance of this subjective improvement in daily life. This group did not study mortality rates.

Coronary artery disease is highly associated with hypertension, hyperlipidemia (Denolin, 1977), low HDL levels (Castelli, Doyle, and Gordon, 1977), and cigarette smoking. Vigorous exercise has been shown to favorably modify blood pressure (Naughton, Shanbour, Armstrong, McCoy and Lategola, 1966); hyperlipidemia (Shephard, 1981); and HDL levels (Wood, Klein, Lewis,and Haskell, 1974).

Exercise and Pulmonary Disease. Studies concerning exercise and pulmonary disease have focused on chronic obstructive pulmonary diseases (COPD) which include asthma, chronic bronchitis and emphysema. Breathlessness and related weakness, fatigue and activity intolerance are the major disabling effects of COPD. Glass (1981) stated that the downhill spiral of increased shortness of breath, decreasing activity, deconditioning and increasing shortness of breath can be retarded by therapeutic use of exercise.

In evaluating the benefits of a pulmonary rehabilitation program which included exercise training, McGavin et al. (1977) noted that although objective measures of lung function and oxygen uptake did not change, almost all of the exercise subjects improved subjectively and objectively in their tolerance for exercise. Exercising subjects showed significant improvements in breathlessness, well-being, cough, sputum production, 12 minute walk time, length of stride and exercise tolerance. The study involved 12 men each in an exercise and control group. Exercise consisted of progressive stair climbing. Evaluation consisted of spirometry, a 12 minute walk, questionnaires, and graded bicycle ergometry with expired gas analysis.

Cockcroft, Saunders and Berry (1981) studied the effects of exercise training which included bicycle ergometers, rowing machines, swimming, walking and stairclimbing in 39 male subjects with pneumoconiosis and COPD. Eighteen subjects in the exercise group experienced significantly greater feeling of well-being, increased 12 minute walk distance, and improvement in breathlessness, cough and sputum production compared to 16 subjects in the control group. Measurements of lung function and oxygen uptake did not significantly change.

Studies regarding the effects of exercise on patients with chronic lung disease have shown encouraging results. Although exercise has not improved lung function itself, it has been shown to increase exercise tolerance and feelings of wellbeing, two parameters which enhance patients' quality of life.

<u>Stress Testing</u>

Froelicher (1983) defined stress testing as observing and recording the human being's response to its most common physiologic stress -- exercise. Clinical exercise testing serves several purposes as are listed below (ACSM, 1986, p.1):

(1) to aid in diagnosing coronary artery disease in asymptomatic or symptomatic individuals
(2) to assess the safety of exercise prior to starting an exercise program
(3) to assess the cardiopulmonary functional capacity of apparently healthy or diseased individuals
(4) to follow the progress of known coronary or pulmonary disease
(5) to assess the efficacy of various medical and surgical procedures including the effect of medications

The first two purposes of stress testing may be termed "diagnostic" while the latter three may be termed "non-diagnostic" or "functional" (Wilson, 1977). The stress test is preceded by a screening history and physical exam to rule out any contraindications to testing such as those listed below (ACSM, 1986, p.13):

(1) Recent acute myocardial infarction (MI)
(2) Unstable angina
(3) Uncontrolled ventricular dysrhythmia
(4) Uncontrolled atrial dysrhythmia which compromises cardiac function
(5) Congestive heart failure
(6) Severe aortic stenosis
(7) Suspected or known dissecting aneurism
(8) Actual or suspected myocarditis
(9) Thrombophlebitis or intracardiac thrombi
(10) Recent systemic or pulmonary embolus
(11) Acute infection
(12) Third degree heartblock
(13) Signs of emotional distress
(14) A recent significant change in resting ECG
(15) Acute pericarditis

The preliminary screening often includes pulmonary function testing, as it aids in identifying persons with respiratory limitations, and thus aids in interpreting results of the stress test.

Stress testing is done while the subject engages in isotonic exercise involving large muscle groups. Bench stepping was a popular mode of stress testing exercise until recent years when it was virtually replaced by the bicycle ergometer and treadmill. The bicycle ergometer has the advantage of easier monitoring of ECG and BP, but more problems with leg fatigue; the treadmill utilizes walking, a more universal activity, and is therefore not as limited by untrained muscle groups.

One of several protocols for increasing the intensity of exercise (workload) is utilized. Exercise continues until fatigue or other symptoms prevent further exercise, indications occur which warrant stopping, or until maximum uptake of oxygen is achieved. The subject is observed before, during and after testing and ECG, and patient appearance, blood pressure, heart rate response, symptoms and workload are all monitored. Maximum oxygen uptake (VO_2 max) marks the end point of the stress test, but is also used in determining functional status (fitness level). The VO_2 max is usually estimated using a formula, but may be directly measured with breathing valves and gas analysis equipment.

When used for the diagnosis of coronary artery disease, any of the following criteria constitute an abnormal test (ACSM, 1986, p.22):

(1) One millimeter or more of exercise induced ST segment depression or elevation relative to the Q-Q line, lasting .08 seconds or more from the J-point.
(2) Chest discomfort typical of angina pectoris induced or increased by exercise.
(3) Ventricular tachycardia or frequent (>30% premature ventricular contractions, or multifocal premature ventricular contractions.
(4) Exercise induced left or right bundle branch block.
(5) Significant drop (greater than 10 mm Hg) in systolic blood pressure during exercise, or failure of the systolic blood pressure to rise with an increase in exercise intensity after the initial adjustment period.
(6) Sustained supraventricular tachycardia.
(7) R on T PVCs.
(8) Exercise induced second and third degree heart block.
(9) Post-exercise U-wave inversion.
(10) Inappropriate bradycardia.

When the stress test is used to assess functional status of individuals, the actual or estimated VO_2 max is used to determine fitness levels or exercise capacity. Physical fitness levels are determined by comparing the VO_2 max to normative data such as that in Table 1:

Table 1: Cardiorespiratory Fitness Classification

(American Heart Association, 1972, p. 15)

WOMEN

Maximal Oxygen Uptake (ml/kg/min)

AGE	LOW	FAIR	AVERAGE	GOOD	HIGH
20-29	<24	24-30	31-37	38-48	49+
30-39	<20	20-27	28-33	34-44	45+
40-49	<17	17-23	24-30	31-41	42+
50-59	<15	15-20	21-27	28-37	38+
60-69	<13	13-17	18-23	24-34	35+

MEN

Maximal Oxygen Uptake (ml/kg/min)

AGE	LOW	FAIR	AVERAGE	GOOD	HIGH
20-29	<25	25-33	34-42	43-52	53+
30-39	<23	23-30	31-38	39-48	49+
40-49	<20	20-26	27-35	36-44	45+
50-59	<18	18-24	25-33	34-42	43+
60-69	<16	16-22	23-30	31-40	41+

Stress testing for functional assessment also gives information which is useful in prescribing exercise such as a person's "anaerobic threshold". "Anaerobic threshold" indicates a ventilatory inflection point when ventilation and oxygen consumption become nonlinear. This is a point below which exercise intensity is advised for optimum results. The "anaerobic threshhold" can be estimated using heart rate and work load or can be extrapolated from data obtained with gas analysis apparatus.

