

AN ABSTRACT OF THE DISSERTATION OF

Timothy R. Burnham for the degree of Doctor of Philosophy in Human Performance presented on September 12, 2000. Title: The Effects of Exercise on Physiological and Psychological Variables in Cancer Patients Following Clinical Treatment

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Abstract approved: \_\_\_\_\_

  
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The treatment of certain types of cancers brings with it serious physiological and psychological side effects in cancer survivors, including: decreased aerobic capacity, muscle wasting, body composition changes, fatigue, and a diminished overall quality of life. Exercise may directly influence the physiological side effects of cancer and cancer treatment, and also improve psychological function. The purpose of this study was to examine the effect of aerobic exercise on physiological and psychological function in patients rehabilitating from cancer treatment. A second purpose was to evaluate the differential effects of low and moderate intensity exercise on these variables.

Eighteen survivors of breast or colon cancer (15 female and 3 male, 40-65 years of age) served as subjects. The subjects were matched by aerobic capacity and scores on a Quality of Life questionnaire, and then randomly assigned to a control, low (25-35% heart rate reserve (HRR)) or a moderate (40-50% HRR) intensity exercise group. The exercise groups performed lower body aerobic exercise three times a week for ten weeks. Subject attendance for the exercise sessions was 95%. Following the exercise training, there were no statistically significant differences between the two exercise groups on any of the physiological variables. Therefore the exercise groups were combined into one group for the final analysis. The results revealed statistically significant increases in aerobic capacity ( $p < .001$ ), and lower body flexibility ( $p = .027$ ), a significant decrease in body fat ( $p < .001$ ), and a significant increase in Quality of Life ( $p < .001$ ) and a measure of energy ( $p = .038$ ) in the exercise group when compared to the control group. Measures of fatigue and anxiety significantly decreased ( $p = .029$ ,  $p = .011$  respectively) in the exercise group between the pre and post-study measurements, but were not significantly different from controls ( $p = .160$ ,  $p = .373$  respectively). These results indicate that low and moderate intensity aerobic exercise programs were equally effective in improving physiological and psychological function in this population of cancer survivors. Aerobic exercise appears to be a valuable and well-tolerated component of the cancer rehabilitation process.

**The Effects of Exercise on  
Physiological and Psychological Variables  
in Cancer Patients Following Clinical Treatment**

**by  
Timothy R. Burnham**

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Timothy R. Burnham, Author

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# **The Effects of Exercise on Physiological and Psychological Variables in Cancer Patients Following Clinical Treatment**

## **INTRODUCTION**

As a result of improved diagnosis and treatment, more people are surviving cancer. Today, fifty percent of those diagnosed with cancer are alive five years later (36). However, cancer survival brings with it physiological and psychological side effects including: muscular atrophy, weight changes, lowered aerobic capacity, decreased strength and flexibility, nausea, fatigue, depression and an overall decrease in the quality of life (3,8,13,21,23,35,46,60). The majority of these side effects appear amenable to improvement through regular exercise, and the research that has been conducted with cancer survivors indicates that exercise can be an effective tool in the rehabilitation of cancer patients (11,12,15,38,39,46,71,72,73,77). These studies have shown that cancer patients who exercise as part of their rehabilitation can improve aerobic capacity (38,39), walking speed and distance (11,12), muscular strength (15) and body composition (73). In addition, exercise can reduce nausea (71), reduce fatigue (11,12), and improve quality of life (15,38,77) in cancer survivors.

While exercise appears to have a positive effect on physiological and psychological function in people rehabilitating from cancer treatment, to date, there has been no single study of cancer survivors that has evaluated the effect of exercise on the physiological measures of aerobic capacity, body composition, lower body flexibility, as well as psychological measures of quality of life, energy, fatigue and anxiety. In addition, the previous research on the effects of exercise for cancer survivors has used moderate (65-85% of peak heart rate) (38,39,72,73) or high (80% of maximum heart rate) (11,12) exercise intensities. In light of the Surgeon General's recommendation for the inclusion of moderate physical activity in daily living to improve the health of the American public (67), and the growing

body of literature demonstrating the efficacy of low intensity (33) or “lifestyle” physical activity (14) to yield comparable health benefits as higher intensity exercise, it was of interest in this study to evaluate the effects of two levels of exercise intensity. Therefore, the purpose of this study was to investigate the effect of low and moderate intensity aerobic exercise on physiological and psychological function in people who had survived cancer treatment.

## METHODS

### Subjects

Twenty one people (three males and 18 females, ages 40-65) who were at least two months post-cancer treatment served as subjects. The subjects were recruited from the local area hospital and medical clinic. To be eligible, the subjects had to be cleared by their physician to participate, not currently taking any mood enhancing medications or herbal remedies, and receive a score of seventy or more on the Karnofsky Performance Status Scale (KPS) (Appendix E). The KPS measures functional status based on performance of physical activity and is the most widely used method of quantifying the functional status of patients with cancer (48). Patients surviving breast, colon or lung cancer (the three most common cancers in the region) were accepted as subjects. In addition, the subjects could be surviving any of the three main types of cancer treatment (surgery, radiation, chemotherapy) or a combination of the three. Each subject was informed both verbally and in writing as to the nature and requirements of the study, and all subjects signed and received a copy of the informed consent form. The procedures for this study were approved by institutional review boards of Oregon State University and the St Charles Medical Center (Appendix B).

### Design and Procedure

This study utilized a matched groups, repeated measures design. Subjects were matched by aerobic capacity (relative) and quality of life and then randomly assigned to either a control group (n=7), a low intensity exercise group (25-35% of heart rate reserve, n=7) or a moderate intensity exercise group (40-50% of heart rate reserve, n=7). The control group was instructed to pursue their normal activities and refrain from participating in any new exercise regimens during the study period. The exercise

groups reported for a controlled exercise program three times a week for ten weeks. All subjects reported to the laboratory at the onset of the study for collection of demographic and medical information. Subsequently, the following physiological pre-test measures were collected: maximal aerobic capacity, body composition, and lower body flexibility. The subjects also completed the Quality of Life Index for Cancer Patients and the Linear Analogue Self-Assessment (LASA) psychological measurements. The ten-week study period followed the initial data collection. The same physiological and psychological measures were collected at the end of week 5 and following the end of the ten-week study period.

The emphasis of the supervised exercise program was to develop aerobic conditioning and flexibility. An outline of the initial exercise workout and time devoted to each component appears below.

I. Aerobic Warm-up	3-5 minutes
II. Stretching	5 minutes
III. Aerobic Exercise	14 minutes
IV. Aerobic cool-down	3-5 minutes
V. Stretching	5-8 minutes
<b>Total Time</b>	<b>30-37 minutes</b>

The aerobic exercise was performed on treadmills, stationary bicycles and stair climbing machines. The exercise intensity for the low intensity group started at 25-35% of heart rate reserve, building to approximately 40% of heart rate reserve by week ten. Similarly, exercise intensity for the moderate exercise group started at 40-50% of heart rate reserve and rose to approximately 60% of heart rate reserve by the tenth week. Heart rate was monitored during exercise using a Polar heart rate monitor (Target model). The duration of the aerobic exercise was initially 14 minutes and was divided equally among the three exercise modalities (four minutes and forty seconds on the treadmill, Stairmaster and stationary bicycle in a rotational order). In accordance with the American College of Sports Medicine recommendations (31), the

aerobic exercise period was increased by two minutes a week, such that it was 32 minutes during week ten. Total exercise workout time was 30-37 minutes initially and increased to 50-59 minutes by the end of the ten-week period.

The aerobic capacity test was conducted on a treadmill (Leeson Speedmaster). Subjects first established a comfortable walking pace (1.5 – 4 mph) on the treadmill, then the grade of the treadmill increased one degree every minute. The subjects were verbally encouraged to perform maximally. The test continued to volitional exhaustion. During this test, heart rate was monitored using a heart rate monitor (Polar, Target model). Oxygen consumption was measured using an open circuit indirect calorimetry technique. Before each test, the metabolic cart (Vacu Med Vista Mini CPX) was calibrated to known concentrations of oxygen and carbon dioxide. During the test, the subjects wore a facemask connected to the metabolic cart that allowed them to inhale room air while exhaled gases flowed into the metabolic cart. This permitted quantification of expiratory volumes and concentrations of oxygen and carbon dioxide.

Skinfold measurements were taken using Lange calipers following the procedures described by Jackson and Pollock (1978) (27) and Jackson, Pollock and Ward (1980) (28) for men and women, respectively. For men, measurements were taken at the chest, abdomen and thigh, while the sites for the women were the triceps, suprailliac and thigh. The standard error of the estimate is reported to be  $\pm 3.6\%$  for men (27) and  $\pm 3.9\%$  for women (28). Lower body (hamstring and back) flexibility was measured with the modified sit and reach test using the procedures described by Hoeger (25).

Quality of life was measured using the Quality of Life Index for Patients with Cancer developed by Padilla and coworkers in 1983 (53) (Appendix C). This tool consists of 14 questions divided into three main groups: general physical condition, normal activity and personal attitudes toward the quality of life. The scale consists of a 100 millimeter line with word anchors at each end. The subject marks the line with an "x" at the point they feel applies to them. An example appears below (not to scale).

How much nausea do you experience?

Excruciating \_\_\_\_\_ None

The scores are determined by measuring from the left hand side to the mark made by the subject. All fourteen scores are totaled and divided by fourteen. The higher the score, the greater the quality of life. Padilla et al. (53) report test-retest reliability for the fourteen measures as  $r \geq .60$ . A second measure of reliability, computation of internal consistency using Chronbach's alpha, reveals  $r = .88$ .

Fatigue and emotional distress were measured using a six-item Linear Analogue Self-Assessment scale (LASA) developed by Sutherland et al. (1998) (65) (Appendix D). This scale has been derived from the Profile of Mood States (POMS). It uses analogues to assess fatigue, anxiety, confusion, depression, energy levels and anger. Sutherland and her co-workers tested the reliability and validity of this measure on 60 cancer patients. Test-retest reliability of the LASA averaged  $r = .61$ . When the LASA was validated to the original POMS scale, the correlation was  $r = .79$ . These researchers concluded the LASA was a feasible, reliable and valid measure of emotional distress in cancer patients.

### **Statistical Analysis**

The independent variable in this study was the exercise program. The dependent physiological variables were aerobic capacity, body composition and lower body flexibility. The psychological dependent variables were Quality of Life, and the LASA measures (fatigue, anxiety, depression, confusion, energy, anger). All values were reported as means and standard deviations. An alpha level of  $P < 0.05$  was considered statistically significant. A repeated measures ANOVA was used to determine if the changes to the physiological dependent variables were statistically significant. Non-parametric statistics were used to test for differences between groups for the psychological dependent variables. The Friedman Two Way Analysis of

Ranks was used to determine an overall significant difference between groups. A follow up Mann-Whitney U test was used to determine which groups are significantly different from each other.

## RESULTS

Demographic data pertaining to age, height, gender, Karnofsky score, type of cancer, type of treatment and time post-cancer treatment appear in Table 1. No significant differences were found between the groups on age, height, Karnofsky score or time post-cancer treatment.

**Table 1. Subject Characteristics (mean  $\pm$  standard deviation).**

	Control n = 6	Low Intensity n = 6	Moderate Intensity n = 6
Age in years	56.0 $\pm$ 10.1	54.2 $\pm$ 8.1	50.7 $\pm$ 8.2
Height (cm)	163.8 $\pm$ 10.4	170.2 $\pm$ 8.8	166.3 $\pm$ 7.1
Gender	Female = 5 Male = 1	Female = 5 Male = 1	Female = 5 Male = 1
Karnofsky score	95.8 $\pm$ 6.6	93.3 $\pm$ 12.1	92.5 $\pm$ 4.2
Type of cancer	Breast = 5 Colon = 1	Breast = 5 Colon = 1	Breast = 5 Colon = 1
Type of treatment (Numbers may be greater than n due to combination therapy)	Chemotherapy = 5 Radiation = 2 Surgery = 4	Chemotherapy = 5 Radiation = 5 Surgery = 3	Chemotherapy = 4 Radiation = 3 Surgery = 4
Time post-treatment in months	9.0 $\pm$ 5.3	10.3 $\pm$ 5.1	9.8 $\pm$ 4.2

No subject in any group withdrew from the study, nor did any subjects in the exercising groups suffer an exercise-related injury during the study. The low intensity group had an attendance rate of 97%, while the rate for the moderate intensity group was 92%. The combined exercise group attendance rate was 94.5%. One subject was excluded from the control group when a post-study questionnaire revealed that she had engaged in significant exercise training during the course of the study, contrary to the instructions received for her participation as a control subject. To maintain the

matched group status, the two subjects matched with the excluded control subject were also removed from the analysis. This reduced the size of each group from seven subjects to six.

