ABSTRACT

VANDE VOORT, C. K. Heart rate responses to chair aerobics in healthy older women. MS in Adult Fitness/Cardiac Rehabilitation, December 1998, 67pp. (N.K. Butts)

This study investigated heart rate responses of 12 older (mean age = 63.1 yrs) apparently healthy women from the La Crosse Exercise and Health Program. Although each volunteer participated in 2, 24-hour heart rate monitoring sessions, only portions of that time period representing sleep, daily activities, chair aerobics, and peak heart rate were analyzed. Heart rates were recorded minute-by-minute using a Polar Vantage XL heart rate monitor and activity logs were kept. There was a very strong and significant ($p < .01$) correlation ($r = .94$) between heart rates of day 1 and day 2. A two-way REANOVA showed significant ($p < .05$) differences among heart rate responses of sleep (69.9 bpm), daily activities (85.4 bpm), chair aerobics (102.4 bpm), and peak heart rate (124.8 bpm). %HRmax (calculated using 220-age) for sleep, daily activities, chair aerobics, and peak heart rate were 44.6, 54.5, 65.3, & 78.8%, respectively. The majority of Ss obtained their peak heart rate during low-impact aerobics or some other form of exercise. Based on these results, chair aerobics and peak heart rates were classified as "moderate" and "hard" intensity, respectively, thus meeting the American College of Sports Medicine (1998) recommendations for exercise intensity for healthy adults. Chair aerobics, as well as other light to moderate exercise, may play a role in reducing the rate of age-associated deterioration in many physiological functions, even if these activities do not reach the intensity necessary to increase absolute measures of fitness.

HEART RATE RESPONSES TO CHAIR AEROBICS

IN HEALTHY OLDER WOMEN

A THESIS PRESENTED

TO

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CHAPTER I

INTRODUCTION

Heart rate, the number of times the heart beats or contracts in one minute, is controlled by both intrinsic and extrinsic mechanisms. Both the sympathetic and parasympathetic portions of the autonomic nervous system control heart rate through chronotropic and inotropic effects. At rest the atria are under parasympathetic stimulation or vagal control resulting in a resting heart rate below the inherent 100 beats per minute of the sinoatrial node, the normal pacemaker. During exercise, the autonomic nervous system withdraws the parasympathetic stimulation and begins stimulating the sympathetic fibers to the atria resulting in an increase in heart rate. As heart rate increases, more blood is pumped to the tissues in the body that need it, thus heart rate varies greatly with different activities and within individuals.

During exercise the cardiovascular system is stressed and reacts with increased heart rate and blood pressure to supply the increased need for blood to the tissues. According to the American College of Sports Medicine (ACSM, 1995), exercise improves cardiovascular function as seen with increased maximal oxygen uptake, and lower myocardial oxygen cost, heart rate, and blood pressure for a given submaximal intensity. A reduction in coronary artery disease risk factors such as high blood pressure, high cholesterol, and body fatness may also occur with regular exercise. Lower mortality and morbidity are also benefits of regular physical activity. Furthermore, exercise may also decrease anxiety and depression and enhance feelings of well being. In order to receive these benefits, the ACSM (1998b) recommends 20-60 minutes of exercise, 3-5 days per week, at an intensity of 55-90% of maximum heart rate.

Chair aerobics has become a popular form of exercise in the last several years, especially among the older population. Chair aerobics consists of strengthening, stretching, and aerobic dance like movements done with music while sitting in a chair. Because the participant remains seated, there is less stress on the joints than activities such as jogging or walking. At this point there has not been any research done on the effect that chair aerobics has on the cardiovascular system or if it stresses the heart sufficiently to meet the requirements needed to receive the benefits of exercise as suggested by the ACSM (1995).

Need for the Study

Chair aerobics provides an alternative exercise for many people. Due to the recent development of this type of exercise class, however, no research has been published on the effect of chair aerobics on the heart rate of older women. Can chair aerobics stress the cardiovascular system (i.e., heart rate) enough to obtain the training benefits of exercise? Monitoring heart rate during a variety of activities including sleep, daily activities, chair aerobics, and peak heart rate would allow a comparison of heart rates achieved in each of these areas.

Purpose of the Study

The purpose of this study was to compare heart rates obtained during chair aerobics to the heart rates achieved during normal daily activities in healthy older women.

Null Hypothesis

The null hypothesis for this study was: there will be no significant difference in heart rate responses during chair aerobics as compared to normal daily activity in older women.

Assumptions

This study had the following assumptions:

1. The Polar Vantage XL Heart Rate Monitor (Polar USA, Inc., 1992) measured heart rates accurately.
2. Each subject kept an accurate record of her daily activities during the monitoring periods.
3. The daily routine of the subjects consisted of activities done in normal, everyday life (i.e., eating, cooking, sleeping, shopping, housework, etc.). These activities varied from subject to subject.
4. Each subject was physically capable of completing all the movements involved in the chair aerobics class.
5. The heart rates achieved during the first few hours of sleep were consistent with those achieved during the last hours of sleep.
6. Sleep heart rates were averaged during sleep hours reported on the activity log.
7. Average heart rates between 8 a.m. and 3 p.m. represented daily activities.
8. Peak heart rate was the highest heart rate achieved regardless of time period.

Delimitations

This study had the following delimitations:

1. Subjects were women ranging in age from 54 to 70 years old who were members of the Adult Fitness portion of the La Crosse Exercise and Health Program (LEHP).
2. The chair aerobics instructor remained the same throughout the testing period.
3. Each subject took prescription medications as usual.

Limitations

The following limitations were recognized:

1. The subjects volunteered for the study.
2. A limited number of subjects were tested.

Definitions of Terms

The following terms were used in this study:

Adult Fitness – a portion of the LEHP for people with no known cardiac, pulmonary, or metabolic disease. Supervision is unnecessary during exercise for this population.

Chair Aerobics – a combination of strengthening, stretching, and upper and lower body movements led by an instructor while listening to music and sitting in a straight-back chair.

Chair Aerobics Heart Rate – an average of the minute-by-minute heart rates recorded during the 30-minute chair aerobics session.

Daily Activities – things done throughout the day including eating, cooking, washing dishes, sleeping, vacuuming, dusting, cleaning, walking, biking, sleeping, shopping, talking on the phone, watching TV, reading the paper, and receptionist work.

Daily Activities Heart Rate – the average of the hourly heart rates from 8 a.m. – 3 p.m.

Maximal Heart Rate – the maximal times the heart beats in one minute determined directly through an exercise test or predicted using an equation. In the present study, it was predicted using two ACSM (1995) equations: 220 – age; and 210 – (.5 x age).

Peak Heart Rate – the highest heart rate achieved for three consecutive minutes, which were not more than 5 beats apart, and could occur during any activity.

Polar Vantage XL Heart Rate Monitor – a heart rate monitor designed to indicate heart rate levels during activity. A monitor/transmitter worn around the chest senses electrical signals generated by the heart and electronically computes and digitally displays the heart rate in beats per minute (bpm) on a watch display. The watch has the ability to store heart rate data for further analysis (Polar USA, Inc., 1992).

Sleep Heart Rate – the average of the hourly heart rates during sleep hours as recorded on activity logs.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

A clear linear relationship exists between heart rate and energy expenditure, thus measuring heart rate is one of the easiest ways to measure intensity during exercise. Different modes of exercise, however, may vary this relationship between heart rate and VO_2. As the body ages, the cardiovascular system experiences many changes that affect how the heart reacts to stress. It should be noted, however, that older individuals do experience the same benefits of exercise as the younger population (ACSM, 1998a).

Benefits of Exercise

According to the ACSM (1995), the benefits of regular physical activity have been well established. These benefits consist of improved cardiorespiratory function including increased maximal oxygen uptake (VO_{2max}), lower VO_2 cost for a given submaximal intensity, increased lactate threshold, increased exercise threshold for the onset of disease symptoms, and lower heart rate and blood pressure at given submaximal intensities. Regular exercise also reduces coronary artery disease (CAD) risk factors through modest reductions in resting blood pressures in hypertensives, lowering serum triglycerides and raising high-density lipoprotein (HDL), reducing body fat composition, and improving glucose tolerance. Also regular physical activity can result in decreased anxiety and depression, increased well being, and enhanced performance at work and play.

The ACSM (1998b) has set guidelines for exercise to receive the benefits mentioned above. They recommend exercising at 40-85% of VO_{2max} or 55-90% of maximum heart rate. The ACSM suggests 20 to 60 minutes of continuous aerobic activity performed 3-5 days per week. Individuals who are unfit should exercise at 55-64% of HRmax and may need to begin with a shorter duration.

Older Population

As the body ages, several physiological changes take place. Maximal heart rate, VO_{2max}, cardiac output, muscular strength, flexibility, and bone mass decrease (ACSM, 1995). The ACSM recommends modifications in the exercise programs of older individuals, but also emphasizes that each person is unique in the aging process. The recommended intensity for older adults is 50-70% of heart rate reserve. In addition, new guidelines (ACSM, 1998a) recommend that the frail and very old exercise at 40-60% of heart rate reserve. To avoid injury, duration should be increased before intensity, and the modality used should not impose significant orthopedic stress.

There have been many studies on the effect of aerobic exercise on the older population. Green and Crouse (1995) did a meta-analysis of the effects of endurance training on the elderly. They reviewed 29 studies with 1,446 subjects with a mean age of 68.3 ± 4.5. They found that endurance exercise training significantly increased VO_{2max} in this population. An "average" 68-year-old who exercises 30 minutes, three times per week can improve VO_{2max} by $3.5 ml \cdot kg^{-1} \cdot min^{-1}$ or approximately 14%. Although this was slightly lower than younger subjects it still can be very beneficial. This amount can be enough to make a difference between independent daily living and assisted living according to Green and Crouse. Age related ventricular limitations were the main reason that older individuals obtained smaller increases in oxygen uptake than younger counterparts.

Hamdorf, Withers, Penhall, and Haslam (1992) studied the effects of a six month, twice weekly progressive walking program on the cardiorespiratory fitness and habitual activity patterns of previously sedentary 60-70 year old women. The workouts included flexibility, strength, calisthenics, and walking at 40-60% of heart rate reserve. As a result, resting heart rate decreased significantly (7.4%) as well as the submaximal exercise heart rate (6.9%). The subjects also showed significant improvements in habitual activity patterns that included things such as dressing, taking out the trash, vacuuming, walking, climbing, and jogging.

Blumenthal et al. (1989) investigated how exercise can modify the aging process. Cardiovascular performance decline due to age is caused by changes in peripheral circulation and intrinsic myocardial systolic and diastolic function. They studied 130 men and women ranging in age from 60-83 who were free of coronary disease. They exercised three times per week for 16 weeks during which time there was a warm-up, 30 minutes of cycling, 15 minutes of walking or jogging, and using the arm ergometer. The workload was 70% of maximum heart rate reserve. Women significantly increased peak VO_2 (8.6%) and anaerobic threshold (13%). Cholesterol was significantly reduced and bone mineral content was increased in those with initially low bone density. Physically the participants reported that they felt better, looked better, and had more energy, endurance, and flexibility. Socially they also reported improved familial relations and better sex lives. In addition, they reported better moods, and more self-confidence and life satisfaction.