There is some controversy as to the value of exercise testing to screen asymptomatic individuals for coronary artery disease or other cardiac anomalies. At best, studies show specificity to be

80-90% in men and about 70% in women and sensitivity at 60-80% overall (ACSM, 1986). Chung (1983) attributes the high incidence of false positive results to errors in interpretation of S-T, T wave changes, and less than optimum testing circumstances. Computerized interpretation of exercise tests may enhance the interpretation of questionable tracings in the future and allow greater reproducibility.

Recommendations vary regarding stress testing in individuals planning to participate in vigorous exercise. Chung (1983) advocated stress testing in all such individuals, as he felt it provides useful information regarding the diagnosis of coronary artery disease and identification of high risk individuals, and it provides information concerning the individual's functional capacity. Goldberg and Elliot (1984) recommended stress testing in men over 35, women over 45 and in younger persons with high risk or cardiovascular abnormalities before engaging in strenuous exercise. The American College of Sports Medicine (1986) recommended stress testing before exercising in individuals over 45 and in individuals with one or more of the following risk factors:

1. History of high blood pressure (>145/95)
2. Elevated total cholesterol:HDL cholesterol ratio >5
3. Cigarette smoking

4. Abnormal resting ECG -- including evidence of old MI left ventricular hypertrophy, ischemia, conduction defects, or dysrhythmias
5. Family history of cardiac or other atherosclerotic disease prior to age 50
6. Diabetes mellitus

The cost/benefit value of stress testing in persons with inflammatory rheumatic disease but without indications of cardiopulmonary involvement remains unanswered.

Conceptual Framework

SLE is a complex disease that, because of arthritis and fatigue, can lead to low levels of physical fitness and increasing functional impairment. Evidence exists that exercise is safe and can assist in maintaining functional status in persons with arthritis. Vigorous exercise has been shown to benefit persons with other chronic diseases, and in particular, those with cardiac and pulmonary disease. It is not known whether vigorous exercise would be safe or of benefit to persons with SLE. This study, then, describes the results of stress testing in women with SLE and addresses the following questions:

(1) Is there an increased prevalence of abnormal stress test results in women with SLE?

(2) Is it safe for women with SLE to begin an endurance exercise program?

Operational Definitions of the Concepts

Women with SLE . Women with SLE are women who meet the diagnostic criteria outlined on page 5, and defined in Appendix A.

Stress testing . Stress testing includes measurements and observations made during bicycle ergometry for the purpose of both diagnostic and functional assessment.

Abnormal Stress Test Results . Abnormal stress test results consist of stress ECG's which are interpreted as "abnormal according to the criteria listed on page 22.

Safety of Endurance Exercise . The safety of endurance exercise is determined by observations of heart rate, blood pressure, and symptoms before, during and after the stress test and results of the resting ECG, pulmonary function tests and stress ECG.

Assumptions of the Study

Three assumptions were made in this study:

1. Subjects participating in this study were representative of all women who have SLE without indications of cardiac and pulmonary complications who meet eligibility criteria.
2. All subjects had identical test protocols.
3. ECG and pulmonary abnormalities are detectable by the protocol utilized.

Chapter II: Methods

Study Design

This study used a descriptive design. Data were collected concurrently with data for studies entitled, "The Effect of Physical Conditioning on Fibrositis Patient Outcome" (Clark, unpublished) and "Physical Fitness Tests for Clinical Use: Validity Testing" (Burckhardt and Clark, unpublished).

Sample and Setting

The sample consisted of ten female volunteers with SLE who were recruited from the rheumatology clinic of a university hospital setting and from various local rheumatologists' private practice settings. All subjects met the ARA criteria for SLE (listed in appendix A), and did not meet any of the following exclusionary criteria: (1) presence of another rheumatic disease; (2) age<20, or>59; (3) known cardiovascular disease; (4) insulin dependent diabetes; (5) pregnancy; (6) taking any medication that might interfere with response to strenuous exercise (e.g. beta blockers); and (7) acute exacerbation of their SLE by physician report. Exclusionary criteria were used in an attempt to rule out extraneous variables that could contaminate the study.

Instruments

Questionnaire.

A two page questionnaire sought demographic and medical history information on each subject (see Appendix B).

Spirometer. A Gould 5000 spirometer was used to measure pulmonary function in order to aid in identifying persons with respiratory limitations and to help in interpreting the stress test results. Measurements included FVC, FEV_1, FEF25-75%, and FEF75-85%. Definitions of these parameters are as follows (Gould, Inc., 1983):

(1) FVC: The forced vital capacity is the vital capacity (liters) performed with a maximally forced expiratory effort.

(2) FEV_1: The forced expiratory volume timed is the volume of air (in liters) exhaled in one second during the performance of the forced vital capacity.

(3) FEF25-75% The forced expiratory flow from 25-75% of FVC is the mean expiratory flow (in liters per second) during the middle half of the FVC.

(4) FEF75-85% The forced expired flow from 75-85% of FVC is the mean expiratory flow (in liters per second) from 75% to 85% of the FVC.

Results on any of the above below 80% predicted were considered abnormal.

Bicycle Ergometer. Stress testing was accomplished using a Corival 300 bicycle ergometer which is electronically calibrated for workload in watts, regardless of cycling speed. The workload is independent of body weight.

Electrocardiograph (ECG). Each subject was connected to a Marquette Case II computerized, 12 lead ECG with continuous monitoring and printout capabilities. Resting and stress ECGs were interpreted by a computer program as well as by a physician. The same physician did all of the interpretations. Criteria for abnormal ECG listed in table 2 on page 22 were used. Results were listed as either abnormal or normal. Any abnormal results were described according to criteria involved.

Respiratory Apparatus. A Hans-Rudolph two-way respiratory valve was used to transfer subjects' expired air into a mixing chamber where it was analyzed by a Gould 9000 Pulmonary Exercise Laboratory. Minute ventilation and expired gases were analyzed for CO_2 and O_2 concentration using an infrared and paramedic analyzer respectively. This allowed continuous monitoring of O_2 utilization (VO_2) in milliliters per kilogram per second.