The means and standard deviations for the physiological variables (aerobic capacity, body composition, modified sit and reach) appear in Table 2. The analysis of variance results revealed no significant differences between the exercise groups on aerobic capacity ( $F = .05$ ,  $df = 1,11$ ,  $p = .824$ ), body composition ( $F = .5$ ,  $df = 1,11$ ,  $p = .512$ ), or sit and reach ( $F = .14$ ,  $df = 1,11$ ,  $p = .722$ ). The intent of using two

**Table 2. Physiological measures for the control and the two exercise groups (mean  $\pm$  standard deviation).**

Dependent Variables	Pre-Study	Mid-Study	Post-Study	Percent change Pre to Post
$\dot{V}O_2$ (ml· kg <sup>-1</sup> · min)				
Control	26.4 $\pm$ 8.1	27.3 $\pm$ 7.2	27.1 $\pm$ 7.8	+ 2.7%
Low Intensity	28.6 $\pm$ 12.8	31.9 $\pm$ 13.1	33.0 $\pm$ 12.6	+ 15.4%
Moderate Int.	28.3 $\pm$ 10.6	32.5 $\pm$ 10.5	34.4 $\pm$ 9.7	+ 21.5%
$\dot{V}O_2$ (L· min)				
Control	1.7 $\pm$ .8	1.7 $\pm$ .8	1.7 $\pm$ .7	+ .6%
Low Intensity	2.3 $\pm$ .5	2.6 $\pm$ .6	2.7 $\pm$ .6	+ 17.4%
Moderate Int.	1.8 $\pm$ .7	2.1 $\pm$ .7	2.3 $\pm$ .7	+ 22.0%
Weight (kg)				
Control	63.8 $\pm$ 19.3	64.6 $\pm$ 21.1	63.7 $\pm$ 19.1	- .2%
Low Intensity	90.9 $\pm$ 30.1	90.6 $\pm$ 30.8	89.7 $\pm$ 29.8	- 1.3%
Moderate Int.	66.7 $\pm$ 10.9	66.9 $\pm$ 9.9	66.7 $\pm$ 9.7	0%
% Body Fat				
Control	24.6 $\pm$ 6.6	24.5 $\pm$ 5.6	24.6 $\pm$ 5.5	- 0%
Low Intensity	28.1 $\pm$ 11.8	26.8 $\pm$ 11.7	25.1 $\pm$ 11.3	- 3.0%
Moderate Int.	23.5 $\pm$ 6.8	22.6 $\pm$ 6.1	21.7 $\pm$ 5.8	- 1.8%
Sit & Reach (cm)				
Control	30.8 $\pm$ 6.1	32.9 $\pm$ 5.3	29.6 $\pm$ 8.5	- 3.9%
Low Intensity	32.0 $\pm$ 12.5	33.3 $\pm$ 12.1	34.3 $\pm$ 11.2	+ 7.2%
Moderate Int.	28.6 $\pm$ 8.9	32.2 $\pm$ 8.4	36.4 $\pm$ 6.6	+ 27.2%

exercise intensities in this study was to ascertain which level brought about the greatest benefit. Since the statistics indicated that the two exercise groups did not respond differently, the results of the two exercise groups were combined into one group ( $n = 12$ ) and compared with the control group ( $n = 6$ ) for final analysis. The means and standard deviations for the three dependent physiological variables for the control group and the combined exercise groups appear in Table 3.

**Table 3. Physiological measures for the control and combined exercise groups (mean  $\pm$  standard deviation).**

Dependent Variables	Pre-Study	Mid-Study	Post-Study	Percent change Pre to Post
$\dot{V}O_2$ (ml' kg' min)				
Control	26.4 $\pm$ 8.1	27.3 $\pm$ 7.3	27.1 $\pm$ 7.8	+ 2.7%
Exercise	28.4 $\pm$ 11.2	32.2 $\pm$ 11.3	33.7 $\pm$ 10.7	+ 18.6% *
$\dot{V}O_2$ (L' min)				
Control	1.7 $\pm$ .8	1.7 $\pm$ .7	1.7 $\pm$ .7	+ .6%
Exercise	2.1 $\pm$ .7	2.4 $\pm$ .7	2.5 $\pm$ .6	+ 19.2% *
Weight (kg)				
Control	63.9 $\pm$ 19.3	64.6 $\pm$ 21.1	63.7 $\pm$ 19.1	- .2%
Exercise	78.7 $\pm$ 25.0	78.7 $\pm$ 25.0	78.2 $\pm$ 24.3	- .6%
% Body Fat				
Control	24.7 $\pm$ 6.6	24.5 $\pm$ 5.6	24.6 $\pm$ 5.5	- .1%
Exercise	25.8 $\pm$ 9.5	24.7 $\pm$ 9.2	23.4 $\pm$ 8.7	- 2.4% *
Sit & Reach (cm)				
Control	30.8 $\pm$ 6.1	32.9 $\pm$ 5.3	29.6 $\pm$ 8.5	- 3.9%
Exercise	30.3 $\pm$ 10.5	32.7 $\pm$ 10.2	35.4 $\pm$ 8.8	+ 16.8% *

\* denotes a significant difference,  $p < .05$

The repeated measures ANOVA results revealed a statistically significant within subjects difference for aerobic capacity ( $F = 18.53$ ,  $df = 2$ ,  $p < .001$ ), body composition ( $F = 9.76$ ,  $df = 2$ ,  $p < .001$ ) and modified sit and reach ( $F = 4.02$ ,  $df = 2$ ,  $p = .027$ ). The interaction effect for group by time was significantly different for all

three variables (aerobic capacity:  $F = 5.74$ ,  $df = 2$ ,  $p = .007$ , body composition:  $F = 4.42$ ,  $df = 2$ ,  $p = .020$ , modified sit and reach:  $F = 7.65$ ,  $df = 2$ ,  $p = .002$ ). Therefore, the exercise group significantly increased on measures of aerobic capacity and modified sit and reach, and significantly decreased body fat percentage over the three test periods when compared to the control group. The groups did not differ significantly on body weight ( $F = 1.86$ ,  $df = 2$ ,  $p = .244$ ).

The psychological variables assessed in this study are presented in Table 4. With the Quality of Life measure, the higher score means a higher quality of life, while the lower score in the LASA data is the more desirable score (less fatigue).

The Friedman two-way analysis of ranks showed a significant increase in Quality of Life over the three test periods for the exercise group (Chi-Square = 16.62,  $df = 2$ ,  $p < .001$ ). The control group however did not show a significant difference over time (Chi-Square = .333,  $df = 2$ ,  $p = .846$ ). The Mann-Whitney U test revealed no significant differences between the groups either pre-study (Mann-Whitney U = 31.00,  $p = .639$ ) or mid-study (Mann-Whitney U = 20.50,  $p = .146$ ). Post-study scores however were significantly different (Mann-Whitney U = 5.00,  $p = .003$ ). These results indicate that Quality of Life improved over the course of the study in the exercising group but not in the control group, and this improvement required more than five weeks of exercise to reach statistical significance.

The probability values for the LASA results measured over the three testing periods appear in Table 5. There were no significant within group changes over time for the control group. The exercise group showed a significant within group difference over the course of the study on fatigue (Chi-Square = 7.04,  $df = 2$ ,  $p = .029$ ), energy (Chi-Square = 6.50,  $df = 2$ ,  $p = .038$ ) and anxiety (Chi-Square = 9.04,  $df = 2$ ,  $p = .011$ ). The followup Mann-Whitney U test revealed that the difference between the groups on the measure of energy was not significant until the post-study test ( $p = .011$ , Mann Whitney U = 9.0). The difference between the groups on the measures of fatigue and anxiety were not sufficient to reach statistical significance by the post-study measure ( $p = .160$ , Mann-Whitney U = 21.0;  $p = .373$ , Mann-Whitney U = 26.5, respectively). The variability surrounding the measures of fatigue

**Table 4. Psychological Measures (mean  $\pm$  standard deviation).**

Dependent Variables	Pre-Study	Mid-Study	Post-Study	Change Pre to Post-Study
Quality of life				
Control	88.5 $\pm$ 8.3	86.5 $\pm$ 7.3	86.6 $\pm$ 6.2	- 1.9
Exercise	85.7 $\pm$ 13.7	89.8 $\pm$ 12.9	95.1 $\pm$ 4.4	+ 9.4 * †
LASA				
Fatigue				
Control	29.0 $\pm$ 23.3	26.5 $\pm$ 19.6	32.2 $\pm$ 34.5	+ 3.2
Exercise	31.4 $\pm$ 21.1	21.6 $\pm$ 24.0	15.3 $\pm$ 21.4	- 16.1 *
Anxiety				
Control	23.5 $\pm$ 20.0	25.8 $\pm$ 12.3	19.7 $\pm$ 26.1	- 3.8
Exercise	21.3 $\pm$ 21.8	22.4 $\pm$ 24.9	5.9 $\pm$ 5.6	- 15.4 *
Confusion				
Control	11.7 $\pm$ 18.7	21.2 $\pm$ 17.5	11.5 $\pm$ 15.7	- .2
Exercise	11.2 $\pm$ 20.2	5.9 $\pm$ 11.2	6.6 $\pm$ 10.2	- 4.6
Depression				
Control	9.7 $\pm$ 14.8	15.7 $\pm$ 17.5	17.5 $\pm$ 16.0	+ 7.8
Exercise	11.1 $\pm$ 15.9	12.0 $\pm$ 15.5	4.8 $\pm$ 5.2	- 6.3
Energy				
Control	35.2 $\pm$ 13.5	31.2 $\pm$ 13.5	38.7 $\pm$ 13.4	+ 3.5
Exercise	36.3 $\pm$ 26.1	20.5 $\pm$ 16.9	19.7 $\pm$ 15.7	- 16.6 * †
Anger				
Control	11.2 $\pm$ 15.5	10.8 $\pm$ 11.4	13.0 $\pm$ 21.6	+ 1.8
Exercise	14.4 $\pm$ 17.6	10.6 $\pm$ 18.1	15.5 $\pm$ 22.1	+ 1.1

\* denotes a significant within group difference over time,  $p < .05$

† denotes a significant between group difference,  $p < .05$

and anxiety was quite large, leading to the non-significant between groups difference. This result suggests the exercise group significantly reduced fatigue and anxiety and increased energy when the pre-study to post-study measurements were compared while the control group had no significant pre-study to post-study changes. Further, the variability around the measure of energy was less than that of fatigue or anxiety allowing for a significant between groups difference.

**Table 5. Within group probability values for LASA data.**

LASA Variable	Control Group	Exercise Group
Fatigue	.846	.029 *
Anxiety	.606	.010 *
Confusion	.959	.209
Depression	.196	.132
Energy	.223	.038 *
Anger	.882	.205

\*denotes a significant difference,  $p < .05$

## DISCUSSION

Cancer diagnosis and treatment brings with it a number of negative physiological and psychological side effects. These include lowered functional capacity, alterations in body composition, decreased strength and flexibility, increased fatigue and emotional distress, and a diminished quality and outlook on life. This study found that ten weeks of aerobic exercise significantly improved aerobic capacity, body composition, lower body flexibility, quality of life, and a measure of energy over time compared to the control group. Further, a measure of fatigue and anxiety significantly decreased in the exercise group but not in the control group.

