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THE EFFECTS OF INTERVAL AND ENDURANCE RUNNING UPON ANTHROPOMETRIC AND PHYSIOLOGICAL PARAMETERS IN COLLEGE-AGED FEMALES

by

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THE EFFECTS OF INTERVAL AND ENDURANCE RUNNING UPON

ANTHROPOMETRIC AND PHYSIOLOGICAL

PARAMETERS IN COLLEGE-AGED FEMALES

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ABSTRACT

THE EFFECTS OF INTERVAL AND ENDURANCE RUNNING UPON
ANTHROPOMETRIC AND PHYSIOLOGICAL
PARAMETERS IN COLLEGE-AGED FEMALES

By Roger E. Alteri

Sixty-three college-aged females between seventeen and twenty-two years of age were randomly assigned to one of four running regimens described as: (1) interval running two times weekly (Group I), (2) long slow-distance endurance running twice weekly (Group II), (3) interval running three sessions weekly (Group III), and (4) long slow-distance endurance running three times weekly (Group IV).

Before and after ten weeks of experimental conditioning, data were collected and analyzed using a two-way analysis of variance for height, weight, nine circumferential assays, seven skinfolds, four body composition component responses, five selected blood chemistry and volume variables, and twelve cardiovascular parameters.

The number of students who hoped to matriculate and the low incidence of absenteeism throughout verified the interest that college-aged females have in improving their well-being. Data analyses revealed significant

pre/post F ratios for the following variables: (1) elevated cholesterol, Group II, (2) increased serum lactate dehydrogenase in all four groups, (3) elevated triglyceride values, Groups II, III, and IV, (4) increased calf girth for Groups I and III, (5) decreased suprailiac skinfold for Groups I, II, and III, while Groups II and III also decreased in sub-scapular skinfold, (6) lowered resting heart rate for Groups I and II, (7) increased post-exercise systolic blood pressure for Groups II and III, (8) reduced diastolic blood pressure for Groups III and IV, (9) improved duration of effort on the Modified Balke Treadmill Test for Groups I, III, and IV, (10) improved distance covered on the Cooper Twelve Minute Run-Walk Test for Women in all groups, and (11) increased maximal aerobic power for Groups III and IV.

DEDICATION

"Success has a hundred fathers; failure is an orphan" was the inscription on a plaque given to this writer very early in his professional preparation by Mr. Fisher Tichenor. This verse, and his many years of nurturing, guidance, and encouragement were sustaining motives which resulted in the completion of this culminating formal educational experience in which this commentary is inscribed.

Only in token, partial repayment of my appreciation for this man's support through the years is this Doctor of Arts dissertation dedicated to Mr. Fisher (Ping) Tichenor.

ACKNOWLEDGMENTS

Completion of a study of this magnitude was not possible without the unselfish concern of many friends who gave so willingly of their time and skill proficiencies.

The writer wishes to express appreciation to the graduate committee members whose divergent but complementary backgrounds resulted in continued improvements in reporting; Dr. Powell McClellan, major professor, who provided guidance and knowledgeably prepared essential computer models which facilitated and expedited the statistical analyses; Dr. Amiel Solomon, Department Chairman, Health, Physical Education, Recreation and Safety, for his strengthening revisions and constant encouragement valuable to human relations and appreciated so much by his colleagues and students; Dr. Donald Lau, higher education committee member, for his personal concern for the nature of the study and many adopted revisions for improvement. The investigator felt privileged to be afforded professionals whose constant concern was manifested in the student's behalf.

The author is deeply indebted to Carol Clauson, John Poole, and Tom Prohaska, who invested valuable time making laboratory assessments possible. A special thank you is extended to Robert Duggan, David Gardner, doctoral colleague, Earl Pleasant, and Lynda Holloway for the sacrifices made as members of the research team. Their conscientious efforts and faithful participation were always reassuring.

Certainly the author would be remiss to not acknowledge a deep sense of gratitude to the members of the Rutherford Hospital Blood Laboratory for the educational and technical assistance provided. Thank you Miss Janice Beard, Laboratory Director, and Miss Judy Wooten, Chemistry Section Supervisor, for your friendship and guidance throughout the investigation.

Special sentiment with as much meaning as interpretation will allow is extended to Mrs. Margie Mayhew for her consistent support and positive encouragement at every beckoning. This interest has been a motivating force throughout the years.

Finally, it is more than appropriate that my constant source of strength be acknowledged and recorded here. Only through the everyday blessings of Jesus Christ is the health, strength, and energy for all things provided.

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INTRODUCTION

> Many questions regarding the effectiveness of physical conditioning upon the functional capacities of humans remain unanswered. The advantages and disadvantages of different programs have been investigated and discussed in the literature, but the results are not conclusive.[1]

Kilbom and Flint and others corroborated that only a few studies dealt with the effect of physical training on women.[2] Directly, Michael commented that "In 1942, Metheny reported the only known study on the maximal work capacity of American women in excellent physical condition."[3] Furthermore, the more comprehensive and longitudinal studies have been the result of work by European investigators.[4]

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[1] H. G. Knuttgen and others, "Physical Conditioning Through Interval Training with Young Male Adults," Medicine and Science in Sports, V (Winter, 1973), 220.

[2] Asa Kilbom, "Physical Training with Submaximal Intensities in Women, I. Reaction to Exercise and Orthostasis," Scandinavian Journal Clinical Laboratory Investigation, XXVIII (1971), 141; see also M. Marilyn Flint, Barbara L. Drinkwater, and Steven M. Horvath, "Effects of Training on Women's Response to Submaximal Exercise," Medicine and Science in Sports, VI (Summer, 1974), 89.

[3] Ernest D. Michael, Jr. and Steven M. Horvath, "Physical Work Capacity of College Women," Journal of Applied Physiology, XX (1965), 263.

[4] John S. Hanson and William H. Nedde, "Long-Term Physical Training Effect in Sedentary Females," Journal of Applied Physiology, XXXVII (1974), 112; see also Flint, Drinkwater, and Horvath, loc. cit.

Hanson and Nedde reported "That with the exception of one major study by Bausenwein in which forty-nine women participated, physical training in females has received scant attention."[5]

Flint, Drinkwater, and Horvath credited Kilbom with the most thorough study to date which longitudinally investigated the effects of training on women across a wide span of ages, nineteen to sixty-four years.[6]

The fact that so few studies have been completed, yielding unvarying and unequivocal data among women, is even more pronounced when compared to published literature of similar description involving men. Additionally, the few studies that had been completed selected middle-aged women as participants, with fewer studies reported using college-aged females. Also, many studies were concerned with the female's capacity, rather than the identification of her response to training.

Higgs states that

> The sociological stigma against severe exercise for women provides a partial rationale for this dearth of research. In addition, there is no doubt that a certain reluctance by many women to work at exhaustive levels of exercise also exists. However, there is a great need for enhancing our knowledge of the physiological responses which take place in women during heavy exercise; in the world of sport

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[5]Hanson and Nedde, loc. cit.

[6]Flint, Drinkwater, and Horvath, loc. cit.

> the trend is increasing toward more and more endurance activities for women.[7]

This, together with Title IX and the potential catalytic effects it may have on female participation in physical activities at all levels, will necessitate diminishing wide gaps in our knowledge concerning the female and her physiologic responses to varying conditioning regimens.

Since knowledge of maximal aerobic power is of great importance for a rational utilization of manpower, it is very regrettable that our understanding of the female is so limited. On the other hand, the present state of science in this area should serve as a stimulant to further research.

STATEMENT OF THE PROBLEM

If physical education programs nationally, especially in the public schools, were of quality in both content and leadership, perhaps people would realize the value of the discipline throughout their educational experiences and its practical implications throughout life. This author suggested, that if this utopia existed, the profession's concern relative to the required vs. elective program would

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[7]Susanne L. Higgs, Maximal Oxygen Intake and Maximal Work Performance of Active College Women (Knoxville: Eric, Ed. No. 081748, The University of Tennessee, April, 1973), pp. 1-2.

be minimized. People would sense the value of being physically educated and would participate for both fun and fitness. That this quality does not exist at the developmental and preparatory levels gives rise to the professional problems that physical educators face on the collegiate level relative to the justification for the required program.

Having to accept students with grossly inadequate motor skill proficiency levels and low physical work capacities resulting from less than satisfactory informative and developmental public school programs, the challenge to the collegiate professional seems axiomatic.

Therefore, college teachers should investigate and implement the most efficacious and efficient methods known to evaluate the present status of our students, to correct and prescribe programs leading to the immediate rehabilitation of their capacities, and provide learners with bodies of knowledge which will serve their healthful living throughout life.

However, this investigator feels that too many professional physical educators responsible for physical instruction at the collegiate level are lacking in a thorough understanding of the scientific basis of how the individual functions physiologically during elevated threshold levels of physical stress.

The existence of such a condition can be of infinite consequence to the detriment or well-being of the student and the professional. Many professionals would agree that exercise, if not properly prescribed and supervised, can lead to serious damage and even asystole.

With the aforementioned commentary serving as a philosophical construct, this study purports to: (1) add clarity to existing reports and contribute further to the body of knowledge relative to the college-aged female and her physiological responses to the training conditions prescribed in this study; (2) ascertain which of the two training regimens prescribed in this study, interval or long-slow-distance endurance running is the most effective in positively altering desired organic changes in body composition alterations, cardiovascular parameters, and selected blood chemistry variables; and (3) provide reference results from which teachers involved with women of similar age group description can more successfully plan and implement programs which have substantive quality resulting in more favorable organic change for students.

The study assumed a character of unique dimension in that: (1) blood chemistry determinations not found by this investigator in studies which involved college-aged females were computed; (2) anaerobic metabolism functions through oxygen debt measures were taken; and (3) a comparison of the benefits of interval vs. long-slow-distance endurance running on selected anthropometric and physiological parameters in a traditional college teaching situation was completed.

PURPOSE OF THE STUDY

The specific purpose of this study was to ascertain the effects of interval and long-slow-distance endurance running upon selected blood chemistry variables, anthropometric dimensions, and cardiovascular improvements in sixty-three college-aged females enrolled in a physical conditioning class.

DELIMITATIONS OF THE STUDY

The investigation was delimited to include only college-aged females who, after being randomly chosen, volunteered to matriculate in two sections of a physical conditioning class at Middle Tennessee State University, Murfreesboro, Tennessee. The class met two and three times weekly for ten weeks, spring semester 1975. Data were collected during pre- and post experimental conditioning.

IMPLICATIONS FOR TEACHING

Perhaps, educational history will record this era as the age of accountability. Certainly, public and governmental pleas for education to be more accountable for the things it does should encourage the profession to be meticulous about the leadership provided and the quality of instruction that results.

The ramifications of accountability in education are many. Some people simply desire more effective methods leading to improved learning and performance. This study was designed to provide answers leading to more effective physical conditioning programs and more satisfying experiences for students.

Still others proclaim that education could be more efficient with the student's time and money. Some want shorter semesters of instruction, less time per class, allowing for the accumulation of more credit hours per semester. This study attempted to determine if more efficacious methods of conditioning did exist which would result in more rapid changes over a shorter period of time. If such a discovery were substantiated through this study, it might serve as a partial rationale for offering conditioning courses which would meet more frequently for a shorter semester, thereby providing the student with the results desired while freeing him early to expend energies in other course work.

DEFINITION OF TERMS

Aerobic Metabolism

Aerobic metabolism referred to metabolic functions which derived their energy primarily from an adequate oxygen supply.

Anaerobic Metabolism

Anaerobic metabolism referred to metabolic functions which occur in the absence of an adequate supply of oxygen.

Anthropometric Dimensions

Anthropometric dimensions were the numerical values which resulted from bodily measurements including both circumferential and skinfold assessments.

Blood Chemistry Variables

The blood chemistry variables delineated in this study included triglyceride, cholesterol, hematocrit, hemoglobin, and serum lactate dehydrogenase.

Cholesterol

A fatty constituent of many tissues whose elevated level was recognized as a "risk factor" associated with coronary heart disease.

College-Aged Females

Reference was made to include young women in the traditional 17-22 age classification.

Heavy Exercise

Heavy exercise referred to activity which resulted in an oxygen uptake and concomitant cardiac response approaching 70 percent of a female's maximum.

Hematocrit

Hematocrit readings suggested the volume percent of erythrocytes in whole blood.

Hemoglobin

Hemoglobin was the oxygen carrying pigment of whole blood.

Interval Running

Interval running was a series of repeated bouts of running 220 yards in fifty seconds with two minute periods of rest interspersed.

Lean Body Weight

Lean body weight referred to fat-free portions of an individual's body composition.

Long Slow-Distance Endurance Running

This method of running, described in terms of this study, referred to continuous, uninterrupted, submaximal, aerobic running covering progressive distances of one and one and one-half miles which resulted in a terminal heart rate approximately equal to 80 to 90 percent of an individual's maximal heart rate.

Maximal Aerobic Power

The individual's maximal oxygen uptake which suggested the capacity to inspire, transport, and utilize oxygen under physiologically demanding conditions.

Oxygen Debt

The amount of oxygen required in the post-exercise recovery period to reverse the anaerobic reactions of the exercise period.

Percent Body Weight Fat

Percent body weight fat was expressed as a percentage suggestive of the adipose tissue component of body composition. This value was derived by subtracting the ratio of lean body weight to total body weight from unity.

Physical Conditioning Class

In this study physical conditioning was defined in terms of the interval and endurance running regimens prescribed.

Serum Lactate Dehydrogenase

Serum lactate dehydrogenase was an enzyme which catalyzed the transference of hydrogen ions.

Triglycerides

Triglycerides were a compound consisting of three molecules of fatty acid esterified to glycerol; a neutral fat that is the usual storage form of lipids in animals. It appeared to have clinical significance, being recognized among the "risk factors" predisposing individuals to coronary heart disease.

Whistle Drilling

This procedure referred to the sounding of rhythmical audible cues which served to indicate running pace.

LIMITATIONS OF THE STUDY

Earnest researchers must be as meticulous as possible in the selection of their subjects in order to insure the credibility of their efforts. Traditionally, random sampling techniques are employed in order to obtain subjects whose characteristics generally represent the larger population.

Although random sampling techniques were employed in this study involving sixty-three college-aged females enrolled at Middle Tennessee State University at least two limitations were evident relative to the population selected as participants. It was assumed that: (1) female students at Middle Tennessee State University exhibited characteristics that closely represented college-aged females at other institutions; and (2) variables such as scheduling conflicts and credit received in the course previously were limitations affecting the size of the volunteer population.

HYPOTHESES

The following null hypotheses were tested:

Hypothesis 1. Interval running with a training frequency of twice weekly, for ten weeks, will not result in significant organic changes in selected blood constituents, anthropometric dimensions, or selected cardiovascular parameters.

Hypothesis 2. Interval running three times weekly will not result in significant changes in the parameters delineated.

Hypothesis 3. Interval running three times weekly will not result in significant alterations in any of the variables delineated when compared to the same training regimen administered twice weekly.

Hypothesis 4. Long slow-distance endurance running with a training frequency of twice weekly for ten weeks will not result in significant changes in blood chemistry variables, anthropometric dimensions, aerobic or anaerobic capacities.

Hypothesis 5. Long slow-distance running with a training frequency of three sessions weekly will not result in significant organic changes in the parameters delineated.

Hypothesis 6. Long slow-distance running three times weekly will not result in significant alterations in any of the variables delineated when compared to the same training regimen prescribed twice weekly.

Chapter 2

REVIEW OF RELATED LITERATURE

Comparatively few studies have been designed to investigate the effects of varying training regimens on the physiological responses of the female between seventeen and twenty-two years of age.[1] This comparison assumed even greater significance when contrasted to the myriad of literary contributions published which were designed to reflect information of similar description among men.

The specific purpose of this review of literature was to report completed studies which investigated the untrained college-aged females physiological responses to physical training. Directly, the commentary was delineated to profile her blood chemistry responses, body composition responses, and cardiovascular responses to interval running and long slow-distance endurance running.

Since there was not a proliferation of studies which dealt specifically with college-aged females relative to the

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[1]Asa Kilbom, "Physical Training with Submaximal Intensities in Women, I. Reaction to Exercise and Orthostasis," Scandinavian Journal Clinical Laboratory Investigation, XXVIII (1971), 141; see also M. Marilyn Flint, Barbara L. Drinkwater, and Steven M. Horvath, "Effects of Training on Women's Response to Submaximal Exercise," Medicine and Science in Sports, VI (Summer, 1974), 89.

criteria mentioned, a synthesis of information reporting the physiological responses of middle-aged women and pre-adolescent and adolescent girls seemed relevant. In addition, where appropriate data were not available, studies using the male were cited.

EFFECTS OF INTERVAL TRAINING UPON PHYSIOLOGICAL RESPONSES IN FEMALES

Blood Chemistry Variables

The effects of varient training regimens and frequencies upon cholesterol, triglycerides, hematocrit, hemoglobin, and serum lactate dehydrogenase values have been of special interest to the physical educators from both preventative and competitive perspectives. The concept of reduced physical activity and hypercholesterolemia and elevated triglyceride levels have been recognized and reported as coronary heart disease risk factors.

Epidemiological studies have been published which demonstrated a positive correlation between sedentary living and elevated cholesterol levels and risk of coronary heart disease. Stocks 1951, Logan 1952, and Morris 1953, reported greater mortality from and higher incidence of coronary heart disease respectively among more sedentary populations in England.[2]

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[2]Leif M. Hagerup, P. F. Hansen, and F. Skov, "Coronary Heart Disease Risk Factors in Men and Women," American Journal of Epidemiology, XCV (1971), 99.

The ten year Irish-Boston Heart Study (1960-1970) involving 575 pairs of brothers between the ages of thirty and sixty-five revealed, that although the Irishmen's diets were higher in cholesterol, autopsies and other evaluations demonstrated that their hearts averaged fifteen years younger than the American brother. Both brothers in each pair were born and reared at least twenty years in Ireland. One of the brothers had immigrated to the Boston area and had lived there at least two years. Researchers concluded that constant physical activity was the salient reason for this improved condition.[3]

The fourteen year Framingham Study involving 2,282 men and 2,845 women, concluded that there was an increased risk of coronary heart disease proportionate to total serum cholesterol.[4]

In an attempt to investigate the effects of exercise on the alteration of serum cholesterol and triglyceride values, Mann and associates used the medium of interval training to condition sixty-two men between the ages of twenty-five and sixty years. The trainees exercised four times weekly for six months. The interval training regimen consisted of a series of calisthenics with alternate periods of walking, jogging and running. Exercise intensities were

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[3]Richard A. Passwater, "Dietary Cholesterol Is It Related to Serum Cholesterol and Heart Disease?" <u>American Laboratory</u>, XXXIV (September, 1972), 28.

[4]Ibid., p. 23.

designed to result in episodic increases of the pulse rate to 160 to 190 beats per minute monitored through telemetry. These experimental conditions were reported to have evidenced a 3 percent decrement in serum cholesterol while triglyceride values were significantly increased. Distinctly lower initial cholesterol values resistant to change may provide a partial explanation for the 3 percent decrease, while an increased food intake was thought to have affected the elevated triglyceride values.[5]

Utilizing interval training of the walk-jog description, Bonanno's findings did not corroborate those of Mann and associates. Thirty-nine untrained middle-aged men, classified as high risk subjects, trained three times weekly for twelve weeks at a training intensity designed to stimulate cardiac to a level equal to 70 to 85 percent of maximum heart rate recorded through telemetric instruments. The training stimulus was reported to have reduced serum triglycerides substantially when measured twenty-four hours after an exercise session. However, values returned to baseline levels when rechecked ninety-six hours after exercise. Significant reduction of cholesterol values, pre- and post, were not confirmed. The author concluded that

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[5]George V. Mann and H. Leon Garrett, "Exercise to Prevent Coronary Heart Disease: An Experimental Study of the Effects of Training on Risk Factors for Coronary Disease in Men," American Journal of Medicine, XLVI (January, 1969), 13-26.

approximately three exercise sessions a week were necessary to maintain triglyceride reductions.[6]

Similar conclusions have been corroborated by Fox and Haskell who reported that proper exercise, even though it must be performed every two or three days was justified in order to maintain desired lowered triglyceride levels. They also stated that the effects of exercise on lowering serum triglycerides appeared to be more acute than chronic.[7]

Using a variety of training methods including calisthenics, walking, jogging, and interval running, Milesis[8] and Garrett and associates[9] trained a total of thirty-four men aged twenty-five to fifty-four years four times weekly for eleven weeks and five times weekly for six weeks respectively. The Milesis protocol, although not reported as being statistically significant, did result in favorable changes in serum cholesterol and triglyceride values. Serum cholesterol was reduced from 33.2 milligrams

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[6]Joseph A. Bonanno and James E. Lies, "Effects of Physical Training on Coronary Risk Factors," The American Journal of Cardiology, XXXIII (May 20, 1974), 760.

[7]Samuel M. Fox and William L. Haskell, "Physical Activity and the Prevention of Coronary Heart Disease," Bulletin of the New York Academy of Medicine, 2d Series, XLIV (August, 1968), 950.

[8]Chris A. Milesis, "Effects of Metered Physical Training on Serum Lipids of Adult Men," Journal of Sports Medicine, XIV (1974), 8.

[9]H. Leon Garrett, Roy V. Pangle, and George V. Mann, "Physical Conditioning and Coronary Risk Factors," Chronic Disease, XVIV (1966), 901.

percent (243.1-209.9) while triglycerides increased 12.6 milligrams percent (129.5-142.1). Mann on the other hand reported significant alterations in both parameters. Cholesterol and triglyceride values were effected positively showing decreases from 233 milligrams percent to 195 milligrams percent and 187 milligrams percent to 117 milligrams percent respectively.

H. Harrison Clarke aptly stated

> That the largest number of investigations on the effect of exercise on blood cholesterol level has been conducted with middle-aged men as subjects, walking, jogging, and running as primary modes of exercise, performed mostly on ergometers where the exercise dosage could be regulated. . . . .
> . . . .
> Only rarely have studies been conducted on the effects of exercise on the blood cholesterol levels of women.[10]

Directly, exclusive of an experimental effort by Kilbom, this investigator found studies dealing with the effects of interval training on selected blood chemistry variables in females to be non-existent. Kilbom determined hemoglobin, hematocrit, and serum cholesterol basal values on thirty-three female subjects age nineteen to sixty-four. Training was conducted intermittently two to three times a week for seven weeks on bicycle ergometers using a work load corresponding to 70 percent of their individual maximal aerobic capacity. During each training session subjects

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[10] H. Harrison Clarke, "Exercise and Blood Cholesterol," Physical Fitness Research Digest, Series 2, No. 3 (July, 1972), 8, 11.

performed six intervals of three minutes duration each with two minutes rest between.

Kilbom reported that hematocrit values were unchanged following training, while hemoglobin concentration was unchanged in Groups I and II, mean age 27.7 and 44.0 respectively, but declined significantly in Group III, mean age 56.4. Cholesterol concentration declined significantly by 10 percent in Group I but was not significantly altered in the other groups.[11]

To further elucidate the relationship between physical training and hemoglobin and hematocrit concentrations in blood, Roitman and Brewer used nine highly conditioned male competitive athletes to investigate the effects of an interval-type training stimulus on these blood constituents. The interval regime had no significant effect on the hemoglobin or hematocrit values.[12]

These results were compatible with those of Rand and others who also found the influence of athletic training on the hemoglobin-oxygen affinity of forty-six highly conditioned male athletes to be of little physiological value.[13]

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[11]Kilbom, loc. cit.

[12]J. L. Roitman and J. P. Brewer, The Chronic and Acute Effects of Exercise Upon Selected Blood Measures (Knoxville: Eric, Ed. No. 083-220, The University of Tennessee, May 16, 1973), p. 3.

[13]Peter W. Rand and others, "Influence of Athletic Training on Hemoglobin-Oxygen Affinity," American Journal of Physiology, CCXXIV (June, 1973), 1334.

Summary

A review of the literature related to the effects of interval training on blood hemoglobin, cholesterol, triglyceride, and hematocrit concentrations in humans, with special interest in the untrained college-aged female revealed the following:

1. Study groups have typically been middle-aged men training on varient exercise prescriptions which have led to contradictory results.

2. The differences in results seem attributed to the type of exercise, the dosage, and length of continuance.

3. Few studies failed to show a positive effect from exercise in significantly reducing blood cholesterol.

4. The effect of exercise on triglycerides was more acute than chronic. Levels were lowered only for a few days following cessation of exercise.

5. The literature clearly substantiated that the importance of low triglyceride levels in the avoidance of coronary heart disease is such, as to justify regularity of exercise, at least every two or three days.

6. Studies which attempted to elucidate the effects of interval training on blood chemistry constituents were at best sparse among men, and assumed an even greater distinction of being non-existent among women. Completed research on the female utilized ergometric methods.

7. Clearly, studies on untrained college-aged females conditioned through interval training methods in an activity setting were not discovered by this investigator.

8. It appeared that interval training regimens of the description cited, failed to significantly alter hematocrit or hemoglobin concentrations in whole blood.

9. This investigator was unable to disclose literary efforts which attempted to show the effects of interval training on serum lactate dehydrogenase.

Anthropometric Dimensions

"Obesity has been recognized as a major health problem in the United States for a number of years."[14] Since World War II an ever increasing awareness of the potential dangers of obesity and its pathological implications upon the cardiovascular system has been the concern of many health related professionals.

Wilmore and Behnke stated that documentation was available which suggested a positive relationship between obesity or excess fat and increased morbidity and mortality. They further commented that a correlation existed between obesity and increased coronary heart disease. Also, obesity was found more frequently in childhood and early

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[14] Jack H. Wilmore and Albert R. Behnke, "Predictability of Lean Body Weight Through Anthropometric Assessment in College Men," Journal of Applied Physiology, XXV (October, 1968), 349.

adolescence, and there was substantial eviaence to indicate that it was likely to persist if encountered early in life.[15] Moody also reported that research indicated obesity was a problem of epidemic proportions which had a major stronghold in our children and adolescent populations.[16]

Investigative efforts by Hampton and associates somewhat qualified the prevalence of obesity among adolescents. Beginning with the ninth grade and continuing throughout the next three years, eighty-nine male and ninety-three female students enrolled in physical education classes participated in a longitudinal study of gross body composition. Obesity standards of over 20 and 25 percent body weight fat for boys and girls respectively were established. Using these ranges, the investigators found little difference in the percent of boys who fell into the obese classification from grade to grade: 11 percent in the ninth, 13 percent in the tenth and eleventh grades and 14 percent in the twelfth grade. For the girls, there seemed to be more change: 11 percent in the ninth grade, 12 percent in the tenth grade, 17 percent in the eleventh grade and 14 percent in the twelfth grade.[17]

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[15] Ibid.

[16] Dorothy L. Moody, Jack H. Wilmore, and Robert N. Girandola, "The Effects of a Jogging Program on the Body Composition of Normal and Obese High School Girls," Medicine and Science in Sports, IV (Winter, 1972), 210.

[17] Mary C. Hampton, Ruth L. Huenemann, and Albert R. Behnke, "A Longitudinal Study of Gross Body Composition

A recent study completed in California by McNamara and Wilmore using ninety-five boys, eight to twelve years of age, revealed a 13 percent prevalence of obesity.[18] Obviously, the answer to obesity is prevention not rehabilitation. Moody stated,

> Exercise has been demonstrated to be an effective agent both in the prevention and rehabilitation of obesity. Several studies have indicated that exercise promotes significant decreases in girths and skinfolds and in total body fat as determined through density assessments.[19]

Moody confirmed that only limited data were available on changes in the body composition of adolescent girls as a result of exercise and comparable studies on the obese adolescent girl are non-existent.[20]

Unfortunately, that studies using interval training regimens to condition the female in an effort to report anthropometric alterations are also non-existent indicated a need.

Adams and DeVries studied the physiological effects of a form of interval training upon women aged fifty-two to

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and Body Conformation and Their Association with Food and Activity in a Teen-Age Population," American Journal of Clinical Nutrition, XIX (December, 1966), 425.

[18] J. J. McNamara and J. H. Wilmore, "Prevalence of Coronary Heart Disease Risk Factors in Boys, 8-12 Years of Age," Medicine and Science in Sports, VI (Spring, 1974), 85.

[19] Moody, loc. cit.

[20] Ibid.

seventy-nine. Skinfolds were measured according to the method of Sloan and Weir at two sites: (1) over the triceps, and (2) over the iliac crest in the mid-axillary line. The sum of the two skinfolds were used in the data analysis.

The twenty-three women, mean aged 65.9 trained three times weekly for three months using progressive interval jog-walk exercise prescriptions, increasing the jog phase from fifteen seconds to three minutes while correspondingly decreasing the recovery intervals from one minute to fifteen seconds. Although some parameters did change, no significant alterations were discernible between pre- and post-test body weight or skinfolds.[21]

Kilbom trained ten middle-aged women, mean age 34.5 years, on bicycle ergometers at 50 percent of their maximal oxygen uptake, three times weekly for six weeks in the morning. The work bouts consisted of six, three minute, intervals separated by two minute rest periods. It was determined that body weight remained unchanged.[22]

Beginning with 133 male subjects, mean aged thirty-eight years, and finishing with sixty-two, Mann and Garrett

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[21]Gene M. Adams and Herbert A. DeVries, "Physiological Effects of an Exercise Training Regimen Upon Women Aged 52 to 79," Journal of Gerontology, XXVIII (1973), 50.

[22]Asa Kilbom, "Effect on Women of Physical Training With Low Intensities," Scandinavian Journal Clinical Nutrition, XXVIII (1971), 345.

and associates conditioned participants five times weekly for six months using a form of interval training among other regimens. Heart rates ranged between 160-190 beats per minute during the interval running.

Anthropometric measurements included body weight and skinfold thickness at the triceps, scapular angles and flank sites on the right side made with Lange calipers. Girths were measured with a steel tape at mid-biceps, mid-thigh and mid-calf levels. The chest girth was measured at the nipple line in normal position and expanded, the waist girth was measured at the level of the umbilicus.

The girth and skinfold measurements reflected a weight change in the trained men. The loss of subcutaneous fat was highly significant at each of the three sites, triceps, scapula, and flank. Thigh and biceps girths, although increased, were not significantly changed, whereas the calf girth was increased significantly. These changes support the explanation that in these men subcutaneous fat deposits diminished and leg musculature increased with training. The thigh girths were only slightly increased, perhaps because of intricate compensating changes of fat and muscle.[23]

Bonanno and Lies trained thirty-nine middle-aged men, who were at a high risk of coronary artery disease,

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[23]Mann and Garrett, op. cit., p. 13.

three times weekly for twelve weeks using a form of interval training which resulted in a cardiac response equal to 70 to 85 percent of maximal rate. The investigators reported a lack of significant weight reduction and no changes in mean values for lean body mass as determined by skinfold thickness measurements. They reported that no dietary restrictions were imposed and that most studies of the same restriction have found minor weight reduction or an increase in lean mass, or both.[24]

<u>Summary</u>

A review of the literature in an attempt to elucidate the effects of interval running upon anthropometric dimensions has disclosed:

1. Interrupted jog-walk forms of interval training appeared most frequently using middle-aged men and less frequently using more mature women.

2. In many instances, training regimens were not well defined as interval training.

3. Many interval programs of varient intensities were used in concert with continuous running programs, also of varient intensities, which made it extremely difficult to establish trends with respect to body composition alterations. Literature cited reported insignificant body composition alterations following training.

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[24]Bonanno and Lies, op. cit., p. 763.

4. Research attempting to report the effects of varient interval training programs upon anthropometric changes in the college-aged female population, trained or untrained, was found to be uninvestigated by this researcher.

In order to support the contentions that interval training programs have positive preventative and rehabilitative implications in the treatment of obesity, research energy needs to be expended under well defined and controlled conditions.