Sphygmomanometer and stethoscope. A Tycos@ brand sphygmomanometer and Littman@ stethoscope were used to measure subjects' blood pressures before, during and after the stress test. The sphygmomanometer was calibrated routinely. Normal resting blood pressure was considered to be 100/60 to 140/90. Systolic blood pressure was expected to rise with increasing workload; and a decrease of 10mm Hg. or more were considered abnormal.

Exertion Scale. The new Borg Perceived Exertion Scale (RPE), a 10-point visual scale with anchors (ACSM,1986), was used to note the subjects' tolerance to exercise (see Appendix C). A "9" was considered equivalent to volitional exhaustion at which time the testing was terminated.

Procedure

Volunteers who met the eligibility criteria were scheduled for testing. They were advised to eat breakfast as usual and report at 9:00 a.m. wearing loose clothing and footwear suitable for exercise.

When each subject reported as scheduled, she was asked to read and sign a consent form (see Appendix D for Committee on Human Research approval and consent form). Each subject was then assigned a code number for the purpose of assuring anonymity. Each subject was then asked to fill out the questionnaire.

Prior to stress testing, each subject signed a special consent form required by the testing laboratory (Appendix F) then underwent a screening history and physical examination by the physician, which focused on identifying cardiovascular or pulmonary abnormalities which could affect test results or put the subject at risk. The subject was then asked to rest in a supine position for five minutes, after which a standard 12 lead ECG was taken. Next, standard spirometry readings were taken.

Each subject was then asked to mount the bicycle ergometer and the respiratory apparatus was attached. Each subject began to peddle at a work load of zero for one minute while baseline data was collected. The workload was then increased to 16 watts and increased by 16 watts each minute until the subject reached volitional exhaustion or was unable to tolerate any more exercise because of pain or other symptoms. The subject was asked to rate her perceived exertion at each increase in workload, and blood pressure measurements were recorded at these intervals as well. Each subject then "cooled down", that is, continued to exercise at a work load of zero for three to five minutes, so that her heart rate could gradually return to near normal levels. An ECG was recorded continuously. Each subject was then observed and electronically monitored for five to fifteen minutes, at which time the test session was concluded.

Data Analysis

Questionnaire items and stress testing measurements were used to describe the sample and answer the research questions (1) What is the prevalence of abnormal stress test results in women with SLE? and (2) Is it safe for women with SLE to begin an endurance exercise program? using measures of central tendency (mean or mode, where appropriate) and measures of standard deviation.

Chapter III: Results

Description of the Sample

Ten women with SLE participated in the study. Three were recruited from the rheumatology clinic of a university hospital and seven were referred from local private rheumatology practices. Table 2 lists demographics and Tables 3 and 4 list health characteristics of each of the ten subjects.

Table 2: Demographics of the Sample

Subj. #	Age	Race*	Marital Status **	Education (years)	Occupation	Employed (hrs./wk.)	Total Family Income
1	33	W	M	13	Home	NA	35,000
2	35	W	M	16	Clerical	0	31,200
3	36	A	M	14	Clerical	22	40,000
4	43	W	D	18	Clerical	40	30,000
5	29	W	M	13	Manager	17.5	15,000
6	36	W	M	17	Semi-Prof.	0	12,000
7	38	W	S	19	Semi-Prof.	8	10,000
8	47	W	D	12	Clerical	0	
9	29	W	M	16	Sales	15	22,000
10	39	W	M	16	Manager	40	27,000

* W=White; A=Asian
** M=Married; D=Divorced; S=Single

Table 3: Medical History Information of Sample Part A

Subj. #	Weight (lbs.)	SLE Symptoms (Years)	SLE Diagnosis (Years)	Perceived Disease Severity	Disabled Related to SLE	Meds for SLE*
1	92	2	1	5	No	N P
2	192	8.5	8	8	Yes	P I
3	114	5	5	8	No	P A
4	160	21	5	7	No	P A
5	132	8	2	5	No	P A
6	130	2	2	5	Yes	P
7	128	3.5**	21**	4	Yes	P A
8	162	3	1	3	Yes	N
9	105	6	5.5	3	No	P A C
10	132	2	2	9	No	N

*N=NSAID P=Prednisone A=Antimalarial I=Immune modulating

** Subject #7 was diagnosed for 21 years; but symptomatic for 3.5 years

Table 4: Medical History Information of the Sample Part B

Subj. #	Other Disease	Number Other Meds	Vitamins	Calcium	Smoker	Regular Exerciser
1	Asthma	6	No	No	No	No
2	Asthma*	6	Yes	Yes	No	No
3	None	0	Yes	Yes	No	No
4	Allergies	3	Yes	No	No	No
5	None	2	No	No	No	No
6	Waardenberg	1	No	Yes	Yes	Yes
7	None	0	No	No	No	Yes
8	Nephritis	0	Yes	No	No	No
9	None	0	No	No	No	No
10	None	0	No	No	No	No

*also migraines, seizure disorder

Mean age of the sample was 36.5 (range= 29-47, S.D.=5.7). Nine subjects were white; one was Asian. Seven were married, two were divorced and one was single. Mean total family income was

\$24,688./year (range=10,000.-40,000.; median=27,000.) Formal education of the sample ranged from 12-19 years ($\bar{X}$=15.4; S.D.= 2.32).

Occupations of the sample included: 1 homemaker, 5 clerical, 2 managerial, and 2 semi-professionals. Six were employed outside the home for 8-40 hours weekly ($\bar{X}$=17.17 hours) and one considered herself employed full time in the home. Three were unemployed because of "disability associated with SLE" and one felt she was "underemployed" because of the same.

Average weight of the sample was 135.2 lbs. (range = 98-192; S.D.=28.7) The sample had been diagnosed as having SLE for 1-21 years ($\bar{X}$=5.85; S.D. 5.93) had symptoms for 2-21 years ($\bar{X}$=6.1; S.D.=2.16) and presently viewed their disease severity from 3-9 ($\bar{X}$=6.1; S.D.=5.77) on a 10-point visual scale where 1 is least severe and 10 is most severe. Subjects took from one to three medications for their SLE ($\bar{X}$=1.8;S.D=.63). Two took aspirin or NSAIDs alone and eight took prednisone either alone, with NSAID, with antimalarial or with immune modulating.