In keeping with recent trends in exercise prescription to encourage even modest levels of physical activity for health benefits, this study evaluated the effects of two levels on exercise intensity (low and moderate). No statistically significant differences were found in any of the physiological and psychological variables studied between the exercise groups. Apparently the combination of low to moderate intensity and moderate duration exercise for a ten-week period did not impose enough differential overload to detect significant changes between the exercise groups. While different responses to the two levels of exercise were not seen here, this also suggests that low intensity exercise may be as beneficial as moderate intensity exercise in this group of subjects. This is in keeping with several other studies that showed lower intensity exercise produced health benefits similar to those from moderate intensity exercise (14,33). King et al. (33) found moderate intensity exercise was as beneficial as higher intensity exercise in terms of cardiorespiratory fitness and HDL cholesterol levels for middle aged adults. Dunn et al. (33) found home-based moderate intensity physical activity was effective in improving the aerobic fitness of adult men and women. Research is being accumulated that suggests that physical activity, when performed on a regular basis, need not be strenuous to achieve health benefits (67). Blair et al. (2) have found that moderately fit men and women showed a decreased all cause mortality rate when compared to a low fitness group. This suggests that moderate levels of exercise bring about positive health benefits. While it is known

that regular exercise of a longer duration or more vigorous intensity brings about greater physiological benefits (67), this type of exercise may not be well tolerated by people surviving cancer treatment.

The exercise regimen in this study utilized intensities of 25-60% of heart rate reserve. These exercise intensities were lower than the 50-75% of heart rate reserve reported by the Winningham and MacVicar group (38, 39, 72, 73) or the 70% of heart rate reserve reported by Dimeo et al. (11, 12). Despite exercising at these lower intensities, the absolute gains in aerobic capacity noted in this study (exercise: +.37 L·min, + 19.2%) were similar to those reported by MacVicar and Winningham (38), who found a 20.7% increase in absolute aerobic capacity (+.36 L·min) in breast cancer patients performing cycle ergometry for a 10-week period. The increase in aerobic capacity in this study however was less than the 40% increase found by MacVicar et al. (39) in their subsequent study. In the latter study, breast cancer patients performed the same exercise protocol as in the original study, yet a greater increase in aerobic capacity resulted. Many of these patients were still on chemotherapy (41 of 45), and so were more compromised than the subjects in the current study. MacVicar et al. (39) found an absolute aerobic capacity increase of .43 L·min, however their pre-test value (1.02 L·min) was substantially lower than the exercise group in the current study (2.02 L·min.), probably due to the ongoing chemotherapy treatments.

The findings in the present study indicate that low - moderate intensity exercise can lead to a significant improvement in aerobic capacity in cancer survivors. It is possible that these lower levels of intensity might be better tolerated by people surviving cancer. The attendance rate in part, lends credence to this statement. The attendance rate for this study was 94.5% as compared to the 69.5% reported by Durak and Lilly (15). In the latter study, the initial mean intensity level for their subjects was 4.11 METs which increased to 5.81 METs by the end of their study. Calculations on the subjects in the current study revealed an estimated exercising MET level that ranged from 2.0-3.2 initially and rose to 4.1- 5.0 METs by the end of the study. The lower intensity level may have allowed the subjects in the current study to adapt more easily to the exercise and so attend more of the sessions. In addition, this study

utilized a circuit form of aerobic exercise in which the subjects rotated between three types of exercise equipment in each workout session. Switching modalities may have relieved some of the discomfort of exercise and allowed the subjects to enjoy their exercise sessions to a greater extent. In addition to the high attendance rate, no subjects withdrew or were injured during this training regimen, which indicates that this population can exercise safely and effectively for a ten-week period.

Rehabilitating cancer patients often experience prolonged inactivity due to treatment side effects (38). This can lead to a progressive decline in physiological function characterized by weakness and rapid fatigue upon exertion (38). The development of aerobic capacity is a significant factor in reducing fatigue and increasing the ability to take part in daily activities (38, 46). The psychological data collected in this study support this concept.

The LASA data revealed a significant increase in energy for the exercise group when compared to the control group, and a significant pre to post-study decrease in fatigue and anxiety in the exercise group. These findings are similar to those reported by other researchers (11,12,15, 38, 46), who found that exercise decreases fatigue and measures of emotional distress. Fatigue is a common side effect of cancer treatment, occurring in approximately 70% of patients (62). The symptom of fatigue in these patients may last months or perhaps years (3, 4). One approach to combat fatigue is rest. However if patients become inactive after cancer treatment, physiological and psychological deterioration will occur (12, 46). The results of this study indicate that exercise can decrease fatigue and anxiety and increase energy, counteracting the negative consequences of their cancer treatment and recovery.

Along with the improvement in aerobic capacity, energy, fatigue, and anxiety, the exercise group significantly reduced body fat percentage (-2.4%). This reduction is greater than that reported by Winningham et al. (73), who reported a .51% decrease in body fat in breast cancer patients performing ten weeks of cycle ergometry. Winningham et al. also reported a weight gain (.82 kilograms) in their exercising cancer patients. They concluded that the subjects gained muscle and reduced body fat. The exercise group in the current study experienced a slight but not statistically

significant, weight loss (.5 kg). However, this slight reduction in weight may mask the underlying changes in body composition. The concurrent changes in percent body fat and body weight translate to a reduction of 2.01 kilograms of fat and an increase of 1.51 kilograms in lean body mass in the exercise group. A significant portion of lean body mass is muscle. An increase in muscle mass has been shown to increase metabolic rate (41). If cancer patients reduce physical activity after treatment, this could lead to muscular atrophy, decreased metabolic rate and an increase in fat deposition (73). Aerobic exercise may reverse this process, thus benefiting this population with regard to weight control.

In addition, the subjects in the exercise group significantly increased their performance on the modified sit and reach measure (+16.8%) when compared to the control group. Hoeger and Hopkins report intraclass reliability for this test to be  $R = .94$ . Despite this high coefficient, the control group showed an increase of 1.1 centimeters in the modified sit and reach measure from the pre-study to mid-study data collections. This value then dropped 3.3 centimeters by the post-study measure. Minkler and Patterson (45) report that the modified sit and reach test is moderately related to hamstring flexibility in women ( $r = .66$ ) and men ( $r = .75$ ) but poorly related to low back flexibility in women ( $r = .25$ ) and men ( $r = .40$ ). Therefore this measure is more highly related to hamstring flexibility than lower back flexibility. The fluctuation in control group scores may have been due to normal variation in the flexibility of the hamstrings or some unknown factor. No study to date has reported flexibility measures in cancer survivors. A comparison to age adjusted norms of the population (25) shows that both groups initially scored between the 50-60 percentiles on the modified sit and reach measure. By the end of the study, the exercise group scored between the 70-80 percentiles, while the control group showed no change. As a practical issue, hamstring and trunk flexibility is important in the maintenance of normal daily activity, such as dressing, housework and recreational activity. Additionally, increasing lower body flexibility may also decrease the risk of back injury (29). An exercise program of this type may augment independent living and mobility in people similar to the subjects studied here.

The quality of life measure significantly improved in the exercise group, but not in the control group. In fact, the quality of life measure decreased in the control group. This is similar to the results of other researchers (15, 38, 77). Young and Sexton (77), using the same measuring tool as the current study, found the mean difference was 6.3 points out of one hundred possible points (exercisers = 74.1, control = 67.8), while the current study found a mean post-study difference between exercise and control of 8.5 points (control = 86.6, exercisers = 95.1). It is unknown why the endpoints were higher in the current study; perhaps it is a result of a small sample size. As more patients are surviving cancer diagnosis and treatment, the quality of a person's life may be as important as the length of life (1, 21, 34, 46, 77). Quality of life encompasses both psychological and physiological function. Common psychological side effects of cancer treatment include fatigue, depression, anxiety, confusion, body image concerns, and a sense of a loss of control over normal activities (22). Coupled with these psychological side effects is the physiological decline associated with inactivity. A main focus of cancer rehabilitation has been the effort to improve quality of life (23). A number of interventions are available to help patients cope with disease and treatment; however many of these are psychological in nature (education programs, support groups). While these approaches are important, and several of the subjects in this study were involved with support groups, there may be a connection between physiological and psychological function. It is possible that improved physiological function leads to an improvement in psychological function. It is interesting to note that the exercise group showed improvement in the psychological measure of Quality of Life and the LASA measures of energy, fatigue and anxiety coincident with an improvement in aerobic capacity, body composition and trunk flexibility. Therefore this type of program may be an alternative or adjunct treatment for this population. However, there are several limitations to this study that should be noted. The study was conducted with middle-aged subjects who were 9-10 months post-treatment, and it utilized a low to moderate exercise intensity over 10 weeks. More study is needed to evaluate the effectiveness of a similar exercise

program over a longer period of time and with a larger, more varied population of cancer survivors.

Possible causal relationships between the physiological and psychological variables studied cannot be ascertained within the design of the present study. However, it is possible that the subjects felt more self-sufficient and in control of their lives as they improved their aerobic capacity, flexibility and decreased their body fat. Coupled with this, feeling more energy and less fatigue, as noted with this study, is an expected outcome of an exercise program (11,12,46,67). One of the main goals of cancer rehabilitation is to improve overall quality of life, both physiologically and psychologically. The results of this study indicate that a low to moderate intensity aerobic exercise regimen can be well tolerated by cancer survivors and can be an effective means to improve physiological and psychological function.

## BIBLIOGRAPHY

1. Andersen, B. L. Psychological interventions for cancer patients to enhance the quality of life. *Journal of Consulting and Clinical Psychology*, 60(4): 552-568, 1992.
2. Blair, S. N., H. W. Kohl, III, R. S. Paffenbarger, Jr., D. G. Clark, k. H. Cooper, and L. W. gibbons. Physical fitness and all-cause mortality: a prospective study of healthy men and women. *JAMA* 262:2395-401, 1989.
3. Blesch, K. S., J. A. Paice, R. Wickman, N. Harte, D. K. Schnoor, S. Purl, M. Rehwalt, P. L. Kopp, S. Manson, S. B. Coveny, M. McHale and M. Cahill. Correlates of fatigue in people with breast or lung cancer. *Oncology Nursing Forum*, 18(1): 81-87, 1991.
4. Blesch, K. S. Rehabilitation of the cancer patient at home. *Seminars in Oncology Nursing*, 12(3): 219-225, 1996.
5. Brown, R. S., D. E. Ramirez and J. M. Taub. The prescription of exercise for depression. *The Physician and Sportsmedicine*, 12: 35-45, 1978.
6. Camoriano, J. K., C. L. Loprinzi, J. N. Ingle, T. M. Therneau, J. E. Krook and M. H. Veeder. Weight change in women treated with adjuvant therapy or observed following mastectomy for node-positive breast cancer. *Clinical Oncology*, 8(8): 1327- 1334, 1990.
7. Cohen, M. Z., D. L. Kahn and R. H. Steeves. Beyond body image: The experience of breast cancer. *Oncology Nursing Forum*, 25(5): 835-841, 1998.
8. Courneya, K. S. and C. M. Friedenreich. Determinants of exercise during colorectal cancer treatment: an application of the theory of planned behavior. *Oncology Nursing Forum*, 24(10): 1715-1723, 1997.
9. Crews, D. J. and D. M. Landers. A meta-analytic review of aerobic fitness and reactivity to psychosocial stressors. *Medicine and Science in Sports and Exercise* 19(5): S114-S120, 1987.
10. Denmark-Wahnefried, W., V. Hars, M. R. Conaway, K. Havlin, B. K. Rimer, G. McElveen and E. P. Winer. Reduced rates of metabolism and decreased physical activity in breast cancer patients receiving adjuvant chemotherapy. *American Journal of Clinical Nutrition*, 65: 1495-1501, 1997.
11. Dimeo, F. C., M. H. M. Tilmann, H. Bertz, L. Kanz, R. Mertelsmann and J. Keul. Aerobic exercise in the rehabilitation of cancer patients after high dose chemotherapy and autologous peripheral stem cell transplantation. *Cancer*, 79(9): 1717-1722, 1997.
12. Dimeo, F., B. G. Rumberger and J. Keul. Aerobic exercise as therapy for cancer fatigue. *Medicine and Science in Sports and Exercise* 30(4): 475-477, 1998.