Cardiorespiratory Parameters

"In the past twenty years interval training has been occupying a growing place in various sports, with efficiency as regards long and middle distance running."[25] To be more persuasive, Fox and Mathews commented that over the past century, there has been massive assaults on athletic performance records. One of the many factors that undoubtedly contributed to this was improvement in training methods. Fox and Mathews cited interval training methods as having perhaps produced more successful athletes than any other system of conditioning.[26]

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[25] J. L. Ardisson and others, "Cardiorespiratory Effects of Interval Training," Journal of Sports Medicine and Physical Fitness, XIII (June, 1973), 74.

[26] Edward L. Fox and Donald K. Mathews, Interval Training: Conditioning for Sports and General Fitness (Philadelphia: W. B. Saunders Company, 1974), p. 1.

Ardisson suggested that Wilt described this type of training to involve

> . . . repeatedly running a specific distance at a predetermined speed, resting a specific interval following each fast run, recovering through use of specific activity (walking or jogging) during the interval between fast runs. . . . .
> . . . .
> That the effort does not require continuous exertion over a rather long distance but several solicitations over a short distances with intercalated rest-periods of short duration.[27]

According to Down, Astrand was to be credited as perhaps the first to show the significance of this concept of training, experimentally, with respect to muscular work of an intermittent type. Astrand investigated the physiological effects of rest pauses on a non-steady state work load, and found that heavy work, when split into short periods of work and rest half and one minute, respectively was transformed into submaximal work load on circulation and respiration and could be maintained aerobically for as much as an hour; yet in two or three minutes of work performed at the same time, work out-put approached maximum, and the task was completed only with great strain on circulation and respiration.[28] Down quoted Åstrand as having concluded,

> "First, that a total amount of work could be divided into appropriate periods to facilitate

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[27]Ardisson, loc. cit.

[28]Michael Geoffrey Down, "An Appraisal of Interval Training," Track and Field News, No. 19 (March, 1965), 593-594.

> efficiency and enable training of the large muscle groups of the body to be induced without simultaneously loading the respiratory and circulatory organs excessively, and second, that by selecting longer periods of two or three minutes a greater training effect on those organs could be accomplished."[29]

Down also described similar studies by Christensen on the influence of rest pauses on mechanical efficiency which further demonstrated that the length of the work period was critical as far as the load on the respiratory and circulatory organs was concerned. Using two subjects running on a treadmill at twenty kilometers per hour (12.4 mph) to exhaustion, maximum values for oxygen intake, blood lactic acid and heart was reached in three or four minutes respectively; whereas, using short spells of work and rest at the same speed--thirty seconds--the subjects ran for fifteen and twenty minutes respectively, with only slight increases in blood lactic acid, despite a marked decrease in oxygen intake, at a relatively constant heart rate of 140-150 beats per minute throughout the work period. Down concluded that

> The implications from this experiment are obviously that interval training calls for a way of working which is not only more economical, but more demanding of the circulatory and respiratory systems and more favorable to the development of efficient chemical reactions, if devised accordingly--in fact it represents a scientific approach to training methodology.[30]

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[29]Ibid.

[30]Ibid.

When compared to uninterrupted or endurance exercise, the same proliferation of studies relating the effects of interrupted or interval training to physiological responses such as cardiorespiratory parameters were at best sparse. If interval training does result in increased accomplishments of work under more effective and efficient physiological adjustments, these methods could be adapted to have implications for the physical conditioning of individuals other than athletes. Fox and Mathews suggested in their text that this was true. They prescribed this training method for personalized conditioning programs simply to develop better fitness for health.[31]

However, the comparatively few studies that attempt to show the effects of interval or intermittent training on physiological response in humans are weighted toward the trained individual, with few studies having been done with untrained subjects.

In an earlier study reported by Kilbom, ten women, twenty-three to forty-five years old (mean age: 34.5), trained on bicycle ergometers three times weekly for six weeks. Subjects initiated the training with a work load corresponding to 50 percent of their maximal oxygen uptake, cycling for six, three minute, intervals separated by two minute rest periods. The work load used for training was

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[31]Fox and Mathews, op. cit., p. 3.

successively increased by 0-150 kpm/minute in order to keep the rate unchanged from one training session to the other. The mean value for heart rate in the third minute of an interval (the average of all six intervals in all training sessions) was 135 beats per minute for all subjects, corresponding to 59 percent of their maximal oxygen uptake prior to training. In all subjects, relative training intensity was checked at every training session with electrocardiograph or by palpation.

The subjects' reactions to physical exercise were examined twice before and twice after the training period. Subjects cycled on a mechanically braked bicycle ergometer (Monark, Sweden) for six minutes at each of the submaximal 300, 450, and 600 kpm/minute loads with a five minute rest interposed between loads. The pedalling rate was fifty rpm, and the revolutions were checked with a special tachometer driven by the pedals. On the basis of heart rate and the work load at these submaximal loads, each subject's maximal uptake was estimated with the aid of the Astrand nomogram. The subject then cycled at the corresponding maximal load for three to six minutes until exhaustion. The second maximal load was usually at a level somewhat lower or higher than the first, depending on whether or not data from the first maximal load indicated that exertion had been maximal the first time.

Kilbom reported oxygen uptake at all loads was not significantly altered after training, as compared to before training, when assessed by submaximal conditions. However, when evaluated under maximal work loads, maximal oxygen uptake increased by an average of 6 percent, from 33.9 milliliters per kilogram per minute to 35.8 milliliters per kilogram per minute. Under submaximal conditions, pulmonary ventilation at a given oxygen uptake was somewhat less after training, but the difference was only significant at 300 kpm/minute. Maximal pulmonary ventilation was slightly higher after training when assessed under maximal conditions, but not significantly. When assessed through submaximal work loads, heart rate was somewhat lower after training and the difference was significant at 450 kpm/minute and 600 kpm/minute. Under maximal conditions, heart rate was somewhat higher following training. Mention should be made that members of the experimental group were all office workers who were physically inactive in their work and spare time for two years.[32]

Kilbom also conditioned thirty-three women ranging in age from nineteen to sixty-four years two and three times weekly for seven weeks on bicycle ergometers using interval training protocols. Subjects were arranged according to age into three groups. Group I, nineteen to thirty-one years (mean age 23.7), Group II, thirty-seven to forty-eight years (mean age 44.0), and Group III, fifty-one to sixty-four

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[32]Kilbom, "Effect on Women of Physical Training with Low Intensities," loc. cit.

years (mean age 56.4). The reaction of subjects to submaximal and maximal exercise was determined twice before, at an interval of a few days, and twice after training. Subjects cycled on mechanically brake bicycle ergometers (Monark, Sweden) at a pedalling rate of fifty rpm at the submaximal loads of 300, 450, and possible even 600 and 750 kpm per minute. The exercise lasted for six minutes on each load with a few minutes' rest between each load.

Using heart rates and corresponding submaximal loads from the first exercise test, the maximal oxygen uptake of the subjects was predicted according to the Astrand nomogram. Thereafter the subjects cycled at a load demanding the predicted maximal oxygen uptake for three to six minutes until complete exhaustion was reached. In the second exercise test a somewhat longer or higher load was chosen depending on whether or not the data from the first load indicated that the maximal oxygen uptake had been attained.

Training was conducted on each occasion in six intervals of three minute durations each with two minutes rest in between. The load was determined on the basis of the heart rate-oxygen uptake diagram established for each individual during work on a bicycle ergometer before training. The load which corresponded in a steady state to 70 percent of the individual's maximal oxygen uptake was used at the beginning of training. This rate was also very close to 70 percent of the difference between their maximal and resting heart rate. During the entire period of training, Group I had an average heart rate of 166 beats per minute during the third minute of the six intervals, Group II had 142 beats per minute, and Group III, 141 beats per minute. These figures correspond to 73, 69, and 77 percent, respectively, of their maximal aerobic power, and to 75, 68, and 60 percent, respectively, of the difference between their maximal and resting heart rate. The load was initially 300-600 kpm per minute and was successively increased during the training period by 75-225 kpm per minute.

Oxygen uptake values (in liters per minute) at submaximal loads were significantly lower in Group I only at 600 kpm per minute. In all groups maximal oxygen uptake was significantly greater after training than before. The average percentile increase in maximal aerobic power was 12.4, 11.1, and 8.4 percent in the respective groups if improvements were expressed in liters of oxygen per minute, and 10.9, 13.2, and 9.3 percent if expressed in milliliters per oxygen per kilogram per minute.

Pulmonary ventilation at submaximal loads were somewhat less in all groups after training, however, the difference was only significant in Group I. At maximal loads, pulmonary ventilation was significantly greater following training in all groups. Heart rate was consistently, significantly lower at submaximal loads after training than before. During maximal exercise average heart rate in the three groups was unchanged after training.

After the period of training, average blood pressure was lower at the same load in all groups, with the difference being most pronounced in Group I (116/72-112/71) and Group III (139/84-124/77). The diastolic pressure was lowered significantly in Groups II (78/74) and Group III (84/77). Orthostatic test results with subjects functioning under basal conditions evidenced consistently lower heart rate and systolic and diastolic blood pressure values.[33]

In thirteen women twenty-one to sixty-one years of age, circulatory studies at submaximal and maximal exercise were made before and after seven week's training by Kilbom. Subjects were divided into three groups according to age. Group I, twenty-one to twenty-eight years (mean 23.0), Group II, forty-three to forty-eight years (mean forty-six), and Group III, fifty-three to sixty-one years (mean 55.0).

The exercise test was performed on a mechanically braked Monark bicycle ergometer using a protocol similar to that described earlier. Training was performed three times a week intermittently for one half hour on bicycle ergometers with an intensity corresponding to approximately 70 percent of the individuals maximal aerobic power. Work to rest ratios have been described earlier.

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[33]Ibid.

Submaximal post testing revealed oxygen uptake values somewhat less with a 600 kpm per minute load, but the difference was not significant. Lesser loads resulted in unchanged values. Heart rate was significantly reduced after training in Groups I and II at submaximal loads. Group III changes were not significant.

Maximal post exercise testing evidenced increased maximal oxygen uptake capability by a mean of 10.3 percent in Groups I and II and 6.3 percent in Group III. Maximal heart rate was unchanged after training in Groups I and II but somewhat, although not significantly higher in Group III.

During submaximal work, systolic, diastolic, and mean blood pressures were not significantly changed in Group I, significantly lower in Group II, and somewhat lower in Group III after training. During maximal work all blood pressures were unchanged after as compared to before training. Blood pressure was monitored through the introduction of inter-arterial catheters. The resting heart rate declined in Groups I and II (76-72 beats per minute), but not in Group III (63-63 beats per minute).[34]

Knuttgen and associates studied three groups of Swedish military conscripts, each participating in a different form of interval running. Three experimental

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[34]Asa Kilbom, "Physical Training with Submaximal Intensities in Women, II. Effect on Cardiac Output," Scandinavian Journal Clinical Laboratory Investigation, XXVIII (1971), 164.

groups (mean age 20.6 years) were designated according to platoon assignments. Group I was composed of twenty subjects, Group II nine subjects, and Group III eight subjects. For each group the total time for exercise was fifteen minutes. The respective interval training routines were: Group I, alternated fifteen seconds running and fifteen seconds rest, three days per week for two months, Group II, alternated three minutes running with three minutes rest, three days per week for two months; Group III, one month no formal training, then alternated three minutes running with three minutes rest, five days per week for one month.

Each group was subjected to physical performance testing on three occasions: test one at induction, test two at one month after induction, and test three at two months after induction. Standard exercise tests for determination of physiological response to submaximal and maximal exercise were performed on an electrically braked bicycle ergometer and maximal aerobic power determined. Heart rate was monitored by electrocardiograph.

Experimental conditioning resulted in increased aerobic capacity for all three groups from test one to test two (45.8-49.3, 43.1-51.9, and 46.4-50.4 milliliters per kilogram per minute), respectively, and from test one to test three, 45.8-52.6, 43.1-53.4, and 46.4-57.0 milliliters per kilogram per minute) respectively. The increases from test two to test three were significant for Group I and III but not Group II.

Heart rate was significantly lowered in submaximal exercise for all groups from test one to test two (161-146, 158-140, and 158-143) respectively, and from test one to test three (161-146, 158-142, and 158-135) respectively. Differences between test two and test three were not significant. Heart rate in maximal exercise was significantly lower for all groups from test one to test three (200-190, 194-186, and 197-191) respectively.

A general observation of the study was the major change in physical fitness in each group by the various programs of interval training. The concept of all-out exercise for short intervals (with appropriate recovery periods) appeared highly acceptable for bringing about a large increase in the transport and utilization of oxygen and in a relatively short time. Particularly impressive were the results for the groups training with the model of three minutes exercise and three minutes rest. The model of fifteen seconds exercise and fifteen seconds rest was judged as being less effective in improving maximal aerobic power in the type of subjects studies.[35]

The conclusions reported by Knuttgen and others seemed to conflict with evidence reported by Fox and

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[35]H. G. Knuttgen and others, "Physical Conditioning Through Interval Training with Young Male Adults," Medicine and Science in Sports, V (Winter, 1973), 220.

associates, who conditioned twenty-three untrained students at the Ohio State University through interval training methods. After selection, maximal aerobic power was determined by exhaustive bouts of work performed on a bicycle ergometer.

The subjects were divided into three groups of eight, eight, and seven men, equated as nearly as possible on the basis of maximal oxygen consumption. Groups trained on a 220 yard indoor, oval track for seven and one-half weeks, five days per week using interval programs described as short distance sprints at a fast pace with many repetitions (Group S), long distance at a relatively slow pace with few repetitions (Group L), and both short distance sprints and long distance runs on an equal and alternating basis (Group M). Work to rest ratios for all groups were reported to be one to three.

Following training, all three groups improved significantly in maximal oxygen consumption when expressed as liters per minute. However, only Groups S and M improved significantly where aerobic capacity was expressed in units of milliliters per kilogram per minute. Maximal pulmonary ventilation did not improve significantly with training in any group. Both maximal and submaximal heart exercise heart rates decreased significantly after training within each group.[36]

Harper and associates also reported that interval running five days weekly for seven weeks resulted in significant gains in relative maximal oxygen consumption using matched groups of college men.[37]

The effect of varient interval training regimens upon submaximal and maximal cardiovascular performance using forty male undergraduate students at Old Dominion University was studied by Williams.

Students (mean age 19.2 years) were assigned to varient interval running groups according to performance on a composite of scores obtained from the Ohio State University Step Test and the Cooper Twelve Minute Run-Walk Test. Training programs with varient exercise prescriptions ranging from thirty-yard sprints with a fifty-yard jog between each bout in two one-mile runs with an intermittent ten minute rest were implemented. Each group participated for thirteen weeks with criterion measures of improvement being based upon pre- and post-results on the two tests mentioned.

The investigators concluded that aerobic capacity improvements were demonstrated and that varient interval

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[36]Edward L. Fox and others, "Intensity and Distance of Interval Training Programs and Changes in Aerobic Power," Medicine and Science in Sports, V (Spring, 1973), 18.

[37]Clarke, op. cit., p. 10.

running programs administered to untrained male subjects was effective in improving submaximal and maximal cardiovascular performance. It was further deduced, that since the total distance for each running group was held relatively constant, the results substantiated the conclusion of other investigators that duration of work, within certain limits, was of some importance in the realization of the training effect (i.e. Knuttgen's work).[38]

Mann and Garrett also reported that middle-aged men who completed sixteen weeks of conditioning showed that five sixty-minute sessions per week over six weeks would improve work capacity as measured with a maximal treadmill test by 35 percent and that either two thirty-minute sessions or three twenty-minute sessions per week of high intensity, i.e. near maximal capacity, interval training would maintain fitness.[39]

Hypertensive and normotensive as well as post-coronary patients have all been reported to respond favorably to interval jogging and walking programs. Investigations completed by Bonanno and Lies, Choquette and associates and Boyer and Kasch using large numbers of

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[38]Melvin H. Williams and Ron L. Edwards, "Effect of Varient Training Regimens Upon Submaximal and Maximal Cardiovascular Performance," American Corrective Therapy Journal, XXV (January-February, 1971), 11.

[39]George V. Mann and Leon Garrett, "The Amount of Exercise Necessary to Achieve and Maintain Fitness in Adult Persons," Southern Médical Journal, LXIV (May, 1971), 549.

middle-aged men, had all been very successful in reducing mean arterial systolic and diastolic blood pressures in both hypertensive, "borderline" hypertensives (systolic 140-159 or diastolic 95 millimeters of mercury or both), and normotensive patients. Their combined efforts supported the notion that interval training walking and jogging programs can be valuable adjunctive therapy for persons suffering from this "risk factor" associated with coronary heart disease.[40]

The concept that interval training may also be useful in the rehabilitation of the severely disabled anginal patient was supported by Kavanaugh.

> Interval training is theoretically attractive as a means of training the post-coronary patient, since by appropriate choice of exercise and recovery intervals substantial cardiac training can be achieved without stimulation of anaerobic metabolities and associated increases in blood pressure and cardiac workload.[41]

To test this hypothesis, Kavanaugh trained six patients with frequent episodes of induced anginal attack. The program was based upon running or jogging (one-half of one minute) followed by one to one and one-half minutes of

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[40]Bonanno and Lies, op. cit., p. 761; see also Gaston Choquette and Ronald J. Ferguson, "Blood Pressure Reduction in 'Borderline' Hypertensives Following Physical Training," Canadian Medical Association Journal, CVIII (March 17, 1973), 699; see also John L. Boyer and Fred Kasch, "Exercise Therapy in Hypertensive Men," Journal American Medical Association, CCXI (March 9, 1970), 1668.

[41]T. Kavanaugh and R. J. Shephard, "Interval Versus Continuous Training of Post-Coronary Patients," Medicine and Science in Sports, V (Spring, 1973), 67.

walking or standing. It was reported that over a one year period, patients showed a substantial gain of aerobic power.

Kavanaugh cautioned, however, that this program should not be generalized to predict success in the rehabilitation of other post coronary patients.[42]

Down stated that the physiological considerations of interval training were obscured due to scattered and limited information. What then were the physiological considerations relevant to interval training was the question posed by Down. Down continued that this straightforward question is unanswered and still clouded by equivocal assertions and nebulous convictions. Down's wisdom was to start with fundamentals, and formulate categorically the specific qualities needed by the distance runner as he enumerated the following:

1. Accumulating a maximal oxygen intake capacity during work, i.e., the capacity to perform more work aerobically.

2. High tolerance of the waste products of metabolism, such as lactic acid, i.e., lower blood lactate for a given volume of work.

3. Incurring a maximal oxygen debt, and paying it back after exertion or during recovery, i.e., the capacity to perform more work aerobically.

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[42]Ibid.

4. Ventilating the lungs efficiently by maximally increasing oxygen pressure in the alveoli, i.e., better exchange of gases in the lungs.

5. Carrying oxygen in the blood and delivering it to the tissues, i.e., more efficient transportation of gas in the blood and exchange in the tissues through a higher concentration of hemoglobin.

6. Developing rapid blood flow and large heart stroke volume during exertion, i.e., a faster and stronger circulation.

7. High maximum cardiac output with less increase in pulse rate and blood pressure during submaximal exercise, and a quick recuperation after exercise, i.e., a more economical circulation.

8. Sustaining aerobic contraction of the muscle groups involved, i.e., least energy expended for a given effort--attributed to an increase in the number of functioning capillaries.

9. Relatively high lean body mass, i.e., high specific gravity (fat-free).

10. Efficient heat dissipation, i.e., maintaining body temperature at a reasonable level.

11. Improving coordination of one's movements, i.e., greater skill and precision of the neuromuscular system through increased efficiency in the transmission of nerve impulses.

12. Developing a mental callousness to fatigue--i.e., the concept of willpower, which, though a psychological foundation, be it in the blood, the nervous system, or what you will.[43]

Summary

A thorough review of the literature in an attempt to analyze the effects of interval running upon cardiovascular parameters was completed and the following conclusions were synthesized:

1. The studies that involved athletes utilized few trained subjects and investigated acute rather than chronic effects of interval training.

2. Interval training appeared to favorably result in an improved bradycardia both under basal and stress conditions.

3. Decrements were also substantiated relative to basal and exercising blood pressure responses following interval training with both normotensive and hypertensive subjects.

4. Evidence was available which suggested that varient training regimens involving both sexes with wide age ranges within each sex proved to be highly successful in improving maximal aerobic power when expressed in both

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[43]Down, op. cit., p. 593.

absolute (liters per minute) and relative (milliliters per kilogram per minute) values.

5. Desirable alterations in cardiovascular parameters were influenced when work loads were established at an intensity greater than 50 percent of an individuals maximal working capacity as determined by submaximal and/or maximal assessment.

6. The literature disclosed that the interesting interaction between frequency, intensity and duration variables beckoned for further clarification with qualifications specific to training programs and age groups.

7. Variant experimental conditions and age groups, excluding the untrained college-aged female appeared in the literature making it difficult to generalize trends with implications for college women, a group not investigated.

8. The literature demonstrated a need for investigative efforts which reveal the effects of interval training on other than ergometric methods, i.e., running.

9. Well defined comparative studies between continuous and interval running and their effects upon physiological changes in humans are needed.

EFFECTS OF LONG SLOW-DISTANCE ENDURANCE RUNNING ON PHYSIOLOGICAL RESPONSES IN FEMALES

Blood Chemistry Variables

Earlier it was mentioned that only rarely have studies been conducted on the effects of exercise on the blood cholesterol levels of women. Once again Kilbom must receive credit for longitudinal contributions in this area.

In a study by Pohndorf, a man and wife team swam one thousand yards daily for ten weeks then adjusted her regimen to swimming one thousand yards three to five times weekly. It was reported that serum cholesterol level was lowered during the initial ten weeks and maintained the reduced level during the nine week altered period.[44] Getchell was unable to report favorable changes in cholesterol and triglyceride levels in a group of eleven middle-aged (mean 35.5) women as a result of a ten week jogging program.[45]

A greater proliferation of investigations attempting to clarify the effects of endurance training programs upon alterations in cholesterol and triglyceride levels were reported among men in variant age groups.

In summarizing the effects of prolonged exercise programs upon serum cholesterol and triglyceride reduction in the male, Clarke stated Johnson and associates studied eleven varsity swimmers at the University of Maryland, who consumed diets in which 40 percent of the calories were derived from fat. During the training season the swimmers maintained low levels of cholesterol. This result was

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[44]Clarke, loc. cit.

[45]L. H. Getchell and J. C. Moore, "Responses of Middle-Aged Women to Physical Training," Medicine and Science in Sports, VI (Spring, 1974), 75.

attributed to the high energy expenditure rate of the subjects. Subsequently, similar results by the same investigator were not duplicated using Howard University swimmers. However, Karvonen and colleagues at the Institute of Occupational Health in Helsinki demonstrated that Finnish skiers, aged twenty to thirty-eight, had lower blood cholesterol levels when compared to nonathletes at the same ages. Ogness also reported favorable reductions in nonesterified fatty acids in subjects with light and heavy exercise performed on a bicycle ergometer; the reductions were 15.2 percent during light work and 34.6 percent during heavy work. His exercise regiments were based on proportions of maximum oxygen uptake required: one-third for light and two-thirds for heavy exercise.[46]

Clarke continued that other investigators have also concluded exercise to be a positive therapy in the reduction of cholesterol and triglycerides. Montoye and associates found that a program of mild noon hour exercise engaged in two or three times a week by thirty-one middle-aged male faculty members at Michigan State University resulted in lowered cholesterol levels provided the subjects lost weight.[47]

Tooshi formed one control and three experimental groups, each containing eight to nine men twenty-seven to

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[46]Clarke, op. cit., p. 8.

[47]Clarke, op. cit., p. 9.

forty-five years of age. The experimental groups participated five days per week for twenty weeks in progressive endurance exercises consisting mostly of nonstop walking, jogging, and running. The exercise regimens were the same for all groups, but the time of participation per day varied: fifteen, thirty, and forty-five minutes. The group participating forty-five minutes per day had a significantly greater reduction in blood cholesterol than did all other groups. The cholesterol reduction for the thirty-minute group was greater than for the control and the fifteen-minute groups. The cholesterol levels of the latter two groups did not change significantly.[48]

Pollock and colleagues randomly assigned thirteen men between thirty and forty-seven years of age to two experimental groups; a control group of seven sedentary men was also included. One experimental group exercised two days and the other four days per week for sixteen weeks. Training periods were thirty minutes in duration and consisted of continuous walking, jogging, or running progressively increased as the condition of the subjects improved. Significant cholesterol decreases occurred for the experimental but not for the control group. The

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[48]Ibid., p. 7.

cholesterol difference between the two experimental groups was not significant.[49]

In perhaps the most longitudinal study to date, Golding initiated a twenty-year study of the effects of exercise on blood cholesterol. During the first year, forty-five men participated; the following year new subjects were added. The third year the first two groups were combined and a new group was started. This procedure was continued annually. Eighteen men had been in the program for ten or eleven years; about thirty-six had been in it for nine or more years.

The exercise regimen which consisted of developmental exercises and swimming began at a very low level of intensity and increased each week.

The original cholesterol levels were slightly high. During the first year, significant reductions occurred; this trend continued into the second and third years. During the fourth and fifth years, the cholesterol level increased, although it was still significantly below the original levels. A reduction occurred again in the seventh, which coincided with the national interest in jogging, an activity which was added to the exercise program.[50]

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[49]Ibid.

[50]Clarke, op. cit., p. 11.

Phillips, Daniel, and Naughton and McCloy also collaborated that exercise of the endurance type provided favorable alterations in cholesterol levels.[51]

Several investigators have also reported that exercise of the endurance type has reversable effects on elevated triglyceride levels. The benefits of exercise for fourteen men, aged thirty-five to fifty-five years were studied at the University of Illinois by Holloszy, Skinner, Tors, and Cureton. All subjects led sedentary lives for three or more years. They participated in a progressively strenuous program of calisthenics and distance running (two to four miles) on an average of 3.35 times per week for six months. All but one of the subjects showed reduced serum triglyceride levels at the end of the study; the average value decreased from 208 milligrams percent prior to the exercise program to 125 milligrams percent during the last week of training. As the study progressed, it became evident that the reduction in triglycerides was an acute effect that appeared shortly after exercise and usually persisted for around forty-five hours.

After completion of the six-month exercise period, several men with initially elevated serum triglyceride levels remained sedentary for five to six days while continuing on their regular diets. With inactivity,

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[51]Clarke, op. cit., p. 9.

triglyceride levels of four men rose 150 milligrams percent. Within two to three hours following a three mile run, a triglyceride reduction occurred in three men; by twenty hours, the triglyceride reduction of the fourth subject was also evident. These decreases were still present at forty-four hours after exercise in four of the men.[52]

With twenty-four male faculty members at the University of Southern Mississippi, Daniel formed four groups of six subjects each, designated as control, mild work, moderate work and heavy work. The exercise groups trained for five days per week for seven weeks running on a treadmill. The distance was the same for all groups but the speed varied as follows: mild work, five miles per hour for nine minutes; moderate work, seven miles per hour for six minutes, twenty-three seconds; and heavy work, nine miles per hour for five minutes. Highly significant differences in reduced mean serum triglycerides were obtained for the three exercise groups when compared with the sedentary control group. Further, the moderate-work and heavy-work groups had significantly lower mean triglyceride levels than did the mild-work group.[53]

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[52]John O. Holloszy and others, "Effects of a Six Month Program of Endurance Exercise on the Serum Lipids of Middle-Aged Men," American Journal of Cardiology, XIV (December, 1964), 753.

[53]Samuel M. Fox and John L. Boyer, "Mechanisms by which Physical Activity May Reduce the Occurrence or Severity of Coronary Heart Disease," Physical Fitness Research Digest, Series 2 (October, 1972), 3.

Pollock randomly assigned twenty men between thirty and forty-seven years of age to two experimental groups and a control group. One experimental group exercised two days and the other four days per week for sixteen weeks. Training periods were thirty minutes in duration, and consisted of continuous walking, jogging, or running, with the intensity progressively increased as the condition of the subjects improved. The average triglyceride level of the two experimental groups significantly decreased; the difference between the mean reductions of the two groups, however, was not significant. The triglyceride level of the control group remained constant for the duration of the experiment.[54]

The acute effects of endurance exercise on triglyceride levels were also collaborated by Nikkila and Konttinen, Cohen and Goldberg, and Oscai and associates.[55]

In an attempt to further clarify the effects of endurance training upon blood volumes, Roitman and Brewer studied the effects of chronic training upon hemoglobin and hematocrit values in nine trained college cross country runners between the ages of eighteen and twenty-two. It should be mentioned that these athletes trained throughout the year so fitness was at a rather high standard. However, changes in blood volumes were reported on the basis of the

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[54]Ibid.

[55]Clarke, op. cit., p. 4.

effects of chronic training (during season). The effect of chronic training showed a significant increase in hemoglobin from pre-season to post-season ($p < .01$). The changes in hematocrit, although positive, were not significant.

It was further interesting to look at some comparisons to a control group of subjects taken from the same geographical area. The control group consisted of twenty males ranging in age from thirty-two to sixty-six years. The data showed the training runners to all be lower in hemoglobin and hematocrit in the pre-season sample. The post-season data showed the experimental group approaching the control levels in hematocrit, while surpassing them in hemoglobin.[56]

Brynteson and Sinning reported significant improvement in pre- and post-conditioning hematocrit values (41.5-42.2 volume, percent cells), but insignificant changes in hemoglobin content (14.9-15.0 grams percent) in twenty-one male volunteers (mean age twenty-four years) who exercised for ten weeks on schedules of varient frequencies at a pedalling work load which elicited a heart rate equal to 80 percent of maximum.[57]

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[56] Roitman and Brewer, loc. cit.

[57] Paul Brynteson and Wayne E. Sinning, "The Effects of Training Frequencies on the Retention of Cardiovascular Fitness," Medicine and Science in Sports, V (Spring, 1973), 29.

Saltin and associates studied forty-two male subjects (thirty-four to fifty years old) before and after eight ten weeks of strenuous endurance-type conditioning two to three times weekly. The training program consisted of warm-up and cool-down exercises to stimulate musculo-skeletal circulation before and after running bouts covering two miles. The investigators were unable to report significant changes in hemoglobin or hematocrit blood volumes.[58]

Serum lactate isoenzyme changes after muscular exertion were studied by Rose and others who conditioned nine healthy male volunteers for at least one year. Subjects ran between ten and twenty-five miles weekly and had oxygen consumption values greater than fifty milliliters per kilogram per minute. Venous blood samples were drawn before and within one minute upon completion of a 10,000 meter run. The blood was allowed to clot and the serum removed immediately. The investigators reported insignificant changes in total serum lactate dehydrogenase in the subjects studied. Further, the researchers reported these findings to be different from similar investigations using untrained subjects. Insignificant changes were attributed

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[58]Bengt Saltin and others, "Physical Training in Sedentary Middle-Aged and Older Men: Oxygen Uptake, Heart Rate, and Blood Lactate Concentration at Submaximal and Maximal Exercise," Scandinavian Journal Clinical Laboratory Investigation, XXIV (1969), 323.

to the high level of physical fitness in the sample studied.[59]

Summary

This investigator's search of literature relating the effects of long slow-distance endurance running upon changes in cholesterol, triglycerides, hemoglobin, hematocrit, and serum lactate dehydrogenase concentrations in blood permitted the following to be synthesized:

1. Studies using endurance types of training regimens have proved successful in favorably altering cholesterol levels.

2. Studies were heavily weighted toward investigations which involved middle-aged men as opposed to the female of a similar age. Investigations completed which involved the middle-aged female utilized divergent training stimuli which revealed conflicting results.