One subject had nephritis and one had a seizure disorder directly related to their diagnoses of SLE. Two had asthma, one had a history of migraines and one had Waardenberg's Syndrome, a congenital anomaly affecting her inner ear. They took 0-6 additional regular medicines not counting vitamins or calcium ($\bar{X}$=1.8; S.D.=2.4). Four reported that they took a vitamin supplement. Two reported that they took calcium supplements.

Nine subjects in the sample were nonsmokers and one was a smoker. Two reported doing aerobic exercise at least three times weekly while eight did not.

Stress Test Results

Baseline heart rate(HR), blood pressure(BP), and ECG are listed in Table 5.

Table 5: Baseline Heart Rate, Blood Pressure and ECG

Subj. #	Resting ECG	Resting HR	Resting BP
1	Normal	92	118/80
2	Normal	80	102/70
3	Abnormal*	80	126/70
4	Normal	80	100/78
5	Abnormal*	82	122/84
6	Abnormal*	72	132/88
7	Normal	82	130/74
8	Normal	72	110/60
9	Normal	88	120/80
10	Normal	84	100/76

*Abnormal ECG's were all borderline ST changes.

Mean resting heart rate for the sample was 81.2 (range=72-92; S.D.=6.2) and mean blood pressure was 115.8/77, (range = 100-130/62-88; S.D. 11.98/7.2). Three subjects had abnormal resting ECG's with ST depression and were interpreted as "borderline".

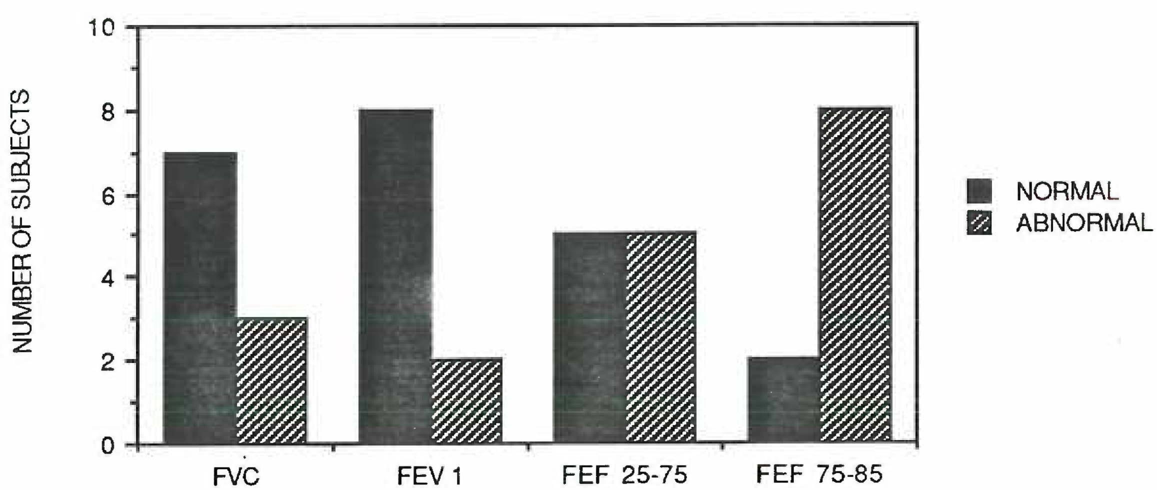
Results of pulmonary function tests are listed in Table 6 followed by Figure 2 which shows percent of normal and abnormal pulmonary function tests in this sample.

Table 6: Pulmonary Function Test Results*

Subj #	FVC	FEV_1	FEF25-75	FEF75-85
1	101	92	55	54
2	100	112	124	129
3	54	46	22	21
4	101	104	80	88
5	63	68	71	51
6	115	104	68	70
7	78	83	86	49
8	93	98	88	70
9	105	101	72	71
10	95	103	111	78

*Results given in percents of predicted

Figure 2: Pulmonary Function Test Results



Eight out of ten subjects had one or more abnormal pulmonary function tests. Three had abnormal FVC, two had abnormal FEV_1; five had abnormal FEF 25-75 and eight had abnormal FEF 75-85.

Tables 7 and 8 list stress test measurements and Figure 2 shows percent normal and abnormal stress ECG's in this sample.

Table 7: Stress Test Results Part A

Subj #	Test Time	HR at AT*	Work at AT*	Max. HR	% Pred. Max. H.R.	Max. Work
1	6:00	164	64	184	97	80
2	7:00	106	64	158	84	112
3	7:20	155	64	170	91	96
4	7:40	122	48	145	79	112
5	5:00	140	64	152	79	80
6	10:20	147	80	177	95	128
7	11:00	152	96	177	96	176
8	6:20	115	80	146	82	96
9	7:00	128	64	153	80	112
10	7:20	133	48	167	90	112

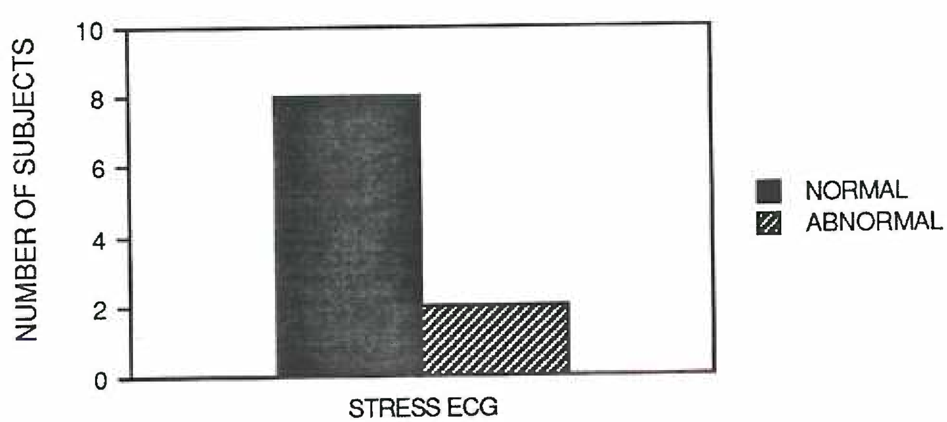
*AT denotes "anaerobic threshhold"

Table 8: Stress Test Results part B

Subj. #	VO Max	Term. RPE	Reason Term.	Stress ECG**	Fitness Level
1	21.22	5	Leg/B*	N	Fair
2	16.08	9	Leg	A	Low
3	20.67	4	Leg	A	Fair
4	16.57	4	Leg	N	Low
5	15.39	5	Leg	N	Low
6	25.08	5	Leg	N	Fair
7	27.80	9	Leg	N	Average
8	20.71	7	Leg	N	Fair
9	20.67	10	Leg	N	Low
10	19.47	9	V.E.	N	Low