The ACSM position stand, "Exercise and Physical Activity for Older Adults" (1998a) reports that older adults achieve the same 10-30% increases in VO_{2max} with endurance exercise training as younger individuals do. This increase is attributed mainly to an increase in the maximal arteriovenous O_2 difference in women. There has been no evidence that women achieve an increased VO_{2max} from an increase in left ventricular mass, cardiac output, stroke volume, or end-diastolic volume during maximal exercise as seen in men.

The cardiovascular system responds very similarly to submaximal exercise in younger and older adults. When working at the same percent of VO_{2max}, or relative workload, heart rate is lower in older individuals, but at the same absolute work rate, heart rate responses of young and old are similar. Arteriovenous O_2 difference at the same absolute workload is higher in older adults while cardiac output is lower. Total peripheral resistance tends to be higher in older women at relative and absolute workloads (ACSM, 1998a).

Chair Aerobics

There is limited research on chair aerobics, and the majority of studies available focus more on flexibility and strengthening than the aerobic component. Muscle strength, flexibility, and neurological response decrease as the body ages (ACSM, 1995), however, range of motion and muscular strength are needed to maintain balance. Mills (1994) studied the effect of low-intensity aerobic exercise on muscle strength, flexibility, and balance on 47 subjects 65 years old and older. The subjects participated in 8 weeks of chair exercises consisting mostly of stretching and strengthening. He found that low-intensity aerobic exercise in the chair improved flexibility and range of motion in the ankles and right knee. Muscle strength and balance did not change perhaps because of the short length of the study or too low of an intensity was performed.

McMurdo and Rennie (1993) investigated the effects of a chair aerobics class with 49 subjects ranging in age from 64-91 living in a nursing home. The experimental group participated in a 45-minute exercise-to-music session 2 times per week for 7 months. The first 10 minutes were warm up followed by 35 minutes of seated exercise putting the joints through a full range of motion and doing repetitive upper and lower limb strengthening. Pre- and posttest measurements included postural sway, flexibility of spine and knees, handgrip strength, and functional capacity. Following the seven-month trial the exercise group had significantly higher grip strength, better spinal flexion, faster chair to stand time, and a higher score on an activities of daily living questionnaire. The exercise group improved while the control group deteriorated. This study showed that chair exercise is safe and effective for residents in nursing homes.

Low-Impact Aerobics

Many adult fitness participants around the country take part in aerobic dance classes for exercise. Aerobic dance refers to a choreographed routine of movement from various types of dance combined with other rhythmic movements continuously performed to music. Low impact aerobics by definition means that one foot must always be in contact with the ground. Hopkins, Murrah, Hoeger, and Rhodes (1990) looked at the effects of low-impact aerobic dance on the functional fitness of older women. Functional fitness refers to the ability of the individual to meet the normal and unexpected demands of daily life effectively and safely. Sixty-five women, ranging in age from 57-77 years old, were divided into an experimental group who exercised 50 minutes per day, 3 times per week, for 12 weeks, and a control group. The class consisted of 15 minutes of warm-up, 20 minutes of aerobic dance, and a 15-minute cool down. The dance movements consisted of large arm movements and using major muscle groups of the legs. A half-mile walk test was used to evaluate cardiorespiratory endurance. The results showed the experimental group improved significantly in cardiorespiratory endurance (+13%), strength (+62%), flexibility (+9%), agility (+13%), body fatness (-5%), and balance (+12%). The control group deteriorated in cardiorespiratory endurance, motor control, and agility, and remained the same in the other areas. This study showed the necessity of exercise for older women as well as the specific benefits of aerobic dance.

Taking a heart rate count is the most common way to measure intensity during aerobic dance. Berry, Cline, Berry, and Davis (1992) investigated the relationship of heart rate and VO_2 during two forms of aerobic dance and treadmill running. The female subjects exercised at approximately 50% of their VO_{2max} during each of the following three exercise trials: aerobic dance where the arms were used extensively overhead (ABOVE), aerobic dance where the arms were kept below the shoulders (BELOW), and treadmill running (TR). Mean heart rates during each of the trials were 136 bpm. Mean VO_2 values for ABOVE, BELOW, and TR were 1.48, 1.51, and 1.47 $l \cdot min^{-1}$, respectively, and were not significantly different. Mean cardiac output values were also not significantly different. These results show a similar relationship between heart rate and VO_2 during low-intensity aerobic dance and running.

Heart Rate and VO_2

Heart rate is easy to measure and is linearly related to VO_2 so it is often used to measure aerobic training intensity. However, there has been some question as to the relationship of relative maximal heart rate (%HRmax), maximal heart rate reserve (%HRmax reserve), and maximal oxygen uptake (%VO_{2max}) in older subjects. Panton et al. (1996) looked at this relationship in men and women age 60-80 during submaximal exercise on a treadmill. Each subject did three 6-minute stages on the treadmill eliciting 40, 60, and 80% of HRmax reserve. Maximal heart rate reserve was significantly less than %VO_{2max} for all three intensities, especially between 53 and 88% of VO_{2max}. When using the %HRmax reserve method, resting heart rate represents an exercise intensity of zero but oxygen uptake at rest represents some proportion of VO_{2max} greater than zero. When resting energy expenditure represents a relatively high percentage of VO_{2max}, the % HRreserve method can underestimate true energy cost of exercise. In young and middle-aged individuals with average or high fitness levels, resting VO_2 does not play a role because it represents less than 10% of VO_{2max}. But in someone with a lower fitness level, resting VO_2 may represent up to 25% of VO_{2max} which could result in % HRreserve underestimating true energy cost. Using % HRmax may be a more appropriate way to prescribe exercise for older individuals because it does not correct for resting heart rate. In summary, the relationships between %HRmax reserve and %VO_{2max} may change as people age (Panton et al.). Also, there is interindividual variability in the relationship between $\%VO_{2max}$ and %HR max in women (Franklin, Hodgson, & Buskirk, 1980).

Recently the ACSM revised their 1990 position stand, "The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness, and Flexibility in Healthy Adults" (1998b). They have changed the recommendations for training from 60-90% of maximum heart rate or 50-85% of maximum oxygen uptake reserve to 55-90% of maximum heart rate and 40-85% maximum oxygen uptake reserve. They recommend these lower intensities for individuals who are unfit. They also increased the approximate difference between the $\%VO_{2max}$ (or %HRR) and the % HRmax from 10 to 15% for light and moderate intensities. Londeree and Ames (1976) among others found that HRmax underestimates $\%VO_{2max}$ by about 15% depending somewhat on the age of the subjects and the intensity of the exercise.

After the age of 25 years, VO_{2max} decreases 5 to 15% per decade (ACSM, 1998a). This decrease is attributed to a decline in maximal cardiac output (due to a decrease in maximal heart rate) and maximal arteriovenous O_2 difference. Older adults depend greatly on the Frank-Starling mechanism to increase stroke volume during exercise as shown by the increase in end diastolic volumes. Larger end systolic and diastolic volumes result in a decreased ejection fraction in older adults.

Heart Rate

Aging Effects

Lakatta (1993) stated that as the body increases in age, there is an increase in the elastic and collagenous tissue in all parts of the conduction system of the heart. Also fat builds up around the sinoatrial node and at the age of 60, there is a decrease in the number of pacemaker cells. In the sitting position, heart rate decreases with age in males and females however there is no difference between supine heart rate in older and younger subjects. Respiratory variation of heart rate also diminishes with age as well as a spontaneous variation in heart rate over a 24-hour period.

Lakatta (1993) indicated several cardiovascular changes that occur as the body ages. With orthostatic stress, the acute heart rate increase takes longer to achieve and is less in magnitude with age. Heart rate variability decreases with age when comparing the standing or supine position because of reduced baroreceptor activity. Peripheral vascular resistance does not decline with age. Although the heart rate increase is blunted in older individuals, stroke volume is better preserved, and expected end diastolic volume reduction is less than younger subjects.

Maximal heart rate decreases eight to ten beats per decade or about 7% of heart rate reserve (Paterson, 1992). Some of the reasons for this may be a decreased end organ sensitivity to beta-adrenergic stimulation and an age dependent increase in basal levels of catecholomines, decreased heart rate response to beta-agonists, and blunted heart rate response to beta-adrenergic blockade.

It is well accepted that the heart rate of older individuals is lower during exercise than younger individuals. One reason for this may be the difference in the chronotropic response to catecholamines. Kohrt, Spina, Ehsani, Cryer, and Holloszy (1993) studied 130 active subjects – young and old – who were active but not regular exercisers. They participated in a 9-month progressive exercise program. After training, supine, standing, exercise, and postexercise heart rates decreased in all subjects. When comparing young to old, they found similar basal norepinephrine and epinephrine levels, but these levels of norepinephrine and epinephrine differed significantly in response to stress. Older subjects had an exaggerated norepinephrine response to posture change and an attenuated norepinephrine and epinephrine response to exercise. The older population had a higher catecholamine response to the same level of exercise. After 9 months of exercise, the increases in norepinephrine and epinephrine were 39 and 57% lower which makes sense when looking at the smaller increase in heart rate and the improvement in VO_{2max} because of improved exercise tolerance. Kohrt et al. concluded that compared to younger subjects, older subjects have a blunted catecholamine response to exercise at the same intensity. This could be a result of the smaller muscle mass used during exercise. They also found that exercise training reduced metabolic and hemodynamic stress during exercise in older and younger subjects.

The ACSM (1995) gives several equations used to predict maximal heart rate. These include: $HR_{max} = 220 - age$ (low estimate) and $HR_{max} = 210 - (0.5 \times age)$ as a high estimate. The first equation may underestimate maximal heart rate while the second may slightly overestimate maximal heart rate. Because of this, the ACSM (1995) recommends using a measured maximal heart rate instead of a prediction whenever possible because of the variability in maximal heart rates in persons over the age of 65. When establishing a training heart rate in older individuals, the ACSM (1995) recommends using the HR reserve method:

$HR = [\text{exercise intensity} \times (HR_{max} - HR_{rest})] + HR_{rest}$.

Heart Rate Variability

Heart rate variability (HRV) is the rhythmic periodicity of sinoatrial neural discharge and is a noninvasive way to measure parasympathetic activity. It is determined by recording and analyzing each R to R interval. The parasympathetic and sympathetic systems modulate circulatory function thus there is interplay between the two, modulated by respiration, called sympathovagal balance. Reduced parasympathetic dominance, as reflected by decreased HRV during respiration, is associated with an increased incidence of sudden death. Beat to beat variation measures cardiac autonomic responses.