3. No investigative efforts were disclosed showing the effects of endurance running upon cholesterol levels of college-aged females.

4. Research suggested that both work intensity and frequency, i.e. Ogness and Tooshi, are factors important to optimal success in the reduction of cholesterol.

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[59] Leslie I. Rose and others, "Serum Lactate Dehydrogenase Isoenzyme Changes After Muscular Exertion," Journal of Applied Physiology, XXVIII (March, 1970), 279.

5. The reducing effects of endurance exercise upon triglyceride levels appeared to be acute rather than chronic, lasting for only a few days; necessitating two to three exercise solicitations per week for cumulative effects, i.e. Goldberg, Oscai, Holloszy, and Cureton.

6. More intense work loads were reported to be most effective in attaining triglyceride values positively, i.e. Daniels.

7. Hemoglobin and hematocrit value adjustments revealed varying results elicited from endurance training attributable to age, regimen variation and physical fitness of subjects.

8. No studies purporting deductions based upon research with college-aged females and their responses to endurance exercise and blood volume changes were disclosed.

9. Total serum lactate dehydrogenase values were not affected significantly by endurance running in well conditioned male subjects. No research was found of a similar description involving women.

10. Finally, although the results of the effects of long slow distance endurance exercise on some of these variables have been reported to be inconsistent, so have the conditions under which the studies were conducted.

Anthropometry

An earlier commentary in this text attempted to describe the prevalance of obesity in Americans of all ages and the implications of this recognized risk factor upon health.

Hein and Ryan commented,

> In the last decade, a growing body of evidence derived from clinical observations and experimental studies points to definite values for exercise in maintaining desirable weight. . . . .
> . . . .
> It is now well-established that overweight, or obesity, not only shortens life but also contributes to the development of degenerative disease. Their information permitted them to conclude that even moderate overweight produces a 40 percent higher than normal risk, while marked obesity yields a 70 percent higher death rate for age. Analysis of the mortality ratios for the obese among some 50,000 policy-holders of one large insurance company caused its statisticians to observe that: "weight control appears to be the most practical means at present of preventing or retarding the degenerative diseases of middle and later life."[60]

The question was what was the most effective exercise. The effects and benefits of interval or intermittent exercise upon anthropometric dimensions has previously been discussed. This portion of the literature review as designed to present information relative to the effects of long slow distance endurance or uninterrupted training upon body composition in females.

Moody and associates conditioned forty female students (mean age 16.3 years), twelve were classified as "normal" and the remaining twenty-eight as obese, using

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[60]Fred V. Hein and Allyn J. Ryan, "The Contributions of Physical Activity to Physical Health," Research Quarterly, XXXI (1960), 263.

30 percent body fat as the arbitrary line of division between the two groups.

All subjects participated for at least one semester (15 weeks) in an activity program of walking and jogging. Of the obese girls, nineteen girls elected to continue their participation for a second semester, or a total of twenty-nine consecutive weeks of supervised activity. The programs consisted of walking and jogging with progression from one mile in equal proportions, to three to three and one-half miles with 75 percent jogging. No attempt was made to gain dietary control over the subjects.

Hydrostatic determinations of body density and skinfold measurements at twelve independent sites, using a Lange Skinfold Caliper, were completed at the beginning, after fifteen weeks, and at the termination of the two full semesters.

The obese group exhibited a substantial increase in body density and consequent decrease in relative body fat as a result of the exercise program. There was a significant increase in lean body weight, but the total body weight decreased only slightly reaching statistical significance only in the fifteen week obese group. The loss in body fat amounted to 2.31 kilograms for the fifteen week obese group and 2.66 kilograms for the twenty-nine week obese group. There was no change in the sum of the girth measurements for the fifteen week obese group and a slight decrease for the twenty-nine week obese group. The sum of the twelve skinfolds decreased markedly in both obese groups, amounting to 20.9 percent and 23.5 percent respectively for the fifteen and twenty-nine week obese group. The normal group exhibited no significant changes in their body composition as a result of the exercise program. Likewise, they experienced no significant changes in the sum of the seven girths. There was, however, a significant decrease of 16 percent in the sum of their skinfolds. Within this normal group, four lean girls actually gained fat weight during the fifteen week program.[61]

Tooshi used twelve, normal middle-aged females to study the effects of a twenty-week continuous progressive jogging program, thirty minutes per day, five days per week on body composition changes. Subjects were between thirty and fifty-eight years of age and had not engaged in any exercise program for at least one year. The program involved continuous progressive jogging: the intensity of work-out was set at fourteen minutes per mile at the beginning of the program and increased to eight minutes at the end of the tenth week. Fasting body weight and eight skinfold fat measures were obtained from all the subjects, using Lange Skinfold Calipers. Eight sedentary women with comparable age were used as a control group.

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[61]Moody, Wilmore, and Girandola, loc. cit.

From the data collected at the end of twenty weeks of conditioning, the investigator reported that a significant reduction occurred in both body weight and eight skinfold fat measures.[62]

In another of Tooshi's studies reported earlier, normal middle-aged men experienced significant reductions in total body fat resulting from twenty weeks of progressive endurance training (jogging-walking) for forty-five minutes five days weekly. Groups participating for shorter periods of time (i.e. fifteen and thirty minutes) experienced no changes anthropometrically.[63]

Skinner and collaborators trained fifteen actively employed professional men ranging in age from thirty-five to fifty-five (mean age 41.7) who had been sedentary for three years or longer in most instances.

The program was conducted six days per week, and men were instructed to train a minimum of three times with encouragement toward more. Three days each week a program of "progressive rhythmic endurance training" similar to that developed by Cureton and used in many Y.M.C.A. gymnasiums was followed. This consisted of continuous rhythmic calisthenics interspersed with running, and

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[62]Ali Tooshi, Effects of Endurance Jogging on Cardiovascular System and Body Composition in Middle-Aged Women (Washington, D.C.: Eric Document Ed. 081744, U.S. Educational Resources Information Center, April, 1973).

[63]Clarke, loc. cit.

stretching. On the other three days, the men ran on an indoor dirt track. As the program progressed, the work demands increased. During the last three months of the program, the men were pushed near the limits of their exercise tolerance once or twice per week with "all out" test exercises such as treadmill running or bench stepping or with strenuous running workouts on the track, during which they would run for two to four miles.

These efforts were reported to have resulted in a mean increase in specific gravity from 1.058 to 1.063 ($p < 0.025$), while abdominal, chest and gluteal girths decreased significantly, as did the sum of the six skinfold measurements. Average weight for the group remained constant, although some did experience both gains and losses. These results demonstrated that such a program resulted in significant changes in anthropometric measurement and specific gravity, which are indicative of an increase in muscle mass and a decrease in adiposity.[64]

Evidence reported concerning the effects of endurance training upon anthropometric alterations permit the following deductions:

1. A wide range in approaches, frequencies, and assigned intensities and durations made it difficult to

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[64]James S. Skinner and others, "Effects of a Program of Endurance Exercises on Physical Work Capacity and Anthropometric Measurements of Fifteen Middle-Aged Men," The American Journal of Cardiology, XIV (December, 1964), 747.

discern clear responses of body measurements to the various exercise programs with predictive anticipatory value for other populations or trainees.

2. The trends that were discernible showed increases in lean body weight or specific gravity, decrements in adiposity, significant improvements in cumulative skinfolds, and conflicting reported improvements in total body weight changes. These findings are confirmed in both normal, and obese groups.

3. Completed studies need to be replicated in an attempt to reproduce and establish the reliability of reported findings.

4. Studies of considerable depth and detail must be undertaken before a thorough understanding can evolve relative to the complex interaction between exercise and body composition alterations.

Cardiovascular Parameters

> Only within the last decade have researchers taken an active interest in, and concentrated their efforts towards studying the physiological responses of the female to exercise.[65]

One of the areas in which there is a particular interest and conflicting results is that of working or endurance capacity.[66]

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[65]Jack H. Wilmore and C. Harmon Brown, "Physiological Profiles of Women Distance Runners," Medicine and Science in Sports, VI (Spring, 1974), 178.

[66]Ibid.

Drinkwater recently completed a comprehensive review of the existing research in this area, and concluded that the data available relative to the female's responses to exercise was meager when compared to that for males.[67]

Seemingly much more time has been spent assessing the maximal aerobic capacity of the females rather than training and attempting to improve its function.

This literature review as designed to profile the work completed relative to the female's cardiovascular responses to exercise, from the standpoint of assessing her aerobic capacity as well as her response to endurance training and its effects upon improved function. Although the college-aged female was of particular interest, profiles will be presented from other age groups as well.

Wilmore and Sigerseth studied sixty-two normal and healthy female volunteers, seven to thirteen years of age to determine the maximal oxygen intake and related metabolic and heart rate measurements.

Subjects made three visits to the laboratory, one for introductory purposes, the subsequent visits for test re-test purposes. The work capacity test was performed on a variable load, friction bicycle ergometer. Each subject began the exercise with a work load of 0 kpm per minute at a pedalling rate of fifty rpm. At the conclusion of each

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[67] Ibid.

minute of work the load was increased by increments of 150 kpm per minute until the subject was unable to maintain the exercise cadence.

Heart rates, interpreted from electrocardiograms and expired air, were recorded and collected during the pre-exercise resting period, at one minute intervals during the exercise, and at one minute intervals during a three minute post exercise recovery period.

Work capacity test data reflected that the highest recorded maximal heart rate was 220 beats per minute, attained by a thirteen year old; twenty-four of the sixty-two subjects attained maximal rates of 200 beats per minute or higher, with only three subjects having maximal heart rates lower than 180 beats per minute.

The mean maximal values for ventilation BTPS liters per minute for the seven to nine, ten to eleven, and twelve to thirteen age groups respectively were 52.7, 59.5, and 70.1. Two eleven year old girls had the highest maximal ventilations, attaining values of 103.3 liters per minute and 2.84 liters per kilogram per minute. The mean maximal oxygen intake values STPD for the same age groups respectively were 1.59, 1.87, and 2.40. The relative values respectively were 53.5, 50.7, and 48.7 milliliters per kilogram per minute. The highest maximal oxygen intake values recorded, attained by two thirteen year-old girls, were 3.10 liters per minute, 63.7 milliliters per kilogram per minute, and 2.08 liters per minute. Ventilation (liters per minute) and oxygen intake (liters per minute) were found to be significantly influenced by both the subject's age and work capacity, while riding time and ventilation (liters/kilogram/per minute) were found to be significantly influenced be age only.

In analyzing the data from each of the recorded measurements with respect to the subject's age and working capacity (total work performed), maximal heart rate was found to be independent of both of these. Submaximal heart rates, maximal ventilation, submaximal oxygen intakes (milliliters/kilogram/minute), and maximal oxygen intake (liters/minute), were all found to be either directly or inversely related to both age and work capacity. The authors stated that their data were similar to that reported by other investigators using male subjects of the same age, suggesting similarities between the capacities of the sexes. Both the submaximal and maximal responses to the work capacity test, for all the variables measured, were found to have low correlations with maximal oxygen intake. Thus, the validity of using these variables in the prediction of maximal oxygen intake was reported to be of questionable value for girls of these ages.[68]

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[68]Jack H. Wilmore and Peter O. Sigerseth, "Physical Work Capacity of Young Girls 7-13 Years of Age," Journal of Applied Physiology, XXII (1967), 923.

Astrand also reported that values for maximal oxygen intake per kilogram body weight and maximal pulmonary ventilation were approximately equitable in males and females prior to age fourteen. Astrand further commented that the maximal heart rate was about the same for males and females, although cardiac response to stress was not as efficient for females. He commented that there was considerable conformity between boys and girls with respect to rest and work values for different functions.

Astrand found that following puberty the oxygen intake per kilogram body weight was less in females and reached values (46-48 milliliters/kilogram/minute) about 17 percent lower than those for men. During stress, lower pulmonary ventilation values among women were also reported by Astrand. However, a greater ventilation per liter oxygen consumed was actually a constant finding for girls in different age groups during maximal work (about 10 percent greater than that of boys), and also during sub-maximal work for girls older than about fourteen years (about 20 percent). Astrand concluded that following puberty there was a relative decrease in her capacity to do hard work and indicated that her capacity of oxygen transport and certain other functions lie 25 to 30 percent lower than those of the man. In relation to body weight the difference was 15 to 20 percent.[69]

In 1942, Metheny and Brouha and others reported a comparative study reflecting some physiological responses of women and men to moderate and strenuous exercise. The seventeen women involved in the study were graduate students in hygiene and physical education between the ages of twenty and twenty-seven. Their subjects were not selected at random and were considered to be more healthy and active than the average counterpart. They were not, however, considered athletes in a trained state. The thirty male subjects were between the ages of nineteen and twenty-three, and none were athletes in training. Moderate exercise, referred to as "the walk," was walking at 3.5 miles per hour on an 8.6 percent grade for fifteen minutes on a motor driven treadmill. The strenuous exercise, referred to as "the run," was running at seven miles per hour on the same grade for five minutes or until unable to continue.

Mean maximal oxygen consumption values for moderate and strenuous exercise respectively were reported to be 27.8 and 40.9 milliliters/kilogram/minute. Diastolic pressure for moderate and strenuous work was eighty-four and eighty-eight millimeters of mercury respectively.

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[69]P. O. Astrand, "Human Physical Fitness with Special Reference to Sex and Age," Physiological Reviews, XXXVI (July, 1956), 307.

Based upon the subjects' responses to moderate and strenuous work, the following conclusions were advanced. For moderate work:

1. There was no marked difference between the men and women in ventilation or oxygen consumption.

2. The women showed a more rapid increase in heart rate and reached a higher maximum, although oxygen consumption in cubic centimeters/minute/kilogram was roughly equivalent for the two groups.

3. The rates of recovery for heart rate were approximately the same, although the women must recover from a higher maximum level.

4. Systolic pressure was the same, but diastolic pressure following the walk was greater.

During strenuous exercise, the following observations were reported:

1. The average duration of the run for the women was only half that for the men, so that the women performed only half as much work before becoming exhausted.

2. The maximal pulse rate was approximately equal for the two groups, but the women reached this maximum more quickly. The rates of recovery were the same.

3. Systolic pressure was lower and diastolic pressure higher for the women immediately after the run.

4. Maximal oxygen consumption was less for the female.

5. As a final comparison the investigators concluded that the eight "best" women equalled in every respect the performance of the ten "poor" men in the strenuous exhausting exercise. They demonstrated slightly greater fatigue as a result of fifteen minutes of non-exhausting exercise in which a steady state was reached and maintained.[70]

Higgs also studied the college-aged female to ascertain her maximal oxygen intake capacity. Subjects were described as twenty fairly active physical education majors who volunteered at the University of Minnesota.

The assessment of maximal oxygen uptake was essentially the method described by Taylor, Buskirk, and Henschel, with adjustments in the speed of the treadmill because of the use of women subjects. A speed of five, six, or seven miles per hour was selected by questioning each subject on her current exercise pattern and by observing her efficiency of running on the treadmill. A minimal rest period of fifteen minutes was allowed between three minute runs. No more than two three minute runs were completed on any one day and, at strenuous work loads, only one run was undergone. The grade for the initial run was 2.5 percent and was increased for each successive run until the increment in oxygen consumption from one grade to the next was less

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[70]Eleanor Metheny and others, "Some Physiologic Responses of Women and Men to Moderate and Strenuous Exercise: A Comparative Study," American Journal of Physiology, CXXXVII (1942), 318.

than one cubic centimeter per kilogram of body weight. At this point in leveling off in oxygen consumption, the individual was considered to have reached her maximal oxygen intake. Several related physiological measures were used as additional criteria to verify the attainment of maximal oxygen intake: ventilatory volume, oxygen extraction ratio, respiratory quotient, and maximal heart rate. The mean oxygen intake for active college women was reported to be 41.32 cubic centimeters/kilogram/minute with individual values ranging from 31.69 to 51.49 cubic centimeters/kilogram/minute. The maximal heart rate during the assessment of maximal oxygen intake was 185.8 beats per minute.

Higgs compared her values with those of other investigators who have reported values between forty-six to fifty-five milliliters/kilogram/minute for highly trained women, thirty-seven and thirty-nine milliliters/kilogram/minute for fairly active women, and around an average of thirty milliliters/kilogram/minute for untrained women.[71]

Michael and Horvath examined the aerobic capacity of thirty female college students seventeen to twenty-two years of age (mean age 19.4). These subjects were described to be recreationally active and not involved in any strenuous conditioning programs. Maximal exercise tolerance

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[71]Susanne L. Higgs, Maximal Oxygen Intake and Maximal Work Performance of Active College Women (Knoxville: Eric, Ed. No. 081748, The University of Tennessee, April, 1973).

testing consisted of cycling one minute at 300 kpm-minute and increasing the work load 150 kpm each minute until the subject was exhausted. The maximal heart rate averaged 184 beats per minute with a range between 170 and 202 beats per minute. The average absolute maximal oxygen consumption was 1.78 liters/minute with an average corrected relative value of 29.8 milliliters/kilogram/minute.[72]

Macnab and others studied twenty-four women mean age (18.7 years), randomly selected from the population of first-year students enrolled in the Faculty of Physical Education at the University of Alberta. Subjects completed the Mitchell, Sproule, and Chapman and the Astrand bicycle ergometer tests for maximal oxygen uptake.

The Mitchell, Sproule, and Chapman test of maximal oxygen uptake was administered on a motor-driven treadmill following a ten-minute warm-up of three miles per hour, 10 percent grade, followed by a ten minute rest. The subject then began running at six miles per hour for two minutes and thirty seconds at a zero percent grade. After a ten minute rest period, the grade was increased by 2.5 percent. This procedure was repeated until the oxygen uptake on two consecutive exercise periods leveled off or declined.

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[72] Ernest D. Michael, Jr. and Steven M. Horvath, "Physical Work Capacity of College Women," Journal of Applied Physiology, XX (1965), 263.

The Astrand test of maximal oxygen uptake was performed on a Monark bicycle ergometer modified for women to include cycling at a pedaling frequency of fifty rpm, beginning at 450 kpm, continuing for four minutes, followed by a five-minute rest period. The work rate was then increased by 150 kpm/minute and the subject pedalled an additional four minutes. This procedure continued until the oxygen uptake leveled off or declined.

The author reported absolute values for maximal oxygen uptake, liters per minute, on the treadmill and bicycle tests to be 2.32 and 2.12 respectively. Relative values, milliliters/kilogram/minute were 39.06 and 35.67 respectively. Macnab compared these values to those reported by other investigators who have obtained absolute values of 2.9 (Astrand), 3.06 (Von Dobeln), 2.3 (Hermansen and Andersen), and 2.59 (Holmgren). The same researchers achieved relative values, milliliters/kilogram/minute of 48.40, 49.35, and 38.00. Metheny has also reported a relative value of 40.90. The age range represented is between eighteen to twenty-nine years.[73]

Recently, Atomi and Miyashita tested the maximal oxygen uptake of 102 sedentary and 46 active adult Japanese females, whose ages ranged between twenty and sixty-two years.

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[73]Ross J. Macnab, Patricia R. Conger, and Peter S. Taylor, "Differences in Maximal and Submaximal Work Capacity in Men and Women," Journal of Applied Physiology, XXVII (1969), 644.

The maximal oxygen uptake test was performed on a Monark bicycle ergometer. Following a short rest, the subject commenced work, pedalling at fifty rpm and 300 kpm/minute load. Work intensity increased 150 kpm/minute at the end of every two minutes until the subject could no longer maintain the metronome pace. The active females participated in a regular Y.W.C.A. conditioning program and a recreational sport club two hours per day, two to three times weekly.

For the sedentary females, the mean maximal oxygen uptake liters per minute and milliliters/kilogram/minute respectively were 1.59 and 32.4 for twenty to twenty-nine years, 1.39 and 27.9 for thirty to thirty-nine years, 1.34 and 26.0 for forty to forty-nine years, and 1.18 and 24.4 for fifty to fifty-nine years. For active women, the same test measure values were 1.92 and 37.5 for twenty to twenty-nine, 1.71 and 31.9 for thirty to thirty-nine, 1.57 and 28.8 for forty to forty-nine, and 1.44 and 27.3 for fifty to fifty-nine years respectively. Both pulmonary ventilation and terminal heart rate values demonstrated decreasing trends for both groups as a function of age.[74]

An effort has thus far been made to present studies which have attempted to assess the female's cardiovascular

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[74]Yoriko Atomi and Mitsumasa Miyashita, "Maximal Aerobic Power of Japanese Active and Sedentary Adult Females of Different Ages (20 to 62 years)," Medicine and Science in Sports, VI (Spring, 1974), 223.

response to standardized work. The last portion of this review is designed to profile the female's response to endurance training (running). Special interest is focused upon cardiovascular changes in untrained college-aged females, with supplementary literature presented to profile the female at different ages and states of physical condition.

Brown studied a number of pre-adolescent girls from eight through thirteen years before and after three months of cross-country training. The subjects were of average ability and volunteered to participate from several regional schools in California. Several physiological measures were recorded, including heart rate, ventilation and maximal oxygen uptake. The girls trained four to six times a week, running four to seven miles a day, depending on their age. After six weeks of preliminary training, they competed nearly every weekend at distances of three-fourths to one and one-quarter miles.

The author reported that prior to training, the subjects' maximal oxygen consumption values were not different from those reported for other untrained girls. However, following six and eleven weeks of training, they improved their aerobic capacity by a reported 18 percent.

During treadmill testing the cardiac response was monitored by electrocardiography with maximal rates of 195 achieved by all. Most had rates over 200 beats per minute. No significant change was reported in maximal or submaximal heart response to testing following training. The author concluded that this suggested that in children there may not be a significant change in stroke during short periods of training.[75]

Sinclair and associates studied the effects of a given physical training program as compared to a typical physical education program upon the improvement of aerobic capacity in fifty girls, aged fifteen to sixteen.

Initial maximum oxygen uptake values were determined from performance on a modified Bruce Multistage treadmill test. For all girls before training, maximal values for oxygen uptake, minute ventilation and heart rate averaged 2.06 liters/minute (34.9 milliliters/kilogram/minite), 82.2 liters per minute and 202 beats per minute, respectively. The group was randomly divided for the comparative study. Twenty-five girls performed single twelve-minute run-walk sessions five days each week for eight weeks in lieu of participating in class. Following training, it was reported that maximal oxygen consumption and maximal minute ventilation improved 14.5 and 15.4 percent respectively. This change when compared to the control group was significant ($p < 0.005$).[76]

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[75]C. Harmon Brown, "New Dimensions in Physical Activity and Fitness for Girls and Women," American Corrective Therapy Journal, XXV (May-June, 1971), 68.

[76]R. D. Sinclair and others, "Effects of a Moderate Exercise Training Program on Aerobic Capacity of Teenage Girls," Medicine and Science in Sports, V (Spring, 1973), 72.

Eisenman conditioned eight girls between the ages of twelve and thirteen, and eight women between eighteen and twenty-one years of age for fourteen weeks to determine the effects of distance running upon maximal oxygen uptake. Treadmill tests designed to assess maximal oxygen uptake were administered prior to and after two, six, and fourteen weeks of training.

The endurance running resulted in significant increases in aerobic capacity regardless of how maximal oxygen uptake was expressed.[77]

Knibbs conditioned thirty-three untrained female subjects eighteen to nineteen years old for six weeks using a bicycle ergometer. Training consisted of twenty minutes of cycling at a work intensity equal to 50, 65, or 80 percent of their physical work capacity. Frequency of training took place once or three times weekly. Heart rate, ventilation rate and oxygen uptake were measured.

Knibbs reported that training was more effective as work intensity and frequency of participation increased, and was remarkedly effective at the highest intensity of work, i.e. 80 percent of maximum work capacity, when performed three times weekly. Whereas before training a heart rate of 170 beats/minute was reached when the rate of working averaged 702 kpm/minute, at the end of training this heart rate was

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[77] P. A. Eisenman, "A Comparison of Effects of Training on Aerobic Capacity in Girls and Young Women," Medicine and Science in Sports, VI (Spring, 1974), 75.

not reached until the work rate was 936 kpm/minute. The oxygen uptake associated with this heart rate was from twenty-eight milliliters/kilogram/minute to thirty-three milliliters/kilogram/minute. With the work rate fixed at 702 kpm/minute the heart rate fell from 170 beats/minute before training to 149 beats/minute after training. At the lowest intensity of training, 50 percent of maximum work capacity, performed once weekly, the physiological changes were minimal.

From these results, Knibbs concluded that it would seem that untrained females can increase their oxygen uptake and their intensity of working and reduce the heart rate by training. Twenty minutes strenuous exercise, at the 80 percent level, once a week, or twenty minutes less strenuous work, at the 50 percent level, three times weekly, are effective in achieving this.[78]

Edwards used a systematic training experiment using predetermined heart rate levels to regulate the intensity of a daily fifteen minute continuous exercise program to clarify the question, "At what point does exercise become training," or "What work intensity is necessary to induce measurable cardiovascular changes?" Intensity levels were established below the heart rate of 150 mentioned as the

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[78]A. V. Knibbs, "Some Physiological Effects of Intensity and Frequency of Exercise on Young Non-Athletic Females," Physiological Society (March, 1971), p. 25.

intensity necessary for cardiovascular efficiency, yet above 120 below which no benefits apparently accrue. Specifically, Edwards sought to determine if a work intensity eliciting a heart rate of 145 beats/minute and/or a work intensity eliciting a heart rate of 125 beats/minute was sufficient stimulus to induce the classic training effects: lower basal resting pulse, lower submaximal heart rate, and increased physical work capacity.

Twelve female subjects aged seventeen to twenty-one years were selected from students registered in the Required Physical Education Program at the University of Pittsburgh with the understanding that they would receive one physical education credit upon fulfillment of all experimental obligations. The twelve sedentary young women comprising the sample of the study were selected by matching submaximal heart rates on the pre-test to equate the two training groups on fitness. Times to heart rate 180 were ranked and paired according to their correspondence; those subjects whose responses could not be paired withdrew, leaving a training of six matched pairs. One of each pair was then randomly assigned by a coin toss to Group I (training HR 125) or Group II (training HR 145). A modified version of the Balke Test was used to assess physical working capacity. The test normally terminated at 180 was continued until the subject stopped.

The training consisted of a daily fifteen minute period of horizontal treadmill exercise at a predetermined heart rate level five days per week for a total of nineteen days. Heart rates were recorded and treadmill speed adjusted to maintain predetermined training rates.

Every variable (with the exception of basal heart rate) moved in the direction expected. Although all the improvements did not reach significance, they did show patterns and trends. From a post-training comparison of Group I and Group II there appeared to be a trend of greater changes (increased benefits) with the higher level of training, but this was not confirmed by a significant difference between the respective debt as using the independent "t" for two groups (one-tailed).

Group I values for maximal oxygen uptake liters per minute, milliliters/kilogram/minute, test run times and basal heart rates pre- and post respectively were 1.70 and 2.14, 27.26 and 34.26, 11.3 and 12.3, and sixty-three and sixty-three. For Group II the same criterion values respectively were 1.6 and 2.15, 26.18 and 35.08, 10.5 and 12.8, and sixty-five and sixty-eight.

Edwards concluded that his study showed that the training represented an adequate stimulus, i.e., sufficient to induce significant cardiovascular training effects in sedentary young women at both submaximal and maximal levels, and therefore the work load associated with heart rate

125 must be considered a greater than minimal or threshold stimulus for the initially very sedentary woman.[79]

Fringer and Stull conditioned forty-four college women between seventeen and twenty-eight years of age two times weekly for ten weeks on bicycle ergometers.

Criterion testing involved two sessions forty-eight hours apart. During the first session the subject was tested on a continual work test during which she pedalled the ergometer at a work load of 360 kgm/minute for two minutes with the load increased by 180 kgm/minute every two minutes for as long as she could maintain the sixty revolutions per minute cadence. On the second day of testing, the subject performed intermittent exercise on the bicycle. Following a warmup, the work rate was subsequently increased by 180 kgm/minute for each successive six minute bout until the subject could no longer continue the test. Eight to ten minute rest intervals were interposed between successive rides.

The training task was identical to the protocol for testing session one. Ten weeks of conditioning was reported to have resulted in significant gains in work output and maximum heart rate. The pre- and post-test values respectively were 4,393.05 and 7,186.36 kilograms and

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[79] Marigold A. Edwards, "The Effects of Training at Predetermined Heart Rate Levels for Sedentary College Women," Medicine and Science in Sports, VI (Spring, 1974), 14.

190.86 and 193.14 beats per minute. The test retest results from the intermittent work task demonstrated improvements in maximal heart rate, maximal pulmonary ventilation BTPS liters/minute, maximal oxygen uptake STPD liters/minute, and maximal oxygen uptake STPD milliliters/kilogram/minute. The respective values pre- and post-test are 185.18 and 191.86, 80.29 and 93.45, 1.40 and 1.63, 1.94 and 2 625, 33.77 and 45.76. Changes in resting heart rate were not significant. A 37 percent change was seen in maximal oxygen uptake when averaged across both groups.

The investigators concluded that a ten-week training program consisting of two weekly "all-out" bouts on a bicycle ergometer tended to enhance the cardiorespiratory fitness of the subjects as reflected by higher values for maximal pulmonary ventilation, maximal oxygen uptake, and total work output.[80]

Using a conditioning regimen of a less intense description, Flint, Drinkwater and Horvath trained seven sedentary females, ages twenty-three to forty-nine (mean 31.8) three times weekly for six weeks walking on a treadmill for thirty minutes with a controlled heart rate equal to 75 to 80 percent of maximum.

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[80]Margaret N. Fringer and G. Alan Stull, "Changes in Cardiorespiratory Parameters During Periods of Training and Detraining in Young Adult Females," Medicine and Science in Sports, VI (Spring, 1974), 20.

The criterion test was a modified version of the Balke Test which required walking at ninety meters/minute with a 1 percent increment in grade each minute. On the basis of the maximal oxygen consumption test, a grade was selected for each subject which was expected to maintain her heart rate at 75 to 80 percent of maximum during steady state exercise. After each ten minutes of exercise, the grade was adjusted to bring the heart rate closer to the target level.

Training was reported to have resulted in significantly higher oxygen uptake during the non-steady state phase of submaximal work, although steady state values remained unchanged. Maximal aerobic capacity predicted from the Astrand nomogram and corrected for overestimation increased 12 percent following training. An 8 percent decrement in resting heart rate was also reported. Diastolic and systolic resting and exercise blood pressures were uneffected by the training conditions.[81]

In an earlier study reported by Tooshi, progressive endurance running among middle-aged women, five days weekly, for sixteen weeks resulted in significant changes in cardiovascular function. The resting pulse rate dropped from seventy-five to sixty-six, the maximum exercise pulse was

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[81]Flint, Drinkwater, and Horvath, loc. cit.

reduced from 164.4 to 147 beats per minute, five minute recovery pulses were decreased significantly.[82]

A recent study by Wilmore and Brown suggested that the physiological capacity of the female can be greatly improved through endurance running and that the performance gap between the sexes does not need to be so great. These researchers reported that differences that do exist are largely the result of the female becoming sedentary with the approach of menarche.

The physiological profiles of women distance runners (mean age 32.4 years) evidenced a functional capacity for trained women that far exceeded similar values for untrained girls and women. Implicit here was endurance running significantly improved the functional capacity of the female.[83]

From a thorough investigation of literature related to the effects of endurance training upon cardiovascular parameters in the female, the following was concluded:

1. Cardiac responses to endurance training were confounded by a wide variety of assessment protocols and experimental conditioning programs. Generally, resting responses showed bradycardia effects as did exercise and

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[82] Tooshi, loc. cit.

[83] Wilmore and Brown, loc. cit.

recovery heart rate for a given work load. Conflicting evidence was reported for maximal and submaximal cardiac response.