* Leg= Leg Fatigue; B= Breathing; V.E.= Volitional Exhaustion
** N=Normal; A=Abnormal

Figure 3: Stress ECG Results



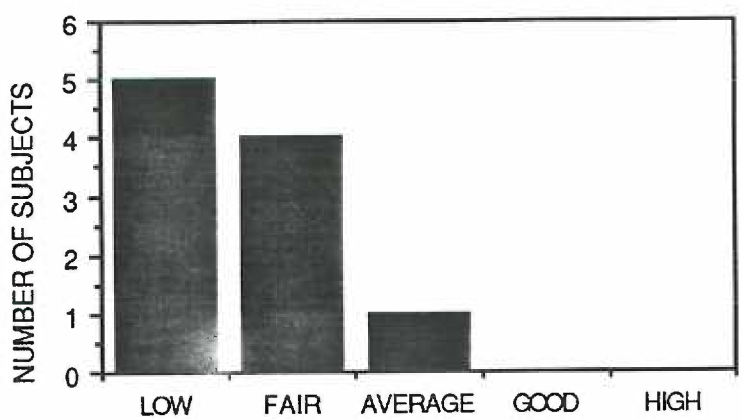
All subjects were able to exercise long enough to reach anaerobic threshhold. Exercise times ranged from 5-11 minutes ($\bar{X}$=7.5; S.D.= 3.87). Subjects reached "anaerobic threshold" at H.R.'s from 106-164 ($\bar{X}$=136.25; S.D.=43.27) and a workloads of

47-93 watts ($\bar{X}$=66.7; S.D.=14.7). Subjects' maximum heart rates achieved were from 146-184 ($\bar{X}$=162.9; S.D.=13.97) and maximum workloads were 80-176 watts ($\bar{X}$=110.4; S.D.=27.66). Maximum oxygen uptake ranged from 15.39-27.80 ml/kg/min. ($\bar{X}$=20.37; S.D.=3.90).

Nine subjects gave "leg fatigue" as their reason for terminating the stress test. One stated she had reached her maximum effort. RPE at termination ranged from 4-10 ($\bar{X}$=6.7; S.D.=2.36).

One subject of ten complained of feeling "faint" after completing the stress test (Subject #1), a symptom which subsided after she had lain down for ten minutes. Two subjects' stress ECG's were interpreted as "abnormal", both because of ST depression. One of these subjects had an abnormal resting ECG, while the other did not. One subject's fitness level was "average"; four were "fair"; and five were "low". Fitness levels of the subjects are shown in Figure 4.

Figure 4. Fitness levels



Subjects #6 and #7, who exercised regularly, had increased exercise tolerance, i.e. increased test time, greater maximum workload attained, higher VO_2 max, and consequently higher fitness levels.

Chapter IV: Discussion

Review of the literature suggested that persons with SLE have increased prevalence of both cardiac and pulmonary disease, which may affect the safety of endurance exercise in this group. This study examined the results of exercise endurance testing in women with SLE and will now discuss those results in relation to the two research questions posed by this study: (1) Is there an increased prevalence of abnormal stress test results in women with SLE? and (2) Is it safe for women with SLE to begin an endurance exercise program? This section will also discuss (1) the relationship between the variable of exercise and functional capacity; (2) other findings of interest; and finally, (3) limitations of the study.

Research Question #1: Is there an increased prevalence of abnormal stress test results in women with SLE?

A high incidence of abnormal stress ECG's was expected in the sample of women with SLE. Findings, however, did not meet those expectations. Only two subjects or 20% of the sample had abnormal stress ECG's, and these were interpreted as minimal, borderline ST depression.

A possible explanation for a lower than expected incidence of abnormal stress ECG's in this sample is related to length of disease. Rothfield (1983) pointed out the high frequency of myocardial infarction in persons who have had SLE for 10-20 years. Ninety percent of the sample had had SLE for only eight years or less; and 80% of the sample had had SLE for only 5.5 years or less. Interestingly, the subject with the longest duration of disease -- 21 years -- was not among those with an abnormal stress ECG.

The role of corticosteroids in the development of hypertension, hyperlipidemia and hypercholesterolemia, all risk factors for the development of cardiovascular disease, has been previously discussed (Aldersberg et al., 1950; Spiera and Rothenberg, 1983). All but two of the subjects were taking prednisone. Both of the subjects with abnormal stress ECG's were on prednisone -- one on the highest dose in the group (30 mg. per day) -- the other on only 4 mg. per day. Greater number of years on corticosteroids would predictably favor an increase in cardiac side effects; but this was not evident in this sample.

Because the specificity of stress tests in women without disease is only 70% (ACSM, 198), there is a 30% probability that the two subjects with abnormal stress ECG's are false positives. Conversely, with sensitivity of stress testing somewhere between 60-80% (ACSM, 1986), there is a chance that two to four of the eight subjects with normal stress ECG's actually do have cardiovascular disease. Though the stress test has relatively low yield for diagnosing cardiovascular disease, expecially in asymptomatic persons, it is important information to obtain. Having a baseline stress ECG gives the nurse something with which to compare future stress ECG's. Those with abnormal stress ECG's can be monitored for increasing abnormality on future tests or for the possibility that the abnormality is occurring at a lower work level. Those with normal baseline stress ECG's can be followed for a possible future change to abnormal. An abnormal stress ECG in a person with a previously normal test is usually a true positive (Morris, 1978).

Research Question #2: Is it safe for women with SLE to begin an endurance exercise program?

The answer to whether or not beginning an endurance exercise program is safe for women with SLE is based on observations of heart rate, blood pressure, and symptoms before, during and after the stress test and on results of the resting ECG, pulmonary function tests and stress ECG. It assumes that a careful screening process to identify individuals in whom exercise would be contraindicated has taken place. The findings of the various parameters will now be presented along with their relevance to the research question.

Heart rate. Mean resting heart rate in the sample was 81.2 with a range of 72-92 (S.D.=6.2) All subjects were within the normal range of 60-90 except one which was 92. This particular subject was taking medications for asthma which are known to increase heart rate. All subjects' resting heart rates were obtained in the exercise laboatory and are probably somewhat higher than if they were obtained upon wakening, as is recommended. Many persons are slightly anxious or apprehensive when undergoing stress testing, a factor which can increase the heart rate.

None of the subjects had a very slow or very rapid resting heart rate, which are two relative contraindications to endurance exercise (ACSM, 1986). All subjects had appropriate increases in heart rate with increases in work load. There were no heart rate findings that would contraindicate endurance exercise in this sample.