Schwartz, Gibb, and Tran (1991) found that HRV decreases with age. They studied 56 healthy subjects ranging in age from 20-81. They studied beat to beat HRV using Power Spectral Analyses and looked at spontaneous and metronome breathing. They found that supine heart rate does not correlate with age but absolute heart rate was lower in older subjects. The balance between parasympathetic withdrawal and increased sympathetic stimulation, as measured by spontaneous breathing, was not affected by age. However, they did see an age affected difference in metronome breathing which is associated with parasympathetic withdrawal and beta-adrenergic responses.

Along with the diminishing of HRV with age comes an autonomic balance shift toward the sympathetic dominance which leads to greater cardiovascular degeneration. De Meersman (1993) studied 72 male runners and 72 sedentary males ranging in age from 14-83 to look at the role of exercise in HRV in the aging population. He assessed HRV during rest and also did stress tests to determine fitness levels of the subjects and found those with significantly higher fitness levels were associated with a significantly higher HRV. This provides evidence that regular physical exercise benefits the aging population by increasing HRV compared to sedentary individuals. Regular exercisers may see a shift toward parasympathetic dominance, which offers cardioprotection.

Low heart rate variability is a risk factor for coronary heart disease (CHD) and cardiac sudden death (CSD) and the incidence of both increases in women after menopause. Davy, Miniclier, Taylor, Stevenson, and Seals (1996) studied physically active postmenopausal women and found that they have a higher HRV than less active women. They also found that greater HRV was associated with an elevated spontaneous cardiac baroreflex sensitivity proposing a link with cardiac vagal modulation of heart rate.

Heart Rate Responses to Different Activities

Sleep

Somers, Phil, Dyken, Mark, and Abboud (1993) investigated sympathetic-nerve activity, blood pressure, and heart rate during sleep in normal subjects. They found heart rates to be lower during deep non-REM sleep than while they were awake. Somers et al. suggested that this results from modulation of the baroreceptor reflex. While in REM sleep, sympathetic-nerve activity was higher than during wakefulness and blood pressure and heart rate were similar to the values recorded during wakefulness. The actual changes in heart rate and blood pressure during sleep were relatively small.

Roberts and Palmer (1996) reported that irregular heart rate and premature ventricular contractions are common during REM sleep. They found that sinus bradycardia (heart rate < 60) often occurred during non-REM sleep possibly due to increased parasympathetic activity.

Normal Daily Activities

The variation of heart rate has been monitored in both young and old as well as women and men in some previous research. In 1996, Roberts and Palmer studied three elderly men and six elderly women to monitor their cardiac responses to normal activities and aerobic walking. They recorded heart rate and heart rhythms with a Holter monitor and had the subjects keep a diary of how time was spent and what activities they participated in. They performed activities such as walking, climbing stairs, carrying groceries and setting them on a counter, and shuffleboard (to simulate sweeping and vacuuming). They found that sinus tachycardia (heart rate > 100 bpm) occurred with walking during usual activities and occasionally during REM sleep.

Wilke et al. (1995) studied the energy expenditure during household tasks in women with coronary artery disease (CAD). Thirty-six older women, 26 with stable CAD and 10 age-matched normal women, participated in nine household tasks: washing dishes, scrubbing pots, ironing clothes, unpacking groceries, sweeping the floor, vacuuming carpet, mopping, changing beds, and washing the floor. In the more vigorous tasks (vacuuming, mopping, changing beds, and washing the floor) the normal subjects were compared to those with CAD. Mean heart rates ranged from 96 bpm while ironing to 129 bpm while washing the floor. They found that percentage of peak heart rate ranged from 62 $\pm$ 2% while washing dishes to 73 $\pm$ 2% while washing the floor. There were no significant differences in heart rate responses to household tasks between the CAD and normal groups. Wilke et al. suggested that housework may be useful as a supplement to an aerobic exercise training program in this population.

Exercise

Heart rates during exercise vary with mode and intensity. Brown, Wu, Li, and Mao (1994) studied the cardiorespiratory responses of healthy females during exercise on rowing, cycle, and arm ergometers. Subjects exercised at a target heart rate of 115 bpm which was 35% of heart rate reserve or 50% HRmax. They found no significant difference in cardiac output (Q) and stroke volume (SV) between rowing and cycling but Q and SV were significantly lower during arm ergometry. Pichon, Hunter, Morris, Bond, and Metz (1996) investigated heart rate responses during circuit and traditional weightlifting. Exercise heart rates were significantly higher during circuit weight training (135 bpm) than traditional weight training (120 bpm) while lifting the same percentage of one repetition maximum.

Porcari et al. (1987) investigated if fast walking was an adequate aerobic training stimulus for 30 to 69 year old men and women. Ninety-one percent of women reached their target heart (THR was $\geq$70% HRmax) while walking a mile as fast as possible. Women age 60-69 years worked at 90% of their predicted heart rate maximum (mean heart rate = 140). Panton et al. (1996) studied elderly individuals during submaximal exercise on a treadmill. They found heart rates were 106 bpm, 124 bpm, and 145 bpm at 40, 60, and 80% of maximal heart rate reserve, respectively.

Summary

Exercise has been shown to be very advantageous for the older population. Although maximal heart rate decreases with aging, older and younger individuals respond similarly to submaximal exercise. The ACSM (1998a) states that exercising at moderate to hard intensity may be required to produce cardiovascular adaptations and reduce cardiovascular risk factors. However, initiating or maintaining a light to moderate intensity exercise program may reduce age-associated deterioration of physiological function in older adults. Studies have shown low impact aerobics, walking, biking, and weight lifting as ways to reach these intensities. However, since there has been no research on chair aerobics, whether this meets the intensity recommendations needs to be determined.

CHAPTER III

METHODS AND PROCEDURES

Introduction

The purpose of this study was to compare heart rates obtained during chair aerobics to heart rates achieved during normal daily activities in healthy older women. Heart rates were measured in healthy older women during 2, 24 hour monitoring sessions. Although the total 24 hours was not reported, heart rates were averaged during sleep, 7 hours of daily activities, chair aerobics, and peak heart rate. Peak could occur at any time during the monitoring period.

Subject Selection

Sixteen female participants in the La Crosse Exercise and Health Program (LEHP) volunteered to be subjects in the study after they were informed of the activities they would be involved in and the requirements of the study. All subjects were classified as "Adult Fitness" members of LEHP meaning they were free from cardiac, pulmonary, and metabolic disease.

Prior to initiating the study, approval from the University of Wisconsin-La Crosse Institutional Review Board was obtained. Each subject filled out an informed consent form prior to participation (see Appendix A) and was given a detailed explanation of testing procedures and the purpose of the study. In addition to the informed consents, the subjects were also reminded verbally that they could withdraw from the study at any time. Each participant also filled out a Medical/Health History Questionnaire (see Appendix B).

Testing Procedures

Pilot Study

Each subject was assigned a number, a Polar heart rate watch, and a transmitter. The pilot study took place during an LEHP exercise session at 4 p.m. on a Wednesday. The participants were assisted in putting on the watch and transmitter before chair aerobics began. The transmitter, attached to an elastic strap, was placed snugly around the thoracic cavity, slightly below the bra line. Watches were worn on the wrists of the subjects. The heart rate monitors had been set to the proper time of day and preprogrammed to record heart rates at 60-second intervals.

The subjects took their places in the straight-backed chairs and instructions were written on poster board for each one to follow (see Appendix C). The researchers talked them through each step and assisted those who needed help as well as checking to see that each watch was started properly.

Everyone participated in a 30-minute chair aerobics trial session wearing the heart rate monitors so they had the opportunity to get used to wearing them. The workout consisted of 5-10 minutes of range of motion and stretching and 20 minutes of cardiovascular and muscular endurance training for both the upper and lower body. This session also provided an opportunity for those who had never done chair aerobics before to learn the different movements. The researchers downloaded the information from the watches into the computer and got a printout of each subject's heart rate recorded each minute. Results of this preliminary study showed that the watches functioned properly and recorded all the information required.

24-Hour Monitoring

On the following two Wednesdays, each subject reported to LEHP at 4 p.m. to begin their monitoring session with the chair aerobics class. They were assisted in putting the watch and transmitter on and starting the watches as in the pilot study. After the 30-minute chair aerobics session they were allowed to go about their normal daily activities wearing the watch until 4 p.m. the following day. Beginning with the chair aerobics class allowed the instructors to assist those who needed help with their watches and ensure that everyone started at the same time.

An experienced chair aerobics instructor led each class which consisted of 30 minutes in the chair of various upper and lower body movements (see Appendix D). The subjects were only required to participate in the sitting portion of aerobics but had the option to participate in the standing low-impact aerobics following chair aerobics.

Each participant received an instruction sheet explaining how to restart their watch if necessary, guidelines on showering and bathing with the watch on, and the researchers' phone numbers in case of difficulties (see Appendix E). They also received an activity log to fill out for the entire time they had their monitor on (see Appendix F). The activity logs had sufficient space to record their activities throughout each day hour by hour. They were encouraged to be quite detailed in their accounts but to go about things as normal including housework, shopping, work, volunteer work, relaxation, and exercise.

After each subject had worn the heart rate monitor for the 24-hour period (4 p.m. Wednesday – 4 p.m. Thursday), they turned in their watches, transmitters, and activity logs on Friday at LEHP. The investigators downloaded the watches onto the computer using the Polar Monitor program. The computer printout showed the heart rates listed minute by minute for both 24-hour periods. The data were saved and printed. The investigators then matched the heart rates recorded with the activity log turned in showing the heart rates achieved during sleep, daily activities, and chair aerobics, and peak heart rate for portions of both days.

Some difficulties occurred in the testing requiring several participants to repeat the 24-hour monitoring until 2 successful trials were completed. These problems included dead batteries, watches that shut off during sleep because of a bad connection, or the program was changed to record at 5 or 15 second intervals when a subject was restarting the watch for various reasons. Four subjects were unable to complete the study so data were analyzed for only the remaining 12 subjects.

Statistical Analysis

Standard descriptive statistics were used to define the subject population. A Pearson product moment correlation was calculated to determine the reliability of monitoring heart rate during various activities. A two-way ANOVA with repeated measures was used to determine whether significant differences existed between heart rate during sleep, daily activities, and chair aerobics, and peak heart rate from day one to day two. A Tukey's post-hoc test was computed for variables indicated as significant by the ANOVA. All data were analyzed at the $p < .05$ level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

The major purpose of this investigation was to compare heart rates obtained during chair aerobics to the heart rates achieved during normal daily activities in older women. One-minute heart rate readings were obtained throughout the two monitoring periods to determine the reliability of the values from day 1 to day 2. A two-way ANOVA with repeated measures was calculated to determine if there were significant differences in heart rates during sleep, daily activities, chair aerobics, and peak heart rate. When appropriate, a Tukey's post hoc analysis was performed on those variables that the ANOVA indicated were significant.