2. Improvements in the cardiovascular fitness of college-aged females have resulted from exercise prescriptions with high intensities and minimal frequencies and from lower intensities and increased frequencies. Generally, greater frequency and intensity usually resulted in increased improvement in fitness variables.

3. Investigations oriented toward training the female were not as prevalent as efforts to assess her capacity to perform. Perhaps this is attributed to the distaste females had for strenuous work and the stigma associated.

4. Studies demonstrated significant gains in maximal oxygen uptake through endurance activity.

5. Gains were shown in maximal pulmonary ventilary, while submaximal values were less effected.

6. Submaximal regimens did not seem to affect significant alterations in systolic or diastolic blood pressures in middle-aged women.

7. Significant physiological differences did not seem to exist between sexes prior to puberty, i.e. Astrand.

8. A myriad of assessment methods and training programs were used, making it difficult to generalize findings to other populations.

9. More studies need to be completed through field testing which have more clearly defined training regimens. Many studies thus far completed utilized ergometric methods. Studies utilizing more continuous-endurance running which eliminates intermittent walking are needed.

10. Most studies using the college-aged female preferred small groups due to laboratory facilities and available equipment. Studies using larger population samples may prove worthwhile.

Chapter 3

METHODS AND PROCEDURES

SUBJECTS

The computer service center at Middle Tennessee State University provided a print-out listing the names and addresses of 3,925 full-time students enrolled during the fall term 1974.

An informative letter was prepared and mailed to each girl providing a basic description of the course, its purpose and content. Prospective participants were asked to indicate their relative interest by pre-registering for one of two sections of the course which was scheduled for the spring semester 1975. Following a six day pre-registration period, 110 respondents who were not graduating the fall term (1975) and did not have schedule conflicts, or had not previously enrolled in the course, completed the pre-registration procedures as delineated. Forty names in each of the two sections of the course were selected and assigned at random to one of four groups for a total of eighty participants. The remaining thirty girls were selected as alternates and randomly assigned as indicated above. In the event participants were unable to matriculate, alternates were assigned in numerical order according to their random selection. Participants were described as college-aged females according to the traditional seventeen to twenty-two age classification.

Prior to final matriculation, each of the initial eighty participants were required to have a comprehensive physical examination by their physician to include an electrocardiographic evaluation. As a follow-up means of articulation between the investigator and family physician, an informative letter (Appendix A), describing the course expectations and the nature of all testing, was prepared and given to each participant to be delivered to the examining physician. Physicians were instructed to indicate or contraindicate participation on the basis of the participant's medical history and present health status. Only those students who survived the screening procedures were enrolled. Although eighty participants were enrolled, the findings were based on sixty-three females who successfully completed all course expectations, blood chemistry and body composition analyses. Cardiovascular assessments were completed on sixty-two females.

Groups were identified as follows:

1. Group I consisted of those participants whose exercise prescription was interval running two times weekly (ITP_2).

2. Group II consisted of those participants whose exercise prescription was long slow-distance endurance running two times weekly (LSD_2).

3. Group III consisted of interval running three times weekly (ITP_3).

4. Group IV consisted of those participants whose exercise prescription was long slow-distance running three times weekly (LSD_3).

COLLECTION OF THE DATA

Data were collected during the pre-experimental conditioning period and repeated again following experimental conditioning. Collection of the data were completed according to the following itinerary:

1. Pre-conditioning anthropometric assessments, January 9 through 12; post testing, April 10 through 15.

2. Pre-conditioning blood collection and analysis January 9, 10, 15, 16, and 17; post testing, April 10 and 11.

3. Cardiorespiratory evaluation, January 17 through 26; post testing, April 14 through 20.

As nearly as possible, controls were exercised in an attempt to minimize physiological inequities resulting from diurnal variation. Subjects reported for all test analyses during similar time intervals for both pre- and post-testing. In addition, subjects were also instructed to report for all analyses in the post-absorptive state, fourteen hours for blood chemistry analysis and three hours for both body composition and cardiovascular assessments.

Subjects were instructed not to ingest alcoholic beverages fourteen hours prior to blood analysis and to refrain from cigarette smoking for three hours prior to cardiovascular assessments. Strenuous exercise was also avoided on testing dates.

The standard procedures determined by the International Committee for Standardization of Physical Fitness Tests were adhered to in the collection of the data.[1]

Blood Collection Procedures

The blood analysis was coordinated through certified medical technicians at Rutherford Hospital, Murfreesboro, Tennessee, under the supervision of Miss Janice Beard, Laboratory Director.

Two seven milliliter tubes of venous blood collected from a venipuncture of an antecubital vein were obtained both during pre- and post-testing, between 6:45 and 8:00 a.m. following fourteen hours in the post-absorptive state.

Hematocrit

Following the collection of seven milliliters of venous blood, hematology technicians computed the hematocrit values on the Coulter Model "S" Analyzer made by Coulter Electronics Incorporated, Hialeah, Florida.

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[1] Leonard A. Larson, ed., Fitness, Health and Work Capacity: International Standards for Assessment (New York: Macmillan Publishing Co., Inc., 1974).

The Model "S" was a highly sophisticated piece of equipment which, through a combination of pneumatics and electronics, took direct reading of red blood cell counts (RBC), white blood counts (WBC), mean cell volume (MCV), and hemoglobin (Hgb); and then computed hematocrit (Hct), mean cell hemoglobin (MCH), and mean cell hemoglobin concentration (MCHC).

The Basic Coulter Principle was used in deriving red blood cell and white blood cells. The hemoglobin reading was taken directly from the white blood cell sample by passing a beam of light through the suspension into a photo-sensitive device which measured the amount of light passing through the fluid. The other parameters, hematocrit, mean cell hemoglobin, and mean cell hemoglobin concentration were computed electronically from the four directly measured parameters. How the parameters were obtained has been illustrated by the mnemonic diagram (Figure 1).

The Coulter Counter Model "S" employed the basic Coulter principle for non-optical, one-by-one counting and sizing of particles. In the Model "S," cells were passed through an orifice (aperture) with a specific path of current flow for a given length of time (representative of a reproducible sample volume). The Model "S" had three one-hundred apertures for red blood cells and three one-hundred apertures for white blood cells.

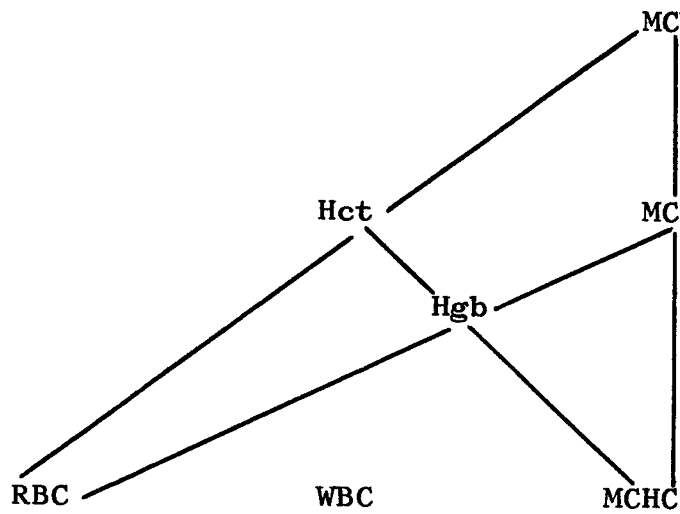

Figure 1

Mnemonic Diagram

Explanation of the Mnemonic Diagram

On Any Line:

1. Any end parameter is equal to the one adjacent divided by the one beyond.

Thus: $$MCV = \frac{Hct}{RBC} = \frac{MCH}{MCHC}$$

$$MCHC = \frac{MCH}{MCV} = \frac{Hgb}{Hct}$$

$$RBC = \frac{Hct}{MCV} = \frac{Hgb}{MCH}$$

2. Any central quantity is equal to the product of the other two.

Thus: $$Hgb = (RBC)(MCH) = (Hct)(MCHC)$$

$$Hct = (RBC)(MCV) = \frac{Hgb}{MCHC}$$

$$MCH = (MCV)(MCHC) = \frac{Hgb}{RBC}$$

The quantity or magnitude of each current change was directly proportional to the volumetric size of the cell. The number of changes within the volume sampled was proportional to the number of cells within the suspension. These changes also provided voltage pulses which were amplified and displayed as vertical spikes on an oscilloscope screen. This pulse pattern then provided a rapid visual check for sample concentration, size distribution of a sample suspension, and overall performance of the aperture and related electronic circuitry. Each aperture in the Model "S" had its own oscilloscope presentation.[2]

Hemoglobin

Following the collection of seven milliliters of venous blood, hemoglobin determinations were also made on the Coulter "S" Analyzer. The hemoglobin reading was taken directly from the white blood sample by passing a beam of light through the suspension into a photo-sensitive device which measured the amount of light passing through the fluid.

Cholesterol

An antecubital vein was entered and seven milliliters of venous blood was collected. Blood cholesterol

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[2] _Instruction and Service Manual for the Coulter Counter Model "S"_ (11 ed; Hialeah, Florida: Coulter Electronics Inc., March, 1972), p. 2-1.

levels were determined by the Auto Analyzer II System by Technicon.[3]

The whole blood samples were allowed to clot and .25 milliliters of the partialed serum was pipetted into a small test tube to which .475 milliliters of 90 percent propanol alcohol were added and mixed with one ounce of zeolite. The filtrate was shaken vigorously to mix thoroughly and allowed to stand for three ten-minute intervals after which each filtrate was shaken again. Following the third mixing period, the filtrates were placed in a centrifuge and spun down for ten minutes at approximately two thousand rpm. Three cubic centimeters of spun filtrate was then placed in four milliliter Auto Analyzer plastic disposable cups and diffused into the Auto Analyzer II colorimeter for computation of serum cholesterol values. Cholesterol determinations were based on the Lieberman-Buchard reaction aspiring an aliquot of the extracted serum into an air segmented stream of the Lieberman-Burchard color reagent and heated to sixty degrees centigrade in a heating bath where the development of the color takes place. The absorbance was read at 630 nanometers in a fifteen millimeter tubular flow cell. Cholesterol values were charted on a recorder by Technicon.[4]

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[3]"Simultaneous Cholesterol/Triglycerides," Technicon Auto Analyzer (Tarrytown, N.Y.: Technicon Instruments Corporation, May, 1971), p. 1.

[4]Ibid.

Triglycerides

Triglyceride determinations were made by the Auto Analyzer II System by Technicon. Values were based on the work by Kessler and Lederer using extracted filtrate samples which were pumped into an air segmented stream of alcohol and potassium hydroxide which was previously mixed in the stream. Saponification of triglycerides to glycerol took place on stream in a 50^{o} centigrade heating bath. This was followed by the oxidation and condensation reactions which also occur on stream in a second heating bath at 50^{o} centigrade. The stream exits the second heating bath and was sent through the fluoronephelometer where in a 2.0 milliliter I.D. flowcell the fluorophor was activated.[5] Normal levels according to this procedure for women range between 120-210 milligrams percent for cholesterol and 30-140 milligrams percent for triglycerides.

This study employed the simultaneous method of determining cholesterol and triglyceride levels using the Auto Analyzer II System extracting samples according to the procedures described by Kessler and Lederer.[6]

Serum Lactate Dehydrogenase

Total serum lactate dehydrogenase (LDH) concentrations were calculated by pipetting one tenth milliliter of

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[5]Ibid.

[6]L. T. Skeggs, ed., Automation in Analytical Chemistry (New York: Technicon Instruments Corporation, 1965), pp. 341-344.

the serum prepared for the combined cholesterol and triglyceride determinations into individual plastic sample cups. Total serum lactate dehydrogenase values were determined on the Gilford Micro-sample Spectrophotometer, Worthington Statzyme GOT. Normal values for females range between 40-120 milliunits per milliliter.

Cardiorespiratory Stress Analysis

All students were apprised of the extensiveness of the study and were requested to sign a waiver form exonerating Middle Tennessee State University and its staff from legal liability and acknowledged an assumed risk as a volunteer, Appendix B. Each student participant was instructed to present a signed statement from their family physician authorizing that their present health status indicated participation in a class of this description. Subjects were acclimated to the testing conditions by walking on the treadmill at the prescribed speed and were made familiar with electrode and other paraphanalia placement. Laboratory testing was conducted in consultation with Dr. S. C. Garrison, cardiologist.

Blood Pressure

Blood pressures were recorded during basal conditions following ten minutes of rest in the supine position and during the first minute of recovery at the cessation of exercise using the cuff and auscultation method at the brachial artery with anaeroid sphygmomanometers.

Heart Rate and Electrocardiographic Monitoring

A resting heart rate was also determined during the pre-exercise rest period by palpation at the radial artery with the subject in the supine position. With the subject in the exercise position on the treadmill, an additional pre-exercise heart rate was taken. Exercise and recovery heart rates were measured the last fifteen seconds of each minute to a terminal rate of 180 during exercise and for five successive minutes during recovery. Resting, exercise, and recovery heart rates were monitored on a standard Hewlett-Packard oscilloscope and electrocardiograph recorder using lead II.

Pulmonary Ventilation

Expiratory air was collected for one minute under basal conditions prior to exercise with the subject standing on the treadmill. Additional exercise expiratory air volumes were determined each minute beginning with a heart rate of 150 beats per minute and terminating with a heart rate of 180. Volumes were also collected each minute for five minutes during recovery. Expiratory gas was collected in meteorological bags and diffused into a wet gasometer for minute volume determinations. These values were converted to STPD according to the formula by Consolazio.[7]

[7]C. Frank Consolazio, Robert E. Johnson, and Louis J. Pecora, Physiological Measurements of Metabolic Functions in Man (New York: McGraw-Hill Book Company, 1963), pp. 15-19.

Aerobic Capacity

Maximum aerobic power was estimated from maximum data of pulmonary ventilation (VE) and maximal oxygen consumption (VO_2STPD) liters per minute and converted to a relative value of milliliters per kilogram of body weight.[8] Expired gas was collected during each minute of exercise using sixty cubic centimeter syringes. Concentrations of oxygen and carbon dioxide were determined on the Beckman E_2 oxygen and LB2 carbon dioxide analyzers.

Environmental conditions in the laboratory were controlled between nineteen and twenty-one degrees centigrade and barometric pressures were recorded before each test. Expired air temperatures were recorded before exercise and after each minute during recovery.

Oxygen Debt

Expiratory gas was collected each minute for five successive minutes during recovery from which lung volume determinations were derived. Samples of recovery expired air were also collected the last thirty seconds of each of five minutes in recovery and were analyzed for oxygen and carbon dioxide concentrations. These values were plotted against basal values to determine oxygen indebtedness.

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[8] Donald K. Mathews and Edward L. Fox, The Physiological Basis of Physical Education and Athletics (Philadelphia: W. B. Saunders Company, 1971), p. 219.

Stress Test Protocol

Participants performed the Balke Test as modified by Falls walking on a Quinton Multi-stage motor-driven treadmill at a constant speed of 3.5 miles per hour. The treadmill remained for two minutes at zero percent grade followed by 3 percent increments each of five successive minutes, then 1 percent per minute elevations to a terminal heart rate of 180 beats per minute.[9]

Body Composition Analysis

Wilmore and Behnke reported that lean body weight can be estimated with a substantially greater accuracy than body density, logically generalizing that for purposes of general body composition analysis, predictions should be limited to estimations of lean body weight (LBW). The percentage body fat, normally determined from the body density, is easily calculated by subtracting the ratio of lean body weight to total body weight from unity.[10]

Lean body weight or fat free weight was calculated from the regression formula by Wilmore and Behnke. This equation is reported to have an R of 0.929 and a standard

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[9]Harold B. Falls and L. Dennis Humphrey, "A Comparison of Methods for Eliciting Maximum Oxygen Uptake from College Women During Treadmill Walking," Medicine and Science in Sports, V (Winter, 1973), 239.

[10]Jack H. Wilmore and Albert R. Behnke, "An Anthropometric Estimation of Body Density and Lean Body Weight in Young Women," The American Journal of Clinical Nutrition, XXIII (March, 1970), 272.

error of 1.729. Wilmore reported this correlation to be in agreement with those found by Von Dobeln, Young and Tensuan.[11]

Body dimensions were measured with a steel anthropometric tape for circumferential assessments, and Lange skinfold calipers for skinfolds measured on the dominant side of the body. Three independent repeated measures were taken at each landmark and the mean of each recorded. All skinfolds and circumferences were measured with the subject in a standing position.

Skinfold and Circumferential Sites

In addition to the landmarks necessary for computation of lean body weight suggested by Wilmore, the following skinfolds and circumferences were recorded before and after training. Skinfolds: (1) mid-axillary, (2) suprailiac, (3) abdominal, (4) thigh, and (5) knee. Circumferences: (1) chest, (2) breast, (3) minimum abdomen, (4) umbilical abdomen, (5) hips, (6) thigh, and (7) calf. All measurements were taken as described by Wilmore and Behnke.[12]

The Training Regimens

The conditioning program consisted of two distinct running regimens described below as interval running and

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[11] Ibid., p. 271.

[12] Ibid., p. 268.

long slow-distance endurance running. The Cooper Twelve Minute Run-Walk Test for Women was administered during pre- and following eight weeks of experimental conditioning as a field measure of predicted aerobic capacity.

Interval Running

The interval running program was initiated by having the participants complete eight repetitions of 220 yard runs in fifty seconds, each with a two-minute recovery interval. Total distance was one mile initially. The terminal goal was to complete twelve repetitions of 220 yard runs in fifty seconds each with a two-minute recovery interval. Total distance was one and one-half miles.

Long Slow-Distance Endurance Running

Participants in the long slow-distance endurance running program sustained a continuous uninterrupted pace completing a work volume of one mile initially. Participants were "whistle drilled" to establish a consistent pace throughout the effort. This procedure involved rhythmical signalling at constant time intervals equal to their target time for completion of the effort. The pace equaled that time established by Cooper resulting in a "good" rating on the Twelve Minute Run-Walk Test for Women.[13] The terminal goal was to accomplish one and one-half miles of

[13]Mildred Cooper and Kenneth H. Cooper, Aerobics for Women (Philadelphia: M. Evans and Company, Inc., 1972).

submaximal aerobic work without stopping. All running was completed on a 280 yard indoor track with synthetic sport-tread surfacing.

Chapter 4

ANALYSIS AND DISCUSSION OF DATA

To test the hypotheses that interval running and/or long slow-distance endurance running performed two and three times weekly for ten weeks would not result in significant changes in selected blood chemistry variables, anthropometric dimensions, or cardiovascular parameters, including aerobic and anaerobic capacities, data were collected following the completed experimental conditioning programs and analyzed using a two-way analysis of variance with repeated measures upon one variable. Means and standard deviations for all group measures are reported. Only when a significant F ratio were computed were the data for two-way analysis of variance reported.

BLOOD CHEMISTRY RESPONSES

Cholesterol

Although an analysis of the blood chemistry data disclosed elevated post-test serum cholesterol concentrations in all groups, values were only statistically significant for the long slow-distance endurance group, training twice weekly. All values, although elevated, were still within the range of normalcy for college-aged females. Significant differences among training regimens were not evidenced.

The pre/post-training effects reflected a significant increase in cholesterol for Group II (LSD-2) only ($F = 11.54$, $dF = 1/59$, $p < .01$). This information is presented in Table 1.

These findings did not corroborate those of Kilbom who reported a 10 percent reduction in serum cholesterol concentration in women (mean age 27.7 years) using interval training on bicycle ergometers. The same training regimen with older women did not result in significant alterations.[1]

The present findings were also inconsistent with those reported by Mann and associates and Garrett, who reported significant positive alterations in cholesterol levels following interval training.[2] Bonanno's study (which utilized interval training techniques with middle-aged men) resulted in findings consistent with the present investigation.[3]

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[1]Asa Kilbom, "Physical Training with Submaximal Intensities in Women, I. Reaction to Exercise and Orthostasis," Scandinavian Journal Clinical Laboratory Investigation, XXVIII (1971), 141-161.

[2]George V. Mann and H. Leon Garrett, "Exercise to Prevent Coronary Heart Disease: An Experimental Study of the Effects of Training on Risk Factors for Coronary Disease in Men," American Journal of Medicine, XLVI (January, 1969), 13; see also H. Leon Garrett, Roy V. Pangle, and George V. Mann, "Physical Conditioning and Coronary Risk Factors," Chronic Disease, SVIV (1966), 901.

[3]Joseph A. Bonanno and James E. Lies, "Effects of Physical Training on Coronary Risk Factors," The American Journal of Cardiology, XXXIII (May 20, 1974), 760.

TABLE 1

ANALYSIS OF VARIANCE OF CHOLESTEROL RESPONSE TO TRAINING

Source	SS	dF	MS	F
Between--Ss	193930.50	62	3127.91	
Training Regimens	13704.37	3	4568.13	1.495
Erros (b)	180226.12	59	3054.68	
Within--Ss	33946.50	63	538.83	
Pre/Post-	5323.50	1	5323.50	11.5483**
Regimens X Pre/Post-	1425.25	3	475.08	1.0306
Error (w)	27197.75	50	460.98	
Total	227877.00	125	1823.02	

**$p < .01$

Many researchers have reported positive cholesterol responses in the male to endurance running inconsistent with data reported here.[4] However, Getchell did not confirm these changes in a group of eleven middle-aged females.[5] Those findings are in agreement with the present study.

A causative factor accounting for a lack of significant favorable changes may be attributable to normal baseline values resistant to change. The significantly elevated value associated with Group II (LSD-2) may be resultant from altered dietary habits higher in fatty foodstuffs. Since Group I (ITP_2), Group III (ITP_3), and Group IV (LSD_3) did not respond similarly, perhaps the interval training regimen and the increased training frequency of three times weekly are also worthy of consideration.

Hematocrit

Hematocrit values were not significantly altered by the experimental conditions. Group means and standard deviations are reported in Table 2.

These results are compatible with those of Kilbom using women under interval training conditions, and Roitman,

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[4]H. Harrison Clarke, "Exercise and Blood Cholesterol," Physical Fitness Research Digest, Series 2, No. 3 (July, 1972), 8, 11.

[5]L. H. Getchell and J. C. Moore, "Responses of Middle-Aged Women to Physical Training," Medicine and Science in Sports, VI (Spring, 1974), 75.

TABLE 2

MEAN AND STANDARD DEVIATION VALUE FOR GROUP BLOOD CHEMISTRY RESPONSES TO TRAINING

Variable	ITP-2 Pre-	ITP-2 Post-	ITP-3 Pre-	ITP-3 Post-	LSD-2 Pre-	LSD-2 Post-	LSD-3 Pre-	LSD-3 Post-
Cholesterol	180.07 ± 40.11	194.14 ± 40.57	207.25 ± 36.96	223.25 ± 52.77	197.93 ± 31.91	218.12 ± 47.64	209.70 ± 44.19	212.23 ± 29.69
Hematocrit	39.84 ± 1.99	40.57 ± 2.13	39.80 ± 2.45	40.71 ± 2.33	39.08 ± 1.78	39.40 ± 2.36	40.27 ± 1.19	39.74 ± 2.27
Hemoglobin	13.45 ± 0.77	13.57 ± 0.69	13.41 ± 0.89	13.71 ± 0.90	13.19 ± 0.62	13.20 ± 0.91	13.67 ± 0.33	13.32 ± 0.77
Total LDH	61.42 ± 12.10	79.64 ± 26.94	69.43 ± 8.65	91.31 ± 13.01	68.25 ± 12.38	83.00 ± 12.47	66.35 ± 7.93	85.82 ± 14.20
Triglycerides	49.78 ± 31.61	72.57 ± 32.15	58.12 ± 29.79	106.37 ± 49.55	56.68 ± 27.87	92.25 ± 32.09	58.76 ± 34.88	95.82 ± 41.91

Brewer and Rand using highly conditioned male athletes.[6] Hemotocrit values were also unchanged in the studies reported by Roitman and Brewer and Saltin and associates who used long distance running regimens with conditioned male athletes.[7] Positive significant effects of endurance training upon increased hematocrit values were reported by Brynteson and Sinning who trained twenty middle-aged males on bicycle ergometers.[8] Apparently the variation of training frequency, intensity, and duration, along with differences in age, sex, and physical conditioning of the subjects interact in an interesting manner resulting in conflicting findings.

Hemoglobin

Hemoglobin values were not significantly altered by the training conditions prescribed in this study. Tabular

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[6]Kilbom, op. cit., p. 148; see also J. L. Roitman and J. P. Brewer, The Chronic and Acute Effects of Exercise Upon Selected Blood Measures (Knoxville: Eric, Ed. No. 083-220, The University of Tennessee, May 16, 1973); see also Peter W. Rand and others, "Influence of Athletic Training on Hemoglobin-Oxygen Affinity," American Journal of Physiology, CCXXIV (June, 1973), 1334.

[7]Roitman and Brewer, loc. cit.; see also Bengt Saltin and others, "Physical Training in Sedentary Middle-Aged and Older Men: Oxygen Uptake, Heart Rate, and Blood Lactate Concentration at Submaximal and Maximal Exercise," Scandinavian Journal Clinical Laboratory Investigation, XXIV (1969), 323-334.

[8]Paul Brynteson and Wayne E. Sinning, "The Effects of Training Frequencies on the Retention of Cardiovascular Fitness," Medicine and Science in Sports, V (Spring, 1973), 29.

data illustrating means and standard deviations are also presented in Table 2.

These findings are in agreement with those reported by Kilbom, who found no significant positive changes in hemoglobin concentration following interval training on bicycle ergometers in women across a wide span of years (mean ages 27.7-56.4 years).[9] Roitman and Brewer also confirmed no significant changes in hemoglobin values following interval running with highly conditioned athletes.[10]

Endurance training was reported to have resulted in conflicting findings relative to hemoglobin responses. Studies by Brynteson and Sinning and Saltin and associates using men corroborate the present findings.[11] However, positive changes in increased hemoglobin values following chronic distance running, using highly conditioned male athletes, was reported by Roitman and Brewer.[12]

The fact that the literature reviewed only disclosed positive changes in hemoglobin concentration among highly conditioned athletes capable of sustaining programs of high intensity may be revealing. Perhaps programs of energy

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[9]Kilbom, loc. cit.

[10]Roitman and Brewer, loc. cit.

[11]Brynteson and Sinning, loc. cit.; see also Saltin and others, loc. cit.

[12]Roitman and Brewer, loc. cit.

demands greater than the capacity of persons less highly trained than athletes are necessary to positively alter hemoglobin concentration.

Total Serum Lactate Dehydrogenase (LDH)

Analysis of serum lactate dehydrogenase data reflected no significant differences among training regimens. Statistically significant differences were found in pre/post- main effects ($F = 80.81$, $dF = 1/59$, $p < .01$). This information is presented in Table 3. Significant increases in total serum lactate dehydrogenase following experimental conditioning is reported for all four groups.

Studies supporting or refuting the present findings in females were not found by this researcher. However, Rose and others reported similar findings using untrained male subjects; but trained male subjects failed to show significant changes in total serum lactate dehydrogenase values.[13]

The Sanders and Bloor endurance running protocol using well-trained male subjects also failed to support significant alterations in total serum lactate dehydrogenase values.[14]

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[13]Leslie I. Rose and others, "Serum Lactate Dehydrogenase Isoenzyme Changes after Muscular Exertion," Journal of Applied Physiology, XXVIII (March, 1970), 279.

[14]T. M. Sanders and C. M. Bloor, "Effects of Repeated Endurance Exercise on Serum Enzyme Activities in Well-Conditioned Males," Medicine and Science in Sports, VII (1975), 44.

TABLE 3

ANALYSIS OF VARIANCE OF SERUM LACTATE DEHYDROGENASE RESPONSE TO TRAINING REGIMENS

Source	SS	dF	MS	F
Between--Ss	17370.16	62	280.16	
Training Regimens	1449.46	3	483.15	1.7905
Error (b)	15920.70	59	269.84	
Within--Ss	19072.00	63	302.73	
Pre/Post-	10901.47	1	10901.46	80.8158**
Regimens X Pre/Post-	211.87	3	70.62	.5235
Error (w)	7958.67	59	134.89	
Total	36442.16	125	291.54	

**p < .01

> Serum lactate dehydrogenase rises acutely after muscular exercise in man. Thus a rise in LDH after muscular exercise may be used as an indicator of cellular necrosis or altered permeability.[15]

Unaffected significant changes in total serum lactate dehydrogenase from the serum as a result of the increased cardiac output and organ blood flow.[16] The elevated serum lactate dehydrogenase levels in the females participating in the present study suggested that the training stimulus was intense enough to place physiological demands upon vital organs.

Triglycerides

The data analysis revealed significantly elevated triglyceride levels in all groups excluding (ITP-2). No significant group differences were revealed. The pre/post-main effects were significant for ITP-3, LSD-2, and LSD-3 ($F = 93.39$, $dF = 1/59$, $p < .01$). Data are presented in Table 4.

Interval training and triglyceride reactions in the female are an interesting combination found by this researcher to be uninvestigated. Studies of similar descriptions using the male have revealed somewhat incompatible results. Investigations by Bonanno and Lies, and Fox and Haskell, do not corroborate the present findings,

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[15]Rose and others, loc. cit.

[16]Sanders and Bloor, op. cit., p. 46.

TABLE 4

ANALYSIS OF VARIANCE OF TRIGLYCERIDE RESPONSES TO TRAINING REGIMENS

Source	SS	dF	MS	F
Between--Ss	132126.88	62	2131.08	
Training Regimens	7148.74	3	2382.91	1.1249
Error (b)	124978.13	59	2118.27	
Within--Ss	70341.00	63	1116.52	
Pre/Post-	41619.84	1	41619.84	93.3993**
Regimens X Pre/Post-	2430.04	3	810.01	1.8178
Error (w)	26291.12	59	445.61	
Total	202467.88	125	1619.74	

**$p < .01$

while Mann and associates also reported elevated triglyceride levels following interval training.[17] Mann attributed the elevation to an increased food intake.

A proliferation of investigations have substantiated the reversable effects of endurance training upon elevated triglyceride levels in the male.[18] However, Getchell was unable to report favorable changes in decreased triglycerides in a group of middle-aged women following ten weeks of jogging.[19]

Since literature was heavily weighted toward either unchanged or favorable effects of training upon triglyceride values, it was assumed that the elevation in the present study was attributed to the influence of exercise inducing a larger food intake. Values, although elevated, were still within the normal range.

BODY COMPOSITION ANALYSES

In addition to height and weight, anthropometric data were recorded for sixteen measurements which included nine circumferential assays and seven skinfold appraisals.

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[17] Bonanno and Lies, loc. cit.; see also Samuel M. Fox and John Boyer, "Mechanisms by which Physical Activity May Reduce the Occurrence of Severity of Coronary Heart Disease," Physical Fitness Research Digest, Series 2 (October, 1972), 3; see also Mann and others, op. cit., p. 20.

[18] Garrett, Pangle, and Mann, op. cit., p. 901; see also Fox and Boyer, op. cit., p. 3.

[19] Getchell and Moore, loc. cit.

Lean body weight, fat weight, total body weight, and percent body weight fat changes were also computed. In areas where significant F ratios were not found, only group means and standard deviations were reported.

Height and Circumferential Measurements

An analysis of circumferential data revealed no significant differences among training regimens or interaction in the following ten dimensions: (1) height, (2) total body weight, (3) above the breast measurement, (4) chest circumference at nipple level, (5) minimal abdominal, (6) umbilical abdominal, (7) maximal abdominal, (8) hips, (9) thigh, and (10) neck. Group means and standard deviations for each circumferential measure are presented in Table 5. A significant pre/post- main effect was computed for calf circumference ($F = 41.28$, $dF = 1/59$, $p < .01$). Data are presented in Table 6.