Blood pressure. Endurance exercise is contraindicated in persons with resting systolic blood pressure >200 or resting diastolic blood pressure >120 (ACSM, 1986). Blood pressure in the sample ranged from 100-130 systolic and 62-88 diastolic. All were within the normal range. During stress testing, no abnormal blood pressure response occurred in any of the subjects such as a >10mm drop in systolic blood pressure with exercise, or a failure of the systolic blood pressure to rise with an increase in work load.

There were no blood pressure abnormalities which would lessen the safety of endurance exercise.

Resting ECG . Three subjects had borderline positive resting ECG's, all of which involved ST depression. Specificity of the resting ECG is even less than for the stress ECG, especially with respect to ST depression in asymptomatic individuals. There are some ECG changes which would contraindicate endurance exercise at least until further workup takes place. These are: signs of recent acute MI, uncontrolled ventricular dysrhythmia, uncontrolled atrial dysrhythmia which compromises cardiac function, third degree heart block or significant, new ECG changes. None of the subjects exhibited any abnormalities which would contraindicate endurance exercise. If the sujects with ST depression truly do have coronary insufficiency, an endurance exercise program would not be contraindicated, but rather highly advisable -- one that is carefully and individually prescribed by the nurse.

Pulmonary function tests . An increased prevalence of pulmonary abnormalities was expected in the sample. This expectation was met in that 80% of the subjects had 1-4 abnormal pulmonary function tests. Eight subjects had evidence of an obstructive pattern in the smaller and/or smallest airways, a finding characteristic of interstitial pneumonitis. Three of these were more severe in that they were below 60% of predicted.

Three subjects had decreased FVC's, a characteristic of "shrinking lung" or disuse phenomenon (Rothfield, 1983). Subject #7's FVC was only slightly abnormal and may have been influenced by the variable of being a smoker.

Abnormal lung findings do not contraindicate exercise. Occasionally they can lead to cardiac abnormalities with exercise, a fact which highlights the importance of doing stress testing. Abnormal lung function can cause breathlessness or other symptoms which will need to be taken into consideration by the nurse in prescribing exercise.

Stress ECG . The results of the stress ECG were given in discussing question #1. Besides ST depression, none of the criteria for an abnormal stress test (listed on page 22) were met; therefore endurance exercise would not be contraindicated in any of the subjects.

All subjects completed the testing without significant adverse symptoms or events. Based on results for this sample, the answer to research question (2), therefore, is a qualified, "Yes, it is safe for women with SLE to begin an endurance exercise program," providing careful individual screening which includes stress testing, pulmonary function tests, and counselled supervision are provided by competent nurses.

Exercise and Functional Capacity

An interesting finding was that the two subjects who reported they did aerobic exercise at least three times per week were able to exercise longer, achieve greater maximum work loads, had greater VO_2 max and higher fitness levels than the eight subjects who did not regularly exercise. The argument is always raised that perhaps these two "fitter" subjects were generally in better health and physical condition to begin with and were thus better able to participate in regular exercise. It is interesting to note that neither of these subjects perceived their disease severity to be less than the subjects who did not exercise, and they were two of the four subjects who felt they were "disabled" due to SLE.

These findings may indicate that women with SLE who participate in regular aerobic exerise are better able to improve or maintain their fitness levels than those who do not exercise. Whether this improved physical fitness might interrupt the downward spiral of deconditioning and positively impact disease status, functional status, or quality of life is unclear.

Other Topics

Reason for test termination. Leg fatigue, the reason nine subjects gave for test termination, introduces the possibility that stress testing was below a level of intensity that would show

ECG or blood pressure changes. Though this has no effect on the usefulness of the stress test for functional testing, it does raise questions regarding its value for diagnosis. Subjects in the sample did achieve fairly high heart rates despite being limited by leg fatigue. The lowest was 79% and the highest was 97% of the maximum predicted heart rate.

A disadvantage of using the bicycle ergometer for stress testing has been that it requires maximum effort by muscle groups which may be untrained in most people. Degré (1977) stated that a number of studies have shown that subjects are more likely to reach their maximum effort on a treadmill, even though subjects still complain of leg fatigue.

Rated Perceived Exertion (RPE). Borg's new RPE scale (ACSM, 1986) was used to evaluate subjects' level of exertion in order to determine when maximal effort or endpoint of the stress test was reached. Only four subjects reported RPE's of 9 or 10 (maximal exertion) as testing was terminated. One subject reported an RPE of 7 and five subjects reported an RPE of 4 or 5.

The RPE's in this sample were relatively low and did not correlate well with oxygen uptake as they have in other studies (ACSM, 1986). Subject #1, for instance, exercised for six minutes, achieved a maximum heart rate of 184 (97% of predicted), and felt breathless, but rated her exertion to be only 4(somewhat strong).

Leg fatigue may have been such an overriding symptom in this sample, that subjects were unable to perceive their exertion. Or, perception of exertion may have been hard to elicit in a population plagued by chronic fatigue. For whatever reason, nurses should seek other parameters such as breathing pattern and heart rate, for monitoring exercise intensity during exercise in women with SLE.

"Anaerobic Threshold" . All subjects reached "anaerobic threshold". Heart rate at "anaerobic threshold" ranged from 106-164, while work load ranged from 48-96 watts. Knowing the heart rate and work load at anaerobic threshold enables nurses to prescribe individualized target heart rates and exercise intensities. Persons who exercise beyond their anaerobic threshold are more likely to experience extreme fatigue and breathlessness without added benefits in fitness. In women with SLE, these added symptoms could encourage noncompliance with an exercise program and potential loss of benefit.

Limitations of the Study

(1) The size of the sample was small; thus findings are limited in their significance and generalizability.

(2) Length of disease in the subjects was relatively short, making findings less generalizable to women who have had SLE for longer time periods.

(3) Because subjects volunteered to begin the study, a selection bias may have limited the generalizability of the findings.

Chapter V: Summary, Conclusions, Recommendations

Summary

This descriptive study was undertaken to answer the questions (1) Is there an increased prevalence of abnormal stress ECG's in women with SLE? and (2) Is it safe for women with SLE to begin an endurance exercise program?

Ten subjects who met ARA criteria for SLE participated in the study by filling out a 2-page questionnaire and undergoing stress testing by bicycle ergometer. Data collected included demographics, medical history, pulmonary function tests, resting and exercise BP, ECG and heart rate, and perceived exertion with exercise.

Thirty percent of the sample had abnormal ST depression at rest, and 20% had abnormal ST depression during exercise. Eighty percent of the sample had one or more abnormal pulmonary function tests. Despite abnormalities in test results, no contraindications to exercise were noted in the sample. The two subjects who regularly exercised had better exercise tolerance than those who did not exercise.