Results

Physical Characteristics

Sixteen older female subjects volunteered for the study initially; however, four of those subjects were unable to complete the study. Two of the subjects had difficulty with the heart rate monitors continuing to record during activity because of some unknown interference (i.e., the monitor shut off frequently or would display a zero). Several monitors were tried to ensure it was not a problem with the transmitter or watch. One subject had other time commitments and could not complete the study. The fourth was dropped from the study because she was classified as a cardiac patient. Even though she had no cardiac event in her history, she took sublingual nitroglycerin daily for typical angina. The remaining 12 subjects who completed the study were between the ages of 54-70 years and members of the La Crosse Exercise and Health Program. All subjects successfully completed two days of heart rate monitoring. The descriptive characteristics of the subjects are presented in Table 1.

Table 1. Physical Characteristics of Subjects (N = 12)

Variable	Mean	Standard Deviation	Range
Age (yr)	63.1	4.8	54-70
Height (cm)	164.8	2.9	160-170.2
Weight (kg)	75.1	15.1	56.8-113.6

Heart Rate Response During Day 1 and 2 Monitoring Sessions

During each 24-hour monitoring period, a total of 1,440 heart rates were produced. Only portions of the 24-hour period were used in the study. The heart rates recorded each minute of the 30-minute chair aerobics session were averaged and this average was used to represent heart rate responses to chair aerobics. To acquire an average for each hour, the heart rate at the 1st, 13th, 25th, 37th, and 49th minute were averaged and were then used to obtain averages for sleep and daily activities. Using the hourly averages as previously explained, an average for sleep was obtained by averaging the actual hours spent sleeping as recorded in the activity log. To measure heart rate responses representing daily activities, the hourly averages from 8 a.m. to 3 p.m. were averaged. Peak heart rate was defined as the highest heart rate reached in the 24-hour period with 3 consecutive minutes not more than 5 beats apart. All of these values were calculated for each testing period.

The subjects wore the heart rate monitors for 2, 24-hour periods to determine if there were significant differences in heart rates in the 4 selected conditions between days. There was a very strong and significant ($p < .01$) correlation ($r = .94$) between day 1 and day 2. A comparison of the heart rates of day 1 and day 2 are shown in Table 2.

Table 2. Heart Rates (bpm) During Sleep, Daily Activities, Chair Aerobics, and Peak for Days 1 and 2

Activity	Day 1	Day 2
Sleep	71.0 ± 8.7	68.8 ± 5.6
Daily Activities	84.9 ± 7.1	85.9 ± 6.7
Chair Aerobics	103.3 ± 11.1	101.5 ± 9.8
Peak Heart Rate	126.5 ± 16.6	123.0 ± 12.8

Note. All values represent mean ± standard deviation.

Since there was no significant difference between day 1 and day 2 heart rates, these values were averaged and are presented in Table 3. A significant ($p < .05$) difference was found among the heart rates of the subjects across all four conditions. As expected, heart rates during sleep were significantly ($p < .05$) lower than all other

Table 3. Average Heart Rates (bpm) of Days 1 and 2 During Sleep, Daily Activities, Chair Aerobics, and Peak Heart Rate

Activity	Mean	SD	Range
Sleep	69.9*	7.2	60.3-90.8
Daily Activities	85.4*	6.8	70.4-95.2
Chair Aerobics	102.4*	10.2	80.8-126.1
Peak Heart Rate	124.8*	14.6	102.3-163.3

*significant ($p < .05$) difference among all comparisons

Peak Heart Rate > Chair aerobics > Daily activities > Sleep

conditions. Heart rate responses to daily activities were significantly ($p < .05$) higher than sleep but lower than chair aerobics and peak. Heart rate responses to chair aerobics were significantly ($p < .05$) higher than either daily activities or sleep but lower than peak heart rate. Also, as expected peak heart rates were significantly higher than all other conditions.

Discussion

Day 1 vs. Day 2

Heart rates were obtained throughout day 1 and day 2 to determine the reliability of those values. There was a very strong and significant ($p < .01$) correlation ($r = .94$). Based on this data, using the Polar Vantage XL Heart Rate Monitor (1992) to record heart rates over a 24-hour period was a reliable way to measure heart rate. It also shows that there was little variability in heart rate responses from day to day.

<u>% of Maximum HR</u>

One method used to measure intensity of exercise or activity is to determine at what percentage of "heart rate maximum" an individual is working. Heart rate maximum is the maximal times the heart beats in one minute and can be determined directly through an exercise test or predicted using various equations. The ACSM (1995) provides two equations to predict maximum heart rate: (220-age) and [210 – (.5 x age)]. For this study, heart rate maximum was predicted using both equations since actual maximum heart rates were not available. Using these equations to represent maximal heart rate, the percentage of maximum heart rate for sleep, daily activities, chair aerobics, and peak were calculated.

In this study, the predicted maximal heart rate was 156.9 bpm using 220 – age (low estimate) compared to 178.5 bpm using [210 – (.5 x age)] (high estimate). Because of the difference in the predictions of these two equations, the intensity of the different activities studied were calculated using both predicated maximum heart rates and are presented in Table 4.

Table 4. Percentage of Maximum Heart Rate Obtained for Sleep, Daily Activities, Chair Aerobics, and Peak Heart Rate Using Different Prediction Equations

Activity	220 – age	210 – (.5 x age)
Sleep	44.6	39.2
Daily Activities	54.5	47.9
Chair Aerobics	65.3	57.3
Peak Heart Rate	78.8	71.5

Sleep

While sleeping, heart rates ranged from 60.3-90.8 bpm thus representing 44.6% HRmax using 220 – age to predict maximum heart rate. Somers et al. (1993) found that heart rates fell from 64 bpm during wakefulness to 59 bpm during stage 4 sleep for 8 healthy, younger subjects. During rapid eye movement (REM) sleep, heart rate was 63 bpm, similar to the rates recorded during consciousness. The 69.9 bpm found during sleep in the present study were slightly higher. In the current study, sinus bradycardia was seen often during sleep and several subjects had some tachycardic beats as well similar to the responses reported by Roberts and Palmer (1996) during sleep.

During REM sleep, an irregular heart rate is common which can result in sinus tachycardia (Roberts & Palmer, 1996). While in REM sleep, sympathetic-nerve activity increases above the levels recorded during wakefulness while heart rate and blood pressure return to levels recorded during wakefulness (Somers et al. 1993). In non-REM sleep, sinus bradycardia is a common occurrence due to parasympathetic stimulation. One reason for the variation in heart rate among the present subjects may be how long they were in REM sleep vs. non-REM sleep. Also, some wrote in their logs that they "tossed and turned" during sleep and this restless sleep could also increase heart rate slightly.

Normal Daily Activities

An average of the normal daily activity heart rates was 54.5% HRmax using the 220 -- age prediction equation for HRmax. As expected, throughout the day, the variation in heart rate was quite extensive. More intense activities such as walking, biking, climbing stairs, and cleaning were balanced out by periods of sitting, reading, knitting, watching TV, and napping. A list of activities performed during this baseline period is included in Table 5.

Table 5. Activities included in Baseline Period (8 a.m. – 3 p.m.)

Exercise	Cleaning	Hobbies	Writing	Sitting	Misc.
Biking	Dusting	Quilting	Paying Bills	Reading	Driving
Walking	Dishes	Knitting	Filing	Watching TV	Errands
Bowling	Vacuuming	Sewing	Paperwork	Computer	Shopping
Stairs	Washing Windows	Needlepoint	Office Work	Resting	Visiting
Blowing Leaves & Snow	Mopping			Napping	Hanging Christmas Lights
	Laundry			Phone	Getting Hair Done
	Making Beds				

Wilke et al. (1995) looked at energy expenditure of older women during nine different household tasks. For the less vigorous tasks, they looked only at women with coronary artery disease (CAD) but for the more strenuous activities, they compared healthy individuals to those with CAD. Many of the activities such as washing dishes, unpacking groceries, sweeping the floor, vacuuming, mopping, changing bedding, and washing floors were included as daily activities in the current study. The mean heart rates for all of these activities was 110 bpm in Wilke's et al. study compared to the 85.4 bpm in the current study. However, in the current study many of the household tasks were included throughout the day but were balanced out by time spent sitting, resting, reading, and watching TV.

Specifically, Wilke et al. (1995) found a mean heart rate of 100 bpm for washing dishes compared to 97 bpm in the current study. Heart rate responses to changing beds were slightly lower in the current study (91 bpm compared to 112 or 125 bpm in CAD and normal subjects reported in Wilke et al.). Sweeping the floor resulted in very similar heart rates between studies, 113 bpm (current) and 107 bpm (Wilke et al.). A slightly larger difference was seen in vacuuming with mean heart rates of 98 bpm (current study) compared to 111 bpm (Wilke et al.). When looking at housework in general, the current study found a mean heart rate of 99.7 bpm vs 110 bpm (Wilke et al.). Overall, heart rate responses to household tasks in the current study were very similar to those reported by Wilke et al.

Roberts and Palmer (1996) looked at the heart rate response to various activities that were thought to represent normal daily activities. Heart rates were recorded while subjects carried 5 pounds (68 bpm), 10 pounds (70 bpm), climbed 10 (73 bpm) or 20 stairs (78 bpm), walked at 5 minutes of a normal pace (80 bpm), played shuffleboard to simulate sweeping or vaccuuming (78 bpm), and walked at 60% of age adjusted heart rate. In general, these values were lower than those found for similar activities in the current study.

Panton et al. (1996) found resting heart rate in older women to be 75.5 bpm whereas Davy et al. (1996) reported sitting heart rates to be 59 bpm and standing 70.3 bpm. In this study, portions of the day were spent resting, watching TV, knitting, and reading which may be considered similar to resting. Heart rates were typically in the 60's and 70's during these times for the present subjects which is similar to those reported in the studies mentioned above.

Many subjects also exercised during the day and achieved their peak heart rate at that time. These activities are discussed further in the peak heart rate section. Overall, the range for the average of the 7-hour period of normal daily activities was 70.4 – 93.9 bpm which indicates that some participants spent more of their day doing activities of greater intensity for longer periods of time. Wilke et al. (1995) reported housework as 62-73% HRmax compared to 58-72% HRmax in the current study. Daily activities qualify as "light" intensity and actually fall on the edge of the ACSM's (1998b) recommendations for physical activity when using the 220 – age equation. Although, fitness benefits may not be attained through these activities, some health benefits may be acquired.