The majority of interval training exercise prescriptions which appeared in the literature were in the form of progressive jog-walk regimens. Moody's study, which involved both normal and obese high school girls (under 30 percent body fat for normalcy), evidenced no significant girth changes following training in the normal group.[20]

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[20]Dorothy L. Moody, Jack H. Wilmore, and Robert N. Girandola, "The Effects of a Jogging Program on the Body Composition of Normal and Obese High School Girls," Medicine and Science in Sports, IV (Winter, 1972), 210.

TABLE 5

MEAN AND STANDARD DEVIATION VALUES FOR CIRCUMFERENTIAL MEASURES (cm.)

Variable	ITP-2 Pre-	ITP-2 Post-	ITP-3 Pre-	ITP-3 Post-	LSD-2 Pre-	LSD-2 Post-	LSD-3 Pre-	LSD-3 Post-
Above Breast	81.84 ± 3.88	81.90 ± 3.48	82.93 ± 4.30	82.73 ± 4.08	85.39 ± 3.16	84.17 ± 3.47	82.40 ± 4.33	82.61 ± 4.73
Breast	86.05 ± 5.41	85.97 ± 4.98	87.76 ± 5.08	86.38 ± 9.62	90.41 ± 3.45	88.33 ± 8.02	87.45 ± 5.60	88.22 ± 7.02
Minimal Abdominal	65.45 ± 3.21	65.47 ± 4.02	68.29 ± 4.88	68.25 ± 4.46	70.55 ± 6.54	69.75 ± 5.13	68.08 ± 5.57	69.34 ± 6.10
Umbilical Abdominal	71.00 ± 5.23	72.68 ± 6.66	74.70 ± 4.70	74.81 ± 5.79	77.78 ± 6.28	78.08 ± 6.30	75.73 ± 7.34	74.80 ± 9.95
Maximal Abdominal	81.30 ± 7.31	81.92 ± 7.48	83.66 ± 5.86	84.21 ± 6.27	87.35 ± 4.87	86.24 ± 5.04	82.76 ± 6.06	84.55 ± 5.49
Hips	93.83 ± 5.30	94.45 ± 4.86	95.57 ± 4.82	95.87 ± 4.69	98.75 ± 4.70	98.18 ± 5.13	96.86 ± 5.69	96.88 ± 5.44
Thigh	55.52 ± 4.48	55.68 ± 4.27	58.13 ± 3.11	57.92 ± 2.98	61.05 ± 4.00	60.28 ± 3.75	58.10 ± 3.54	58.84 ± 3.71
Calf	32.88 ± 2.24	33.42 ± 2.00	34.41 ± 2.18	35.01 ± 2.04	35.70 ± 2.09	36.05 ± 1.97	34.31 ± 1.89	34.95 ± 1.75
Neck	30.78 ± 1.10	31.20 ± 1.15	31.44 ± 1.34	31.53 ± 1.11	31.55 ± 0.97	31.61 ± 1.33	30.88 ± 1.10	30.90 ± 1.38

TABLE 6

ANALYSIS OF VARIANCE FOR CALF CIRCUMFERENCE RESPONSE TO THE TRAINING REGIMENS

Source	SS	dF	MS	F
Between--Ss	581.70	62	9.38	
Training Regimens	110.54	3	36.85	4.6141
Error (b)	471.16	59	7.99	
Within--Ss	22.44	63	0.36	
Pre-Post-	9.07	1	9.07	41.2840**
Regimens X Pre/Post-	0.41	3	0.14	0.6285
Error (w)	12.96	59	0.22	
Total	604.14	125	4.83	

**$p < .01$

These findings were in part compatible with the present study. Mann and associates used interval running to condition 133 middle-aged men. No significant changes occurred in upper body girths, while the waist circumference did experience a significant decrement following training.[21]

Skinner and collaborators used an endurance running regimen to condition fifteen middle-aged men. The investigators reported significant abdominal and chest girth reductions.[22] The present study did not confirm these findings using college-aged women.

Since a girth measurement encompasses both lean and fat tissue, changes in one are likely to be masked by changes in the opposite direction in the other component. Thus, slight increases in lean body weight in the present study, usually associated with muscle hypertrophy, may provide a partial explanation for insignificant changes in the girths enumerated.

The significant increase in calf circumference associated with Groups I (ITP-2), III (ITP-3), and IV (LSD-3), while no significant change occurred in Group II (LSD-2), may be partially explained through the interaction

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[21]Mann and Garrett, op. cit., p. 18.

[22]James S. Skinner, John O. Holloszy, and Thomas K. Cureton, "Effects of a Program of Endurance Exercises on Physical Work Capacity and Anthropometric Measurements of Fifteen Middle-Aged Men," The American Journal of Cardiology, XIV (December, 1964), 747.

of both training frequency of Groups III and IV and the additional muscular hypertrophy that might be expected from more frequent training episodes. The increased muscular involvement of the plantar flexors often associated with interval running may also be meritorious of consideration. Mann and associates also reported significant increases in calf girth following interval training using middle-aged men.[23]

Skinfolds

Analysis of skinfold data revealed no significant main effects or interaction in the following five measures: (1) tricep, (2) mid-axillary, (3) thigh, (4) abdominal, and (5) knee. Mean and standard deviation values for all skinfold measures are presented in Table 7.

Adams and DeVries and Bonanno and Lies reported insignificant skinfold responses to interval training.[24] Adams and DeVries studied the physiological effects of interval running upon women aged fifty-two to seventy-nine. From the skinfolds measured and applicable to the present discussion, no significant alterations were observed. Similar findings were reported as a result of the Bonanno

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[23] Mann and Garrett, op. cit., p. 20.

[24] Gene M. Adams and Herbert A. DeVries, "Physiological Effects of an Exercise Training Regimen upon Women Aged 52 to 79," Journal of Gerontology, XXVIII (1973), 50; see also Bonanno and Lies, loc. cit.

TABLE 7

GROUP SKINFOLD MEAN AND STANDARD DEVIATION VALUES

Variable	ITP-2 Pre-	ITP-2 Post-	ITP-3 Pre-	ITP-3 Post-	LSD-2 Pre-	LSD-2 Post-	LSD-3 Pre-	LSD-3 Post-
Sub-Scapular	14.56 ± 5.54	12.32 ± 4.58	17.98 ± 7.51	15.50 ± 5.22	19.71 ± 6.02	17.16 ± 5.58	18.51 ± 5.10	16.52 ± 5.72
Tricep	13.30 ± 4.25	12.97 ± 3.94	14.85 ± 3.96	14.42 ± 3.49	16.91 ± 3.89	16.76 ± 5.02	15.84 ± 3.91	15.91 ± 5.39
Mid-Axillary	11.83 ± 4.06	11.15 ± 3.74	13.92 ± 6.31	13.81 ± 5.34	15.02 ± 4.39	14.08 ± 4.42	16.11 ± 4.72	14.57 ± 5.15
Suprailiac	24.80 ± 8.51	20.96 ± 8.19	28.07 ± 8.48	24.66 ± 7.30	31.46 ± 6.61	27.71 ± 7.42	30.54 ± 6.65	28.07 ± 8.17
Abdominal	23.15 ± 7.52	22.77 ± 6.42	28.55 ± 4.85	27.88 ± 5.23	31.60 ± 6.03	30.00 ± 8.04	29.75 ± 5.25	28.94 ± 7.25
Thigh	27.09 ± 9.25	27.97 ± 6.79	26.86 ± 5.27	26.34 ± 4.19	27.49 ±11.34	31.23 ± 4.86	26.32 ±14.57	26.45 ±11.74
Knee	6.10 ± 1.72	6.95 ± 1.98	7.58 ± 2.19	7.51 ± 1.86	7.97 ± 1.96	7.73 ± 2.14	7.75 ± 2.11	8.67 ± 2.68

and Lies training stimulus with middle-aged men. These findings are compatible with the majority of skinfold responses in the present investigation.

Although exacting skinfold sites measured were not stipulated, Tooshi reported a significant reduction in composite values for eight skinfold measures following endurance jogging with fifteen middle-aged females.[25] Conflicting findings to those reported presently were also confirmed by Skinner and collaborators who reported significant positive changes in thigh and tricep skinfolds following endurance aerobic running using fifteen middle-aged males.[26]

Skinfold data analyses did distinguish significant pre/post- main effects for sub-scapular and suprailiac measures respectively ($F = 24.01$, $dF = 1/59$, $p < .01$ and $F = 23.35$, $dF = 1/59$, $p < .01$). These data are presented in Tables 8 and 9, respectively. Groups I (ITP-2) and IV (LSD-3) did not change significantly in sub-scapular skin thickness, while Groups II (LSD-2) and III (ITP-3) were significantly positively affected. Since a significant group x pre/post-interaction was not revealed, it can be

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[25]Ali Tooshi, Effects of Endurance Jogging on Cardiovascular System and Body Composition in Middle-Aged Women (Washington, D.C.: Eric Document Ed. 081744, U.S. Educational Resources Information Center, April, 1973), p. 1.

[26]Skinner, Holloszy, and Cureton, loc. cit.

TABLE 8

ANALYSIS OF VARIANCE OF SUB-SCAPULAR SKINFOLD RESPONSE TO TRAINING REGIMENS

Source	SS	dF	MS	F
<u>Between--Ss</u>	3895.81	62	62.84	
Training Regimens	416.10	3	138.70	2.3517
Error (b)	3479.71	59	58.98	
<u>Within--Ss</u>	575.45	63	9.13	
Pre/Post-	168.48	1	168.48	24.52222**
Regimens X Pre/Post-	1.61	3	0.54	0.0779
Error (w)	405.36	59	6.87	
Total	4471.26	125	35.77	

**$p < .01$

TABLE 9

ANALYSIS OF VARIANCE OF SUPRAILIAC SKINFOLD RESPONSE TO TRAINING REGIMENS

Source	SS	dF	MS	F
Between--Ss	6950.69	62	112.10	
Training Regimens	878.25	3	292.75	2.844
Error (b)	6072.44	59	102.92	
Within--Ss	1248.42	63	19.82	
Pre/Post-	351.33	1	351.33	23.3561**
Regimens X Pre/Post-	9.58	3	3.19	0.2123
Error (w)	887.51	59	15.04	
Total	8199.11	125	65.59	

**$p < .01$

assumed that changes were the result of other than the training regimens. Sub-scapular skinfold means for both pre- and post-test measures were lower for Group I (ITP-2). Lower initial skinfolds may partially explain the insignificant change. Group IV (LSD-3) demonstrated the smallest mean difference value between pre/post- and was not significant. Higher pre/post- mean differences for Group II (LSD-2) and III (ITP-3) resulted in significant sub-scapular change. Groups I and IV also failed to demonstrate a significant increase in lean body weight, which may also partially explain the lack of significant positive skinfold response.

Significantly decreased suprailiac improvement was also disclosed in Groups I (ITP-2), II (LSD-2), and III (ITP-3), while insignificant findings were recorded for Group IV (LSD-3). The reason for the non-conformity of Group IV is not immediately clear. Logically, on the basis of other group responses of both lower and similar exercise frequency and intensity changes should have resulted. A definite positive pre/post- mean difference did occur (30.54 millimeters--28.07 millimeters) which may have been of significant value physiologically but not statistically. Decreased skinfold responses to running among normal high school females were documented by Moody and Wilmore.[27]

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[27]Moody, Wilmore, and Girandola, op. cit., p. 212.

Body Composition Responses

Body composition assays on four relevant measures revealed no significant pre/post- training effects or interaction, in that the groups did not differ from each other significantly in lean body weight, fat weight, total weight, and percent body weight fat. Mean and standard deviation values for these parameters are illustrated in Table 10.

Adams, Kilbom, and Moody have all used forms of interval training (progressive jog-walk regimens or cycling) to train normal females with an age span of sixteen to seventy-nine years.[28] These researchers also reported no significant body composition alterations following conditioning. Bonanno and Lies used interval training to condition thirty-nine middle-aged men three times weekly for twelve weeks. Analyses revealed a lack of significant weight reduction and no changes in mean values for lean body mass. They further commented, "that no dietary restrictions were imposed and that most studies of the same restriction have found minor weight reduction or an increase in lean mass, or both."[29] These investigative

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[28]Adams and DeVries, loc. cit.; see also Asa Kilbom, "Effect on Women of Physical Training with Low Intensities," Scandinavian Journal Clinical Nutrition, XXVIII (1971), 345; see also Moody, Wilmore, and Girandola, loc. cit.

[29]Bonanno and Lies, op. cit., p. 763.

TABLE 10

GROUP BODY COMPOSITION MEAN AND STANDARD DEVIATION VALUES

Variable	ITP-2 Pre-	ITP-2 Post-	ITP-3 Pre-	ITP-3 Post-	LSD-2 Pre-	LSD-2 Post-	LSD-3 Pre-	LSD-3 Post-
Height	164.19 ± 5.61	164.56 ± 5.81	162.81 ± 7.81	162.77 ± 8.02	163.22 ± 5.09	163.78 ± 5.30	161.33 ± 6.30	160.32 ± 7.27
Lean Body Weight	39.54 ± 3.72	40.18 ± 3.13	41.54 ± 4.64	41.99 ± 4.51	43.04 ± 4.11	43.69 ± 5.07	40.68 ± 4.26	41.29 ± 3.89
Fat Weight	13.73 ± 3.11	13.46 ± 2.90	15.47 ± 3.32	15.32 ± 3.21	17.60 ± 3.37	17.28 ± 3.67	15.61 ± 3.13	16.05 ± 3.37
Total Weight	53.27 ± 6.17	53.65 ± 5.67	57.01 ± 7.37	57.31 ± 7.23	60.65 ± 7.08	60.98 ± 8.38	56.30 ± 6.83	57.34 ± 6.64
Percent Body Weight Fat	25.50 ± 3.83	24.83 ± 3.46	26.89 ± 3.29	26.51 ± 3.03	28.86 ± 2.52	28.14 ± 2.66	27.55 ± 2.99	27.74 ± 3.43

efforts corroborate the present findings relative to the effects of interval running on body composition alterations. However, contradictions to the present investigation and the effects endurance running may have on body composition components are reported by other investigators. Tooshi reported significant body weight reduction following a twenty week continuous progressive jogging program using middle-aged females.[30] Tooshi and Skinner reported significant positive body composition changes in middle-aged men following endurance training.[31] These researchers reported reductions in total body fat and increases in specific gravity respectively.

Since previous investigative efforts as well as the present study have failed to show significant body composition changes following interval running programs, it may be assumed that the energy expenditure is less than adequate to result in favorable alterations. On the other hand, studies are weighted toward favorable body composition benefits following long distance endurance running. This may suggest that an increase in duration of effort elicits enhanced catabolism of fat stores and dependence upon this energy source for sustained effort. The result is a decrease in

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[30]Tooshi, loc. cit.

[31]H. Harrison Clarke, ed., Physical Fitness Research Digest, Series 4 (July, 1974), 7; see also Skinner, Holloszy, and Cureton, loc. cit.

fatty depositions. The actual caloric expenditure may also be greater during sustained aerobic work.

Moody and Wilmore have conjectured,

> . . . that dietary modification must also be a part of any comprehensive weight loss program in order to obtain the degree of weight loss usually sought. Lastly, it will be necessary to undertake studies of considerably more depth and detail before a thorough understanding can evolve relative to the complex role of exercise in weight reduction and control.[32]

Dietary controls were not imposed in the present study.

CARDIOVASCULAR ANALYSES

Data were recorded for twelve selected cardiovascular variables which included: (1) resting heart rate, (2) heart rate during recovery, at one minute, three minutes, and five minute intervals, (3) resting systolic and diastolic blood pressures, (4) exercise, systolic and diastolic blood pressures during the first minute of recovery, (5) duration of effort on the treadmill rpm, (6) Cooper twelve minute run-walk improvements, (7) aerobic power (milliliters per kilogram per minute), and (8) oxygen indebtedness. In areas where significant F ratios were not computed, only group means and standard deviations were reported. Group mean and standard deviation values for each measure are reported in Table 11.

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[32]Moody, Wilmore, and Girandola, op. cit., p. 213.

TABLE 11

GROUP MEAN AND STANDARD DEVIATION VALUES FOR SELECTED CARDIOVASCULAR RESPONSES TO TRAINING

Variable	ITP-2 Pre-	ITP-2 Post-	ITP-3 Pre-	ITP-3 Post-	LSD-2 Pre-	LSD-2 Post-	LSD-3 Pre-	LSD-3 Post-
Resting HR	86.53 ± 20.65	72.00 ± 18.14	84.12 ± 11.75	74.00 ± 14.16	81.18 ± 16.71	69.14 ± 14.28	78.64 ± 10.99	77.00 ± 12.74
Resting Systolic	113.84 ± 9.50	111.07 ± 9.75	115.25 ± 10.75	114.68 ± 10.47	112.56 ± 8.70	114.50 ± 9.53	113.64 ± 7.97	114.70 ± 9.74
Resting Diastolic	76.61 ± 5.67	73.53 ± 4.70	72.87 ± 5.41	73.87 ± 4.16	75.62 ± 4.51	76.00 ± 6.69	73.05 ± 7.65	71.23 ± 4.68
Exercise Systolic	132.00 ± 10.29	139.69 ± 20.78	134.87 ± 13.44	146.00 ± 19.14	141.12 ± 16.24	150.62 ± 15.69	137.94 ± 12.30	143.17 ± 19.71
Exercise Diastolic	75.07 ± 4.87	69.61 ± 10.02	76.62 ± 4.93	70.62 ± 7.40	74.62 ± 8.96	69.87 ± 9.30	72.47 ± 10.03	65.05 ± 10.37
First Min Recovery HR	145.38 ± 11.26	141.92 ± 7.78	146.25 ± 11.61	138.75 ± 10.24	140.62 ± 14.36	141.56 ± 7.68	143.52 ± 11.42	142.05 ± 9.36
Third Min Recovery	120.00 ± 6.12	120.00 ± 10.60	120.93 ± 8.60	123.75 ± 12.84	113.43 ± 10.91	113.43 ± 12.20	118.23 ± 11.71	123.52 ± 8.43

TABLE 11 (continued)

Vabiable	ITP-2 Pre-	ITP-2 Post-	ITP-3 Pre-	ITP-3 Post-	LSD-2 Pre-	LSD-2 Post-	LSD-3 Pre-	LSD-3 Post-
Fifth Min Recovery HR	109.61 ± 11.26	109.61 ± 12.82	113.41 ± 9.43	116.25 ± 12.84	105.00 ± 10.95	106.87 ± 10.78	112.05 ± 10.76	115.58 ± 8.81
Treadmill RPM's	465.30 ±109.50	658.00 ±190.74	501.68 ±122.70	661.31 ±178.48	560.75 ±176.53	620.12 ±172.51	501.00 ±156.61	633.00 ±200.25
12 Min Test	2021.15 ±234.14	2424.61 ±262.47	2107.50 ±222.41	2606.56 ±201.51	2081.87 ±256.92	2527.18 ±281.39	2051.76 ±243.25	2479.70 ±289.50
$\dot{V}O_2$ ML/Kg/Min	25.34 ± 6.07	28.73 ± 3.79	26.58 ± 4.80	30.48 ± 3.89	27.04 ± 4.65	26.73 ± 7.84	26.57 ± 5.87	32.28 ± 7.02
Anaerobic Power ML/Kg/Min	24.65 ± 12.00	26.85 ± 9.35	25.66 ± 7.89	25.90 ± 8.59	24.76 ± 9.85	23.72 ± 9.29	27.98 ± 13.80	25.56 ± 9.80

Analyses of cardiovascular data revealed no significant main effects or interaction in the following four parameters: (1) resting systolic blood pressure, (2) resting diastolic blood pressure, (3) recovery heart rates at one, three, and five minute intervals, and (4) anaerobic capacity.

Resting Blood Pressure

Kilbom reported significant reductions in both systolic and diastolic blood pressure values in thirty-three women following interval training on bicycle ergometers.[33] Similar findings are confirmed by Bonanno and Lies, Choquette and associates and Boyer and Kasch using large numbers of middle-aged men.[34] Their combined efforts supported the notion that interval training can be valuable adjunctive therapy for persons classified as "borderline" hypertensives and normotensives. These composite findings are not compatible with the present investigation which failed to significantly alter either blood pressure value.

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[33]Kilbom, "Physical Training with Submaximal Intensities in Women, I. Reaction to Exercise and Orthostasis," op. cit., p. 152.

[34]Bonanno and Lies, loc. cit.; see also Gaston Choquette and Ronald J. Ferguson, "Blood Pressure Reduction in 'Borderline' Hypertensives Following Physical Training," Canadian Medical Association Journal, CVIII (March 17, 1973), 699; see also John L. Boyer and Fred Kasch, "Exercise Therapy in Hypertensive Men," Journal American Medical Association, CCXI (March 9, 1970), 1668.

Subjects in the immediate study had blood pressure values well within the normal and acceptable range. Because of their normalcy these pressures may have been more resistant to change than the elevated values described by Choquette, Boyer and Kasch. Astrand has supported this conjecture by stating that "In the case of persons without elevated blood pressure, eventual changes are in any case moderate."[35] Similar findings are corroborated by Flint, Drinkwater and Horvath who conditioned middle-aged females using an endurance training regimen with a controlled heart rate equal to 75 to 80 percent of maximum. These researchers reported diastolic and systolic resting blood pressure values to be unaffected by the training conditions.[36] It appears that resting diastolic and systolic blood pressures are unaffected by interval or endurance running in normal middle-aged and college aged females.

Recovery Heart Rates

Recovery heart rate values at one, three, and five minute intervals following exercise were not statistically significant for any of the experimental groups. Although

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[35] Per-Olof Astrand and Kaare Rodahl, Textbook of Work Physiology (New York: McGraw-Hill Book Company, 1970), p. 406.

[36] M. Marilyn Flint, Barbara L. Drinkwater, and Steven M. Horvath, "Effects of Training on Women's Response to Submaximal Exercise," Medicine and Science in Sports, VI (Summer, 1974), 89.

published literature which demonstrated the effects of interval running upon recovery heart rates in the male or female were not found by this investigator, comparisons can be made between the present findings and those documented by other researchers elucidating the effects of endurance training on the same parameter in the male and female. Tooshi reported a significant reduction in five minute recovery pulses in sedentary middle-aged females following an endurance conditioning program.[37] Training male subjects, Brynteson and Sinning also reported significant training effects reflected through changes in five minute recovery heart rates in male subject's mean age of 28.4 years.[38] These reports are not in agreement with the present investigation which failed to reveal significant recovery heart rate training effects. Mention should be made, that the Tooshi and Brynteson and Sinning regimens had precribed training frequencies of five and three and four times weekly respectively. This may suggest that since the training stimulus elicited similar cardiac response in both the present study and the investigations reported here (50 per cent of maximum heart rate), perhaps a training frequency greater than three times weekly is necessary to produce more efficient cardiac function as

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[37]Tooshi, Effects of Endurance Jogging on Cardiovascular System and Body Composition in Middle-Aged Women, loc. cit.

[38]Brynteson and Sinning, loc. cit.

measured by recovery heart rates. This conclusion was supported by Cooper who recommended at least three and preferably four days of training per week to maintain cardiovascular fitness.[39]

Anaerobic Capacity

From the data analyses associated with the determination of the training effects resulting from the experimental conditions upon anaerobic capacity, no significant changes were evidenced. Significant pre/post- main effects and interaction were lacking.

Anaerobic capacity changes in females resultant from interval training regimens expressed in dimensions described by this investigator (milliliters per kilogram per minute) were not found by this researcher. However, Kilbom reported decrements in pre/post- blood lactate values following interval training at submaximal intensities in women across a wide span of age (19 to 64 years).[40] Reduced levels in this parameter following training would be indicative of improved anaerobic function resultant from ameliorated aerobic metabolism.

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[39]Ibid., p. 32.

[40]Kilbom, "Physical Training with Submaximal Intensities in Women, I. Reaction to Exercise and Orthostasis," loc. cit.; see also Kilbom, "Effect on Women of Physical Training with Low Intensities," loc. cit.; see also Asa Kilbom and Irma Astrand, "Physical Training with Submaximal Intensities in Women, Effect on Cardiac Output," Scandinavian Journal Clinical Laboratory Investigation, XXVIII (1971), 166.

Since studies which attempted to report the effects of interval and/or endurance training upon improvements in the anaerobic capacities of males or females in measures which have comparative meaning specific to the nature of the present investigation, it can only be mentioned that the findings in this study were as expected. Since both training regimens were designed to improve aerobic rather than anaerobic function the findings support the specificity of training theories which physiologists corroborate. Brown reported that competitive cross-country conditioning of pre-adolescent girls from age eight to thirteen designed to improve maximal oxygen consumption resulted in a low correlation for success in competitive events which involved the anaerobic component. Lactic acid concentrations from extracted blood following each race evidenced values far higher than previously recorded during laboratory testing. These measures indicated a considerable anaerobic energy supply during races ranging from three-fourths to one and one-quarter miles.[41]

Although data analyses did not reflect statistically significant improvements in the parameters described earlier, significant pre/post- main effect changes were evidenced in the following variables: (1) resting heart rate, (2) post exercise systolic and diastolic blood

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[41]C. Harmon Brown, "New Dimensions in Physical Activity and Fitness for Girls and Women," American Corrective Therapy Journal, XXV (May-June, 1971), 68.

pressures, and (3) maximal aerobic power (milliliters per kilogram per minute) and associated improvements. The analyses of variance for between group interaction failed to disclose significant F ratio values.

Resting Heart Rate

The resting heart rate responses to the prescribed training regimens reacted in the positive decrement classically expected and reported in the literature. However, values reached statistical significants for Groups I (ITP-2) and II (LSD-2) only ($F = 14.96$, $dF = 1/62$, $p < .01$). These data are reported in Table 12. Groups III (ITP-3) and IV (LSD-3) did not demonstrate statistically significant pre/post- within group improvements. Although Group III (ITP-3) did not show statistically significant alteration in basal heart rate values, the pre/post- mean difference of 10.12, while being just below the critical value of 10.26, may have been of physiological significance and does reflect classical trends in basal heart response to training. These trends have been reported in the female by Kilbom who used interval training regimens to condition women across a wide span of years.[42] Other investigators have reported decrements in basal heart rate responses

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[42]Kilbom, "Physical Training with Submaximal Intensities in Women, I. Reaction to Exercise and Orthostasis," loc. cit.; see also Kilbom and Astrand, loc. cit.

TABLE 12

ANALYSIS OF VARIANCE OF RESTING HEART RATE RESPONSE TO TRAINING REGIMENS

Source	SS	dF	MS	F
Between--Ss	16396.39	61	268.74	
Training Regimens	271.50	3	90.50	1.3255
Error (b)	16124.89	58	278.02	
Within--Ss	13043.00	62	210.38	
Pre-Post-	2529.03	1	2529.03	14.9644**
Regimens X Pre/Post-	711.81	3	237.27	1.4039
Error (w)	9802.16	58	169.00	
Total	29439.39	123	239.35	

**$p < .01$

following endurance training.[43] Edwards concluded that submaximal endurance training (heart rates between 125 and 140 beats per minute) represented an adequate stimulus sufficient to induce significant cardiovascular training effects in sedentary young women on all variables studied except basal heart rate.[44] Conflicting reports in the literature are compatible with the basal heart rate responses in the present investigation.

Logically, the significant positive improvements revealed for Groups I and II should have been duplicated in Group III and IV because of the increased training frequency. Mention has already been made of the definite positive improvement in Group III although not statistically significant. That Group IV did not show more favorable improvement may be partially justified on the basis of a discernibly lower basal value at pre-test than any other group. This lower rate may have been more resistant to significant change under the experimental conditions prescribed.

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[43] Tooshi, "Effects of Endurance Jogging on Cardiovascular System and Body Composition in Middle-Aged Women," loc. cit.; see also Getchell and Moore, loc. cit.; see also Margaret N. Fringer and G. Alan Stull, "Changes in Cardiorespiratory Parameters During Periods of Training and Detraining in Young Adult Females," Medicine and Science in Sports, VI (Spring, 1974), 20.

[44] Marigold A. Edwards, "The Effects of Training at Predetermined Heart Rate Levels for Sedentary College Women," Medicine and Science in Sports, VI (Spring, 1974), 14.

Post Exercise Recovery Systolic Blood Pressure

Significant increases in systolic pre/post- main effects were computed within Groups II (LSD-2) and III (ITP-3), ($F = 14.88$, $dF = 1/62$, $p < .01$). Significant between group differences were not computed. Data are reported in Table 13.

Kilbom conditioned women across a wide span of years nineteen to sixty-four using interval training regimens and reported systolic pressure response for a standard volume of work to be significantly lower in Group I (mean aged 23.7 years) and Group III (mean aged 56.4 years).[45] A further investigation of similar description by Kilbom provided results somewhat in conflict with previous work, in that systolic pressure did not significantly change in the younger women (mean age 23.0). Previous investigation revealed significantly lower systolic pressure in older women (56.4 years), but were not as definite in a later study involving women of similar age (55.0 years).[46] Endurance training regimens have also produced inconsistent systolic responses to training regimens. Flint, Drinkwater and Horvath reported no change in exercise systolic blood pressures values in

[45]Kilbom, "Physical Training with Submaximal Intensities in Women, I. Reaction to Exercise and Orthostasis," op. cit., p. 152.

[46]Kilbom and Astrand, loc. cit.

TABLE 13

ANALYSIS OF VARIANCE OF POST EXERCISE SYSTOLIC BLOOD PRESSURE RESPONSE TO TRAINING REGIMENS

Source	SS	dF	MS	F
Between--Ss	23957.53	61	392.75	
Training Regimens	1466.91	3	488.97	1.2610
Error (b)	22490.63	58	388.77	
Within--Ss	10792.50	62	174.07	
Pre/Post-	2172.28	1	2172.28	14.8878**
Regimens X Pre/Post-	157.41	3	52.47	0.3596
Error (w)	8462.81	58	145.91	
Total	34750.03	123	282.52	

**$p < .01$

middle-aged women.[47] Pollock was also unable to report significant positive findings in middle-aged men.[48] However, Skinner and collaborators documented a decrease in post-exercise systolic values in middle-aged men.[49]

Astrand wrote, "No consistent data are available concerning the blood pressure during work before and after training."[50] This seemed to be compatible with the literature documented here. Variable findings may be justified on the basis of a composite of factors which effect investigative outcomes related to blood pressure response including: (1) variation in the physical condition of the subjects being investigated, (2) age, (3) sex, and (4) training stimuli. These considerations along with the variability range of the systolic pressure may interact producing inconsistency.

The consistent increase in the systolic value associated with the present study may be appreciated through the realization that the exercise intensity and duration of effort was much greater during the post-test as compared to the pre-test. The improved physical fitness and concomitant increase in stroke volume and cardiac output typically associated with improved cardiovascular

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[47]Flint, Drinkwater, and Horvath, loc. cit.

[48]Clarke, Physical Fitness Research Digest, loc. cit.

[49]Ibid., p. 10.

[50]Astrand and Rodahl, loc. cit.

function may have resulted in increased arterial pressure. Further, the post-test intensity may have resulted in more nearly approaching an anaerobic debt and the accumulation of metabolic waste products resulting in increased peripheral resistance. Kilbom reported increased work and systolic blood pressure to be linearly correlated.[51]

Post Exercise Recovery Diastolic Blood Pressure

Significant decreases in diastolic pre/post- main effects were computed within Groups III (ITP-3) and IV (LSD-3), ($F = 22.52$, $dF = 1/62$, $p < .01$). Significant between group differences were not computed. Data are reported in Table 14.