13. Donovan, K., R. W. Sanson-Fisher and S. Redman. Measuring quality of life in cancer patients. *Journal of Clinical Oncology*, 7(7): 959-968, 1989.
14. Dunn, A. L., M. E. Garcia, B. H. Marcus, J. B. Kampert, H. W. Kohl III, and S. N. Blair. Six-month physical activity and fitness changes in Project Active, a randomized trial. *Medicine and Science in Sports and Exercise*, 30(7): 1076-1083, 1998.
15. Durak, E. P. and P. C. Lilly. The application of an exercise and wellness program for cancer patients: a preliminary outcomes report. *Journal of Strength and Conditioning Research*, 12(1): 3-6, 1998.
16. Ferrans, C. E. and B. R. Ferrell. Development of a quality of life index for patients with cancer. *Oncology Nursing Forum*, 17(3): 15-21, 1990.
17. Fobair, P., R. T. Hoppe, J. Bloom, R. Cox, A. Varghese and D. Spiegel. Psychosocial problems among survivors of Hodgkin's disease. *Journal of Clinical Oncology*, 4(5): 805-814, 1986.
18. Friedenreich, C. M. and T. E. Rohan. A review of physical activity and breast cancer. *Epidemiology*, 6: 311-317, 1995.
19. Friedenreich, C. M., and K. S. Courneya. Exercise as rehabilitation for cancer patients. *Clinical Journal of Sport Medicine*, 6: 237-244, 1996.
20. Gammon, M. D. and E. M. John. Recent etiological hypotheses concerning breast cancer. *Epidemiological Reviews* 15(1): 163-168, 1993.
21. Ganz, P. A., J. J. Lee and J. Siau. Quality of life assessment: an independent prognostic variable for survival in lung cancer. *Cancer*, 67:3131-3135, 1991.
22. Garfinkel, M. A. Cancer Statistics and Trends. In: *American Cancer Society Textbook of Clinical Oncology*. Atlanta: Library of Congress, 1991, pp. 1-6.
23. Graydon, J. E. Women with breast cancer: Their quality of life following a course of radiation therapy. *Journal of Advanced Nursing*, 19: 617-622, 1994.
24. Hoeger, W. K. and D. R. Hopkins. A comparison of the sit and reach and modified sit and reach in the measurement of flexibility in women. *Research Quarterly for Exercise and Sport*, 63(2): 191-195, 1992.
25. Hoeger, W. K. *Lifetime Physical Fitness & Wellness*, Englewood: Morton Publishing Company, 1989.
26. Hoffman-Goetz, L. Help clients with cancer participate in physical activity. *ACSM'S Health & Fitness Journal*, 2(20): S22-S23, 1998.
27. Jackson, A. S. and M. L. Pollock. Generalized equations for predicting body density for men. *British Journal of Nutrition*, 40: 497-504, 1978.
28. Jackson, A. S., M. Pollock, and A. Ward. Generalized equations for predicting

- body density for women. *Medicine and Science in Sports and Exercise*, 12: 175-182, 1980.
29. Johnson, B. L. and M. J. Garcia, *Fitness and Performance for Everyone*, Portland: Brown and Littleman, 1977.
  30. Johnson, J. B. and A. W. Kelly. A multifaceted rehabilitation program for women with cancer. *Oncology Nursing Forum*, 17(5): 691-695, 1990.
  31. Kenney, W. L. *ACSM's Guidelines for Exercise Testing and Prescription. 5th edition* Baltimore: Williams and Wilkins, 1995.
  32. Kent, H. Breast cancer survivors begin to challenge exercise taboos. *Canadian Medical Association Journal*, 155(7): 969-971, 1996.
  33. King, A. C., W. L. Haskell, D. R. Young, R. K. Oka, and M. L. Stefanick. Long-term effects of varying intensities and formats of physical activity on participation rates, fitness, and lipoproteins in men and women aged 50-65 years. *Circulation*, 91: 2596-2604, 1995.
  34. Knobf, M. T. Physical and psychologic distress associated with adjuvant chemotherapy in women with breast cancer. *Journal of Clinical Oncology*, 4: 678-684, 1986.
  35. Knobf, M. T. Symptoms and rehabilitation needs of patients with early stage breast cancer during primary therapy. *Cancer*, 66:1392-1401, 1990.
  36. Landis, S. H., T. Murray, S. Bolden and P. A. Wingo. Cancer Statistics, 1998. *CA-A Cancer Journal for Clinicians*. 48:6-9, 1998.
  37. Loescher, L. J., D. Welch-McCaffrey, S. A. Leigh, B. Hoffman and F. L. Meyskens. Surviving adult cancers. Part 1: physiologic effects. *Annals of Internal Medicine*, 111:411-432, 1989.
  38. MacVicar, M. G. and M. L. Winningham. Promoting the functional capacity of cancer patients. *The Cancer Bulletin*, 38(5), 1986.
  39. MacVicar, M. G., M. L. Winningham and J. L. Nickel. Effects of aerobic interval training on cancer patient's functional capacity. *Nursing Research*, 38(6): 348-350, 1989.
  40. McAllister, R.M., S.T. Horowitz and R.V. Gilden. *Cancer*, New York: HarperCollins, 1993, pp. 92-110.
  41. McArdle, W. D., F. I. Katch, V. L., Katch. *Exercise Physiology. energy, Nutrition, and Human Performance. Third Edition*. Philadelphia: Lea and Febiger. 1991.
  42. McKenna, R. J. Supportive care and rehabilitation of the cancer patient. In: *American Cancer Society Textbook of Clinical Oncology*. Atlanta: Library of Congress, 1991, pp. 544-554.

43. Melink, T. J., G. M. Clark and D. D. Von Hoff. The impact of phase I clinical trials on the quality of life of patients with cancer. *Anti-Cancer Drugs*, 3: 571-576, 1992.
44. Meyer, T. J. & M. M. Mark. Effects of psychosocial interventions with adult cancer patients: a meta-analysis of randomized experiments. *Health Psychology*, 14(2): 101-108, 1995.
45. Minkler, S., and P. Patterson. The validity of the modified sit and reach test in college-age students. *Research quarterly for Exercise and Sport*, 65: 189-192.
46. Mock, V., M. B. Burke, P. Sheehan, E. M. Creaton, M. L. Winningham, S. McKenney-Tedder, L.P. Schwager and M. Liebman. A nursing rehabilitation program for women with breast cancer receiving adjuvant chemotherapy. *Oncology Nursing Forum*, 21(5): 899-907, 1994.
47. Molinaro, J., M. Kleinfeld and S. Lebed. Physical therapy and dance in the surgical management of breast cancer. *Physical Therapy*, 66(6): 967-969, 1986.
48. Mor, V., L. Laliberte, J.N. Morris and M. Wiemann. The Karnofsky Performance Status Scale: An examination of its reliability and validity in a research setting. *Cancer*, 53: 2002-2007, 1984.
49. Morgan, W. P., J. A. Roberts, F. R. Brand and A. D. Feinerman. Psychological effect of chronic physical activity. *Medicine and Science in Sports and Exercise* 2(4): 213-217, 1970.
50. Nelson, J. P. Perceived health, self-esteem, health habits and perceived benefits and barriers to exercise in women who have and who have not experienced stage 1 breast cancer. *Oncology Nursing Forum*, 18(7): 1191-1197, 1991.
51. Nestle, M., D. G. Bar, D. F. Birt, G. Block, T. Byers, S. Foerster, P. Greenwald, E. J. Hawrylewicz, B. E. Henderson, D. Hunter, L. A. Kohlmeier, D. Kritchevsky, S. K. Kumanyika, L. Kushi, B. F. Liebman, R. Russell, H. Thompson and D. F. Williamson. Guidelines on diet, nutrition and cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA-A Cancer Journal for Clinicians*. 46:325-340, 1996.
52. Olivera, S. a., H. W. Kohl III, D. Trichopoulos and S. N. Blair. The association between cardiorespiratory fitness and prostate cancer. *Medicine and Science in Sports and Exercise*, 28(1): 97-104, 1996.
53. Padilla, G. V., C. Presant, M. M. Grant, G. Metter, J. Lipsett and F. Heide. Quality of life index for patients with cancer. *Research in Nursing and Health*, 6: 117-126, 1983.
54. Parent, C. J. and A. L. Whall. Are physical activity, self-esteem, and depression related? *Journal of Gerontological Nursing*, 10(9): 9-11, 1983.
55. Ransford, C. P. A role for amines in the antidepressant effect of exercise: a review. *Medicine and Science in Sports and Exercise*, 14(1): 1-10, 1982.

56. Razavi, D., N. Delvaux, C. Farvacques, & E. Robaye. The screening of adjustment disorders and major depressive disorders in hospitalized cancer patients. *British Journal of Psychiatry*, 156: 79-83, 1990.
57. Rosenthal, D. S. Changing Trends. *CA-A Cancer Journal for Clinicians*. 48:3-4, 1998.
58. Sarna, L. Functional status in women with lung cancer. *Cancer Nursing*, 17(2): 87-93, 1994.
59. Schwartz, A. L. Patterns of exercise and fatigue in physically active cancer survivors. *Oncology Nursing Forum*, 25(3): 485-491, 1998.
60. Shepard, R. J. Exercise in the prevention and treatment of cancer. An update. *Sports Medicine*, 15(4): 258-280, 1993.
61. Simon, H. B. Discussion: exercise, immunity, cancer and infection. In: Bouchard C., R. J. Shepard, T. Stephens, J. R. Sutton and B. D. McPherson, eds. *Exercise, fitness and health: a consensus of current knowledge*. Champaign: Human Kinetics, 1990, pp. 581-588.
62. Smets, E.M.A., B. Garssen, A.L.J. Schuster-Uitterhoeve and J.C.J.M. de Haes. Fatigue in cancer patients. *British Journal of Cancer*, 68: 220-224, 1993.
63. Smith, S. L. Physical exercise as an oncology nursing intervention to enhance quality of life. *Oncology Nursing Forum*, 23(5): 771-778, 1996.
64. Stoll, B. A. Can unorthodox cancer therapy improve quality of life? *Annals of Oncology*, 4: 121-123, 1993.
65. Sutherland, H. J., P. Walker, & J. E. Till. The development of a method for determining oncology patients' emotional distress using linear analogue scales. *Cancer Nursing*, 11: 303-308, 1988.
66. Turner-Gomes, S. O., L. C. Lands, J. Halton, R. M. Hanning, G. J. F. Heigenhauser, M. Pai and R. Barr. Cardiorespiratory status after treatment for acute lymphoblastic leukemia. *Medical and Pediatric Oncology*, 26: 160-165, 1996.
67. U. S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Control and Prevention, National Center for Chronic disease prevention and Health Promotion, 1996.
68. Warnold, I., K. Lundholm and T. Schersten. Energy balance and body composition in cancer patients. *Cancer Research*, 38: 1801-1807, 1978.
69. Watson, P. G. The optimal functioning plan: a key element in cancer rehabilitation. *Cancer Nursing*, 15(4): 254-263, 1992.

70. Weyerer, S. and B. Kupfer. Physical exercise and psychological health. *Sports Medicine*, 17(2): 108-116, 1994.
71. Winningham, M. L., M. G. MacVicar and C. A. Burke. Exercise for cancer patients: guidelines and precautions. *The Physician and Sportsmedicine*, 14(1): 125-134, 1986.
72. Winningham, M. L. and M. G. MacVicar. The effect of aerobic exercise on patients reports of nausea. *Oncology Nursing Forum*, 15(4): 447-450, 1988.
73. Winningham, M. L., M. G. MacVicar, M. Bondoc, J. I. Anderson and J. P. Minton. Effect of aerobic exercise on body weight and composition in patients with breast cancer on adjuvant chemotherapy. *Oncology Nursing Forum*, 16(5): 683-689, 1989.
74. Winningham, M. L. Walking program for people with cancer. *Cancer Nursing*, 14(5): 270-276, 1991.
75. Winningham, M. L., L. M. Nail, M. B. Burke, L. Brophy, B. Cimprich, L. S. Jones, S. Pickard-Holley, V. Rhodes, B. St. Pierre, S. Beck, E. C. Glass, V. L. Mock, K. H. Mooney and B. Piper. Fatigue and the cancer experience: the state of knowledge. *Oncology Nursing Forum*, 21(1): 23-34, 1994.
76. Wyatt, G. and L. L. Friedman. Long-term female cancer survivors: quality of life issues and clinical implications. *Cancer Nursing*, 19(1): 1-7, 1996.
77. Young-McCaughan, S. and D. L. Sexton. A retrospective investigation of the relationship between aerobic exercise and quality of life in women with breast cancer. *Oncology Nursing Forum*, 18(4): 751-757, 1991.
78. Zigmond, A. & R. Snaith. The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica*, 67: 361-370, 1983.