Chair Aerobics

Heart rate responses to chair aerobics averaged 65.3% HRmax using the 220 – age prediction equation which would comply with the ACSM's (1998b) recommendations for exercising at 55-90% HRmax. There was quite a wide range (80.8-126.1 bpm) of heart rates among subjects during chair aerobics. One reason for this variation may be the different levels of fitness of the subjects. As regular participants in the LEHP program, most subjects had previously been exercising a minimum of three times per week on average but the duration and intensity may have varied among subjects.

One of the benefits of exercise is an improvement in cardiorespiratory function which results in a lower submaximal heart rate at a given workload (ACSM, 1995). Hamdorf et al. (1992) found that working at 40-60% heart rate reserve lowered resting heart rate and submaximal exercise heart rate in older women. This could result in a difference in exercise heart rates among subjects of different fitness levels. When working at the same absolute workload, someone with a lower level of fitness will have a higher submaximal heart rate than someone with a higher level of fitness. One of the training effects of exercise is a lower submaximal heart rate (ACSM, 1995).

Another reason for the variability in heart rates among subjects could be previous experience with chair aerobics. Each subject had participated in chair aerobics at least once during the pilot study, however, some subjects had participated in chair aerobics many times whereas it was less familiar to others. Less experienced subjects may have been using muscle groups they had not previously used during their other forms of exercise.

The variety in the speed or range of motion of the actions during chair aerobics among subjects may have resulted in different heart rates. Doing the arm and leg movements double time or half time will result in an accelerated or decelerated heart rate. Larger ranges of motion with the arms and legs could also lead to higher heart rates.

One previous study of chair aerobics (Mills, 1994) found that participation in chair aerobics improved flexibility and range of motion in the ankles and right knee. McMurdo and Rennie (1993) found that chair aerobics improved grip strength, spinal flexion, chair to stand time, and the score on an activities of daily living questionnaire. However, there have not been any published studies on the energy cost or heart rate responses to chair aerobics.

Using the other ACSM equation [210 -- (.5 x age)], results in chair aerobics achieving 57.3% HRmax which complies with the new ACSM (1998b) recommendations for training intensity. The ACSM (1998b) stated that the minimal training intensity threshold for improvement in VO_{2max} is 55-65% HRmax which is less than the 1990 ACSM position statement of 60%. The reason for this change was to recognize that the minimal requirement for improving fitness and health is variable on the low end of the scale. Those with low levels of fitness can achieve a training effect when working at 55% HRmax whereas those with higher levels of fitness must work at higher intensities. The ACSM (1998b) has also recognized that exercise and physical activity for health and fitness is on a dose response continuum. Many important health benefits are obtained when increasing physical activity from none to light. As you increase intensity, duration, and/or frequency the health and fitness benefits increase.

Chair aerobics is classified as "moderate" activity based on % HRmax (ACSM, 1998b). Based on these findings, chair aerobics can be a beneficial mode of exercise for older adults and those with lower levels of fitness.

Peak Heart Rate

There was a very large range in peak heart rates (102.3-163.3 bpm) among subjects and these peak heart rates were achieved during many different activities. Subjects reached their peak heart rates 12 times (50%) during standing, low impact aerobics. The next two most strenuous activities were walking and housework during which 8.3% reached their peak heart rates. Others reached their peak heart rate during such activities as: sweeping the floor, biking, volunteer work, shopping, scrubbing bathtub, lifting weights, shoveling snow, and driving.

Another reason for the variability in peak heart rate could be the variety of activities performed since the only required activity during the monitoring sessions was chair aerobics. The other 23.5 hours could be spent as the subjects wished and some naturally participated in more strenuous activities than others. Some chose to exercise in addition to chair aerobics by doing low-impact aerobics, walking, biking, or lifting weights whereas others did not. As expected, most subjects reached their peak heart rate doing some form of exercise.

The majority of subjects' peak heart rates occurred during low impact aerobics. While doing aerobics, subjects were working at approximately 79% HRmax which represented an average heart rate of 124 bpm. This is fairly similar to the results found by Berry et al. (1992) who reported that subjects doing low impact aerobics had a heart rate of 136 bpm or 72% HRmax. Low impact aerobics have been shown to improve cardiorespiratory endurance as well as strength and flexibility (Hopkins et al., 1990).

Some subjects reached their peak heart rate while walking. Heart rate responses ranged from 110-138.3 bpm which was about 79% HRmax. Panton et al. (1996) found very similar results when older adults working at 75% HRmax had heart rates ranging from 109-137 bpm. In another walking study, (Porcari et al., 1987) found women age 60-69 reached a mean heart rate of 140 bpm or (90% HRmax) while walking a mile as fast as possible.

Housework was also a common activity where subjects reached their peak heart rate and included sweeping the floor, scrubbing the bathtub, and possibly vacuuming, dusting, and washing dishes. In the current study "housework" raised heart rates to 133.5 bpm while sweeping the floor to 122 bpm and scrubbing the bathtub was 120 bpm. Wilke et al. (1995) studied heart rates of older women (62 + 2 yrs), who had coronary artery disease or were healthy. They measured heart rate for 8 minutes during a variety of household activities. They found sweeping the floor at a self-selected pace to be working at 67% HRmax or 102-112 bpm, slightly lower than in the current study. Although they did not look specifically at scrubbing the bathtub, they did look at scrubbing the floor and found that the healthy population had a heart rate range from 123-135 bpm, very similar to the current study.

Biking and lifting weights also produced peak heart rates in several subjects. The subjects in the current study reached a heart rate of 130.3 bpm while biking at 83% HRmax. Brown et al. (1994) studied the effect of lower intensity activity for older women and found a mean heart rate of 116 bpm was reached at 50 % HRmax while biking. Heart rates during weight lifting depend on several factors. The percent of one repetition maximum (1 RM) affects the actual heart rate recorded as well as the type of weight lifting, circuit or traditional. In the current study, a heart rate of 139 bpm was achieved during traditional weight lifting. The amount of weight lifted was not available. Pichon et al. (1996) found an average heart rate range of 105-135 bpm during traditional weight lifting using 60% 1 RM for bench press and knee extension, 44% 1 RM for a bent row, and 26% 1 RM for knee extension. Heart rates appear similar between these two studies, but not enough is known about the percentage of weights lifted to make an accurate comparison.

Based on the percentage of maximum heart rate, activities performed during peak heart rate were classified as "hard" intensity (ACSM, 1998b). Those subjects who achieved their peak heart rate while exercising were meeting the ACSM recommendations for intensity of exercise for older individuals. When comparing heart rate responses to chair aerobics and peak heart rate, both fell into "moderate" and "hard" intensity, respectively (ACSM, 1995). Percentage of maximum heart rate was 65.3 and 78.8 for chair aerobics and peak, respectively. Most subjects reached their peak heart rate during some type of exercise other than chair aerobics. According to the results of the present study, chair aerobics does meet the qualifications to achieve or maintain the health and fitness benefits that come along with exercise. However, this study shows that some of these individuals achieved higher heart rates during other forms of exercise so they may be achieving greater benefits from those types of exercise rather than chair aerobics. However, duration also plays a role in the benefits received. A lower intensity with a longer duration has also been shown as an effective way to improve health and fitness.

Heart rate responses vary from person to person throughout the day. This may depend on the activities they did throughout the day as well as fitness level. Figure 1 is an example of two different subjects' heart rate responses over a 24-hour period. It illustrates the percent of time during the 24 hours that they spent at various heart rates. As can be seen, subject #1 had both lower and higher heart rates throughout the day than subject #2. One reason for this may be that subject #1 did a greater variety of activities, especially from 8 a.m. to 4 p.m., whereas subject #2 had a job requiring her to sit at a desk throughout the day.

Summary

The results show chair aerobics to be of "moderate" intensity and daily activities as "light" intensity. The null hypothesis for this study, there will be no significant difference in heart rates responses during chair aerobics as compared to normal daily activity in older women, was rejected.

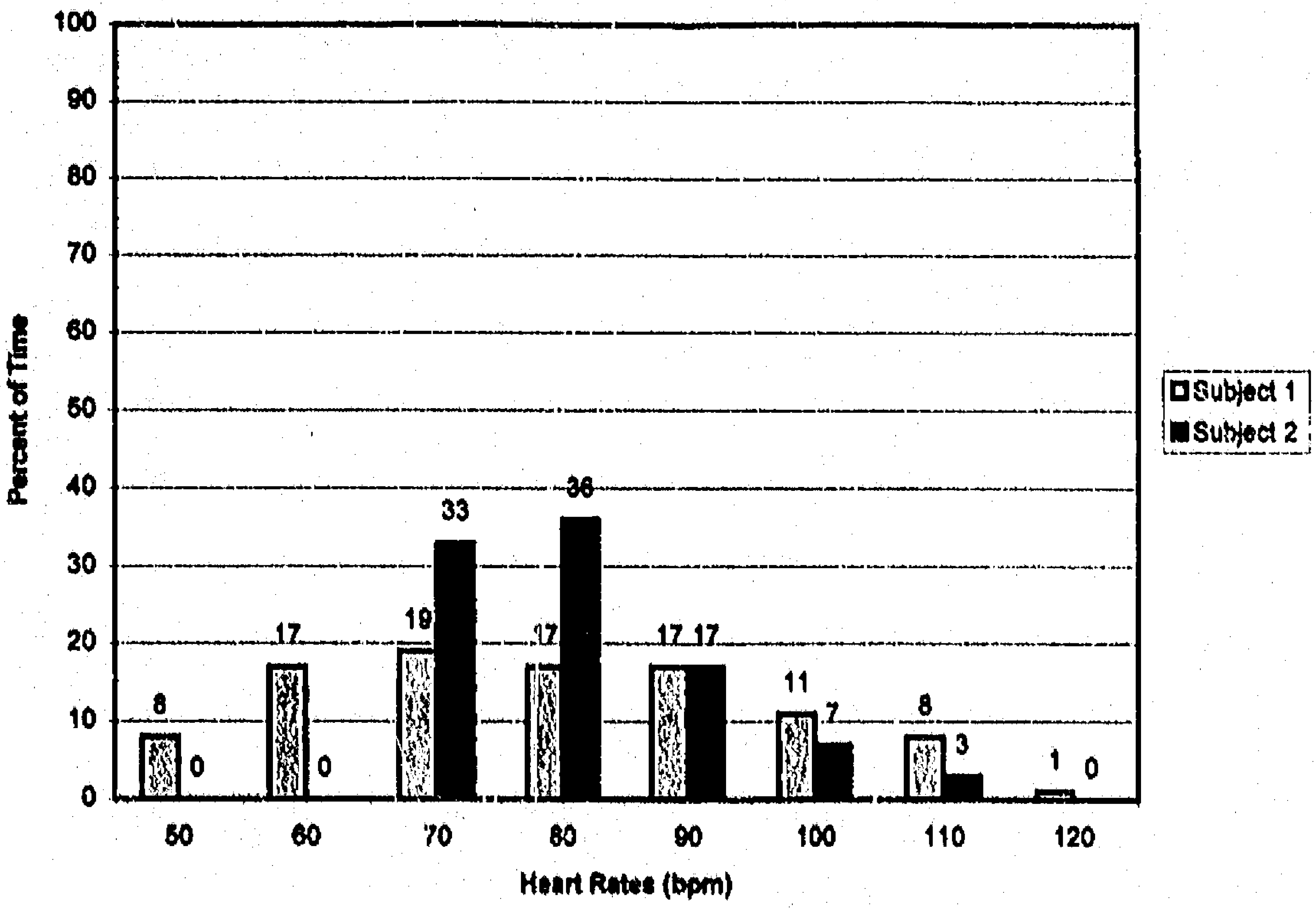

Figure 1. Examples of the frequency of heart rate responses of two subjects over the 24-hour period.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to compare the heart rates obtained during chair aerobics to the heart rates achieved during normal daily activities in healthy older women. Twelve female members of the La Crosse Exercise and Health Program (LEHP) between the ages of 54 and 70 years completed this study. Each subject completed 2, 24-hour periods of continuous heart rate monitoring even though only portions of that period were used in the study. Heart rates were recorded each minute during this time and averages were computed for sleep, daily activities (8 a.m. – 3 p.m.), chair aerobics, and peak heart rate.