Diastolic blood pressure response to exercise revealed trends more definite in both men and women following interval and endurance training programs than those disclosed in an earlier commentary relative to systolic responses. Kilbom reported decrements in diastolic values following interval training in women.[52] Pollock, Skinner, Cureton, and Elder confirmed the positive effects of endurance conditioning upon diastolic values in men.[53] These composite findings are consistent

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[51] Kilbom, "Physical Training with Submaximal Intensities in Women, I. Reaction to Exercise and Orthostasis," op. cit., p. 151.

[52] Ibid.; see also Kilbom and Astrand, loc. cit.

[53] Clarke, Physical Fitness Research Digest, loc. cit.

TABLE 14

ANALYSIS OF VARIANCE OF POST EXERCISE DIASTOLIC BLOOD PRESSURE RESPONSE TO TRAINING REGIMENS

Source	SS	dF	MS	F
Between--Ss	6122.95	61	100.38	
Training Regimens	431.95	3	143.98	1.4674
Error (b)	5691.00	58	98.12	
Within--Ss	3956.50	62	63.82	
Pre/Post-	1098.07	1	1098.07	22.5271**
Regimens X Pre/Post-	31.26	3	10.42	0.2138
Error (w)	2827.17	58	48.74	
Total	10079.45	123	81.95	

**$p < .01$

with the present study in all groups. However, although trends were evident throughout, values were statistically significant for Groups III and IV only. It may be revealing that the training frequency for both groups were equal, i.e. three times weekly. Perhaps this assumed more meaning when contrasted to Groups I (ITP-2) and II (LSD-2) which failed to show significants decrements. It is also interesting to note that this positive significant cardiovascular change for Groups III and IV is consistent with the significant improvements they demonstrated in maximal oxygen consumption as compared to Groups I and II. From these data, it may be safe to assume that the increased training frequency underlies the significant improvement in post-exercise diastolic blood pressure.

Aerobic Power and Related Improvements

Improvements in aerobic power should result in essentially similar responses in criterion measures reflective of such status, whether determined by extended duration of effort on an ergometer for a standard work load (treadmill walking) distance covered on the Cooper Twelve Minute Run-Walk, or more sophisticated appraisals under laboratory supervision, i.e. open or closed circuit assessment of oxygen consumption. On this premise, measures of improved maximal aerobic power are discussed collectively, although data for each were analyzed independently. Tabular data for pre/post- duration of effort on the modified Balke Treadmill Test (rpm), Cooper

Twelve Minute Run-Walk Test (yds.), and oxygen consumption (milliliters per kilogram per minute) are reported in Tables 15 through 17 respectively. The data analyses revealed significant within group pre/post- main effects in duration of effort on the treadmill (rpm), ($F = 370.32$, $dF = 1/62$, $p < .01$).

Amelioration of aerobic power in women through interval training regimens was documented by Kilbom.[54] Classical improved responses in assessments of aerobic power following interval running in males are also recorded by Williams, Knuttgen, and Fox.[55] Similarly, classical responses of aerobic power improvements following endurance training regimens in females were reported by Brown, Sinclair, Eisenman, and Flint.[56]

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[54]Kilbom, "Physical Training with Submaximal Intensities in Women, I. Reaction to Exercise and Orthostasis," loc. cit.; see also Kilbom and Astrand, op. cit., p. 163; see also Kilbom, "Effect on Women of Physical Training with Low Intensities," loc. cit.

[55]Melvin H. Williams and Ron L. Edwards, "Effect of Variant Training Regimen's Upon Submaximal and Maximal Cardiovascular Performance," American Corrective Therapy Journal, XXV (January-February, 1971), 12; see also H. G. Knuttgen and others, "Physical Conditioning Through Interval Training with Young Male Adults," Medicine and Science in Sports, V (Winter, 1973), 220; see also Edward L. Fox and others, "Intensity and Distance of Interval Training Programs and Changes in Aerobic Power," Medicine and Science in Sports, V (Spring, 1973), 18.

[56]Brown, loc. cit.; see also R. D. Sinclair and others, "Effects of a Moderate Exercise Training Program on Aerobic Capacity of Teenage Girls," Medicine and Science in Sports, V (Spring, 1973), 72; see also P. A. Eisenman, "A Comparison of Effects of Training on Aerobic Capacity in Girls and Young Women," Medicine and Science in Sports, VI

TABLE 15

ANALYSIS OF VARIANCE OF TREADMILL DURATION
REVOLUTIONS PER MINUTE

Source	SS	dF	MS	F
Between--Ss	2741364.00	61	44940.39	
Training Regimens	15730.00	3	5243.33	0.1116
Error (b)	2725634.00	58	46993.69	
Within--Ss	1127997.50	62	18193.51	
Pre/Post-	549290.50	1	549290.50	62.8997**
Regimens X Pre/Post-	72204.50	3	24068.17	2.7561
Error (w)	506502.50	58	8732.80	
Total	3869361.50	123	31458.22	

**$p < .01$

TABLE 16

ANALYSIS OF VARIANCE OF DISTANCE COVERED ON THE COOPER 12 MINUTE RUN-WALK (YDS.)

Source	SS	dF	MS	F
Between--Ss	6624872.00	61	108604.46	
Training Regimens	287656.00	3	95885.33	0.8776
Error (b)	6337216.00	58	109262.35	
Within--Ss	7157912.00	62	115450.19	
Pre/Post-	6156584.00	1	6156584.00	370.3155**
Regimens X Pre/Post-	37064.00	3	12354.67	0.7431
Error (w)	964264.00	58	16625.24	
Total	13782784.00	123	112055.15	

**$p < .01$

TABLE 17

ANALYSIS OF VARIANCE OF MAXIMAL AEROBIC POWER IMPROVEMENTS WITH TRAINING

Source	SS	dF	MS	F
Between--Ss	2800.69	61	45.91	
Training Regimens	141.67	3	47.22	1.0301
Error (b)	2659.02	58	45.85	
Within--Ss	1595.29	62	25.73	
Pre/Post-	318.98	1	318.98	165.22**
Regimens X Pre/Post-	156.56	3	52.19	2.7032
Error (w)	1119.75	58	19.31	
Total	4395.98	123	35.74	

**$p < .01$

The proliferation of studies reported in the literature documenting consistent aerobic power improvements through properly prescribed training regimens are supportive of the findings in the present investigation. All groups demonstrated definite classical trends in improved aerobic function (milliliters per kilogram per minute) exclusive of Group II (LSD-2). Results were only statistically significant for Groups III (ITP-3) and IV (LSD-3). Body component values appreciably higher in Group II than any other group may somewhat explain the lack of more definite improvement. Since oxygen consumption values were expressed relative to body weight, higher body component values for Group II may have been prohibitive to more appreciable gain. However, these components were not significantly increased pre/post-. The same training frequency did result in more definite gains in aerobic power for Group I (ITP-2). This places even greater weighted value on the body component consideration, since more nearly equal body weight distributions and the same training frequency did result in significant change in Groups III and IV (ITP-3 and LSD-3) respectively.

Since significant between group interaction was not recorded, it is assumed that changes were not due to the superiority of any particular training regimen. In fact, it appeared that both interval training and long

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(Spring, 1974), 75; see also Flint, Drinkwater, and Horvath, loc. cit.

slow-distance endurance training can result in positive change in aerobic power. These changes, however, were only statistically significant when the training frequency equaled three sessions weekly in either group. From these findings it may be concluded that from the training regimens prescribed in this study, either interval or long slow-distance endurance running can result in significant positive improvements in maximal aerobic power if adhered to three times weekly in initially untrained college-aged females. Williams confirmed the effectiveness of divergent training regimens to induce positive beneficial improvements in aerobic capacity. These variant exercise prescriptions included both internal and endurance approaches.[57]

Further evidence suggestive of positive effects of the conditioning program upon aerobic power was reflected in statistically significant gains in distance traversed on the Cooper Twelve Minute Run-Walk in all four groups. Only pre/post- main effects were significant, suggesting that no particular regimen was superior in improving success on this criterion measure. Only Group II (LSD-2) failed to significantly increase its duration of effort on the treadmill. This was partially reflected in insignificant

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[57]Williams and Edwards, loc. cit.

improvement in maximal aerobic power. However, a definite physiological improvement in effort was evident although statistical significance was not achieved.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

Eighty college-aged females between seventeen and twenty-two years of age were selected from 110 prospective participants who randomly responded to an informative letter mailed to 3,925 females enrolled the Spring term, 1975 at Middle Tennessee State University, Murfreesboro, Tennessee. Of the initial eighty girls who matriculated, sixty-three completed all requirements and pre/post-test data were collected in each of three investigative areas to include: (1) body composition alterations, (2) blood chemistry changes, and (3) cardiovascular responses. One participant was unable to complete cardiovascular post-testing, resulting in an N of sixty-two in that testing division.

Subjects were randomly assigned to one of four treatment training regimens described as: (1) Group I, interval running two times weekly (ITP-2), (2) Group II, long slow-distance endurance running two times weekly (LSD-2), (3) Group III, interval running three times weekly (ITP-3), and (4) Group IV, long slow-distance endurance running three times weekly (LSD-3). The duration of the experimental conditioning program was ten weeks. Additional data were obtained before and after eight weeks of experimental conditioning to assess the effects of these exercise prescriptions upon distance covered on the Cooper Twelve Minute Run-Walk Test for Women.

Data were analyzed for eighteen anthropometric variables including height, weight, nine circumferential assays, seven skinfolds, and four body composition components. Additional analyses were computed for five blood chemistry alterations, and twelve cardiovascular changes. These findings in relation to research hypotheses are discussed in the next section.

CONCLUSIONS

Within the limitations of this investigation, data analyses relative to the predetermined hypotheses permitted the following to be concluded:

1. Interval running twice weekly as prescribed in this study failed to significantly alter hematocrit, hemoglobin, cholesterol or triglyceride values. Therefore, the null hypothesis specific to these blood volume and chemistry variables was accepted.

2. Significant within group pre/post- main effect increases in total serum lactate dehydrogenase was revealed for the interval training group twice weekly. This resulted in rejection of the stated null hypothesis.

3. Interval training two times weekly as prescribed in this study did not significantly change the following eight anthropometric circumferences: (a) above breast, (b) over breast, (c) minimal abdominal, (d) umbilical abdominal, (e) maximal abdominal, (f) hips, (g) thigh, and (h) neck. These findings supported the null hypothesis.

4. A significant within group pre/post- main effect increase in calf circumference was revealed for the interval training group twice weekly. The null hypothesis was rejected.

5. Interval running twice weekly as prescribed in this study did not significantly alter the following six skinfolds: (a) sub-scapular, (b) tricep, (c) mid-axillary, (d) abdominal, (e) thigh, and (f) knee. Therefore, the null hypothesis specific to these skinfold measurements was accepted.

6. Interval running two times weekly did result in a significant decrement in the suprailiac skinfold thickness. In this regard, the null hypothesis was rejected.

7. Interval running prescribed twice weekly failed to demonstrate significant body composition alterations in any of the four components which included: (a) lean body weight, (b) fat weight, (c) total body weight, and (d) percent body weight fat. These data supported the null hypothesis.

8. Interval running two times weekly failed to significantly change the following seven cardiovascular parameters investigated: (a) basal systolic blood pressure, (b) basal diastolic blood pressure, (c) post-exercise systolic blood pressure, (d) post-exercise diastolic blood pressure, (e) recovery heart rate values at one, three, and five minute intervals, (f) maximal aerobic power (milliliters per kilogram per minute, and (g) anaerobic power. These findings supported the null hypothesis.

9. Interval running twice weekly did result in significant within group pre/post- main effect positive changes in: (a) resting heart rate, (b) duration of effort measured in revolutions per minute on the modified Balke Treadmill Test, and (c) distance covered on the Cooper Twelve Minute Run-Walk Test for Women (yds.). These findings resulted in the rejection of the null hypothesis.

10. Interval running three times weekly as prescribed in this study failed to significantly effect cholesterol, hematocrit, and hemoglobin values. Therefore, the null hypothesis specific to these blood volume and chemistry variables was accepted.

11. Significant within group pre/post- main effect increases in total serum lactate dehydrogenase and triglyceride concentrations were computed for the interval

training group with a training frequency of three times weekly. This result substantiated the rejection of the null hypothesis.

12. No significant changes were recorded for the following eight circumferential girths among participants who trained using interval running three times weekly: (a) above breast, (b) over the breast, (c) minimal abdominal, (d) umbilical abdominal, (e) maximal abdominal, (f) hips, (g) thigh, and (h) neck. These results supported the null hypothesis.

13. The interval running group training three times weekly did show a significant within group pre/post- increase in calf circumference. Therefore, the null hypothesis was rejected for this variable.

14. Insignificant changes were also recorded for the following five skinfold measurements following interval running three times weekly: (a) tricep, (b) mid-axillary, (c) abdominal, (d) thigh, and (e) knee. The null hypothesis relative to these variables was accepted.

15. Significant pre/post- main effect decrements were experienced for sub-scapular and suprailiac skinfolds in the interval running group training three times weekly. The null hypothesis was rejected.

16. The null hypothesis was accepted for the interval running group training three times weekly as they failed to show significant effects from training in lean

body weight, fat weight, total weight, and percent body weight fat.

17. Interval training three times weekly did not result in significant alteration in the following five cardiovascular parameters: (a) resting heart rate, (b) basal systolic blood pressure, (c) basal diastolic blood pressure, (d) recovery heart rates at one, three, and five minute intervals, and (e) anaerobic power. The null hypothesis was therefore accepted.

18. Significant pre/post- main effect changes were disclosed in five cardiovascular areas for the interval training group running three times weekly. These changes were: (a) an increased post-exercise systolic blood pressure, (b) decrease in post-exercise diastolic blood pressure, (c) increased duration of effort on the modified Balke Treadmill Test, revolutions per minute, (d) increase in distance covered in yards on the Cooper Twelve Minute Run-Walk for Women, and (e) increase in maximal aerobic power, milliliters per kilogram per minute. These changes resulted in rejection of the null hypothesis.

19. Long slow-distance endurance running twice weekly as prescribed in this investigation failed to effect significant changes in hematocrit and hemoglobin values. Therefore, the null hypothesis was accepted.

20. Significant within group pre/post- main effect increases in total serum lactate dehydrogenase, cholesterol,

and triglyceride concentrations were found for the long slow-distance endurance group with a training frequency of two times weekly. The null hypothesis was rejected.

21. No significant changes were recorded for any of the nine circumferential girths studied. These included: (a) above chest, (b) over the breast, (c) minimal abdominal, (d) umbilical abdominal, (e) maximal abdominal, (f) hips, (g) thigh, (h) calf, and (i) neck. Therefore, the null hypothesis was accepted.

22. Insignificant changes were also recorded for the following five skinfold measurements following long slow-distance endurance running twice weekly: (a) tricep, (b) mid-axillary, (c) abdominal, (d) thigh, and (e) knee. The null hypothesis relative to these variables was accepted.

23. Significant pre/post- main effect decrements were experienced for sub-scapular and suprailiac skinfolds in the long slow-distance group training two times weekly. The null hypothesis was rejected.

24. The null hypothesis was accepted for the long slow-distance endurance group training twice weekly as they failed to show significant effects from training in lean body weight, fat weight, total weight, and percent body weight fat.

25. Long slow-distance endurance running twice weekly did not result in significant alteration in the

following seven cardiovascular parameters: (a) basal systolic blood pressure, (b) basal diastolic blood pressure, (c) post-exercise diastolic blood pressure, (d) recovery heart rate at one, three and five minute intervals, (e) duration of effort on the modified Balke Treadmill Test, measured in revolutions per minute, (f) maximal aerobic power, milliliters per kilogram per minute, and (g) anaerobic capacity. The null hypothesis was therefore accepted.

26. Significant pre/post- main effect changes were computed in three cardiovascular areas for the long slow-distance endurance running group training twice weekly. These changes were: (a) lower basal heart rate, (b) elevated post-exercise systolic blood pressure, and (c) increase in distance traversed in yards on the Cooper Twelve Minute Run-Walk for Women. These findings supported the rejection of the null hypothesis.

27. Long slow-distance endurance running three times weekly as prescribed in this investigation failed to significantly effect cholesterol, hematocrit, and hemoglobin values. Therefore, the null hypothesis relative to these blood volume and chemistry variables was accepted.

28. Significant within group pre/post- main effect increases in total serum lactate dehydrogenase and triglyceride concentrations were computed for the long slow-distance endurance training group with a training frequency

of three sessions weekly. Therefore, the null hypothesis was not supported.

29. No significant changes were recorded for any of the nine circumferential girths studied. These included: (a) above chest, (b) over the breast, (c) minimal abdominal, (d) umbilical abdominal, (e) maximal abdominal, (f) hips, (g) thigh, (h) calf, and (i) neck. Therefore, the null hypothesis was accepted.

30. Insignificant changes were also recorded for all seven skinfold measurements following long slow-distance endurance running three times weekly. These included: (a) subscapular, (b) tricep, (c) mid-axillary, (d) suprailiac, (e) abdominal, (f) thigh, and (g) knee. The null hypothesis relative to these variables was accepted.

31. The null hypothesis was accepted for the long slow-distance endurance group training three times weekly as they failed to show significant effects from training in lean body weight, fat weight, total weight, and percent body weight fat.

32. Long slow-distance endurance running performed three times weekly did not result in significant alteration in the following six cardiovascular parameters: (a) resting heart rate, (b) basal systolic blood pressure, (c) basal disatolic blood pressure, (d) post-exercise systolic blood pressure, (e) recovery heart rate at one, three, and five minute intervals, and (f) anaerobic capacity. The null hypothesis was therefore accepted.

33. Significant pre/post- main effect changes were computed in four cardiovascular areas for the long slow-distance endurance running group training twice weekly. These changes were: (a) a decrease in post-exercise diastolic blood pressure, (b) increase in duration of effort on the modified Balke Treadmill Test, measured in revolutions per minute, (c) increase in distance traversed in years on the Cooper Twelve Minute Run-Walk Test for Women, and (d) increase in maximal aerobic power, milliliters per kilogram per minute.

34. Data analysis failed to prove any one training regimen to be superior to any other. These findings supported the null hypothesis as stated.

Subordinate Conclusions

Concerned teachers use many forms of evaluative methods to ameliorate instruction and learning or skill acquisition. These methods are not always as sophisticated as the processes thus far described. Through observation and interaction professionals also make subjective, less scientific appraisals of student behavior. These also have merit in the planning of learning experiences. Thus, through inspection and observation, the following supportive secondary conclusions seem appropriate:

1. Females are primarily interested in fitness classes of this description largely for reasons of body composition improvement. It appears that positive results

in anthropometric dimensions which result from training regimens as prescribed in this study, without dietary restrictions would be negligible.

2. This study demonstrated that college-aged females are interested in exercise prescription classes. Faithful regular attendance and enthusiastic participation are perhaps the best criterion measures supporting such a conjecture.

3. Enhanced socialization is an outgrowth of such classes and an important part of the class environment and group therapy effects.

4. Apparently, exercise prescriptions of the type prescribed in this investigation do not result in further positive improvements in selected blood chemistry variables associated with increased cardiovascular disease risk.

5. The most significant training effects appear to be in improved aerobic power.

6. From observation and inventory, it appeared that college-aged females enjoyed interval running training regimens as contrasted to long slow-distance endurance approaches.

RECOMMENDATIONS

Based upon an analysis of the data collected and other observations in this investigation, the following recommendations are offered:

1. Administrative consideration should be given to rethinking the present traditional scheduling status for fitness classes carrying a single hour of credit, i.e. eight week courses meeting three times weekly or some similar alternative design which would permit three training sessions weekly and still be awarded the equivalent one hour of credit.

2. These courses should be supplemented with dietary restrictions for students anticipating anthropometric improvements.

3. Effective teacher motivation of students must be a salient feature of functional fitness classes. Only the most knowledgeable, interested and enthusiastic teachers should be given the responsibility for such guidance.

4. Ten minute mini-lectures should be part of each class. These presentations should enhance the participants understanding of the physiological benefits of such a class. Topics for consideration might include: (a) systemic responses to such training conditions, (b) dietary planning, (c) prevention and rehabilitation from disorders associated with sedentary existence, and (d) prevention and treatment of discomforts often associated with initiating fitness programs.

5. Functional fitness classes seem justified and recommendable on the basis of both immediate and long term implications. The immediate benefits appear to be

contingent upon correct exercise prescriptions and adherence to practices which underlie desired health improvements. Therefore, immediate physiological improvements may be relative. However, the knowledge gained and the positive attitudes formed relative to preventive medicine practices should be useful throughout life. Logically, with less than adequate physical education guidance taking place in many public school programs, it seems appropriate that the facilities and expertise at the college level be utilized as a last attempt to introduce and reinforce healthful preventive medicine practices.

6. Replication of the present study with the inclusion of dietary restrictions may provide further meaning to the role of exercise and diet in preventive medicine.

APPENDIX A

MEMORANDUM:

TO: Authorizing Physicians

FROM: Roger E. Alteri--Department of Health and Physical Education, Middle Tennessee State University, Murfreesboro, Tennessee, Box 6476

RE: Special Fitness Class for College-Aged Females

DATE: January 27, 1975

This communique is designed to more definitively inform you that the undersigned is to be subjected to stress testing and physical conditioning which should result in a cardiac response of approximately 180 beats per minute.

Stress tests on a multi-stage treadmill will be conducted twice during the semester. The participants cardiac response will be monitored by way of electrocardiographic techniques. Training sessions consisting of running regimens will be conducted two and three times weekly for a semester.

Please use the above information as a reference and notify me at once should you feel that the participant's present health status contraindicates such exertion.

Warmest personal regards

____
Signature of volunteer

APPENDIX B

DEPARTMENT OF HEALTH, PHYSICAL EDUCATION,
RECREATION AND SAFETY
MIDDLE TENNESSEE STATE UNIVERSITY
EXPERIMENTAL STUDY CONSENT FORM

PROJECT TITLE: "Effects of Interval and Endurance Running Upon Anthropometric and Physiological Parameters in College-Aged Females"

STUDY COLLABORATORS: Dr. Powell D. McClellan, University Faculty Member--Roger E. Alteri, D.A. Candidate

CLASS INSTRUCTOR: Roger E. Alteri

This is to certify that I, ______________________________, hereby agree to participate in an experimental study under the direction of the above. I am __________ years of age.

The study will include:

1. Assessments of anthropometric dimensions
2. Blood Chemistry analyses
3. Cardiorespiratory evaluation

A detailed explanation of this study has been given me and I understand the procedures to be followed. I have been informed of all inconveniences and risks reasonably to be expected from the procedures, and possible beneficial effects thereof. All of my inquiries have been answered, and I choose freely and voluntarily to participate.

______________________________ ________________
Volunteer's signature Date

I have defined and fully explained the extensiveness of this study to the above volunteer.

______________________________ ________________
Investigator's signature Date

APPENDIX C

RAW DATA GUIDE SHEET

GUIDE SHEET FOR IDENTIFICATION OF PRE/POST-RAW DATA VARIABLES*

Blood Variables: (1) cholesterol, (2) hematocrit, (3) hemoglobin, (4) total serum lactate dehydrogenase, and (5) triglycerides.

Anthropometric Measures: (1) height (cm.), (2) weight (kg.), (3) above breast circumference (cm.), (4) breast (cm.), (5) below breast (cm.), (6) minimal abdominal (cm.), (7) umbilical abdominal (cm.), (8) maximal abdominal (cm.), (9) hips (cm.), (10) thigh (cm.), (11) calf (cm.), (12) neck (cm.), (13) sub-scapular skinfold (mm.), (14) tricep skinfold (mm.), (15) mid-axillary (mm.), (16) suprailiac skinfold (mm.), (17) abdominal skinfold (mm.), (18) thigh skinfold (mm.), and (19) knee skinfold (mm.).

Body Composition Components: (1) lean body weight (kg.), (2) fat weight (kg.), (3) total body weight (kg.), and (4) percent body weight fat.

Cardiovascular Parameters: (1) resting heart rate, (2) resting blood pressure, (3) post exercise blood pressure, (4) first minute recovery heart rate, (5) third minute recovery heart rate, (6) fifth minute recovery heart rate, (7) treadmill duration minutes and seconds, (8) treadmill duration rpm, and (9) Cooper Twelve Minute Run-Walk Test distance (yds.).

Aerobic and Anaerobic Capacity Values: (1) resting oxygen consumption (liters per minute), (2) resting oxygen consumption (milliliters per kilogram per minute), (3) maximal oxygen consumption (liters per minute), (4) maximal oxygen consumption (milliliters per kilogram per minute), (5) first recovery oxygen consumption (liters per minute), (6) first recovery oxygen consumption (milliliters per kilogram per minute), (7) second minute recovery oxygen consumption (liters per minute), (8) second minute recovery (milliliters per kilogram per minute), (9) third minute recovery oxygen consumption (liters per minute), (10) third minute oxygen consumption (milliliters per kilogram per minute), (11) fourth minute oxygen consumption (liters per minute), (12) fourth minute oxygen consumption (milliliters per kilogram per minute), (13) fifth minute recovery oxygen consumption (liters per minute), (14) fifth minute oxygen consumption (milliliters per kilogram per minute), (15) sum of five recovery oxygen consumptions (liters per minute), (16) sum of five recovery oxygen consumptions (milliliters per kilogram per minute), (17) difference between five minute oxygen consumptions (liters per minute) and first minute resting oxygen consumption (liters per minute), and (18) oxygen debts (milliliters per kilogram per minute).

*Numbers correspond to variables.

ALLEN	SALLY	208	39.8	13.3	29	25
ALLEN	SALLY	248	41.5	14.3	85	54
HANKINS	AMY	155	37.9	12.7	70	65
HANKINS	AMY	172	36.4	12.5	101	60
MELSON	RITA	142	39.9	13.0	67	5
MELSON	RITA	150	41.0	13.6	96	50
PALMER	PAT	220	41.1	14.1	59	23
PALMER	PAT	232	40.6	14.0	83	58
QUINLISK	KAREN	202	44.3	15.3	65	45
QUINLISK	KAREN	260	41.6	13.8	88	78
SMEAD	TODDY	154	43.0	14.5	45	133
SMEAD	TODDY	152	43.8	14.4	26	124
WILLIAMS	DARLENE	208	39.9	13.4	78	55
WILLIAMS	DARLENE	276	39.7	13.1	114	62
BENSEN	JOY	233	39.2	13.1	72	35
BENSEN	JOY	218	36.3	12.1	104	50
BURR	LAURIE	173	37.2	12.6	57	35
BURR	LAURIE	190	40.2	13.5	70	81
CONGDON	KYLE	205	40.3	13.9	65	30
CONGDON	KYLE	196	41.9	14.1	62	74
JOHNSON	TERESA	163	39.5	13.4	59	70
JOHNSON	TERESA	160	41.2	13.4	28	58
SMITH	PAM	228	37.9	12.8	67	83
SMITH	PAM	202	42.2	14.2	85	142
SMITH	WANDA	115	40.2	13.5	59	53
SMITH	WANDA	140	42.5	14.1	67	105
WHITEHEAD	NANCY	115	37.6	12.7	67	40
WHITEHEAD	NANCY	122	39.2	13.0	106	20

CARROLL	JANE	202	38.2	13.1	67	68
CARROLL	JANE	172	37.3	12.5	80	90
CORLEY	BETH	180	41.0	13.8	91	95
CORLEY	BETH	216	43.5	14.6	98	156
FRAZIER	CINDY	208	36.8	12.5	75	20
FRAZIER	CINDY	302	39.5	12.9	104	70
GRANT	SANDRA	266	41.0	13.8	44	50
GRANT	SANDY	288	37.5	12.9	85	105
POTTS	BECKY	180	39.0	13.2	75	60
POTTS	BECKY	216	39.9	13.6	91	90
SNELSON	KAREN	164	38.3	12.8	62	38
SNELSON	KAREN	158	37.8	12.5	88	50
STINSON	MARY BETH	193	41.0	13.9	72	35
STINSON	MARY BETH	236	41.4	14.1	88	74
DAVIS	LISA	220	37.0	12.3	72	53
DAVIS	LISA	190	38.0	12.7	91	124
FITCH	NANCY	183	39.4	13.5	93	55
FITCH	NANCY	204	34.5	11.1	91	78
HARREL	MARSHA	199	42.8	14.4	59	75
HARRELL	MARSHA	208	43.4	14.7	75	90
LASATER	CINDY	268	38.6	13.2	67	50
LASATER	CINDY	320	41.1	13.9	65	94
LYNCH	AMY	160	37.8	12.7	62	44
LYNCH	AMY	176	40.1	13.3	75	44
MARTIN	LEESA	204	40.3	13.5	75	25
MARTIN	LEESA	192	40.5	13.7	85	78
SHARBEL	CECILIA	195	37.2	12.4	57	135
SHARBEL	CECILIA	220	37.0	12.4	67	159
SINCLAIR	SUSAN	160	39.9	13.5	59	59
SINCLAIR	SUSAN	172	39.5	13.0	88	100
SMLEY	LEISA	185	37.0	12.5	62	45
SMILEY	LEISA	220	39.4	13.3	57	74

BLEDSOE	FREDA	210	38.4	13.0	70	50
BLEDSOE	FREDA	194	38.7	13.0	106	104
DODD	CINDY	165	38.9	13.0	59	50
DODD	CINDY	182	39.6	13.1	104	62
FARRELL	LINDA	182	42.1	14.0	67	50
FARRELL	LINDA	192	41.1	13.9	104	70
HATFIELD	SIGNE	234	43.9	14.9	67	100
HATFIELD	LINDA	328	43.9	14.8	104	198
PATRICK	DEBBIE	225	41.0	14.3	83	60
PATRICK	DEBBIE	216	42.3	14.6	101	82
RUMBAUGH	REBECCA	196	38.7	13.0	59	40
RUMBAUGH	REBECCA	230	37.8	12.9	91	54
WALLACE	ANITA	302	42.8	14.3	54	108
WALLACE	ANITA	354	42.2	14.0	80	156
BLEVINS	ANGIE	226	39.5	13.1	62	135
BLEVINS	ANGIE	236	40.5	13.3	59	232
CUNNINGHAM	GINGER	200	41.9	14.2	85	57
CUNNINGHAM	GINGER	176	44.2	15.0	101	100
DAVIS	SANDY	238	40.0	13.6	72	33
DAVIS	SANDY	256	41.2	14.1	88	110
DAVIS	TINA	181	36.8	12.4	80	50
DAVIS	TINA	204	38.0	12.7	95	98
EADS	ANNETTE	178	38.4	13.1	72	43
EADS	ANNETTE	192	40.5	13.7	88	78
FORBORD	VELINDA	150	36.9	12.0	72	31
FORBORD	VELINDA	174	38.2	12.7	78	72
LOVELL	MELISSA	208	41.5	13.8	67	45
LOVELL	MELISSA	230	43.2	14.5	98	116
THERBER	DEBBIE	181	34.8	11.8	67	33
THERBER	DEBBIE	172	36.9	12.2	78	70
WISE	MARY	240	41.3	14.2	75	45
WISE	MARY	236	43.2	15.0	85	100