**APPENDICES**

## APPENDIX A

### REVIEW OF LITERATURE

#### Introduction

Cancer is the number one health concern for Americans (22). Cancer ranks second only to heart disease as the leading cause of death in the United States. The American Cancer Society reports 23.9% of all deaths were due to cancer in 1996 (36). This same organization estimates cancer has killed 564,800 Americans in 1998 (36). This is more than 1500 people a day. Further, this trend has been increasing in the last 60 years. The cancer death rate (age adjusted per 100,000) for Americans in 1930 was 143. In 1940 it was 152; 157 in 1950; and 171 in 1986 (22).

Along with the increasing death rate came increasing research in the field of cancer. Out of this research arose a greater understanding of cancer and new technology for treatment. Survival rates from this disease parallel this increase in treatment options. Five year survival rates in the 1930's were 20%. This improved to 25% in the 1940's and 33% in the 1960's. Currently 50% of people are alive five years after the diagnosis (36).

This increase in survival rate is due to a number of factors including increased public awareness, more research data and technological advances (35, 46). Current techniques for the treatment of cancer fall into three main areas; surgery, chemotherapy and radiation (40). All of these techniques have certain advantages and disadvantages. The physicians choice of the technique depends on the location and type of cancer (42).

Surgery is the oldest form of cancer treatment (42). The American Cancer Society currently estimates that 60% of cancer patients are treated surgically. Further, greater than 90% of all cancer patients undergo surgery in the diagnosis and staging of cancer (42). Surgical treatment for cancer has several advantages. Tumors have no biological resistance to cancer and surgery has no known carcinogenic effects (42). There are several disadvantages to surgery. Surgery is ineffective if the cancer has metastasized or is too large (40). Surgery also destroys some normal tissue along with the cancerous matter (40). This can lead to a decrease in range of motion and loss of physiological

function in some instances (40). Lastly, the surgical process carries with it some inherent risk to life that cannot be overlooked.

Radiation therapy is the second most common cancer treatment, used in approximately 50% of all cancer cases (40). Radiation stops or slows cancer by destroying DNA. Cells exposed to large doses of radiation are destroyed due to extensive DNA damage. However, cells exposed to lower levels of radiation can repair partially destroyed DNA and survive (40). So by adjusting the dosage of radiation, the more sensitive cancer cells are killed while the healthy cells are damaged but hopefully recover (42). Radiation therapy has an advantage over surgery in that it causes less cosmetic damage and physical function is not as impaired (42). The disadvantages of radiation therapy are the side effects. The most common side effects are lethargy, fatigue, nausea and vomiting (40). Currently these symptoms are treated with rest and anti-nausea drugs.

Chemotherapy is the third major method of treating cancer. It involves the administration of various cytotoxic drugs that kill rapidly dividing cells (40). This treatment has been successfully used for leukemia, lymphoma and testicular carcinomas (40). Unfortunately, these compounds also destroy rapidly dividing normal cells such as those in the gastrointestinal tract, bone marrow and hair follicles (46). Side effects from this treatment include hair loss, nausea, vomiting and fatigue (34). Often patients are advised to combat fatigue and nausea by "pacing themselves" and "taking it easy" (40, 42).

While these three main techniques can be used individually, it is often necessary to combine the three methods to treat certain cancers. Using the strengths and weaknesses of each modality can often enhance the care. For example, surgery is often effective for cancers that are localized. But this technique may not be entirely successful if part of the cancer is left undetected outside the excised area (40). In this case surgery can be followed by radiation to help destroy the cancerous cells that may be left. Chemotherapy can be used after surgery or radiation if it is suspected that the tumor has metastasized (42). Combination therapy can also be conducted the other way around. Initially chemotherapy can be used to reduce the size of the tumor, then surgery can follow to remove the left over cancer cells (40).

With the increased development of these modern techniques to treat cancer coupled with public education and early detection methods, more and more people are surviving cancer (35, 40). As cancer survivors increase, interest in rehabilitation programs for

patients after treatment has grown. The primary goal of cancer rehabilitation is to maximize well-being and minimizing side effects due to illness and the various treatments (35, 68). To accomplish this goal, the patient's basic needs must be fulfilled. These needs include the following areas: physical, psychological, social, sexual, financial and occupational (35). This paper will concentrate primarily on physical and psychological effects. The main negative side effects of cancer treatments include deterioration of lean body tissue, weight changes, lowered aerobic capacity, decreased strength and flexibility, nausea, fatigue, depression, poor body image and lowered self concept (3, 8, 35, 46, 59).

The majority of these side effects may be eliminated or reduced by exercise. Exercise has been shown to increase lean body mass, decrease fat mass, increase aerobic capacity, and increase muscular strength and endurance (31, 41). Exercise has also been shown to decrease measures of depression (5), lessen fatigue and nausea (72), and increase overall mood and self esteem (50, 70). These positive effects of exercise have not been extensively evaluated in cancer patients after treatment.

## **Rehabilitation**

With the increased number of people surviving cancer, the need for rehabilitation is growing. The goal of rehabilitation is to reduce the severity of symptoms caused by illness and treatment and to maximize the overall quality of life. The National Cancer Institute in 1972 targeted four major areas for cancer rehabilitation. These areas include maximizing physical function, providing psychological support, vocational counseling and optimizing social functioning (42). This paper will concentrate on the first two areas.

## **Physical Symptoms Following Cancer Treatment**

### **Fatigue**

Of all the symptoms resulting from cancer and the treatments following diagnosis, fatigue is the most common. Smets et al. (62) report more than 70% of patients receiving chemotherapy or radiation reported fatigue symptoms. These symptoms included such things as tired legs, whole body tiredness, and feelings of wanting to lie

down. Blesch et al. (4) report that fatigue increases with the number of radiation or chemotherapy cycles.

That fatigue presents itself to cancer patients is well accepted (3, 34, 62). However the definition of fatigue and its causes are difficult to establish. Physiological fatigue can be defined as a decrease in physical performance (3). Fatigue however can also manifest itself psychologically, leading to anxiety, depression, boredom or nervousness (3). It is likely that cancer patients experience both physiological and psychological fatigue due to cancer diagnosis and treatment.

Cancer patients have described fatigue as exhaustion, weakness, tiredness, lethargy, inability to concentrate, and lack of motivation (34). These descriptions are very personal and subjective. It is difficult to determine how much of the fatigue sensations are due to the illness, the treatment, or secondary factors such as decreased food intake or sleep disturbances.

While the cause and definition of fatigue remain elusive, so does the treatment. One approach that has shown some benefits is education. If patients are given information about fatigue that allows them to view it as a normal side effect of treatment, they seem to respond more favorably (75). Unfortunately the response by some health care professionals to fatigue symptoms in patients is to have them reduce activity and 'take it easy' (42, 75). This treatment for fatigue may lead to muscular atrophy and general physiologic deterioration. The result may be an increase in fatigue and an increase in the risk of other hypokinetic diseases such as cardiovascular disease and Type II diabetes.

Several studies (12, 38, 46) have investigated the effect of exercise on fatigue in cancer patients. All three of these studies suggest that exercise reduces some of the fatigue in cancer patients. In fact, Mock (46) found cancer patients who did not exercise experienced twice the fatigue that was noted in patients who exercised. Specifics of these studies appear in a later section of this report. While all of these studies have limitations, and the results should be considered preliminary, it appears that exercise may play a role in the reduction of fatigue in cancer patients.

## **Nausea**

Nausea and vomiting are symptoms resulting from the three main types of cancer treatments; surgery, radiation and chemotherapy. Commonly these symptoms are treated with antiemetic drugs. One study, Winningham and MacVicar (72), reported a decrease in nausea in cancer patients who exercised. The results of this study are

outlined in the following section on exercise. To date, no other study has attempted to replicate this effect. Subsequent studies on nausea and exercise would seem to be warranted.

### **Body Composition**

Weight changes, either up or down, after cancer treatment are common. In women surviving breast cancer, the average weight gain is 4.0 to 5.0 kilograms in the year following treatment (34). Weight loss is often seen in the weeks after treatment is initiated.

These weight changes are a complex issue involving several factors. Cancer treatment can cause anorexia and nausea which would lead to a decrease in weight. Secondly, the cancer treatment can lead to fatigue which may reduce the patient's physical activity which can lead to a weight gain.

Several sources (34, 42) report taste changes due to treatment that may affect weight. Some patients lose their sense of taste which can lead to a decreased intake of nutrients (42). Other patients have reported an increased craving for sweets that may increase caloric intake (34). Some patients find that nausea is relieved by eating and this can lead to an increase in caloric intake (34).

Surprisingly little evidence is available on the body composition changes after cancer treatment. One can only assume that with a decrease in physical activity, muscular atrophy occurs. If caloric intake is increased or held constant, a gain in body fat should occur. Knobf (34) reported a positive correlation between weight gain and feelings of worry, distress or decreased happiness. Therefore, weight gain may influence mood and could possibly affect quality of life.

Only one study (73) measured body composition in cancer patients after treatment. These researchers found body composition was positively affected (increased lean body mass and decreased fat mass) in subjects who exercised, and conversely was negatively affected (increased fat mass) in subjects who did not exercise. Additional studies need to be conducted to evaluate the effect of exercise on body composition in cancer patients.

The effect of resistance training on body composition in cancer patients also needs to be evaluated. It seems plausible that a combination of aerobic and resistance exercise may bring about positive changes in the body composition of cancer patients after treatment.

## **Strength and Flexibility**

Patients surviving cancer often reduce physical activity. This leads to muscular atrophy and perhaps easier fatigability (38). In addition to atrophy, range of motion is decreased with lack of use. This overall decrease in strength and flexibility may be reversed if the subject begins an exercise program. Unfortunately, there is a paucity of data on this subject. Only one study, Durak and Lilly (15), investigated the effect of resistance training on muscular strength in cancer patients. They found an overall increase in strength of 70%. However, range of motion data was not reported. It seems logical that a combination of resistance exercise and stretching may help patients retain muscular strength and flexibility.

## **Psychological Aspects of Cancer Treatment**

The number one goal in the treatment of cancer has to be controlling the tumor growth. The second goal should be to maximize the quality of life after treatment. This construct, quality of life, is difficult to define and measure as it means many different things for different people. Ferrans and Ferrell (16) define quality of life as "a person's sense of well being that stems from satisfaction or dissatisfaction with the areas of life that are important to him or her". Generally, five main areas are included in this definition: physical functioning; psychological functioning; social interaction, economic needs; sexual functioning (77).

Being diagnosed with cancer and undergoing treatment is an extremely stressful situation. Donovan et al. (13) suggest that the emotional stress of cancer diagnosis and treatment exceed that of any other disease. These same authors also suggest that the emotional suffering may outweigh the physical suffering one endures. Graydon (23) reports that 45% of women receiving radiation therapy experience depression. Other studies list feelings of anxiety, resentment, anger, discouragement, helplessness and hopelessness as consequences of cancer (13, 16).

Since these emotions can be devastating, quality of life measures should be included in rehabilitation studies of cancer patients.