There was a strong and significant ($p < .01$) correlation ($r = .94$) between heart rates on day 1 and day 2 showing the Polar Vantage XL Heart Rate Monitor was reliable in recording heart rates during various activities. This also showed that there was little variability in heart rate from day to day. There was a significant difference among the heart rates of all four conditions. Overall, peak heart rate was higher than chair aerobics, normal daily activities, and sleep. Using 220 – age to predict maximum heart rate, sleep, daily activities, chair aerobics, and peak were 44.6, 54.5, 65.3, and 78.8% of HRmax, respectively. The other equation to predict maximum heart rate [210 – (.5 x age)] resulted in 39.2, 49.6, 57.3, and 71.5% HRmax for sleep, daily activities, chair aerobics, and peak, respectively. On the basis of these results, chair aerobics qualified as "moderate" intensity. Daily activities and sleep were classified as "light" intensity, and peak heart rate qualified as "hard" intensity.

Conclusions

Based on the results of this study, the following conclusions were reached:

1. Heart rates achieved during peak heart rate, chair aerobics, normal daily activities, and sleep were significantly ($p < .05$) different from each other with peak higher than chair aerobics, normal daily activities, and sleep.
2. The heart rates obtained during the 30-minute chair aerobics session were 65.3% of predicted HRmax or 57.3% HRmax using 210 – (.5 x age) which meets the qualification of "moderate" intensity (ACSM, 1998b).
3. Chair aerobics falls into the recommended activity levels of the ACSM (1998a) for older individuals based on intensity and duration.
4. The heart rates obtained during normal daily activities (8 a.m. – 3 p.m.) were 54.5 or 49.6% of predicted HRmax which is classified as "light" intensity (ACSM, 1998b).
5. The peak heart rate achieved through the 24-hour period was 78.8 or 71.5% HRmax and qualified as "hard" intensity (ACSM, 1998b).
6. The heart rates during sleep were 44.6 or 39.3% HRmax.
7. The greatest variation in heart rate responses across subjects appeared during peak heart rate.
8. The Polar Vantage XL Heart Rate Monitor is a reliable way to record heart rates minute-by-minute over a 24-hour period.

Recommendations

Based on the results of this study, chair aerobics may be a beneficial mode of exercise for older individuals. However, more research in this area could be helpful.

Some recommendations for further study include the following:

1. Measure oxygen consumption in addition to heart rate during chair aerobics.
2. Conduct a 6-12 week chair aerobics training study using older, sedentary individuals to study changes in muscular endurance, muscular strength, flexibility, and VO_2.
3. Obtain a true maximum heart rate from a stress test to get more precise results than from a prediction equation.

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APPENDIX A

INFORMED CONSENT

INFORMED CONSENT

HEART RATE RESPONSES TO CHAIR AEROBICS IN HEALTHY OLDER WOMEN

I, ______________________________, volunteer to be a subject in a study to determine my heart rate for 2, 24-hour periods to compare the heart rate achieved during normal daily activities and a chair aerobics class. I consent to the presentation and publication of these results as long as the information is anonymous and no identification can be made. I also understand that all the data collected from my participation will be identified with a number instead of my name.

(1) I give Cindy Vande Voort and/or Dr. N.K. Butts permission to review my health questionnaire that I completed upon joining the La Crosse Exercise and Health Program (LEHP).

(2) I have been informed that my participation in this study will involve participation in three chair aerobics classes. During each of these classes, I will be wearing a heart rate monitor (including a watch on my wrist and strap around my chest). I will also wear this heart rate monitor for 2 different 24-hour periods while keeping a diary of daily activities.

(3) I have been informed that the general purpose of this experiment is to study heart rate during a 24-hour period and while participating in chair aerobics.

(4) I have been informed that there are no expected discomforts or risks involved in my participation in this study other than the possible inconvenience of wearing the heart rate monitor chest strap for 24 hours. As with any exercise session the possibility of muscle soreness, irregular heart rate, high blood pressure, or death is possible. The LEHP staff are trained to handle any situation that may arise.

(5) I have been informed that the results of this study may be beneficial to me because it will reveal what activities get my heart rate high enough to stress the heart and reach my target heart rate.

(6) I have been informed that there are no "disguised' procedures in this experiment. All procedures can be taken at face value.

(7) I have been informed that I am free to withdraw my participation any time during the study.

Any questions or concerns I may have about this study may be referred to the principal researcher: Cindy Vande Voort (785-1490) and thesis advisor: Dr. Nancy Butts (785-8177).

______________________________	______________________________
Researcher	Participant
(Date)	(Date)

APPENDIX B

MEDICAL/HEALTH HISTORY QUESTIONNAIRE

MEDICAL/HEALTH HISTORY QUESTIONNAIRE

LA CROSSE EXERCISE AND HEALTH PROGRAM
UNIVERSITY OF WISCONSIN-LA CROSSE

IDENTIFICATION DATA: Please fill in the following information.

Name ______________________________ Date ____________

Address ____

City ______________________ State ______ Zip __________

Date of Birth ___________ Age _____ Home phone: ___________

Work phone: ___________

Personal physician ____________________ Clinic ___________

Date of last checkup ____________________

SEX	CURRENT MARITAL STATUS	RACE
[ ] Male	[ ] Single	[ ] White
[ ] Female	[ ] Married	[ ] Black
	[ ] Separated	[ ] Hispanic
	[ ] Divorced	[ ] Asian
	[ ] Widowed	[ ] Other ________

How many years of formal education have you completed?

[ ] No high school   [ ] High school diploma   [ ] College degree
[ ] Some high school   [ ] Some college

What is your usual occupation? ______________________________

Would you consider your job stressful? (Circle appropriate number)
1 = not at all stressful
10 = very stressful   1 2 3 4 5 6 7 8 9 10

MEDICATIONS:
What prescribed medicines do you presently take? Why do you take them?

What non-prescription medicines (over the counter) do you take and why?

ALLERGIES: Are you allergic to or have you had a "bad reaction" to any medicines or other substances? [ ] Yes [ ] No

If yes, please list the medicine and reaction.

PERSONAL HISTORY: Have you ever had -	Yes	No	When?
Heart attack	[ ]	[ ]	______
Open heart surgery (CABG, valve, other)	[ ]	[ ]	______
Angioplasty	[ ]	[ ]	______
Congenital heart problems	[ ]	[ ]	______
Congestive heart failure (fluid in the lungs)	[ ]	[ ]	______
Angina / chest pain, pressure or discomfort	[ ]	[ ]	______
Abnormal heart beats (palpitation)	[ ]	[ ]	______
Heart murmurs	[ ]	[ ]	______
Stroke	[ ]	[ ]	______
Rheumatic Fever	[ ]	[ ]	______
Thyroid problems	[ ]	[ ]	______
Diabetes (IDDM, NIDDM)	[ ]	[ ]	______
High blood pressure	[ ]	[ ]	______
Swelling of the feet or ankles	[ ]	[ ]	______
Cramping in the lower legs or feet with exertion	[ ]	[ ]	______
Blackouts / fainting spells	[ ]	[ ]	______
Shortness of breath at rest or with exertion	[ ]	[ ]	______
COPD	[ ]	[ ]	______
Asthma	[ ]	[ ]	______
Bronchitis	[ ]	[ ]	______
Emphysema	[ ]	[ ]	______
Arthritis	[ ]	[ ]	______
Low back pain	[ ]	[ ]	______
Joint pain or swelling	[ ]	[ ]	______
Other orthopedic problems (bad knees, hips, etc.)	[ ]	[ ]	______
Emotional disorders	[ ]	[ ]	______
Anxiety	[ ]	[ ]	______
Depression	[ ]	[ ]	______
Other	[ ]	[ ]	______

If you answered yes to any of the above questions, please elaborate:

Do you know your cholesterol level? ________

HDL________ LDL________ Triglycerides________

HOSPITALIZATIONS: List all your hospitalizations as best as you can. Type of illness/surgery (please be specific)

Year

1. ______________________________ ______
2. ______________________________ ______
3. ______________________________ ______
4. ______________________________ ______

FAMILY HISTORY: Has any BLOOD RELATIVE had any of the following?

	Yes	No	Relation	Age of occurrence?
Diabetes (IDDM, NIDDM)	[ ]	[ ]	______	______
High cholesterol	[ ]	[ ]	______	______
High blood pressure	[ ]	[ ]	______	______
Heart attack	[ ]	[ ]	______	______
Open heart surgery	[ ]	[ ]	______	______
Stroke	[ ]	[ ]	______	______
Lung problems	[ ]	[ ]	______	______
Cancer	[ ]	[ ]	______	______
Obesity	[ ]	[ ]	______	______

HEALTH HABITS:

Do you currently smoke cigarettes? [ ] Yes [ ] No

If you do not currently smoke cigarettes, have you ever smoked cigarettes?

[ ] Yes [ ] No

If you currently smoke or have ever smoked:

How many packs per day? ______

For how many years? ______

If you are a former smoker, how long ago did you stop smoking? ______

On the average how many drinks do you have per day on weekdays? ______

On weekends? ______

One drink = One 12 oz. Beer

= One 4 oz. Wine

= One 1 oz. Liquor

On the average, how many cups/cans of the following beverages do you consume per day?