EPPERLY	LUELLEN	235	41.1	14.0	72	78
EPPERLY	LUELLEN	240	40.0	13.4	106	64
GALLANT	DEBBIE	236	42.3	14.0	62	30
GALLANT	DEBBIE	194	36.5	12.1	95	58
GOSSER	KENDRA	283	41.0	13.8	67	145
GOSSER	KENDRA	268	40.6	13.8	83	116
IGOU	JEANNIE	245	37.6	13.1	78	75
IGOU	JEANNIE	194	34.1	11.7	114	140
MCCONNELL	NANCY	184	39.0	13.2	59	113
MCCONNELL	NANCY	200	37.7	12.5	101	156
MOSS	FRANCES	242	39.3	13.3	62	15
MOSS	FRANCES	242	38.7	12.7	93	52
SIMONS	PAM	214	40.7	13.9	57	35
SIMONS	PAM	248	40.1	13.5	70	78
WENZEL	SUSAN	198	38.6	13.2	54	5
WENZEL	SUSAN	188	40.8	13.6	98	74
WHITESIDES	BECKY	192	40.1	13.3	59	50
WHITESIDES	BECKY	224	40.8	13.4	80	88
BURTON	ANNE	115	41.9	14.2	80	38
BURTON	ANNE	204	38.8	13.1	80	62
FERRELL	DEBBIE	205	40.4	13.8	70	40
FERRELL	DEBBIE	188	41.7	13.7	78	62
HERNANDEZ	MARIA	190	40.0	13.6	70	50
HERNANDEZ	MARIA	198	40.4	13.9	75	190
HEWITT	MELISSA	190	41.1	13.9	59	80
HEWITT	MELISSA	187	40.4	13.5	57	69
KEATON	TERESA	300	40.3	13.7	67	48
KEATON	TERESA	266	40.8	13.5	88	142
PARKER	VICKI	170	41.3	13.9	72	83
PARKER	VICKI	187	41.0	13.9	75	136
POLLARD	MARY	173	39.7	13.7	62	48
POLLARD	MARY	206	38.7	13.2	85	76
SMITHSON	SHERYL	193	40.2	13.9	78	66
SMITHSON	SHERYL	174	44.5	15.1	80	66

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ALLEN          SALLY
159.40 49.70 76.20 79.80 69.10 64.30 66.00 72.60 90.20 51.80
 33.70 30.00 14.80 11.30  9.80 21.00 21.50 35.50  5.00
ALLEN          SALLY
160.70 49.10 77.20 83.50 71.60 63.10 68.30 71.60 89.80 50.70
 34.10 30.40 11.00 12.30  9.70 12.30 17.30 33.30  5.30
HANKINS        AMY
164.80 40.50 77.80 83.50 67.00 60.40 64.50 70.90 84.70 46.00
 27.80 29.00  5.00  5.00  4.50  8.00  6.50 20.00  4.50
HANKINS        AMY
163.80 40.80 76.00 78.50 66.10 57.30 59.20 66.00 86.60 46.10
 29.20 28.60  5.00  4.60  8.00  7.30 14.00 18.30  4.30
MELSON         RITA
161.30 51.50 78.00 80.80 78.30 64.70 67.30 78.90 90.30 55.30
 33.10 29.20 18.00 14.20 14.20 27.30 25.80 26.20  4.70
MELSON         RITA
161.30 53.30 78.80 81.60 67.00 66.20 75.20 79.40 91.60 55.70
 34.30 30.00 14.30 14.00 10.70 28.00 27.30 30.30  6.70
PALMER         PAT
168.30 56.10 83.70 92.20 76.40 66.90 73.50 80.20 95.90 56.30
 33.60 31.30  8.70 11.80  9.60 21.00 21.50 21.20  4.70
PALMER         PAT
168.30 56.10 83.10 89.60 74.00 65.50 68.20 76.40 95.30 54.90
 34.00 31.00  8.30 11.30  6.30 10.30 17.30 18.30  7.70
QUINLISK       KAREN
159.40 52.70 82.00 88.50 71.80 63.50 70.40 82.80 95.20 56.80
 32.90 30.20 16.00 19.70 14.80 25.80 24.00 30.10  7.20
QUINLISK       KARE
160.00 53.60 83.20 89.80 71.30 65.60 71.40 82.00 95.90 57.40
 33.30 30.90  9.70 18.30 11.30 17.00 21.30 39.00  6.30
SMEAD          TODDY
157.50 48.90 80.00 84.90 71.30 67.70 70.30 82.30 87.90 52.40
 32.20 30.00 27.20 16.00 17.50 37.80 32.60 33.70  6.00
SMEAD          TODDY
158.10 51.30 82.30 88.00 71.00 71.00 80.00 86.00 90.00 53.90
 33.20 31.00 23.30 13.70 21.30 39.00 28.00 29.30  8.70
WILLIAMS       DARLENE
158.80 60.30 85.20 91.30 73.20 66.50 74.40 90.30100.70 62.40
 38.00 31.70 18.00 20.30 16.80 31.30 31.30   .00  6.30
WILLIAMS       DARL
158.10 60.20 83.80 88.20 71.90 66.50 77.90 90.80 99.60 62.50
 38.40 31.40 13.30 17.60 13.00 26.30 27.00 40.60  4.00
BENSEN         JOY
179.10 62.60 88.70 93.40 76.40 68.20 72.60 88.60 96.00 59.10
 33.40 32.70 10.20 10.20 10.50 20.80 22.50 23.30  5.30
BENSEN         JOY
180.00 61.70 87.00 91.40 72.20 67.00 78.00 88.90 96.90 59.40
 34.20 32.00 10.00 10.30 11.30 20.00 25.00 22.30  6.00
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BURR            LAURIE
165.10  46.00  76.20  74.30  67.30  58.20  62.30  76.40  88.00  52.60
 30.00  30.40   7.50   7.30   5.50  13.70  14.30  29.50   2.80
BURR            LAURIE
166.40  48.00  77.20  75.30  65.90  58.10  62.20  78.10  89.30  55.40
 31.00  31.00   7.70   9.00   6.70  20.00  14.30  26.30   6.30
CONGDON         KYLE
164.00  53.00  84.00  87.40  75.20  66.80  76.60  86.40  92.10  55.50
 32.40  31.60  16.20  14.80  10.20  23.70  26.30  31.70   8.70
CONGDON         KYLE
162.60  52.40  83.70  86.40  70.90  67.60  75.50  85.00  92.20  54.20
 32.60  32.20  11.30  11.30  10.00  20.00  25.00  30.30   8.70
JOHNSON         TERESA
166.40  62.60  86.90  88.40  80.20  70.80  74.40  93.00104.30  64.00
 32.10  31.20  16.80  11.80  16.80  40.70  33.20  32.70   8.50
JOHNSON         TERE
167.60  61.80  84.60  89.30  77.60  71.10  83.70  93.60104.90  62.40
 32.70  33.30  16.00  10.70  15.00  29.30  36.70  29.00  11.70
SMITH           PAM
167.00  56.70  83.40  88.70  75.80  67.30  76.10  84.50  95.90  56.40
 33.40  32.20  14.20  16.50  14.00  28.70  29.30  35.70   6.20
SMITH           PAM
168.00  57.20  83.60  89.10  74.80  68.10  73.00  85.40  98.20  57.40
 33.40  32.10  14.00  19.30  10.00  23.30  26.00  24.70   6.30
SMITH           WANDA
160.00  52.20  80.50  89.50  74.00  66.10  80.00  83.00  95.60  55.20
 34.10  30.10  17.80  12.70  12.20  22.80  18.80  32.00   7.30
SMITH           WANDA
160.70  53.00  79.90  91.00  73.70  66.50  72.60  84.70  96.80  55.80
 34.20  32.30  17.30  14.00  12.60  20.00  23.60  21.30   7.30
WHITEHEAD       NANCY
167.60  53.10  83.20  82.00  75.70  64.90  65.70  68.40  96.90  53.50
 33.70  31.40  13.50  14.60   9.30  24.70  16.50  27.70   8.20
WHITEHEAD       NAN
168.30  52.60  86.30  82.00  70.70  63.10  72.40  79.10  95.30  53.80
 33.40  30.70  11.30  15.30  10.30  20.70  16.00  28.70   8.00
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CARROLL          JANE
165.70 58.00 83.10 89.40 74.10 68.60 75.40 85.60 92.80 58.10
 32.90 32.00 15.50 13.20 12.70 28.80 24.70 29.70  7.80
CARROLL       JANE
165.70 59.80 84.80 89.50 76.20 69.40 76.40 87.00 94.20 59.40
 35.20 31.20 13.30 13.30 14.60 23.30 24.60 30.00  7.60
CORLEY           BETH
158.10 62.90 86.60 94.10 85.40 88.10 86.20 88.70104.10 60.80
 33.00 31.10 27.50 20.30 25.00 44.70 36.80   .00  6.80
CORLEY        BETH
158.10 61.00 85.10 90.70 76.70 75.20 84.90 86.30103.40 58.60
 33.50 30.10 28.00 18.00 17.00 33.30 31.30 29.30  6.00
FRAZIER          CINDY
162.60 63.50 90.30 94.50 79.10 70.50 80.20 85.20100.90 65.30
 37.30 32.20 17.30 14.70 15.30 25.70 35.30 28.80  6.50
FRAZIER       CINDY
163.80 64.10 90.20 96.10 77.00 70.60 78.00 87.10100.70 64.20
 37.90 32.60 13.30 16.30 16.70 25.30 31.30 31.00  8.30
GRANT            SANDRA
167.00 67.30 86.70 91.70 76.30 74.10 75.40 90.50101.10 63.20
 39.70 31.60 17.00 17.00 11.00 32.00 27.80 36.50 11.20
GRANT         SANDY
166.40 67.00 82.20 91.20 75.00 76.00 77.60 85.80101.60 63.00
 40.10 33.20 14.00 30.00 15.00 35.30 28.30 40.00  6.00
POTTS            BECKY
168.30 69.70 90.40 95.70 80.40 75.80 86.20 92.90103.30 63.40
 37.00 33.90 26.80 22.70 17.30 43.80 37.00 25.70  6.30
POTTS         BECKY
168.90 82.80 89.40 93.90 79.00 77.20 86.50 96.60105.00 64.40
 38.40 34.40 22.00 19.70 19.70 35.00 39.30 30.00  8.70
SNELSON          KAREN
170.20 79.80 89.30 94.60 88.10 78.70 90.10100.40110.20 73.60
 40.10 32.80 31.30 22.80 22.30 25.80 39.50 40.20  9.50
SNELSON       KARE
171.50 74.70 85.50 91.80 77.20 76.60 91.60 93.30110.20 70.20
 39.30 32.00 28.00 22.70 23.70 35.30 43.70 38.30 11.30
STINSON          MARY-BETH
167.60 57.90 83.10 88.80 77.50 69.70 78.00 86.80 94.20 58.30
 34.40 30.60 25.30 22.30 20.00 32.30 27.30   .00  6.00
STINSON       MARY-BETH
169.00 54.00 79.60 83.90 73.40 65.20 76.50 80.50 90.40 53.60
 34.10 30.30 11.30 14.70  9.30 19.70 19.00 26.30  5.30
DAVIS            LISA
162.60 59.40 82.00 90.30 75.40 69.60 78.30 90.40 95.90 61.60
 35.10 31.80 17.50 17.20 16.00 36.30 30.80 29.00  9.30
DAVIS         LISA
164.50 61.20 82.00 92.00 73.10 72.60 82.10 91.70 96.50 61.40
 35.60 32.70 17.70 20.30 16.70 29.00 31.70 36.70  8.70
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FITCH              NANCY
170.00 60.00 86.70 92.00 77.00 69.70 69.60 82.10102.20 59.70
 36.00 30.80 12.30 13.30 12.50 29.00 28.50 32.00  7.70
FITCHN       NANCY
170.00 61.10 86.00 91.40 75.50 70.00 71.80 81.40100.60 58.70
 36.80 31.20 13.70 12.00  9.30 23.00 23.30 27.00  9.70
HARRELL            MARSHA
158.75 55.30 83.10 89.00 72.70 63.90 70.90 81.70 95.50 59.00
 35.00 31.80 13.00 12.20  9.80 28.50 25.20 32.00 11.50
HARRELL      MARSHA
160.00 54.70 82.90 85.30 73.10 63.60 71.20 81.40 95.10 57.70
 34.70 32.70 12.00 10.00  8.70 21.00 25.30 31.70  9.30
LASATTER           CINDY
163.80 58.40 84.60 89.20 78.00 65.60 77.20 80.50100.60 58.70
 34.80 31.20 17.50 14.00 14.80 24.20 28.00 32.70  7.30
LASATER      CINDY
163.80 58.20 83.60 89.80 72.50 64.70 73.60 79.30 97.20 59.00
 35.80 31.00 11.60 11.60  8.60 15.00 22.60 28.00  6.60
LYNCH              AMY
165.70 59.50 85.00 86.90 74.40 68.80 78.60 86.00 97.80 60.00
 36.80 31.10 16.50 12.20 13.20 25.20 28.30 24.80  4.50
LYNCH        AMY
167.00 57.50 84.50 61.90 74.40 68.80 79.20 85.20 96.50 58.10
 36.20 30.50 19.00 13.00 11.00 24.30 27.00 21.00  6.00
MARTIN             LEESA
155.60 50.00 80.30 82.30 71.50 60.00 65.80 85.10 93.40 58.30
 34.90 29.60 14.30 12.50  9.50 22.80 22.00 31.70  9.00
MARTIN       LEESA
155.00 48.60 78.30 81.90 68.60 59.70 65.70 80.50 93.20 57.80
 34.40 29.40 12.00 13.00  9.00 19.00 20.00 32.70  6.30
SHARBEL            CECILIA
164.50 58.90 88.50 90.20 69.10 72.00 79.20 89.00 96.50 58.20
 34.90 31.50 15.30 18.80 12.30 34.20 41.00 33.80 10.00
SHARBEL      CECILIA
165.10 61.00 88.60 94.20 76.80 72.00 80.50 90.00 97.60 59.80
 35.70 32.40 18.00 17.70 15.70 32.70 47.00 36.70 12.30
SINCLAIR           SUSAN
155.60 57.50 85.40 91.10 72.30 69.10 79.80 88.50 95.70 60.70
 35.90 32.00 28.00 20.30 16.50 38.00 40.30 31.80  8.00
SINCLAIR     SUS
155.60 57.30 84.90 92.50 74.20 69.70 78.40 89.70 92.60 59.60
 35.40 31.80 23.00 19.00 16.00 41.30 33.70 29.70  6.70
SMILEY             LEISA
155.60 52.40 81.20 86.80 68.60 64.70 73.70 84.30 95.90 58.00
 33.40 30.90 20.30 17.20 12.20 32.20 33.20 31.20  6.20
SMILEY       LEISA
156.20 52.80 79.20 87.30 68.80 64.80 75.30 84.10 96.10 59.10
 33.70 30.40 17.70 17.00 14.30 31.00 32.00 31.30  5.00
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BLEDSOE		FREDA							
157.50	49.70	79.50	84.10	70.70	66.00	70.30	79.20	91.40	54.10
33.40	31.30	19.50	20.20	12.00	19.30	28.80	25.00	5.20	
BLEDSOE		FREDA							
158.80	49.00	78.00	55.00	72.00	64.60	68.80	78.10	91.30	53.60
33.50	30.60	16.70	17.30	10.70	15.00	24.70	24.70	5.00	
DODD		CINDY							
158.80	50.90	82.30	84.50	74.40	64.00	68.50	80.40	89.00	56.50
33.30	29.80	21.80	15.70	13.20	31.50	28.30	26.30	6.50	
DODD		CINDY							
158.80	48.40	80.40	80.40	66.90	62.10	67.90	77.30	90.00	53.40
32.60	30.00	10.00	12.30	7.70	15.30	19.30	25.30	6.70	
FARRELL		LINDA							
158.80	53.40	83.10	90.20	73.70	69.70	77.00	81.10	92.90	58.60
31.90	31.60	24.00	17.30	17.30	41.00	35.80	19.30	7.00	
FARRELL		LINDA							
158.10	53.50	82.10	86.70	69.20	68.20	80.00	82.00	90.70	55.00
32.90	31.30	19.30	16.00	18.70	33.30	31.30	27.00	4.30	
HATFIELD		SIGNE							
160.30	59.60	85.30	90.00	77.50	70.00	73.20	82.50	97.50	59.00
37.50	32.90	13.30	18.50	12.20	20.80	27.50	26.50	6.50	
HATFIELD		SIGNE							
160.00	59.80	85.20	92.10	77.30	69.70	82.70	86.40	95.70	57.90
38.70	32.80	19.70	17.70	15.00	18.00	24.00	28.00	7.00	
PATRICK		DEBORAH							
149.90	61.90	86.70	96.50	76.90	78.30	80.50	90.10	100.90	63.90
36.90	33.00	37.60	23.60	32.80	39.60	26.60	40.30	10.10	
PATRICK		DEBB							
150.50	59.40	84.60	95.20	74.30	75.30	76.30	87.90	99.60	62.80
36.40	32.10	27.00	24.00	26.30	36.30	35.30	32.00	7.30	
RUMBAUGH		REBECCA							
168.90	62.90	83.50	92.40	78.00	72.80	73.10	82.40	99.00	60.10
35.70	32.80	16.00	10.30	13.50	36.00	33.80	22.20	6.90	
RUMBAUGH		REB							
168.30	62.40	84.50	92.10	76.60	73.70	71.60	79.60	98.10	58.20
35.80	33.10	14.30	11.30	11.30	29.00	35.70	20.00	7.30	
WALLACE		ANITA							
164.50	59.90	82.60	93.60	80.20	69.70	75.50	82.00	97.20	58.70
36.30	30.60	16.50	15.70	15.00	26.80	24.30	22.20	7.30	
WALLACE		ANITA							
158.10	61.00	83.90	94.10	77.50	69.40	75.80	84.00	99.00	58.90
36.50	31.20	12.30	14.70	15.00	24.70	24.70	25.70	11.00	
BLEVINS		ANGIE							
157.00	45.00	74.30	83.50	66.90	62.00	73.40	76.00	87.50	54.40
32.00	29.80	10.00	10.30	9.20	17.70	31.80	29.30	5.30	
BLEVINS		ANGIE							
157.50	48.00	75.70	85.60	66.50	64.40	69.40	77.20	89.90	55.50
33.70	30.80	11.70	11.30	11.70	25.30	28.70	30.00	7.70	

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CUNNINGHAM     GINGER
173.00 61.00 83.40 82.70 72.30 67.20 78.30 80.90 97.90 56.70
 36.80 31.80  8.20 13.70  6.00 19.80 26.00 28.70  7.70
CUNNINGHAM     GINGER
173.40 62.50 85.00 88.00 74.00 68.20 80.00 87.00 99.60 59.00
 37.30 32.50  9.00 13.60  7.30 17.30 28.00 31.60  7.00
DAVIS          SANDY
154.00 57.00 84.30 89.50 76.50 71.20 74.60 85.60 95.10 59.10
 33.80 30.20 15.70 12.70 14.20 33.70 31.80 27.70 12.80
DAVIS          SANDY
153.70 56.70 85.60 90.50 77.00 70.30 76.20 84.80 93.90 58.50
 35.60 30.20 15.70 13.00 16.00 32.30 27.00 26.30 10.30
DAVIS          TINA
166.00 63.00 84.70 89.40 75.10 67.80 80.70 94.20100.50 62.40
 35.90 30.20 22.70 18.70 12.80 37.50 34.00 30.50 11.50
DAVIS          TINA
167.00 61.80 85.20 89.30 74.20 66.70 72.90 91.50 99.40 61.60
 36.60 30.50 18.30 18.00 12.30 32.70 34.00 29.30  8.70
EADS           ANNETTE
156.00 43.00 74.40 76.50 63.30 58.30 65.70 74.70 87.80 52.00
 30.60 30.20  7.80  9.20  5.30 15.00 19.00 20.20  7.00
EADS           ANNETTE
156.20 45.10 73.50 78.80 64.80 59.30 64.70 74.60 89.00 53.50
 31.80 30.50  7.30 10.00  6.70 14.70 20.30 21.00  6.00
FORBORD        VELINDA
172.00 58.00 82.10 85.40 72.30 64.50 69.80 80.60 95.00 57.30
 34.40 31.50 10.80 13.20  8.50 20.30 19.70 30.70  5.30
FORBORD        VILN
173.40 59.20 84.70 88.10 72.90 65.30 69.20 80.00 97.10 58.70
 35.10 31.80  9.70 13.10 10.70 21.00 24.70 33.00 10.70
LOVELL         MELISSA
176.00 68.00 88.90 88.70 76.00 72.40 79.50 93.80103.40 61.80
 36.60 34.50 23.30 13.20 18.50 34.50 29.70 27.00  7.80
LOVELL         MELI
176.50 69.40 88.20 89.90 76.70 72.50 80.20 94.90103.50 61.90
 37.10 33.70 19.00 12.00 18.70 27.70 30.00 21.30  7.30
THERBER        DEBORAH
160.00 52.00 81.50 84.30 71.50 65.90 73.40 83.80 94.40 57.20
 31.50 30.90 20.30 13.30 16.30 26.20 26.80 32.00  6.00
THERBER        DEBBIE
160.70 52.70 80.50 82.80 72.00 68.00 77.10 87.10 94.60 58.50
 32.40 31.10 19.30 12.80 12.00 21.30 23.70 26.00  7.00
WISE           MARY
173.00 67.00 90.30 92.90 78.60 72.90 81.70 91.30 99.70 58.30
 34.00 32.00 20.20 12.00 16.00 29.50 33.00 22.00  8.50
WISE           MARY
173.40 68.20 86.60 93.60 78.00 74.30 84.20 95.10102.60 59.80
 34.20 32.30 18.70 13.70 21.00 30.70 34.70 20.30  7.00
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EPPERLY             LUELLEN
155.60  51.90  82.80  89.80  74.70  69.90  71.10  76.20  92.10  53.50
 33.30  31.10  13.10  13.00  15.70  24.70  19.50  25.20   6.30
EPPERLY         LUELL
152.20  55.70  84.70  91.30  78.20  76.30  82.40  84.70  94.80  57.70
 33.60  30.80  13.00  14.70  15.70  31.30  29.30  26.30   7.00
GALLANT             DEBBIE
163.20  61.00  85.30  90.00  77.10  69.50  80.40  87.90101.40  62.20
 36.80  31.10  17.50  17.20  12.30  25.80  31.50  20.50  10.50
GALLANT         DEBB
163.20  63.10  86.40  92.70  78.60  71.10  78.60  90.40103.10  63.60
 37.90  31.80  19.70  18.30  13.30  27.30  34.00  28.70  14.30
GOSSER              KENDRA
163.80  64.60  92.20100.10  86.50  80.70  84.90  88.90101.60  59.40
 35.40  30.70  28.00  20.60  19.30  32.70  38.30  33.80   4.50
GOSSER          KENDRA
151.20  66.20  93.00103.00  87.00  83.50  83.70  91.30100.50  60.40
 36.80  31.60  33.00  23.30  27.00  36.30  46.80  33.00   5.60
IGOU                JEANNIE
174.00  64.60  85.80  85.10  87.20  69.40  71.70  76.50103.40  59.30
 36.90  33.00  21.70  12.00  10.70  27.00  28.70  20.80   6.20
IGOU            JEANNIE
174.60  65.40  85.00  84.40  75.60  70.40  76.00  87.80101.50  60.00
 37.70  33.90  13.00  11.30   9.30  14.30  26.00  24.70   7.70
MCCONNELL           NANCY
159.40  54.00  84.70  87.90  73.80  65.80  76.60  87.30  95.70  59.60
 33.60  30.40  22.00  16.50  18.80  34.70  30.20    .00   8.50
MCCONNELL       NAN
158.80  55.80  83.00  90.70  68.30  68.30  72.10  88.60  98.30  61.30
 34.10  30.60  20.30  19.00  20.00  30.60  29.30    .00   9.60
MOSS            FRANCES
163.80  46.60  76.20  78.30  67.70  58.60  65.40  73.50  88.70  51.30
 31.70  29.10  10.50   8.50  10.70  21.30  26.70  22.70   3.30
MOSS            FRANCES
163.80  47.70  75.60  78.90  65.00  59.20  43.40  74.30  89.40  51.30
 33.60  29.50   8.00   7.60   8.30  14.00  22.30  22.00   8.60
SIMONS              PAMELA
161.90  56.30  78.60  86.20  76.70  66.80  73.20  80.50  95.60  60.50
 32.70  31.10  12.80  13.20  12.20  26.80  24.00  37.20   8.20
SIMONS          PAM
162.60  57.00  77.20  85.10  73.10  66.80  78.80  80.90  92.90  59.90
 33.60  31.20  12.30  10.60   8.30  23.30  21.00  26.60   5.30
WENZEL              SUSAN
151.80  46.60  79.00  86.60  68.50  62.00  66.70  80.90  87.70  54.50
 32.60  30.20  25.30  21.20  19.00  27.70  21.30    .00   9.00
WENZEL          SUSAN
151.10  50.00  81.40  86.80  71.40  65.30  69.60  80.80  88.20  56.30
 33.30  30.60  17.00  24.00  20.30  27.00  22.00    .00   8.30
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WHITESIDES REBECCA
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WHITESIDES BE
156.20 49.10 79.20 83.50 71.90 66.20 72.60 75.50 92.10 52.50
32.70 31.40 12.00 11.70 13.70 26.30 22.00 24.00 7.00
BURTON ANNE
171.00 65.00 84.00 90.00 75.70 71.90 80.70 83.50104.40 63.30
36.50 31.80 19.30 19.20 16.20 38.00 34.50 .00 9.30
BURTON ANNE
172.00 63.70 82.60 88.90 75.10 72.00 80.60 84.30102.40 60.60
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FERRELL DEBBIE
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FERRELL DEB
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HERNANDEZ MARIA
152.00 60.00 86.10 95.30 79.00 76.20 91.00 93.20 99.50 61.30
34.80 31.50 25.80 16.50 20.80 45.50 38.80 42.30 7.00
HERNANDEZ MA
151.10 61.90 88.30 98.10 79.20 78.30 89.80 90.60100.40 64.20
35.70 31.90 22.70 17.30 22.30 49.70 42.00 37.70 6.70
HEWITT MELISSA
161.00 54.00 79.20 81.90 73.80 63.60 69.20 79.40 99.20 58.50
33.60 29.50 14.30 17.50 11.20 30.00 30.00 35.00 7.50
HEWITT MELISSA
161.30 53.30 79.10 78.00 69.40 63.80 68.00 85.00 98.30 58.60
34.20 29.80 16.30 15.70 10.70 26.70 33.70 31.30 5.30
KEATON TERESA
163.00 61.00 83.10 86.60 71.60 69.40 79.10 82.40103.70 60.30
35.50 31.80 21.00 21.00 13.80 34.30 32.00 46.70 9.50
KEATON TER
162.20 64.40 83.70 90.60 72.50 70.20 81.30 86.00105.50 63.20
36.10 32.00 21.00 25.30 12.30 29.30 25.60 44.60 9.00
PARKER VICKI
156.00 50.00 80.10 85.10 70.20 64.40 76.80 79.60 91.20 55.00
32.60 30.40 12.80 15.50 13.70 22.30 26.70 28.80 9.80
PARKER VICKI
155.60 51.50 79.70 85.20 71.70 65.60 71.00 82.90 93.10 56.10
33.00 30.50 14.30 19.00 15.00 26.30 29.00 26.30 9.70
POLLARD MARY K
166.00 60.00 84.90 92.00 74.60 71.90 84.90 91.30 97.50 58.80
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POLLARD MARY
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SMITHSON SHERYL
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SMITHSON SHER
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38.94389963	15.05610013	54.00000000	27.88166737
37.96959973	15.33040035	53.30000019	28.76247740
43.35760021	17.64239979	61.00000000	28.92196679
44.55280018	19.84719968	64.39999962	30.81863284
37.18520021	12.81480003	50.00000000	25.62959957
37.09839964	14.40160036	51.50000000	27.96427249
43.21989966	16.78010035	60.00000000	27.96683383
41.52799988	18.27200031	59.80000019	30.55518437
44.89470053	20.10529971	65.00000000	30.93123006
45.01609945	18.28390050	63.30000019	28.88451934

ALLEN	SALLY	75	114/70	132/76	135	120
		90	6#41	488	1855	2240
ALLEN	SALLY	52	106/78	150/78	135	120
		105	8#05	590	1855	2240
HANKINS	AMY	95	098/64	134/70	150	120
		120	5#19	389	1890	2280
HANKINS	AMY	110	098/66	114/80	150	135
		120	5#37	414	1890	2280
MELSON	RITA	86	106/68	114/78	135	120
		120	5#22	390	1885	2110
MELSON	RITA	82	104/74	104/82	135	120
		120	7#08	519	1885	2110
PALMER	PAT	72	126/74	152/72	150	120
		105	7#05	514	2090	2380
PALMER	PAT	42	108/78	160/64	135	120
		105	12#09	887	2090	2380
QUINLISK	KAREN	75	106/74	124/76	150	120
		105	6#51	466	1720	2015
QUINLISK	KAREN	64	122/80	146/50	135	120
		105	9#00	659	1720	2015
SMEAD	TODDY	88	128/78	144/82	150	120
		120	6#02	438	1770	2240
SMEAD	TODDY	92	122/70	150/80	135	120
		105	9#10	671	1770	2240
WILLIAMS	DARLENE	120	128/84	130/80	150	135
		120	5#41	412	2050	2360
WILLIAMS	DARLENE	80	128/72	154/60	150	120
		120	9#35	734	2050	2360
BENSEN	JOY	90	110/80	116/72	150	120
		105	7#22	538	2385	2855
BENSEN	JOY	68	102/72	120/68	150	135
		120	8#13	600	2385	2855
BURR	LAURIE	60	106/74	134/74	150	120
		105	7#06	520	2025	2575
BURR	LAURIE	60	110/80	146/76	150	120
		105	11#52	798	2025	2575
JOHNSON	TERESA	76	110/70	132/68	135	120
		105	10#09	744	2100	2740
JOHNSON	TERESA	76	100/76	110/60	150	120
		120	15#10	1109	2100	2740
SMITH	PAM	135	120/74	134/74	150	120
		120	5#18	387	2185	2605
SMITH	PAM	76	120/68	170/64	150	120
		105	7#33	552	2185	2605
SMITH	WANDA	80	110/80	130/70	165	120
		120	3#53	282	1820	2350
SMITH	WANDA	80	118/74	140/65	135	120
		120	5#52	428	1820	2350
WHITEHEAD	NANCY	72	118/80	140/84	120	105
		90	6#38	481	2500	2770
WHITEHEAD	NANCY	54	106/68	152/78	135	90
		75	8#39	593	2500	2770

CARROLL	JANE	90	100/74	118/82	120	105
		75	6#51	495	2330	2955
CARROLL	JANE	56	110/76	150/62	135	90
		90	6#37	485	2330	2955
CORLEY	BETH	94	114/84	150/78	165	120
		105	9#14	670	1885	2080
CORLEY	BETH	96	128/90	154/82	135	120
		105	7#37	553	1885	2080
FRAZIER	CINDY	64	116/76	160/74	150	120
		120	4#12	306	2155	2650
FRAZIER	CINDY	64	118/80	160/70	135	120
		105	6#29	474	2155	2650
GRANT	SANDY	68	130/80	148/68	135	105
		105	5#08	374	1855	2125
GRANT	SANDY	68	130/74	170/58	135	105
		105	6#52	570	1855	2125
POTTS	BECKY	105	114/78	148/84	135	120
		105	4#43	343	2050	2250
POTTS	BECKY	72	106/70	160/76	150	120
		120	6#27	470	2050	2250
SNELSON	KAREN	88	120/80	168/78	165	120
		105	4#29	326	1770	2100
SNELSON	KAREN	60	122/80	156/60	150	120
		120	6#09	448	1770	2100
STINSON	MARY	90	100/74	110/80	135	105
		90	6#46	493	2295	2575
STINSON	MARY	56	108/80	120/84	150	120
		105	8#39	633	2295	2575
DAVIS	LISA	72	104/66	134/54	135	105
		105	8#53	656	2140	2685
DAVIS	LISA	54	098/58	140/60	150	105
		90	9#02	658	2140	2685
FITCH	NANCY	68	124/78	144/76	135	105
		105	8#41	635	2240	2800
FITCH	NANCY	90	130/76	160/84	135	120
		120	7#13	526	2240	2800
HARRELL	MARSHA	60	104/74	134/84	135	105
		105	10#51	792	2305	2575
HARRELL	MARSHA	88	108/78	152/60	150	135
		120	7#13	527	2305	2575
LASATER	CINDY	76	110/72	164/64	165	135
		120	7#20	535	1845	2350
LASATER	CINDY	84	120/70	160/80	150	120
		120	7#58	548	1845	2350
LYNCH	AMY	90	110/76	154/66	135	105
		105	9#03	656	2360	2855
LYNCY	AMY	52	110/74	180/60	135	90
		105	10#07	743	2360	2855
MARTIN	LEESA	82	114/78	128/70	135	120
		105	9#00	657	2360	2770
MARTIN	LEESA	72	114/78	138/68	135	120
		105	13#18	977	2360	2770