## Exercise and Cancer

### **Physiological Parameters**

One of the first reports on the effect of exercise on patients surviving cancer treatment was conducted by MacVicar and Winningham at Ohio state University in 1986 (38). These researchers explored the possibility that exercise may improve functional capacity. The subjects for the study were ten female breast cancer patients and six healthy female controls matched for age. The cancer patients were divided into two groups, an exercise group ( $n = 6$ ) and a patient control group ( $n = 4$ ). The healthy patients formed an exercising control group. The exercise program served as the independent variable. The subjects met three times a week for ten weeks. They performed cycle ergometry for 20-30 minutes at 65-85% of peak heart rate. This exercise protocol was termed the Winningham Aerobic Interval protocol (WAIT) and was utilized as the independent variable in this group's subsequent research. The dependent variables were aerobic capacity and the Profile of Mood states (POMS). Aerobic capacity was measured with a graded exercise test on the cycle ergometer. The POMS is a sixty five question rating scale evaluating anxiety, depression, anger, vigor, fatigue and confusion.

The pre-test to post-test results for aerobic capacity showed improvement in both exercising groups. The cancer patient  $\dot{V}O_{2peak}$  improved from 1.37 L·min to 1.73 L·min, a twenty percent increase. The healthy controls improved  $\dot{V}O_{2peak}$  from 1.67 to 2.02 L·min, a 17.4% increase. The nonexercising cancer patients however showed a decline in aerobic capacity from 1.1 to 1.09 L·min, a 1.8% decrease.

Total mood disturbance derived from the POMS data showed a decrease for both the healthy exercisers and the exercising cancer patients (45.0 to 3.6 and 50.6 to 7.7 respectively). The cancer control group however showed an increase in total mood disturbance from 19.4 to 38.6. Vigor as measured by the POMS scale increased in the exercising groups (11.1 to 20.3 and 12.8 to 15.6 for the healthy subjects and cancer survivors, respectively). The cancer control group, on the other hand, showed a decrease in vigor from 16.0 to 12.5. Fatigue also decreased in the exercisers, 11.3 to 3.6 for the healthy group and 10.0 to 6.6 for the cancer patients. The non-exercising cancer patients showed a slight increase in fatigue from 9.5 to 10.5.

The results of this study seem to indicate cycle training can improve both aerobic capacity and measures of mood states in exercisers. However, these results should be viewed as preliminary. Limitations of this study include low subject number, all subjects were female and all subjects had the same cancer (Stage II breast cancer). Further, this study was a quasi experimental design. The cancer patients were not randomly assigned to an exercise or control group. Some bias may exist in the assigning of subjects by convenience. For example, subjects more willing and able to engage in exercise may have been placed in the exercise group while subjects not wanting to participate in exercise may have been placed in the control group. Also, the results were presented as trends only. No statistics were reported on the data, making it difficult to speculate if the effects would reach statistical significance. These trends however were intriguing enough to warrant further investigation.

These same researchers, Winningham and MacVicar, continued their investigation of cancer patients in 1988 (72). They had noticed still another trend in their previous report and that was that nausea seemed to be reduced in exercising cancer patients. To evaluate this hypothesis, the researchers used as subjects 42 breast cancer patients receiving chemotherapy. The subjects were matched by age and functional capacity and then randomly assigned to three groups; exercise (n=16), placebo (n=14), and control (n=12). The exercising group rode a cycle ergometer three times a week for ten weeks at an intensity that elicited 60-85% of maximum heart rate. The duration of the exercise was not reported. The placebo group met with instructors weekly and performed some mild stretching, warm-up and cool-down exercises. The control group was instructed to maintain normal activities with the exception of exercise. The independent variable was the cycling exercise and the dependent variable was the amount of nausea experienced.

Nausea was measured by the revised Symptom Checklist 90 scale administered pre and post treatment. Results from the nausea scale were coded as improved, no change, or worse. A Chi square analysis was used to evaluate differences between groups. The exercise group exhibited a statistically significant decrease in nausea compared to the placebo and control groups. In fact, no subject in the exercise group reported a worsening of nausea. Twenty nine percent of the placebo group and seventeen percent of the control group reported an increase in nausea.

These results suggest that exercise has the potential to reduce or control nausea in patients recovering from chemotherapy. However, the results of this study are limited to female breast cancer patients receiving chemotherapy. Further, this study does not

address the ideal intensity for reducing nausea. Also, the exercise was limited to cycle ergometry. Could walking or other types of exercise produce the same effect?

Continuing in this same area of study, MacVicar, Winningham, and Nickel (39) explored the effect of aerobic exercise on functional capacity in cancer patients. Using the same protocol as in their previous study (71), 45 women with stage II breast cancer were randomly assigned to three groups: placebo, control and exercise. The exercise program was the same as described in the previous study. Maximal oxygen consumption measured on the cycle ergometer served as the dependent variable.

The results revealed no significant difference in maximal oxygen consumption between the groups on the pre-test. However, after the ten week exercise period, the exercisers showed a 40% improvement in aerobic capacity (1.02 L·min to 1.45 L·min) while the other groups showed no change in aerobic capacity from the pre-test.

While this study suffers from the same limitations as the previous one, it adds evidence to the small body of research on physical training after cancer treatment. Often cancer patients are told to rest and reduce activity in response to fatigue and weakness. Reducing activity may in fact accelerate the decline in functional capacity. Perhaps exercise can be prescribed for patients to help prevent the decrease in aerobic capacity that can occur while surviving cancer.

Winningham and MacVicar conducted an additional study in 1989 (73). In this study, 24 breast cancer patients were randomly divided into an exercise group (n=12) and a control group (n=12). The exercise group received 20-30 minutes of cycling exercise at 60-85% of maximal heart rate, three times a week for 10-12 weeks. The control group did not participate in exercise but continued their normal activities. The dependent variables studied were body weight and composition. Over the study period, both groups gained weight. The control group gained a mean of 1.99 kilograms while the exercise group gained .82 kilograms. However mean body fat percentage was significantly different at the end of the study period. Percent fat (measured by skinfold thickness) increased significantly in the control group (+2.19%) and decreased significantly in the exercise group (-.51%). Further estimates revealed the exercising group gained 2.04 kilograms of lean body weight while the control group lost 1.26 kilograms of lean weight. The results of this study indicate that exercise may have a beneficial effect on body composition in cancer patients.

The results of the previously discussed studies conducted by Winningham and MacVicar suggest that exercise can produce positive benefits in aerobic capacity, body

composition, nausea, fatigue and mood states. More recent studies (12, 15) have investigated more diverse cancer populations and different types of exercise programs.

Dimeo et al. (11) studied the effect of aerobic exercise on cancer patients recovering from chemotherapy. Thirty two patients (21 females and 11 males) served as subjects. The patients were receiving chemotherapy for either breast cancer, non-Hodgkins lymphoma, nonsmall cell lung carcinoma, sarcoma or seminoma. The researchers divided the patients into either an exercise group (n=16) or a control group (n=16). The assignments to groups was not random. Since the exercise group needed to report to the hospital on all weekdays, the researchers appointed those patients living closest to the hospital (within 50 kilometers) to the exercise group. The remaining patients formed the control group.

The exercise program consisted of a series of intervals performed on the treadmill. Subjects exercised on five consecutive days a week (Monday through Friday) for six weeks. Exercise duration was initially five intervals lasting three minutes each. The intensity of the exercise corresponded to a lactate concentration of  $3 \pm .5$  mmol ·liter. This intensity level corresponded to a heart rate of  $80 \pm 5\%$  of calculated maximum heart rate ( $220$ -age). Lactate concentrations were monitored every fifth day. If lactate levels fell below  $2.5$  mmol ·liter, the speed of the treadmill was increased  $.5$  km·hour to maintain the desired training intensity. The duration of exercise progressed over the weeks in the following fashion: week 2: 4 x 5 minutes, week 3: 3 x 8 minutes, week 4: 3 x 10 minutes, week 5: 2 x 15 minutes, week 6: 30 minutes continuously. Between the intervals, the subjects walked at a slower speed. The control group continued normal activity with the exclusion of exercise.

The dependent variables in the study were walking speed and hemoglobin concentration. Hemoglobin concentrations were evaluated because many patients surviving chemotherapy are anemic. The results revealed no differences in maximum walking speed between the training and control groups ( $6.2 \pm 1.1$  km·hour<sup>-1</sup>,  $6.2 \pm 1.3$  km·hour<sup>-1</sup>) respectively, as a pre-test measure. No differences in hemoglobin were shown with either group on the pre-test ( $10.1 \pm 1.4$  g·dl training,  $10.1 \pm 1.2$  g·dl control). Post-test measures however, were significantly different for maximum walking speed ( $8.3 \pm 1.6$  km·hour<sup>-1</sup> training,  $7.5 \pm 1.3$  km·hour<sup>-1</sup>, control,  $p < 0.05$ ) and hemoglobin concentration ( $13.1 \pm 1.0$  g·dl training,  $12.1 \pm 1.4$  g·dl control,  $p < 0.05$ ). The researchers reported 25% of the control group complained of fatigue and a

decrease in normal activities while none of the exercisers reported debilitating fatigue. The investigators concluded that aerobic activity has positive benefits for cancer patients not only on physical performance and hemoglobin concentration but on fatigue. They suggest a larger randomized study should be conducted to determine the long and short term effects of aerobic exercise for cancer patients.

One limitation of this study is the non-random assignment to groups. Although no pre-test differences were observed, some bias may exist in the groupings. It is also difficult to speculate about the interaction of exercise and fatigue as no measures of fatigue were taken.

Yet in a recent article (12) this same group did just that. Using a subgroup of their initial study, Dimeo, Rumberger and Keul (12) studied five cancer patients all recovering from chemotherapy. All of these patients reported severe, debilitating fatigue. The training program was the same six week walking protocol described in the above study. The dependent variables were maximum walking speed, maximal distance walked, heart rate and lactate concentrations. All of these patients showed statistically significant improvement on these measures. The results were as follows; walking speed ( $6.4 \pm 0.4 \text{ km}\cdot\text{hour}^{-1}$  to  $7.5 \pm 0.9 \text{ km}\cdot\text{hour}^{-1}$ ), walking distance ( $1640 \pm 724 \text{ m}$  to  $3300 \pm 953 \text{ m}$ ), heart rate at  $5 \text{ km}\cdot\text{hour}$  ( $138 \pm 21 \text{ bpm}$  to  $113 \pm 20 \text{ bpm}$ ), lactate at  $5 \text{ km}\cdot\text{hour}$  ( $2.6 \pm 1.4 \text{ mmol}\cdot\text{liter}$  to  $1.3 \pm 1.4 \text{ mmol}\cdot\text{liter}$ ). The researchers concluded that an aerobic exercise program of the type described can be prescribed to reduce fatigue in cancer patients.

It is interesting that these researchers make this claim as no measures of fatigue were taken. It can be implied that a faster walking speed and a longer distance walked represents reduced physiological fatigue. However, it is speculative to make this claim in general as fatigue may have a psychological component as well. The patients reported anecdotally that they felt less fatigue but there was no report of the number of patients claiming less fatigue. Future studies may be better served by attempting to measure pre and post-test fatigue with a more objective scale such as the Symptom Assessment Scale. These studies however, do provide evidence that subjects other than breast cancer patients may benefit from exercise.

The studies reviewed so far have used either cycling or walking as exercise in the rehabilitation of cancer patients. Up to this point no research group has investigated the effect of resistance training on recovering cancer patients. Durak and Lilly (15) took up that challenge. They used 20 cancer patients mean age  $50 \pm 12$  years as subjects. The

gender of the subjects was not reported. The subjects were surviving a variety of cancers including leukemia, lymphoma and carcinoma. All of the patients were treated with either radiation, chemotherapy or both. The subjects exercised twice a week for ten weeks during the study period.

The exercise program consisted of aerobic exercise, resistance training, stretching and relaxation. The aerobic exercise was conducted on aerobic machines. The intensity of the aerobic exercise was monitored by perceived exertion. The level of perceived exertion was not noted in the report. The initial duration of the individual exercise program was not reported. The resistance exercise consisted of 2-3 sets of five exercises (chest press, pulldown, hip extension, leg press, leg extension). The method for determining the initial resistance was not reported. The patients also performed individual stretching exercises as well as controlled breathing and guided imagery at the end of class.