Conclusions

1) There is no increased prevalence of abnormal stress test results in this sample of women with SLE.
2) It is safe for women with SLE in this group to begin an endurance exercise program with competent counseling and supervision, provided their disease is not in exacerbation.
3) Regular endurance exercising is positively associated with better fitness levels and greater exercise tolerance.

Recommendations for Further Testing

1) This study should be repeated with a larger number of subjects. Recruitment of subjects should be directed towards a wide audience of women with SLE and every effort made to determine differences between persons who volunteer vs. persons who decline participation.

2) A longtudinal study should be undertaken which attempts to document the effects of endurance exercising on women with SLE, with specific attention to its effects on:

   a. disease status in general
   b. steroid induced osteopenia
   c. steroid induced hypertension
   d. steroid induced hyperlipidemia
   e. psychological wellbeing
   f. functional impairment
   g. quality of life

Recommendations for Nurses

Caution must be taken in interpretation of results with such a small N.

1) Prior to beginning an endurance exercise program, women with SLE should be carefully screened, specifically evaluating cardiac and pulmonary symptoms.
2) Screening should include pulmonary function testing and functional and diagnostic stress testing.
3) Exercise prescriptions for women with SLE should be individualized according to the test results.
4) Women with SLE should exercise with proper supervision.

5) Nurses should monitor individual responses to exercise, utilizing measures available to nurses such as the 12-minute walk test.

6) Nurses should teach individuals to exercise properly and provide ongoing supervision.

7) Nurses should continue to evaluate the safety and potential benefits of endurance exercise in women with SLE.

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Appendix A: 1982 Revised Criteria for Classification of SLE (Rodnan and Schumacher, 1983,p.211)

1.	Malar rash	Fixed erythema, flat or raised, over the malar eminences,tending to spare the nasolabial folds
2.	Discoid rash	Erythematous raised patches with adherent keratotic scaling and follicular plugging; atrophic scarring may occur in older lesions
3.	Photosensitivity	Skin rash as a result of unusual reaction to sunlight, by patient history or by physician observation
4.	Oral ulcers	Oral or nasopharyngeal ulceration, usually painless, observed by a physician
5.	Arthritis	Nonerosive arthritis involving two or more peripheral joints, characterized by tenderness, swelling, or effusion
6.	Serositis	a) Pleuritis--convincing history of pleuritic pain or rub heard by a physician or evidence of pleural effusion OR b) Pericarditis--documented by ECG or rub or evidence of pericardial effusion

Appendix A (Continued)

7. Renal disorder	a)	Persistent proteinuria greater than 0.5 grams per day or greater than 3+ if quantitation is not performed OR
	b)	Cellular casts--may be red cell, hemoglobin, granular, tubular, or mixed
8. Neurologic disorder	a)	Seizures--in the absence of offending drugs or known metabolic derangements; e.g., uremia, ketoacidosis, or electrolyte imbalance OR
	b)	Psychosis--in the absence of offending drugs or known metabolic derangements, e.g., uremia, ketoacidosis, or electrolyte imbalance
9. Hematologic disorder	a)	Hemolytic anemia--with reticulocytosis OR
	b)	Leukopenia--less than 4,000/mm^3 on 2 or more occasions OR
	c)	Lymphopenia--less than 1,500/mm^3 on 2 or more occasions OR
	d)	Thrombocytopenia--less than 100,000/mm^3 in the absence of offending drugs

Appendix A (Continued)

10.	Immunologic disorder	a) Positive LE cell preparation OR b) Anti-DNA: antibody to native DNA in abnormal titer OR c) Anti-Sm: presence of antibody to Sm nuclear antigen OR d) False positive serologic test for syphilis known to be positive for at least 6 months and confirmed by Treponema pallidum immobilization or fluorescent treponemal antibody absorption test
11.	Antinuclear antibody	An abnormal titer of antinuclear antibody by immunofluorescence or an equivalent assay at any point in time and in the absence of drugs known to be associated with "drug-induced lupus" syndrome

Appendix B: Questionnaire

Age: ______

Ethnic Background (please check one)
- [] White
- [] Black
- [] Hispanic
- [] Asian
- [] Native American

Marital Status
- [] Single
- [] Married
- [] Divorced
- [] Widowed

Number of years of formal education: _____

Occupation: ____

How many hours per week are you currently employed? ________

If unemployed, what is the reason? _________________________

Income (total family): __________

Medical History

Number of years since symptom onset: ______

Number of years since your diagnosis: ______

Do you have any other medical condition? ______

If so, please list: ______________________________

Do you smoke? ______

Do you exercise regularly? ______

If so, please list type of exercise ________________

Number of times per week ________________

How many minutes each time? ________________

Think of the worst your disease has ever been as a 10. Think of when it has bothered you the least as a 1. Now on the scale below, circle the number that indicates how severe you think your disease is today.

1 2 3 4 5 6 7 8 9 10

What medications are you currently taking for your disease?

Drug :	Dosage :
______	______
______	______
______	______
______	______
______	______

Do you take any other medications, either prescription or over the counter?

Drug :	Dosage :
______	______
______	______
______	______
______	______

Appendix C: Rating of Perceived Exertion Scale (ACSM, 1986)

0	Nothing at all
0.5	Very, very weak
1	Very Weak
2	Weak
3	Moderate
4	Somewhat strong
5	Strong
6	
7	Very strong
8	
9	
10	Very, very strong
•	Maximal

Appendix D: Committee on Human Research Approval and Consent Form

THE OREGON HEALTH SCIENCES UNIVERSITY

MEMO

Date: September 18, 1984

To: Sharon R. Clark, M.N. MacH 4132

From: Committee on Human Research, MacHall Rm 2170, Ext. 7887

Subj: Review Status of Your Project, ORS # 1637

PLEASE REFER TO THIS NUMBER IN ALL FUTURE CORRESPONDENCE WITH THE COMMITTEE

Title: Prospective Evaluation of the Effects of Physical Conditioning on Fibrositis Patient outcomes.

Date of Review: EXPEDITED

Type of Review: x Initial _____ Annual _____ Re-Review

The Committee reviewed your protocol at its meeting on the above date, and its decision was as follows:

xx 1. To approve the protocol as presented.

_____ 2. To approve the protocol when the Attorney General's Compensation Statement is incorporated into your consent form. For a copy of this statement, please call Donna Buker X7887.