SHARBEL	CECILIA	68	106/68	132/72	120	105
		105	7#05	518	1680	2685
SHARBEL	CECILIA	56	104/76	150/74	135	105
		90	8#12	599	1680	2685
SINCLAIR	SUSAN	64	112/74	136/74	135	105
		105	13#05	955	2360	2630
SINCLAIR	SUSAN	68	110/80	130/70	135	105
		105	14#13	1042	2360	2630
SMILEY	LISA	120	123/78	130/90	150	135
		120	7#39	561	1680	2350
SMILEY	LISA	82	116/76	130/70	150	120
		105	9#09	669	1680	2350

BLEDSOE	FREDA	88 104/68	124/72	135	135
		135 5#25	393 1680 2360		
BLEDSOE	FREDA	84 102/78	112/78	135	120
		105 7#07	517 1680 2360		
DODD	CINDY	105 100/76	150/74	150	105
		105 8#36	627 2240 2505		
DODD	CINDY	56 092/70	150/68	120	105
		90 13#02	954 2240 2505		
FARRELL	LINDA	84 108/72	108/76	150	135
		120 6#02	440 1895 2645		
FARRELL	LINDA	84 110/72	136/76	150	135
		135 7#07	518 1895 2645		
HATFIELD	SIGNE	72 130/82	140/88	165	120
		105 6#00	441 2240 2600		
HATFIELD	SIGNE	76 130/72	150/70	135	120
		105 9#08	666 2240 2600		
PATRICK	DEBBIE	68 108/80	128/80	165	120
		105 7#53	572 1750 2500		
PATRICK	DEBBIE	66 116/80	160/60	135	105
		105 8#09	600 1750 2500		
RUMBAUGH	REBECCA	76 128/72	156/80	135	120
		105 7#06	517 2330 2725		
RUMBAUGH	REBECCA	54 120/74	190/74	135	135
		135 13#00	953 2330 2725		
WALLACE	ANITA	90 104/64	144/84	150	120
		120 6#34	478 2135 2550		
WALLACE	ANITA	56 116/70	138/78	120	105
		105 6#55	505 2135 2550		
BLEVINS	ANGIE	96 124/76	136/78	150	120
		120 5#09	376 2185 2685		
BLEVINS	ANGIE	106 120/80	138/72	135	135
		135 6#03	443 2185 2685		
CUNNINGHAM	GINGER	92 132/68	140/76	150	120
		120 7#23	537 1960 2860		
CUNNINGHAM	GINGER	84 116/80	168/54	135	120
		120 10#13	747 1960 2860		
DAVIS	SANDY	105 114/70	114/70	150	120
		120 10#56	797 2315 2820		
DAVIS	SANDY	80 134/70	122/74	150	135
		120 11#13	821 2315 2820		
DAVIS	TINA	72 110/70	126/70	135	120
		120 5#09	376 2080 2295		
DAVIS	TINA	64 110/70	136/66	150	135
		120 6#47	495 2080 2295		
EADS	ANNETTE	80 114/70	130/76	150	135
		120 5#10	377 2315 2760		
EADS	ANNETTE	74 118/72	124/70	135	135
		120 9#52	720 2315 2760		
FORBORD	VELINDA	72 110/70	144/76	120	105
		105 6#28	469 1960 2200		
FORBORD	VELINDA	72 108/72	150/74	135	105
		105 7#11	526 1960 2200		

LOVELL	MELISSA	76	122/80	154/72	150	120	
		105	5#44	402	2360	2800	
LOVELL	MELISSA	60	124/76	158/68	150	120	
		120	7#32	549	2360	2800	
THERBER	DIANE	78	106/68	130/74	135	120	
		105	7#58	529	1915	2540	
THERBER	DEBBIE	80	104/68	158/64	150	135	
		120	13#09	964	1915	2540	
WISE	MARY	92	130/80	134/80	150	120	
		105	9#33	696	2360	2860	
WISE	MARY	88	115/78	146/84	150	135	
		120	8#16	603	2360	2860	

EPPERLY	LUELLEN	60	114/76	144/80	120	90
		90	5#42	414 2305 2710		
EPPERLY	LUELLEN	88	118/70	150/80	135	120
		105	7#11	526 2305 2710		
GALLANT	DEBBIE	76	112/80	174/80	135	120
		105	6#22	463 2330 2750		
GALLANT	DEBBIE	62	100/80	152/72	135	120
		105	11#54	868 2330 2750		
GOSSER	KENDRA	70	124/72	130/80	150	135
		120	9#08	666 1745 2160		
GOSSER	KENDRA	82	142/76	200/50	150	135
		135	9#54	741 1745 2160		
IGOU	JEANNIE	75	114/84	140/84	150	120
		120	6#12	451 2330 2380		
IGOU	JEANNIE	96	110/70	124/72	165	135
		120	7#13	526 2330 2380		
MCCONNELL	NANCY	72	110/80	130/60	150	135
		135	6#19	460 1770 1980		
MCCONNELL	NANCY	82	104/68	132/60	135	120
		120	6#45	490 1770 1980		
MOSS	FRANCES	92	108/72	128/74	135	105
		105	6#06	446 1680 2405		
MOSS	FRANCES	90	108/70	120/68	150	120
		120	6#30	474 1680 2405		
SIMONS	PAM	105	120/68	115/76	160	120
		105	6#43	488 1780 2240		
SIMONS	PAM	82	124/70	130/70	150	135
		120	8#49	647 1780 2240		
WENZEL	SUSAN	90	116/88	140/66	150	120
		105	6#50	498 1865 2110		
WENZEL	SUSAN	80	124/76	132/76	135	120
		120	8#40	633 1865 2110		
WHITESIDES	BECKY	76	110/68	136/60	135	120
		105	9#13	674 2260 2685		
WHITESIDES	BECKY	84	120/72	144/58	135	120
		120	9#54	727 2260 2685		
BURTON	ANNE	76	118/82	144/90	135	120
		120	7#17	531 2360 3000		
BURTON	ANNE	86	110/75	142/80	135	120
		120	6#42	488 2360 3000		
FERRELL	DEBBIE	88	112/64	140/60	150	120
		120	4#16	312 2220 2585		
FERRELL	DEBBIE	70	110/76	120/68	135	120
		105	6#10	452 2220 2585		
HERNANDEZ	MARIA	80	112/72	134/78	165	135
		120	2#25	180 1855 2125		
HERNANDEZ	MARIA	92	110/60	140/70	150	135
		120	5#38	409 1855 2125		
HEWITT	MELISSA	68	088/64	140/66	135	120
		105	7#00	511 2025 2430		
HEWITT	MELISSA	56	108/66	148/60	135	120
		105	7#58	583 2025 2430		

KEATON	TERESA	72 120/70	128/78	135	120	
		120 744	566	1885	2405	
KEATON	TERESA	75 118/70	164/54	135	105	
		105 11#02	807	1885	2405	
PARKER	VICKI	72 114/60	134/58	135	105	
		105 9#32	697	2040	2705	
PARKER	VICKI	64 112/70	130/50	150	120	
		120 12#09	889	2040	2705	
POLLARD	MARY	75 120/70	138/62	150	105	
		105 11#21	829	2315	2800	
POLLARD	MARY	56 112/68	162/48	135	120	
		105 15#16	1116	2315	2800	
SMITHSON	SHERYL	90 120/72	150/80	150	120	
		120 4#32	331	2115	2685	
SMITHSON	SHERYL	64 120/74	144/70	150	135	
		120 5#17	385	2115	2685	

ALLEN,SALLY								
ALLEN,SALLY								
.13	2.55	1.36	27.40	1.08	21.90	.58	11.77	.36
.10	2.01	1.40	28.59	.96	19.57	.43	8.85	.23
7.20	.25	5.06	.26	5.20	2.53	51.13	1.90	38.38
4.76	.03	6.36	5.06	10.30	6.72	49.84	6.23	39.79
HANKINS,AMY								
HANKINS,AMY								
.20	5.04	1.02	25.25	.96	23.63	.44	10.79	.31
.19	4.62	1.08	26.55	.71	17.41	.36	8.93	.28
7.69	.31	7.69	.30	7.50	2.32	57.30	1.30	32.10
6.98	.24	5.95	.22	5.47	1.82	44.74	.88	21.64
MELSON,RITA								
MELSON,RITA								
.25	4.91	.99	19.22	.68	13.30	.42	8.22	.25
.23	4.35	1.29	24.22	.94	17.57	.50	9.47	.30
4.87	.26	5.01	.30	5.83	1.92	37.23	.66	12.68
5.68	.28	5.22	.25	4.74	2.27	42.68	1.11	20.93
PALMER,PAT								
PALMER,PAT								
.36	6.37	1.31	23.41	1.11	19.63	.06	1.15	.64
.26	4.62	1.95	34.80	1.75	31.27	.73	13.10	.50
12.26	.13	2.27	.38	6.70	2.31	42.01	.53	10.16
8.96	.40	7.22	.40	7.07	3.79	67.62	2.49	44.52
QUINLISK,KAREN								
QUINLISK,KAREN								
.21	4.01	1.70	32.24	1.08	20.40	.60	11.46	.48
.25	4.73	1.78	33.36	1.12	20.95	.60	11.26	.44
9.19	.41	7.87	.38	7.11	2.96	56.03	1.90	35.98
8.22	.38	7.07	.35	6.47	2.89	53.97	1.63	30.32
SMEAD,TODDY								
SMEAD,TODDY								
.25	5.16	1.03	21.10	.74	15.09	.47	9.59	.35
.27	5.32	1.19	23.50	.85	16.60	.46	8.96	.29
7.25	.27	5.62	.25	5.21	2.09	42.76	.83	16.96
5.77	.24	4.63	.29	5.68	2.12	41.64	.77	15.04
WILLIAMS,DARLENE								
WILLIAMS,DARLENE								
.42	6.93	1.20	19.92	.71	11.79	.32	5.36	.31
.25	4.14	1.99	33.15	1.22	20.34	.75	12.41	.46
5.13	.35	5.76	.29	4.77	1.98	32.81	-.11	-1.84
7.63	.38	6.26	.34	5.67	3.14	52.31	1.90	31.61
BENSEN,JOY								
BENSEN,JOY								
.34	5.51	1.80	28.77	1.32	21.11	.74	11.84	.41
.37	6.05	1.78	28.96	1.40	22.84	.69	11.27	.44
6.62	.39	6.29	.39	6.16	3.26	52.02	1.53	24.47
7.18	.28	4.60	.30	4.95	3.13	50.84	1.26	20.59

BURR,LAURIE								
BURR,LAURIE								
.18	3.98	1.22	26.60	.87	18.88	.55	11.99	.31
.17	3.64	1.54	32.20	1.08	22.61	.53	10.99	.42
6.67	.32	6.89	.21	4.65	2.26	49.08	1.34	29.18
8.72	.31	6.41	.26	5.39	2.59	54.12	1.72	35.92
JOHNSON,TERESA								
JOHNSON,TERESA								
.32	5.15	2.51	40.66	1.48	24.05	.79	12.77	.52
.24	3.77	1.88	30.08	1.18	18.99	.84	13.38	.50
8.41	.51	8.26	.41	6.61	3.71	60.10	2.12	34.35
8.06	.11	1.79	.09	1.40	2.72	43.62	1.54	24.77
SMITH,PAM								
SMITH,PAM								
.33	5.79	1.07	19.01	.98	17.34	.24	4.18	.53
.30	5.34	1.60	28.14	.86	15.01	.54	9.47	.30
9.41	.37	6.45	.83	14.62	2.95	52.00	1.31	23.05
5.20	.38	6.73	.27	4.79	2.35	41.20	.83	14.50
SMITH,WANDA								
SMITH,WANDA								
.20	3.83	1.24	24.01	.91	17.43	.68	13.09	.41
.24	4.47	1.28	24.35	.72	13.60	.54	10.17	.41
7.86	.41	7.90	.32	6.07	2.73	52.35	1.73	33.20
7.67	.26	4.99	.31	5.83	2.24	42.26	1.05	19.91
WHITEHEAD,NANCY								
WHITEHEAD,NANCY								
.16	3.00	1.16	21.88	.98	18.49	.60	11.33	.37
.17	3.18	1.35	25.67	.99	18.91	.54	10.24	.34
6.98	.29	5.40	.24	4.61	2.48	46.81	1.69	31.81
6.49	.32	6.13	.20	3.73	2.39	45.50	1.56	29.60

CARROLL,JANE								
CARROLL,JANE								
.19	3.32	1.53	26.40	.83	14.40	.62	10.47	.30
.15	2.44	1.44	24.09	1.19	19.95	.58	9.82	.44
5.27	.27	4.60	.30	5.16	2.33	39.90	1.37	23.30
7.32	.33	5.49	.27	4.48	2.81	47.06	2.08	34.86
CORLEY,BETH								
CORLEY,BETH								
.23	3.61	1.50	23.87	1.19	18.90	.74	11.80	.58
.34	5.52	1.48	24.26	.60	9.90	.98	16.03	.63
9.28	.39	6.14	.32	5.04	3.22	51.16	2.08	33.11
10.36	.46	7.54	.33	5.41	3.00	49.24	1.32	21.64
FRAZIER,CINDY								
FRAZIER,CINDY								
.28	4.37	2.01	31.65	1.25	19.69	.77	12.16	.44
.24	3.77	1.49	23.30	1.21	19.00	.46	7.12	.43
6.99	.34	5.43	.37	5.87	3.18	50.14	1.80	28.29
6.73	.32	4.93	.27	4.16	2.68	41.94	1.47	23.09
GPANT,SANDY								
GRANT,SANDY								
.30	4.52	1.50	22.40	.97	14.46	.61	9.06	.40
.25	3.68	1.81	27.06	1.36	2.04	.70	10.44	.27
6.01	.30	4.52	.29	4.33	2.58	38.38	1.06	15.78
4.09	.40	6.05	.37	5.56	3.11	28.18	1.88	9.78
POTTS,BECKY								
POTTS,BECKY								
.30	4.35	1.67	24.06	.91	13.14	.59	8.46	.24
.26	3.64	1.53	21.13	1.53	21.13	.90	12.38	.45
3.51	.38	5.40	.34	4.83	2.46	35.34	.94	13.59
6.23	.39	5.34	.35	4.76	3.62	49.84	2.29	31.64
SNELSON,KAREN								
SNELSON,KAREN								
.33	4.17	1.73	21.75	1.74	21.80	.97	12.17	.58
.14	1.92	2.06	27.62	1.42	19.12	.75	9.98	.47
7.31	.42	5.30	.43	5.33	4.14	51.91	2.48	31.06
6.28	.33	4.45	.27	3.68	3.24	43.51	2.53	33.91
STINSON,MARYBETH								
STINSON,MARYBETH								
.24	4.18	1.25	21.68	1.25	21.68	.60	10.34	.41
.28	5.24	34.00	3.92	16.73	2.33	.44	8.07	.38
7.08	.34	5.95	.33	5.76	2.94	50.81	1.73	29.91
7.06	.32	5.94	.28	5.18	18.15	28.58	16.73	2.38
DAVIS,LISA								
DAVIS,LISA								
.26	4.35	1.88	31.69	1.15	19.44	.60	10.07	.38
.28	4.61	1.97	32.22	1.23	20.14	.51	8.38	.41
6.42	.32	5.39	.27	4.58	2.72	45.90	1.43	24.15
6.67	.30	4.90	.29	4.79	2.74	44.88	1.33	21.83

FITCH,NANCY								
FITCH,NANCY								
.28	4.60	1.93	31.83	.96	15.84	.58	9.50	.44
.34	5.54	1.28	20.96	1.02	16.79	.76	12.52	.44
7.29	.29	4.72	.30	4.91	2.56	42.26	1.17	19.26
7.27	.38	6.16	.29	4.80	2.89	47.54	1.20	19.84
HARRELL,MARSHA								
HARRELL,MARSHA								
.29	5.29	1.19	21.57	.92	16.55	.56	10.14	.34
.35	6.44	1.59	29.20	.94	17.12	.56	10.20	.41
6.16	.29	5.24	.30	5.48	2.41	43.57	.94	17.12
7.58	.30	5.46	.29	5.25	2.49	45.61	.73	13.41
LASATER,CINDY								
LASATER,CINDY								
.41	7.09	1.68	28.77	.87	14.85	.81	13.81	.46
.38	6.57	1.54	26.55	1.28	22.07	.79	13.55	.48
7.89	.44	7.49	.37	6.33	2.94	50.37	.87	14.92
8.34	.44	7.50	.34	5.84	3.33	57.30	1.42	24.45
LYNCH,AMY								
LYNCH,AMY								
.34	5.70	2.20	37.08	1.88	31.58	1.51	25.51	.55
.25	4.33	2.15	37.56	1.37	23.94	.64	11.22	.47
9.26	.38	6.40	.38	6.35	4.70	79.10	3.01	50.60
8.19	.32	5.50	.25	4.38	3.05	53.23	1.81	31.58
MARTIN,LEESA								
MARTIN,LEESA								
.27	5.41	1.28	25.55	.91	18.12	.61	12.00	.36
.25	5.11	1.53	31.54	1.19	24.49	.61	12.52	.42
7.23	.30	5.92	.27	5.28	2.45	48.55	1.08	21.50
8.60	.34	7.07	.34	7.00	2.90	59.68	1.66	34.13
SHARBEL,CECILIA								
SHARBEL,CECILIA								
.19	3.28	1.43	24.30	.94	16.00	.45	7.72	.40
.34	5.56	2.07	34.05	1.38	22.74	.76	12.49	.44
6.87	.24	4.17	.27	4.67	2.32	39.43	1.36	23.03
7.14	.42	6.82	.31	5.13	3.31	54.32	1.61	26.52
SINCLAIR,SUSAN								
SINCLAIR,SUSAN								
.22	3.76	1.75	30.44	1.36	23.80	.76	13.24	.40
.28	4.89	2.03	35.54	1.31	22.84	.68	11.89	.43
6.97	.32	5.51	.31	5.41	3.15	54.93	2.07	36.13
7.54	.34	5.91	3.53	6.16	6.29	54.34	4.89	29.89
SMILEY,LEISA								
SMILEY,LEISA								
.28	5.41	1.55	29.67	.55	10.61	.62	11.88	.45
.25	4.80	1.52	28.79	.92	17.48	.54	10.24	.35
8.67	.33	6.29	.21	4.11	2.17	41.56	.76	14.51
6.59	.30	5.71	.24	4.57	2.36	44.59	1.09	20.59

BLEDSOE,FREDA
BLEDSOE,FREDA

.01	.19	.92	18.52	.58	11.70	.29	5.92	.17
.26	5.28	1.44	29.50	1.13	23.19	.50	10.31	.38
3.43	.14	2.81	.13	2.63	1.31	26.49	1.27	25.56
7.68	.27	5.51	.30	6.09	2.58	52.78	1.28	26.38

DODD,CINDY
DODD,CINDY

.23	4.62	1.36	26.80	.31	6.10	.54	10.61	.44
.11	2.30	1.75	36.20	.56	11.67	.63	13.12	.60
8.59	.39	7.75	.30	5.98	1.99	39.03	.81	15.93
12.50	.22	4.47	.26	5.47	2.28	47.23	1.73	35.73

FARRELL,LINDA
FARRELL,LINDA

.22	4.22	1.28	24.10	1.09	20.50	.52	9.74	.43
.20	3.67	1.50	28.03	1.02	19.11	.54	10.07	.32
8.01	.38	7.08	.16	2.95	2.57	48.28	1.45	27.18
5.97	.35	6.50	.32	5.96	2.54	47.61	1.56	29.26

HATFIELD,SIGNE
HATFIELD,SIGNE

.33	5.47	1.93	32.39	1.09	18.33	.75	12.50	.45
.33	5.53	1.98	33.20	1.21	20.25	.78	13.07	.34
7.53	.39	6.54	.42	7.05	3.09	51.95	1.46	24.60
5.75	.41	6.88	.27	4.50	3.01	50.45	1.36	22.80

PATRICK,DEBBIE
PATRICK,DEBBIE

.24	3.83	1.98	32.13	1.47	23.80	.74	12.02	.49
.21	3.56	1.68	28.31	.97	16.39	.58	9.82	.38
7.93	.43	6.99	.29	4.69	3.43	55.43	2.24	36.28
6.33	.28	4.76	.27	4.64	2.49	41.94	1.44	24.14

RUMBAUGH,REBECCA
RUMBAUGH,REBECCA

.34	5.38	1.71	27.20	1.32	21.07	.93	14.86	.58
.18	2.92	2.01	32.24	1.25	20.19	.89	14.30	.58
9.29	.42	6.67	.36	5.78	3.62	57.67	1.93	30.77
9.37	.49	7.86	.39	6.21	3.60	57.93	2.69	43.33

WALLACE,ANITA
WALLACE,ANITA

.38	6.35	2.03	34.02	1.21	20.29	.87	14.58	.50
.36	5.94	1.97	32.38	1.11	18.25	.76	12.48	.46
8.35	.42	7.07	.43	7.17	3.44	57.46	1.54	25.71
7.59	.35	5.79	.39	6.40	3.08	50.51	1.27	20.81

BLEVINS,ANGIE
BLEVINS,ANGIE

.18	3.99	1.05	23.10	.26	5.65	.43	9.49	.28
.26	5.38	1.28	26.69	.84	17.52	.21	4.38	.46
6.24	.23	4.99	.21	4.72	1.41	31.09	.50	11.14
9.59	.30	6.21	.27	5.61	2.08	43.31	.79	16.41

CUNNINGHAM,GINGER
CUNNINGHAM,GINGER

.09	1.42	1.63	26.60	1.08	17.66	.61	9.95	.40
.29	4.58	2.48	39.75	1.57	25.27	.78	12.47	.29
6.49	.34	5.56	.31	5.03	2.74	44.69	2.31	37.59
4.58	.58	9.30	.40	6.44	3.62	58.06	2.19	35.16

DAVIS,SANDY
DAVIS,SANDY

.32	5.68	2.01	35.19	1.43	25.15	.83	14.57	.58
.27	4.73	1.64	28.94	1.03	18.23	.57	10.13	.34
10.17	.47	8.23	.43	7.50	3.74	65.62	2.12	37.22
5.97	.24	4.19	.31	5.56	2.49	44.08	1.15	20.43

DAVIS,TINA
DAVIS,TINA

.22	3.57	1.31	20.93	.95	15.15	.44	6.97	.30
.34	5.55	1.60	25.99	1.00	16.23	.49	7.96	.39
4.70	.33	5.29	.28	4.44	2.30	36.55	1.17	18.70
6.31	.26	4.24	.28	4.51	2.42	39.25	.71	11.50

EADS,ANNETTE
EADS,ANNETTE

.31	7.08	1.08	25.10	1.28	29.66	.31	7.07	.32
.33	7.39	1.29	28.69	.82	18.13	.67	14.92	.38
7.42	.32	7.38	.28	6.56	2.51	58.09	.98	22.69
7.71	.41	9.21	.30	6.68	2.59	56.65	.93	19.70

FORBORD,VELINDA
FORBORD,VELINDA

.29	4.94	1.27	22.07	.76	13.21	.78	13.34	.37
.32	5.35	1.61	27.28	1.04	17.71	.63	10.62	.35
6.43	.34	5.91	.31	5.43	2.57	44.32	1.14	19.62
5.93	.31	5.28	.23	3.97	2.57	43.51	.98	16.76

LOVELL,MELISSA
LOVELL,MELISSA

.18	2.62	1.66	24.30	.92	13.49	.80	11.79	.57
.35	5.02	2.07	29.87	1.73	24.93	1.03	14.92	.59
8.37	.47	6.92	.37	5.42	3.13	45.99	2.24	32.89
8.45	.42	6.07	.36	5.20	4.13	59.57	2.39	34.47

THERBER,DEBBIE
THERBER,DEBBIE

.10	2.00	1.47	28.51	.26	4.97	.57	11.05	.44
.19	3.60	1.81	34.34	1.09	20.68	.59	11.30	.41
8.60	.34	6.68	.35	6.72	1.96	38.02	1.45	28.02
7.73	.29	5.44	.30	5.65	2.68	50.80	1.73	32.80

WISE,MARY
WISE,MARY

.41	6.12	1.63	24.32	.98	14.66	.84	12.54	.54
.31	4.62	1.79	26.35	1.20	17.73	.83	12.23	.50
8.02	.43	6.36	.38	5.74	3.17	47.32	1.12	16.72
7.37	.37	5.48	.35	5.10	3.26	47.91	1.68	24.81

EPPERLY,LUELLEN								
EPPERLY,LUELLEN								
.23	4.54	1.25	24.24	.91	17.60	.63	12.06	.42
.31	5.50	1.80	32.37	1.23	22.11	.63	11.29	.44
8.05	.33	6.35	.30	5.72	2.59	49.78	1.41	27.08
7.83	.30	5.48	.35	6.24	2.95	52.95	1.42	25.45
GALLANT,DEBBIE								
GALLANT,DEBBIE								
.16	2.57	1.85	30.43	1.55	25.44	.93	15.34	.56
.35	5.57	2.83	44.95	1.44	22.93	.77	12.16	.57
9.14	.56	9.27	.32	5.24	3.93	64.43	3.14	51.58
9.03	.47	7.51	.35	5.49	3.59	57.12	1.84	29.27
GOSSER,KENDRA								
GOSSER,KENDRA								
.34	5.25	2.11	32.72	1.62	25.13	.99	15.29	.64
.32	4.68	2.40	35.08	1.63	23.76	.80	11.65	.75
9.90	.57	8.79	.49	7.60	4.31	66.71	2.61	40.46
10.92	.59	8.65	.47	6.91	4.24	61.89	2.64	38.49
IGOU,JEANNIE								
IGOU,JEANNIE								
.24	3.77	1.81	28.10	1.51	23.48	.78	12.10	.36
.34	5.14	2.64	40.43	1.97	30.20	.88	13.52	.52
5.63	.31	4.87	.38	5.94	3.35	52.02	2.14	33.17
7.97	.39	6.03	.38	5.84	4.15	63.56	2.47	37.86
MCCONNELL,NANCY								
MCCONNELL,NANCY								
.29	5.44	1.47	27.39	1.00	18.67	.79	14.57	.40
.21	3.82	1.22	21.95	.83	14.95	.54	9.65	.34
7.41	.35	6.44	.30	5.58	2.83	52.67	1.37	25.47
6.06	.25	4.51	.25	4.48	2.21	39.65	1.15	20.55
MOSS,FRANCES								
MOSS,FRANCES								
.19	4.05	1.15	24.67	.86	18.52	.48	10.32	.31
.21	4.33	1.91	40.23	.76	15.93	.56	11.75	.38
6.76	.33	7.07	.19	4.07	2.18	46.74	1.24	26.49
8.08	.25	5.26	.24	4.99	2.19	46.01	1.16	24.36
SIMONS,PAM								
SIMONS,PAM								
.42	7.53	1.44	25.69	.91	16.17	.53	9.45	.47
.29	5.01	1.59	27.98	.95	16.62	.60	10.45	.41
8.40	.38	6.85	.38	6.85	2.68	47.72	.56	10.07
7.18	.37	6.48	.29	5.17	2.62	45.90	1.19	20.85
WENZEL,SUSAN								
WENZEL,SUSAN								
.32	6.86	.77	16.44	.64	13.72	.43	9.30	.22
.28	5.55	1.49	29.97	1.03	20.67	.62	12.37	.32
4.71	.13	2.79	.09	2.02	1.51	32.54	-.08	-1.76
6.46	.32	6.49	.23	4.58	2.52	50.57	1.13	22.82

WHITESIDES,REBECCA								
WHITESIDES,BECKY								
.21	4.29	1.63	33.20	1.04	21.30	.58	11.85	.39
.20	4.05	1.63	33.67	.86	17.70	.53	10.99	.31
8.03	.33	6.71	.28	5.69	2.62	53.58	1.57	32.13
6.37	.31	5.36	.25	5.24	2.26	45.66	1.28	25.41
BURTON,ANNE								
BURTON,ANNE								
.23	3.47	1.51	23.34	1.00	15.48	.64	9.90	.36
.27	4.26	1.54	24.27	1.11	17.43	.47	7.36	.37
5.56	.33	5.11	.30	4.57	2.63	40.62	1.50	23.27
5.77	.32	4.97	.22	3.44	2.48	38.97	1.13	17.67
FERRELL,DEBBIE								
FERRELL,DEBBIE								
.18	3.83	1.14	23.93	.79	16.58	.41	8.50	.28
.21	4.56	1.53	32.79	.78	16.60	.50	10.64	.30
5.90	.25	5.19	.25	5.18	1.98	41.35	1.06	22.20
6.32	.27	5.81	.19	4.08	2.04	43.45	.97	20.65
HERNANDEZ,MARIA								
HERNANDEZ,MARIA								
.17	2.90	.99	16.63	.99	16.83	.63	10.48	.47
.31	4.94	1.54	24.92	.68	10.95	.53	8.53	.28
7.97	.30	5.06	.38	6.31	2.77	46.65	1.90	32.15
4.46	.29	4.67	.31	5.02	2.08	33.63	.55	8.93
HEWITT,MELISSA								
HEWITT,MELISSA								
.13	2.51	1.40	26.10	1.13	21.17	.21	3.86	.32
.29	5.49	1.97	36.99	.70	13.14	.57	10.69	.24
5.90	.31	5.79	.09	1.60	2.05	38.32	1.38	25.77
4.52	.31	5.74	.28	5.19	2.09	39.28	.63	11.83
KEATON,TERESA								
KEATON,TERESA								
.25	4.18	1.59	26.11	.92	15.11	.41	6.71	.27
.23	3.57	1.94	30.08	1.29	20.04	.58	8.98	.48
4.48	.15	2.39	.27	4.40	2.01	33.09	.74	12.19
7.38	.31	4.80	.33	5.11	2.99	46.31	1.83	28.46
PARKER,VICKI								
PARKER,VICKI								
.08	1.63	1.44	28.94	.80	15.95	.46	9.14	.35
.24	4.62	1.36	26.59	.16	3.11	1.44	28.06	.37
6.96	.30	5.99	.25	5.02	2.15	43.06	1.75	34.91
7.24	.30	5.90	.26	5.13	2.54	49.44	1.35	26.34
POLLARD,MARY								
POLLARD,MARY								
.14	2.29	2.45	40.89	.83	13.90	1.75	29.33	.53
.18	2.95	2.55	42.76	1.69	28.39	.84	14.10	.53
8.89	.49	8.24	.33	5.55	3.94	65.91	3.26	54.46
8.92	.48	8.07	.30	5.08	3.85	64.56	2.97	49.81
SMITHSON,SHERYL								
SMITHSON,SHERYL								
.23	3.56	1.48	22.87	1.11	17.17	.62	9.58	.41
.32	5.00	1.51	23.88	1.25	19.88	.88	13.83	.47
6.37	.38	5.92	.32	4.94	2.85	43.98	1.70	26.18
7.47	.27	4.31	.34	5.40	3.21	50.89	1.63	25.89

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