The dependent variables included strength, maximum time on the aerobic machines and the modified Rotterdam Quality of Life Survey. The modified Rotterdam Quality of Life Survey used in this study consists of three questions relating to the ability to function, side effects of exercise and pain. The questions are rated on a scale from 1 to 9.

The results revealed overall strength increased 70.3%. Time on the aerobic machines (protocol was not mentioned) improved from the initial mean of 14.8 minutes to 22.5 minutes, a 52.1% increase. The modified Rotterdam Quality of Life Survey results suggested the patients performed daily activities more easily, felt stronger and had less pain after the ten weeks of training. Lastly, after 1000 exercise hours, the researchers reported a 69.5% adherence rate and no cases of injury, illness or negative response to this program.

While this program is innovative and shows practical application, there are several limitations. First, no control group was involved in this study. Second, the description of the methods was quite limited, making it difficult to ascertain initial training levels and rates of progression. Third, the types of aerobic machines were not reported. Lastly, little physiological data was reported. Despite these scientific limitations, a program such as this may bring about physiological and psychological benefits to people surviving cancer.

These preliminary results on the effects of exercise on physiological parameters in subjects surviving cancer seem positive. Exercise seems to increase aerobic capacity,

decrease body fat, increase strength, decrease nausea and fatigue, and may impact psychological parameters.

### **Psychological Parameters**

While several reviews (1, 44) have addressed the complex interaction between cancer rehabilitation and psychological states, few articles have considered the trilogy of cancer survival, exercise and psychological variables.

Nelson in 1991 (50) investigated the differences in perceived health, self esteem, health habits, and perceived benefits and barriers to exercise between women with breast cancer and those without cancer. Fifty four women who experienced Stage 1 breast cancer formed the cancer group. Another sample of fifty four women matched by age and income levels served as the control group. All the subjects completed four measurement tools. These included the Rosenberg Self-esteem Scale that evaluates self acceptance, the Health Promotion Life Style Profile that measures the frequency of health promoting behavior, the Exercise Benefits/Barriers Scale that determines the benefits and/ or barriers to exercise and a Perceived Health Scale with which the subjects rate their own health.

The results revealed no significant differences between the groups in perceived health, self-esteem and health habits. The groups did differ significantly on the Exercise Benefits/Barriers scale with the control group scoring higher (more benefit, less barriers) than the cancer group. Seventy four percent of the women experiencing breast cancer participated in exercise. Eighty five percent of the control group participated in exercise. The researchers concluded the differences in the Exercise Benefits/Barriers scale was due to the higher number of non-exercisers in the cancer group. The most popular exercise for both groups was walking. Other exercise modes the women reported participating in were stationary biking, aerobics and swimming. Also, the cancer patients that exercised showed higher levels of self esteem than non-exercising patients.

This retrospective case-control study has several limitations. It is only generalizable to women with Stage 1 breast cancer. Secondly, this research involved the mailing of a survey. The refusal rate was 45% lending more caution to the extrapolation of the results to all women with Stage 1 breast cancer. This study suggests the relationship between exercise and self esteem should be more extensively evaluated.

In 1991, Young-McCaughan and Sexton (77) studied the effect of aerobic exercise on the quality of life in women with breast cancer. Seventy one women with breast cancer were the subjects. The subjects could be surviving any stage of breast cancer and any treatment modality. They were divided into groups by exercise history. Forty two of the women reported that they exercised on a regular basis. These women formed the exercise group. To be eligible for this group, the women needed to perform some type of aerobic exercise or activity. The specifics of the exercise regimen (intensity, duration, frequency, progression) were not reported. The other twenty nine women formed the control group. The dependent variables were quality of life as measured by the Quality of Life Index for Patients with Cancer and the Perceived Barriers to Exercise Scale. The results showed that women exercise had a significantly higher quality of life ( $p = 0.03$ ) than the non-exercising women. The exercisers also perceived fewer barriers to exercise ( $p = 0.0001$ ) than the non-exercisers. The groups did not differ in any of the following areas: age, education, employment, socioeconomic status, stage of cancer, time from diagnosis, types of treatments or pre-existing health conditions. These results seem to suggest that women who exercise have an increased quality of life and fewer barriers to exercise.

There are several limitations to this retrospective study. The sample was one of convenience, not random assignment. This may bias the responses of the groups. Further the data was gathered with a questionnaire. Not all the women who received the questionnaire returned it. Perhaps women who exercised were more likely to answer the questions. Also people tend to over-report exercise. The accuracy of the measure is therefore in question. Additionally, there was no attempt to evaluate progression in the women's exercise programs. The researchers suggest that further studies should be conducted on a prospective basis and detailed information about type, intensity, frequency and duration should be noted.

In 1994, Mock et al. (46) used a prospective design to evaluate a rehabilitation program in women suffering from breast cancer. The subjects were 14 women with Stage I or II breast cancer. All the subjects were receiving chemotherapy. The subjects were randomly assigned to either an exercise group ( $n = 9$ ) or a control group ( $n = 5$ ). The exercise group participated in a rehabilitation program. This program consisted of an exercise program and a support group. The exercise program was a progressive walking regimen. The subjects walked 10 - 45 minutes a day in their own neighborhood at their own pace for 4-6 months. They also participated in a cancer

support group which met for ninety minutes every two weeks. The control group received only medical care. The dependent variables included measures that evaluated physical function, psychosocial adjustment, self-concept, body image and the intensity of symptoms. Physical function was evaluated by a 12 minute walking test which measured the number of meters covered in the time period and the Karnofsky Performance Status Scale which measures the ability to perform physical activity. This scale rates scores from 0 (deceased) to 100 (normal function). Psychosocial adjustment was measured by the Psychosocial Adjustment to Illness Scale (PAIS) and the Brief Symptom Inventory. The PAIS is a questionnaire that measures psychosocial adjustment changes that occur after illness. The Brief Symptom Inventory is a questionnaire that measures the number and intensity of symptoms. Self concept was measured with the Tennessee Self Concept Scale. This one hundred question scale rates overall self-esteem. Body image was measured using the Body Image Visual Analogue Scale. The subject rates their satisfaction with their body image on a one hundred millimeter scale. The subject's symptoms were rated using the Symptom Assessment Scale. This scale measures symptoms including nausea, vomiting, fatigue, anxiety, depression and pain using 100 millimeter visual analogues. All the dependent measures were administered three times: before chemotherapy, at the midpoint of treatment, one month after chemotherapy.

The results revealed no differences in the Karnofsky Performance Scale. However, the 12 minute walking test showed a significant difference between the exercise group and the control group at the post-test measure (1186.8 meters vs. 986.8 meters, respectively). Psychosocial adjustment measured by PAIS decreased in both groups during chemotherapy. The difference between the groups was significant at mid-treatment with the control group showing the higher score (higher score, less adjustment). Emotional distress measured by BSI decreased in the exercise group and increased in the control group reaching significance at the midtest. Self concept scores measured by TSCS showed no difference. Body image remained the same in the exercise group but decreased in the control group. The Symptom Assessment Scale revealed no differences in symptoms at the pretest. By mid-treatment however, significant differences were found in fatigue, nausea and depression with the control group exhibiting more of these symptoms. Post-test results also showed the control group had a statistically significant difference in sleep problems compared to the exercise group.

These results showed that exercise can increase walking ability, decrease some symptoms of cancer treatment and improve psychosocial adjustment. While this study is limited by gender, type of cancer and small sample size, it suggests that exercise may be a valuable treatment in the rehabilitation of cancer patients.

These three studies comprise the present literature available on the interaction between exercise and psychological variables in cancer patients. It seems exercise in general has a positive effect on psychological function.

### **Summary**

These few investigations make up the knowledge base pertaining to the use of exercise as a tool for rehabilitating cancer patients. As a result of their treatment, cancer patients suffer numerous side effects. Common side effects include: fatigue, depression, nausea, muscular atrophy, decreased strength and flexibility, loss of functional capacity, body composition changes and a decrease in overall quality of life. In theory, exercise may relieve some of these negative side effects of cancer treatment.

The studies reviewed have shown rehabilitating cancer patients who exercise can improve aerobic capacity (38,39), walking speed and distance (11,12), muscular strength (15) and body composition (73). In addition, stationary cycling may reduce nausea (71) and walking may reduce fatigue (11,12). Several studies (15,36,77) have shown that exercise may improve quality of life. These results suggest that exercise may be a practical and inexpensive tool in the rehabilitation of cancer patients.

However, the studies reviewed here contain many research design problems and limitations. Three of these studies reviewed had no control group for comparison (11,12,15). A healthy exercise group was provided for comparison in only one study (37). In five of the studies (11,12,15,37,76) group assignments were not random. This may have introduced a bias in the groups at the start of the study period. In three of the studies reviewed (15,37,72) no statistics were applied to the data. The results were reported as trends or changes. Only one study (72) attempted to measure changes in body composition as a result of rehabilitative exercise. Likewise, the only study evaluating strength training in patients surviving cancer showed an increase in overall strength. However, no record was available explaining how strength was measured. Further, little physiological data was gathered and statistics were not applied to the data that was collected.

Together, these studies describe our current state of knowledge concerning exercise as a rehabilitative tool for cancer patients. The results of these studies indicate that aerobic and resistance exercise has a positive affect on some common side effects of cancer treatment. Unfortunately, the majority of these studies suffer from a lack of well controlled research design. This leaves the value of exercise as a rehabilitative tool in this disease in question. The current study will attempt to solve some of these methodological problems. Subjects in this study will be randomly assigned to groups after being matched by aerobic capacity. The exercise program will be comprised of aerobic exercise, resistance training and flexibility exercises. Only one study (15) has attempted this so far. Additionally, this study will measure functional capacity, body composition, and psychological measures. No one study to date has been that comprehensive. Further, this study will assess flexibility which may be important for independent living. Flexibility measures have not been reported in the literature in this type of subject group. Two levels of intensity will be used to evaluate the intensity necessary to show a reduction in symptoms. Finally, this study will measure the dependent variables three times (pre-treatment, mid-treatment, post-treatment). Only one study has previously taken mid-treatment measures (46). This study will attempt to bring more scientific control to this area of research to clarify the role of aerobic exercise and resistance training in the rehabilitation of cancer patients.

If this study is successful, and positive physiological and psychological benefits are found, exercise may be a useful tool for the rehabilitation of cancer patients.

## APPENDIX B



OREGON STATE  
UNIVERSITY

COPY

Report of Review by the Institutional Review Board for the  
Protection of Human Subjects

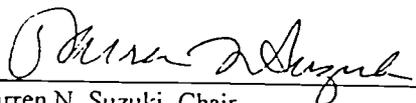
TO: Anthony Wilcox, ExSS

COPY: Tim Burnham, Central Oregon Community College, 2600 N.W. College Way, Bend,  
OR 97701

RE: Physiological and psychological effects of exercise in cancer patients following  
treatment.

The referenced project was reviewed under the guidelines of Oregon State University's Committee for the Protection of Human Subjects and the U.S. Department of Health and Human Services. The committee has **approved** your application. The approval of this application expires upon the completion of the project or one year from the approval date, whichever is sooner. The informed consent form obtained from each subject should be retained in program/project's files for three years beyond the end date of the project.

Any proposed change to the protocol or informed consent form that is not included in the approved application must be submitted to the IRB for review and must be approved by the committee before it can be implemented. Immediate action may be taken where necessary to eliminate apparent hazards to subjects, but this modification to the approved project must be reported immediately to the IRB.

  
\_\_\_\_\_  
Warren N. Suzuki, Chair  
Committee for the Protection of Human Subjects  
(Education, 7-6393, [suzukiw@orst.edu](mailto:suzukiw@orst.edu))

Date: 10/05/99



2500 NE Neff Road  
 Bend, Oregon 97701-6015  
 Telephone (541) 382-4321

September 23, 1999

TO: Tim Burnham, MS, Assistant Professor  
 Central Oregon Community College

From: Michel Boileau, MD, IRB Chair *Boileau*  
 St. Charles Medical Center

RE: "Physiological and Psychological Effects of Exercise in Cancer  
 Patients Following Treatment"

INITIAL APPROVAL PROTOCOL AND CONSENT

.....