TEA ______ COFFEE ______ COLAS ______

How many times per week do you eat:

Cheese _____ Yogurt _____

Sweets (cookies/cake) _______

Butter or shortening ______

Whole grain breads ______

Fried fish or poultry ______

Fish _____ Salad _____

Eggs _____ Skim milk _____

Instant or frozen entrees ______

Red meats (beef or pork) ______

Breakfast meats (saus/ham/bacon) __

How many times do you dine out per week? ________

Of these, how many are fast food restaurants? __________

Overall, how would you rate your diet? (Circle appropriate number)

1 = unhealthy

10 = healthy 1 2 3 4 5 6 7 8 9 10

On the average, how many hours of sleep do you get per night? __________

PHYSICAL ACTIVITY HISTORY:

Have you ever had an exercise test? [ ] Yes [ ] No

If yes, please answer the following questions:

Location of test: ____

Date of test: ____________ Results of test: [ ] Normal

[ ] Abnormal

[ ] Don't Know

If the test was abnormal, please explain: ______________________________

____

Are you aware of any physical limitation that would prevent you from exercising regularly? [ ] Yes [ ] No

If yes, please specify:____

Do you currently exercise on a regular basis? [ ] Yes [ ] No

If yes, please answer the following questions:

How many times per week do you exercise? _______________

How long do you exercise per session? __________________

What types of exercise do you perform?

____

If no, what type of exercise are you interested in?

____

Did you participate in high school or college sports? [ ] Yes [ ] No

If so, please specify: ____________________

How would you rate your level of fitness?

[ ] Poor
[ ] Fair
[ ] Average
[ ] Above average
[ ] Excellent

I hereby certify all statements provided by me in this questionnaire are complete and true to the best of my knowledge. Further, I give my permission to the La Crosse Exercise and Health Program staff to contact my personal physician or the program's medical director should there be questions or concerns about information in this medical history form.

Signature: ____________________ Date: __________

APPENDIX C

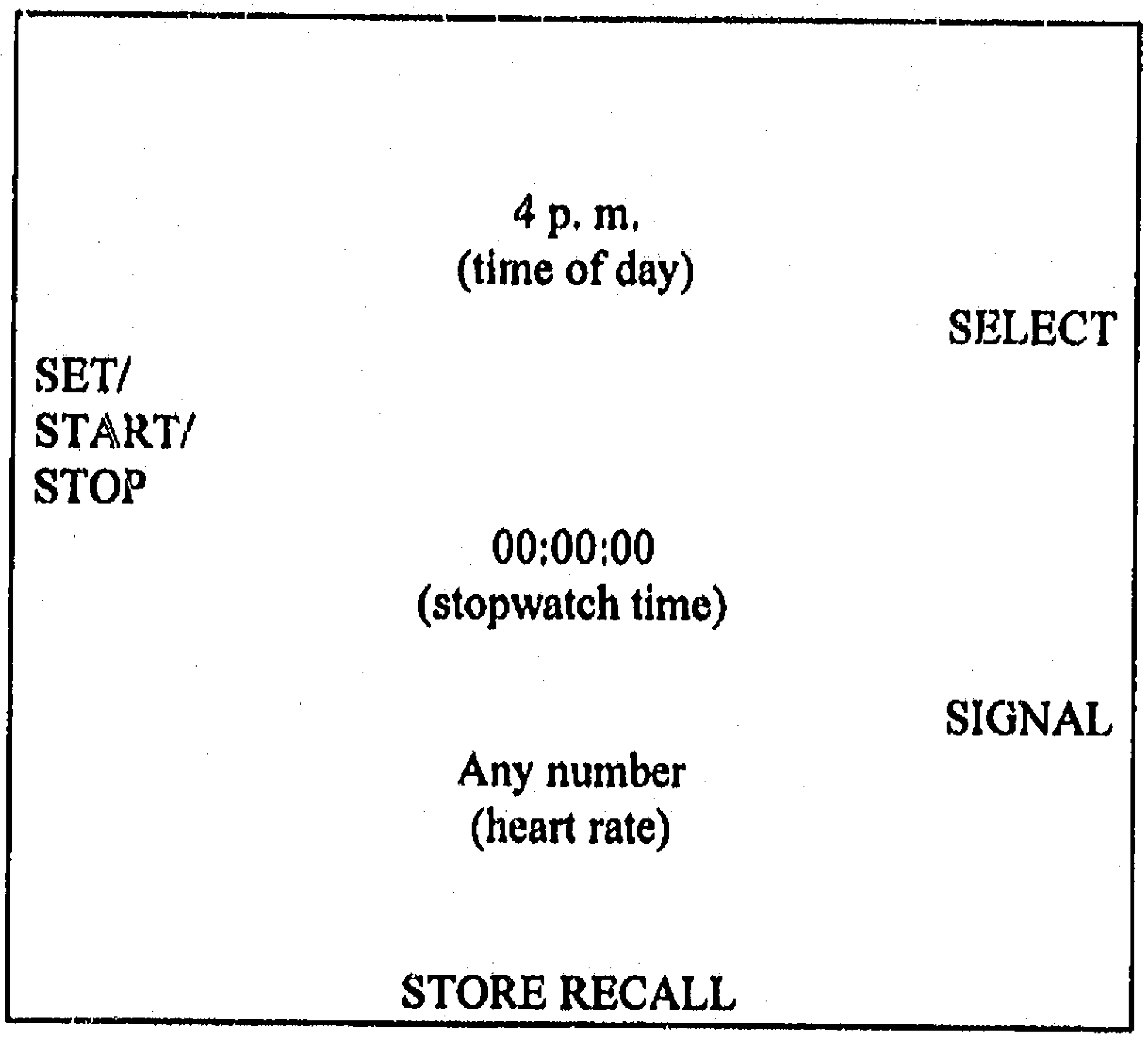
HEART RATE MONITOR OPERATION

Heart Rate Monitor Operation

How to Start the Heart Rate Monitor

1. Press SELECT two times until MEASURE appears at the bottom of the screen.
2. Press STORE/RECALL one time.
3. Press SET/START/STOP and watch will begin recording heart rate.

Polar Heart Rate Watch



APPENDIX D

CHAIR AEROBICS MOVEMENTS AND PICTURES

Chair Aerobic Movements*

Monkey – alternate arms raise overhead then lower to the waist on every beat of the music.

Punch – the fist punches either up, forward, across the body, or down. Can be done together (punch on count 1, return to start on count 2) or alternating (on every beat).

Rainbow Arms – bring arms high overhead and swing in an arc from right to left.

Bow and Arrow – simulate shooting a bow and arrow.

Rubber Bands – arms diagonally in front of the body, extend forearms out.

Eagle – extend arms overhead and extend legs to the front.

Out Out, In In – left arm and leg rotate away from the body, followed by the right side. Then rotate left arm and leg towards the body, followed by the right side.

Arm Circles – circle one or both arms forward or backward.

Elbow Circles – circle one or both elbows forward or backward.

Bent Arm Press – to start, raise arms shoulder height—elbows at 90 degrees and palms turned to center. Press arms forward and touch together in front of chest.

Push Arms – extend arms out from chest, wrists flexed, palms forward.

High Knees – alternate lifting the knees up toward the chest.

Kicks – alternate kicking one foot to the front.

Heel Taps – place the heel of one foot on the floor, returning to home position. Alternate right and left.

Toe Taps – tap the toes while the heels stay flat on the floor.

Marching – lift your knees high off the floor. One foot remains in contact with the floor at all times. Swing arms as if walking.

Mambo – the right foot steps forward (count 1), the left foot steps on the spot (count 2), the right foot steps back (count 3), the left foot steps on the spot (count 4).

<u>V Step</u> – step right foot forward diagonally right and then left foot forward diagonally left. Step back at the same angle with right foot and then step back at the same angle with the left foot.

<u>Bounce the Basketball</u> – bounce feet on and off the ground while pretending to bounce basketball at each side.

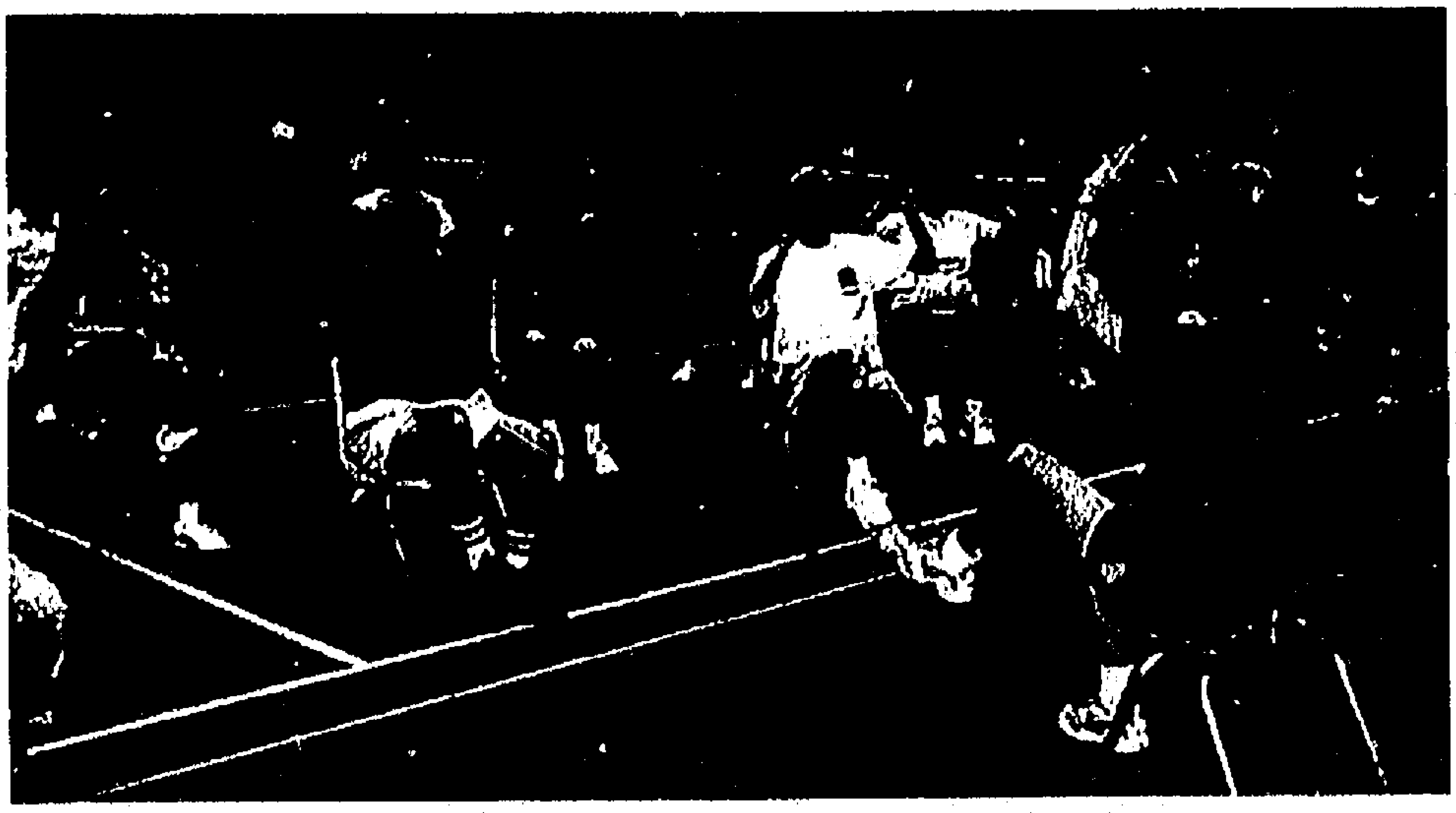
<u>Hold the Walls Up</u> – bounce feet on and off the ground while pressing arms out to the side.