_____ 3. To disapprove the protocol for the following reasons:

_____ 4. To defer the protocol for the following reasons:

Please note that it is in violation of Federal law to enter patients into this study prior to receipt of formal approval by the Committee. Revised consent forms conforming to Committee requirements as submitted will be acknowledged with a formal letter of Committee approval.

Thank you,

[redacted]

Donna Buker, Administrative Assistant
Committee on Human Research

FES:db

NOTE : This thesis project, part of the study entitled "Physical Fitness Tests for Clinical Use: Validity Testing" was covered under this protocol.

THE OREGON HEALTH SCIENCES UNIVERSITY

School of Nursing
Department of Adult
Health and Illness

3181 S.W. Sam Jackson Park Road Portland, Oregon 97201 (503) 225-7839/225-7846

Carol Burckhardt, R.N., Ph.D. and Sharon Clark R.N., M.N. are conducting a study in collaboration with Dr. Robert Bennett and Dr. Linn Goldberg entitled "Physical fitness in patients with rheumatoid arthritis or systemic lupus erythematosus." I have been asked to be a subject in this study.

If I agree to participate in this study, I understand that my participation will include:

1. Bicycle tests with a heart monitor (ECG) and breathing analyzer (gas analyzer).
2. Flexibility testing of my upper legs (hamstrings) and low back which will be measured while I am sitting with my legs straight and feet against a flat surface. I will slowly bend forward to determine how far I can reach down on a yardstick scale.
3. Muscle strength tests in which I will lift soft weights that are strapped to my wrists.
4. A stair climb test in which I will be asked to go up and down a flight of 12 steps as rapidly as possible.
5. A 12-minute walk in a level corridor.
6. A brief medical examination that will consist of height, weight, blood pressure, pulse, and skinfold test for amount of body fat.
7. Answering one questionnaire related to my activities, pain, sleep, mood, and fatigue.

This testing will take approximately 60 to 90 minutes on one occasion.

The risks included in this study are muscle and joint soreness during the exercise. There is a slight risk of fainting during exercise. There is a small chance of heart trouble because of exercise. If any of the above should occur, treatment would be available. I may benefit from this study by being made aware of my level of physical fitness. Current evidence indicates that physical fitness is related to health status in rheumatic disease, and knowing my baseline values may act as a guide to future treatment.

I have talked to Dr. Burckhardt, Ms. Clark or their associates about this study, the details have been explained to me and I have asked those questions that come to mind. I will be assigned a number for purposes of this study. My identity will be known only to the investigators.

"The Oregon Health Sciences University, as an agency of the State, is covered by the State Liability Fund. If you suffer any injury from the research project, compensation would be available to you only if you establish that the injury occurred through the fault of the University, its officers or employees. If you have further questions, please call Dr. Michael Baird at (503) 225-8014." Responsibility for injury incurred during exercise cannot be compensated for by the funding agency of this investigator.

I understand that I may refuse to participate or I may withdraw from the study at any time without affecting my relationship with or treatment at the Oregon Health Sciences University.

I have read the foregoing and agree to participate in the study.

Date:__________ Signature____________________
(patient)

Date:__________ Signature____________________
(witness)

Appendix F: Stress Test Consent Form

The Oregon Health Sciences University
Hospital and Clinics

Informed Consent for
Exercise Electrocardiography

Date Bldg. Fl. Rm.

Unit No.
Name
Birthdate

I hereby authorize and request the physicians and surgeons of the Oregon Health Sciences University Hospital and Clinics to perform Exercise Electrocardiography on

______________________ my ______________________
(Name of Patient) (Relationship)

It has been explained to me and I understand that:

1. During the procedure I will pedal a bicycle ergometer or walk or run on a treadmill while my electrocardiogram is recorded.

2. The exercise will be carried to a limit at which my heart beat is rapid, or I am tired and breathing heavily, or I have discomfort or pain in my chest, or certain changes in the electrocardiogram appear.

3. If heart irregularity occurs, the test will be terminated and I will receive prompt treatment if necessary to reverse any complication. If there is chest pain, I will be permitted to stop the exercise when I feel uncomfortable continuing.

4. The procedure carries a small but significant risk of complication such as prolonged chest pain, heart attack, or heart rhythm irregularity. The risk of serious complication is very small. If any special problems apply, a physician or cardiologist will discuss them with me.

5. I hereby acknowledge that all of my questions have been answered to my satisfaction and that no guarantees have been made concerning the results of this procedure.

______________________ M.D. ______________________
Witness Signature of Patient

6.A-6

Date______________________ ______________________
Signature of Parent or Guardian, if patient is a minor

Time______________________ a.m. p.m.

5699

☐ Please check (X) if this is a telephone monitored consent.

6 A 6 - Rev. 1 7/82

(See instructions on reverse side)

AN ABSTRACT OF THE THESIS OF

DONNA L. NELSON

For the Master of Nursing degree

Date of Receiving this Degree: June 12, 1987

Title: EXERCISE ENDURANCE TESTING IN WOMEN WITH SYSTEMIC LUPUS ERYTHEMATOSUS

APPROVED: [redacted]

Sharon R. Clark, MN, FNP, Associate Professor, Thesis Advisor

Women with systemic lupus erythematosus (SLE) are increasingly requesting advice regarding the feasibility and safety of engaging in exercise programs. There is increased prevalence of cardiovascular and pulmonary disease among persons with SLE. The purpose of this study was to find out whether women with SLE have an increased prevalence of abnormal stress test results and if it is safe for women with SLE to begin endurance exercise programs. Ten women ages 29-47 ($\bar{X}$=36.5) who have had SLE according to ARA criteria for 1-21 years ($\bar{X}$=5.9) were entered into the study. All subjects filled out a 2-page questionnaire, then were stress tested via bicycle ergometry in a human performance laboratory. Workload increased 16 watts/min. (independent of cycling speed). Data collected included demographics, medical history, PFT's,

resting and exercise BP, ECG, and heart rate, and perceived exertion during exercise.

Three subjects had resting ECG abnormalities, and two subjects had a borderline positive stress ECG (all ST depression). Eight subjects had one or more abnormal pulmonary function. Ten subjects exercised for 5-11 minutes ($\bar{X}$=7.6), achieving 79-97% ($\bar{X}$=87%) of their predicted maximum H.R.'s. Nine subjects stopped secondary to leg fatigue. Fitness levels were: Low=5; Fair=4; Average=1. The two subjects who did regular aerobic exercise had better fitness levels and greater exercise tolerance.

There was no increased prevalence of abnormal stress test results in this sample. It was concluded that it was safe for women with SLE in this sample to begin an endurance exercise program which is individualized and monitored by nurses knowledgable in endurance exercise training.