Thank you for submitting the revisions requested in the consent form. I have re-reviewed the 4 revisions as noted in my correspondence to you 8-17-99. Since you have met the requirements of the IRB for approval of this project, this letter serves to inform you that the above named protocol and consent are now approved for use.

We are also in receipt of the ad and patient letter you intend to use. These will be reviewed at our next IRB meeting 10/18/99. The approval of these items should not hinder your implementation of this program.

This program and consent are will be annually reviewed August 2000.

Please be advised that it is your responsibility to inform the Committee if there are any adverse events, protocol changes or changes in the informed consent. You can submit these items to Meredith Dawson, RN, CCRA, IRB Coordinator. Please address C/O SCMC, Cancer Services Department.

Please contact Meredith Dawson, RN, CCRA 542-317-4359 if you have further questions.

Thank you!



2500 NE Neff Road  
Bend, Oregon 97701-6015  
Telephone (541) 382-4321

November 18, 1999

TO: Tim Burnham, MS, Assistant Professor  
Central Oregon Community College

From: Michel Boileau, MD, IRB Chair  
St. Charles Medical Center

A handwritten signature in black ink, appearing to read "Boileau", is written over the printed name of Michel Boileau.

RE: "Physiological and Psychological Effects of Exercise in Cancer  
Patients Following Treatment"

APPROVAL: Advertisement and Patient Letter

.....  
The IRB met today and reviewed the advertisement and patient letter for your project.  
These were approved without further comment.

Please be advised that it is your responsibility to inform the IRB Committee if there are any adverse events, protocol changes or changes in the informed consent. You can submit these items directly to Meredith Dawson, RN, CCRA, IRB Coordinator. Please address C/O SCMC, Cancer Services Department.

Please contact Meredith Dawson, RN, CCRA 542-317-4359 if you have further questions.

Thank you!

**Department of Exercise and Sport Science  
Oregon State University  
Central Oregon Community College  
And  
St. Charles Medical Center**

**INFORMED CONSENT FORM**

**Physiological and Psychological Effects of Exercise in Cancer Patients Following Treatment**

Investigators: Anthony Wilcox, Ph.D., Associate Professor, Oregon State University; Tim Burnham, MS., Assistant Professor, Central Oregon Community College.

**Purpose:** The purpose of this study is to investigate the effects of exercise on physiological and psychological function in patients rehabilitating from cancer treatments.

**I have received an oral explanation of the study procedures and understand they entail:**

**1. Pre-study Screening.** To be eligible for this study I must be cleared by my physician to participate. I must be at least two to three months post-treatment with no spread of the cancer to the bone. I must also receive a score of seventy or more on a standard assessment of physical function (the Karnofsky Performance Status Scale).

**2. What will I do during the study?**

The study period will be ten weeks. At the beginning, week five and at the end of my involvement in the study, I will undergo four tests of my physical function. These include a test of aerobic capacity, body fat measurements, blood pressure and flexibility. I will also fill out two forms. One form asks questions about my quality of life and the other asks questions about fatigue and distress. These forms will take 5-10 minutes each to fill out and involve placing a mark on a scale that shows what is happening with me at the current time. I will complete these six tests in one day at the Central Oregon Community College Physiology Laboratory and they will involve about one hour of my time. Therefore during the course of the study period, I will perform these six tests 3 different times involving about 3 total hours of my time. The tests are described below. All of these tests will be performed at the COCC Physiology Laboratory on the Bend campus.

a. Test of aerobic capacity. This test involves walking on a treadmill at a moderate (3 mph) walking speed. Every two minutes the grade (steepness) of the treadmill will increase. I will continue walking as long as I can. When I feel I can no longer continue the exercise, I can stop. This test usually lasts 8-12 minutes. During the test, I will breathe room air through a mouthpiece so that the amount of oxygen I am using can be determined. My heart rate will be continuously monitored electrocardiographically. Trained laboratory personnel, certified in CPR, will administer the exercise tests. A physician will also be present during this test.

b. Body fat measurements. This will be determined by skinfold measurements. In this method, a double fold of skin and subcutaneous fat is "pinched" with a caliper. Skinfold measurements will be taken from three sites. For men, measurements will be taken at the chest, abdomen and thigh. The sites for the women will be the triceps (back of the arm), suprailliac (above the hip) and thigh.

c. Blood pressure. This will be measured with a blood pressure cuff while I sit in a chair with my arm supported.

d. Flexibility. Lower body flexibility (the back of my legs) will be measured with the sit and reach test. In this test, I will remove my shoes and sit with my legs stretched out straight in front of me and my feet touching the sit and reach box. I will then reach with extended arms, and one hand over the other, as far forward as possible without bending the knees.

Upper body flexibility (my shoulders) will be measured with the shoulder rotation test. A wooden bar with a tape measure on it is used for this test. The left hand is placed on the zero mark of the tape while the right hand is placed at the 8-10 inch mark. I then extend both arms to full length while holding the bar. With elbows locked, the arms are rotated over the head from front to back. As the shoulders are rotated, the right hand slides to allow the arm movement. The score is measured by the distance my hand moves. I understand that if I feel any sharp or severe pain, I should discontinue the movement.

After these initial tests are performed, I will be assigned to one of three groups for the ten week study period. Which group I participate in will be determined randomly. That is, I have an equal chance to be in any of the groups. One group will be the control group. This group will perform the tests described above but will not participate in the exercise program.

The second group will be the low intensity exercise group. This group will come to the gym at Central Oregon Community College three times a week for the ten weeks. These people will be involved in stretching and low intensity exercise on treadmills, stair machines and stationary bikes. Low intensity means I will be initially exercising at about 25-35% of my maximal capacity, which is equivalent to a slow leisurely walk. As the study progresses, the exercise intensity will increase approximately .5-1.5% a week. This means I will be exercising at a slightly faster rate in the later weeks. By the last week of the study, my exercise intensity will be about 40% of my maximal capacity. During the beginning weeks of the study, the stretching and exercise will take about 30 minutes. Towards the end of the study, the exercise time will increase to about one hour.

The third group will be the moderate intensity group. This group will do the same things as the low intensity group (same number of times a week and same length of exercise) but they will exercise at a slightly more vigorous pace. This pace will start at 40-50% of my maximal capacity, which is similar to a brisk walk. As the weeks pass, my intensity will increase 1-2% a week, reaching approximately 60% of my maximal capacity by week 10. If I am in one of the exercise groups, the pace (intensity) will be measured with a heart rate monitor that I will wear around my chest.

## **5. Potential risks or discomforts**

There is a remote risk of death associated with the test of aerobic capacity. In large, varied populations, this risk is one death per 10,000 tests. However during the aerobic capacity test (on the treadmill) I will walk only until I feel I cannot continue.

Furthermore, experienced lab personnel, who are trained in CPR, will be administering all tests and monitoring for signs of exercise intolerance, and a physician will be present during this test. There is also a risk of soreness or fatigue from the exercise program if I am not currently used to exercise. However I will be led through warm-up and cool-down stretching and exercise by experienced exercise leaders, which will help ensure that I progress in my program gradually, reducing the risk of muscle soreness.

## **6. Benefits to be expected from this research.**

I will benefit from my participation in this study by gaining information about my aerobic capacity, body fat percentage, blood pressure and flexibility. I will also be able to see how these measures change throughout the study period

## **7. Confidentiality**

My anonymity will be maintained by assigning me a code number upon entry into the study. All data will be recorded using the code number. The list containing the names of the subjects and their code numbers will only be available to the researchers in this study. I will not be identified in any way in the presentation or publication of the results of the study.

## **8. Compensation for Injury.**

I understand that Oregon State University and Central Oregon Community College and the St. Charles Medical Center do not provide a research subject with compensation or medical treatment in the event the subject is injured as a result of participation in the research project.

## **9. Voluntary Participation Statement.**

I understand that my participation in this study is completely voluntary and that I may either refuse to participate or withdraw from the study at any time without penalty or loss of benefits to which I am otherwise entitled, and it will in no way affect my relationship with or treatment at SCMC.

## **10. If You Have Questions.**

I understand that any questions I have about the research study or specific procedures should be directed to Tim Burnham, COCC, 2600 NW College Way, Bend OR 97701, (541) 383-7743. If I have questions about my rights as a research subject, I should contact the IRB Coordinator, OSU Research Office, (541) 737-8008 or the IRB Chairman at the St Charles Medical Center (541) 382-4321 ext 7010.

I have been completely informed and understand the nature and purpose of the research project. The researchers have offered to answer any further questions that I may have. I understand that my participation in this study is completely voluntary and I may

withdraw from the study at any time without prejudice or loss of benefits to which my participation entitles me. I understand that I will receive a signed copy of the consent form.

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

---

Subject's Name

---

Subject's Signature

---

Date

---

Subject's Address

---

Phone Number

---

Investigator's Signature

---

Date

## APPENDIX C

### Quality of Life Index for Patients with Cancer

Developed by:

Geraldine Padilla, Cary Present, Marcia Grant, Gerald Metter,  
James Lipsett, and Frances Heide

**Instructions:**

Below are several questions pertaining to your physical well-being, normal activities, and general quality of life. To answer a question, place an "X" on the linear scale opposite the question at the point that best shows us what is happening to you at the present (within the past week). The description, 'normal for me', means what was normal prior to illness.

**Quality of Life Index**

With respect to your general physical condition please describe:

**General physical condition:**

1. How much PAIN you are feeling.

Excruciating \_\_\_\_\_ None

2. How much NAUSEA you experience.

Constant \_\_\_\_\_ None

3. How frequently you VOMIT.

Constant \_\_\_\_\_ Not at all

4. How much STRENGTH you feel.

None \_\_\_\_\_ Normal for me

5. How much APPETITE you have.

Not at all \_\_\_\_\_ Normal for me

**Important human activities:**

6. Are you able to WORK at your usual tasks (example: housework, office work, gardening)?

Not at all \_\_\_\_\_ Normal for me

7. Are you able to EAT?

Not at all \_\_\_\_\_ Normal for me

8. Are you able to obtain SEXUAL satisfaction?

Not at all \_\_\_\_\_ Normal for me

9. Are you able to SLEEP well?

Not at all \_\_\_\_\_ Normal for me

**General quality of life:**

10. How good is your quality of life? (GENERAL QL)

Extremely poor \_\_\_\_\_ Excellent

11. Are you able to have FUN? (hobbies, recreation, social activities)

Not at all \_\_\_\_\_ Normal for me

12. Is your life SATISFYING?

Not at all \_\_\_\_\_ Normal for me

13. Do you feel USEFUL?

Not at all \_\_\_\_\_ Normal for me

14. Do you WORRY ABOUT THE COST of medical care?

A great deal \_\_\_\_\_ Not at all

## APPENDIX D

### Linear Analogue Self-Assessment Scale (LASA)

Developed by:

Heather J. Sutherland, Patricia Walker, and James E. Till

Instructions: Place a vertical mark on each scale at the position that best describes your state during the last week.

**How have you been feeling during the past week?**

- |                            |       |                        |
|----------------------------|-------|------------------------|
| 1. Not at all<br>fatigued  | _____ | Extremely<br>fatigued  |
| 2. Not at all<br>anxious   | _____ | Extremely<br>anxious   |
| 3. Not at all<br>confused  | _____ | Extremely<br>confused  |
| 4. Not at all<br>depressed | _____ | Extremely<br>depressed |
| 5. Not at all<br>energetic | _____ | Extremely<br>energetic |
| 6. Not at all<br>angry     | _____ | Extremely<br>angry     |

**APPENDIX E****Karnofsky Performance Status Scores**

<b>Description</b>	<b>Status (%)</b>
Normal; no complaints	100
Able to carry on normal activities; minor signs of symptoms of disease	90
Normal activity with effort	80
Cares for self; unable to carry on normal activity or to do work	70
Requires occasional assistance but able to care for most of his/her needs	60
Requires considerable assistance and frequent medical care	50
Disabled; requires special care and assistance	40
Severely disabled; hospitalization indicated though death is not imminent	30
Very sick; hospitalization necessary, active supportive treatment necessary	20
Moribund	10
Dead	0