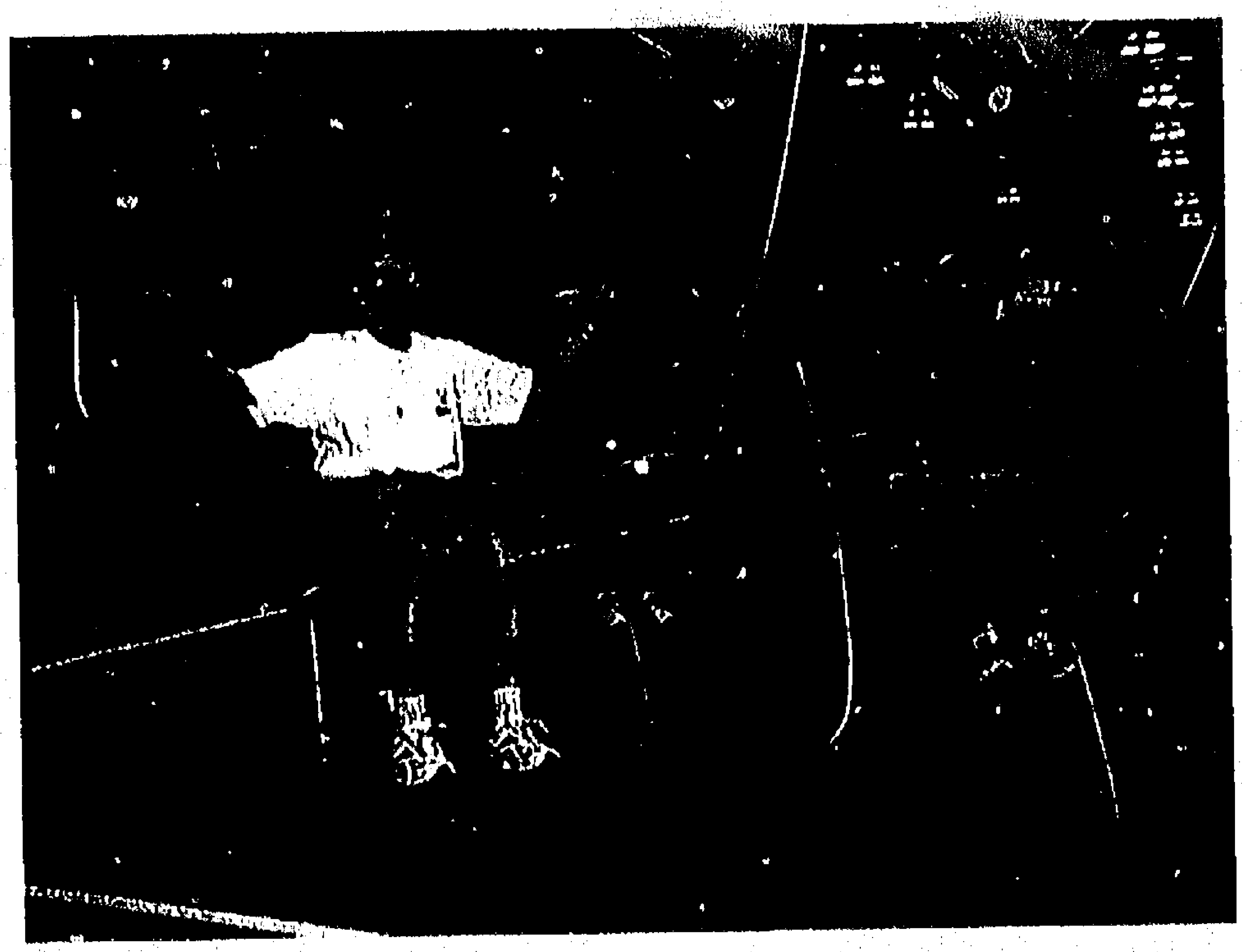
<u>Jump Rope</u> – bounce feet on and off the ground while circling arms at sides as if jumping rope.

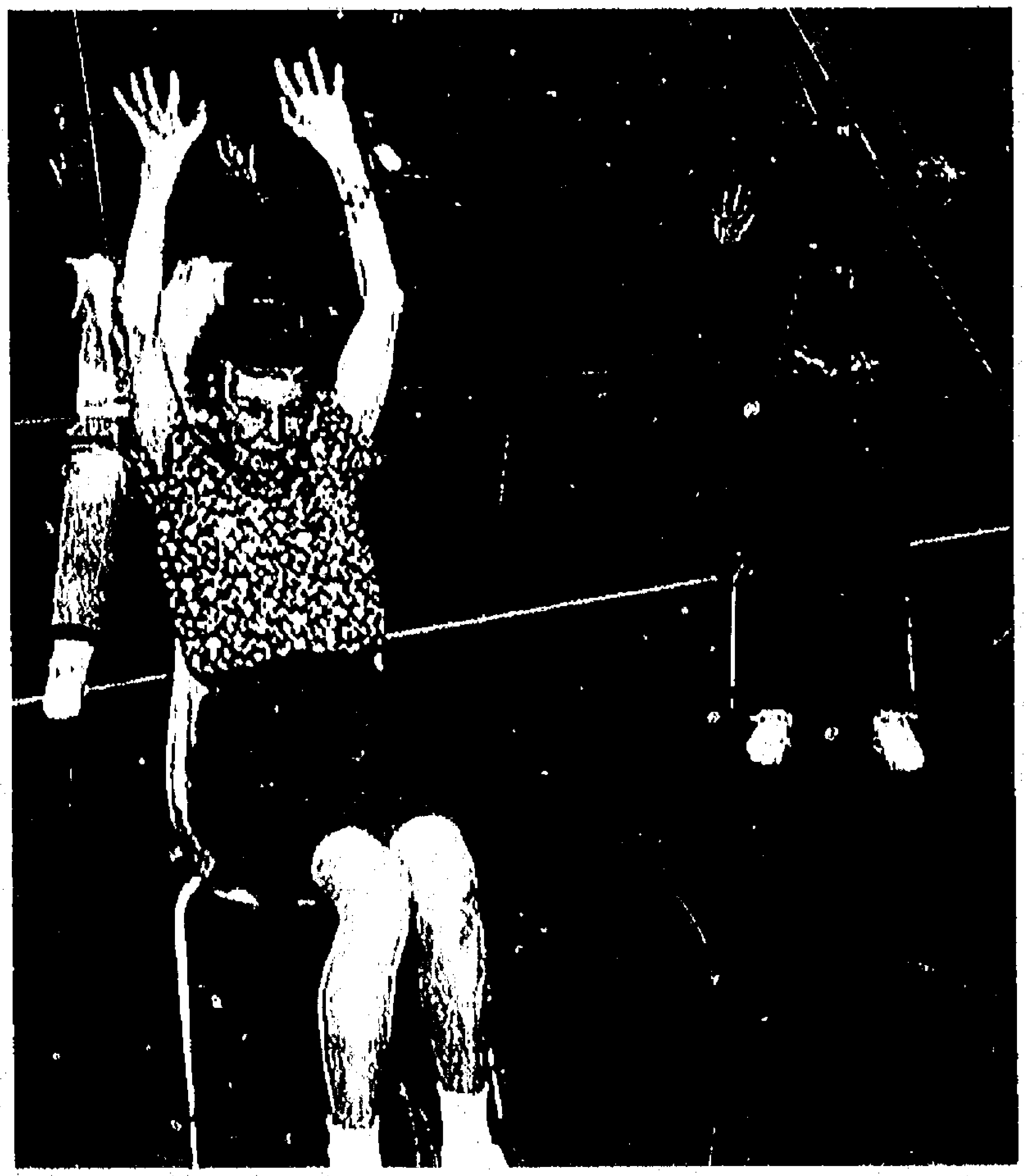
<u>Direct the Choir</u> – bounce feet on and off the ground while making figure eights with the arms.

<u>Picking Apples Off the Tree</u> – extend one arm over head, followed by the other arm.

*These are some of the movements done in a typical chair aerobics class.







APPENDIX E

GUIDELINES FOR WEARING MONITORS

GUIDELINES FOR WEARING MONITORS:

1. Do not wear watch or chest belt in water.
2. Let watch run while showering/bathing but take both the watch and chest belt off. Lightly rub water over the front portion of the chest belt and put it back on along with the watch after bathing.
3. Please wear monitor while sleeping.
4. Women: Remove watch and chest belt at 4 p.m. on Thursday and return watch and chest belt along with activity log to LEHP program on Friday.
5. Men: Remove at 4 p.m. on Tuesday and return watch and chest belt along with activity log to program on Wednesday.
6. REMEMBER TO FILL OUT AND RETURN ACTIVITY LOG.
7. You are only required to participate in the sitting portion (30 minutes) of chair aerobics. Standing portion is optional.
8. If the screen goes completely blank, remove the watch and chest belt because battery is dead.

HOW TO USE THE WATCH:

1. TO START THE TIME.
   - HIT **SELECT** 2 TIMES OR UNTIL **MEASURE** APPEARS ON THE BOTTOM OF THE SCREEN
   - PRESS **STORE/RECALL**
   - PRESS **SET/START/STOP** AND WATCH WILL BEGIN RECORDING HR EVERY MINUTE FOR 24 HOURS

2. TO STOP WATCH AFTER 24 HOURS
   - PRESS **SET/START/STOP**
   - PRESS **SELECT 2** TIMES UNTIL TIME APPEARS
   - PLACE WATCH AND TRANSMITTER INTO CASE

QUESTIONS

Feel free to call us at any time if you have any questions:

Jodi Wenaas	782-6304
Cindy Vande Voort	785-1490

DATES

WOMEN: Wednesday, Nov. 5
Wednesday, Nov. 12
Wednesday, Nov. 19

MEN: Monday, Nov. 10
Monday, Nov. 17
Monday, Nov. 24

APPENDIX F

DAILY ACTIVITY LOG

DAILY ACTIVITY LOG

Identification Number __________

Date ______________

Please keep a record of the activities you do from 4 p.m. Wednesday to 4 p.m. Thursday.
--Thank you.

4pm	5pm
6pm	7pm
8pm	9pm
10pm	11pm
12am-6am	
7am	8am
9am	10am
11am	12pm
1pm	2pm
3pm	4pm