EFFECT OF AEROBIC DANCE AND WATER AEROBIC EXERCISE ON PHYSICAL FITNESS

KANITA TEPKAEW

With compliments of

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (SPORTS SCIENCE)

FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2002

ISBN 974-05-1058-2

COPYRIGHT OF MAHIDOL UNIVERSITY
Thesis entitled

EFFECT OF AEROBIC DANCE AND WATER AEROBIC EXERCISE ON PHYSICAL FITNESS

Ms. Kanita Tepkaew
Candidate

Asst. Prof. Panya Kaimuk, M.D.
Board of Orthopedic Surgery
Major-Advisor

Assoc. Prof. Thyon Chentanez, Ph.D.
Co-Advisor

Prof. Liangchai Limlomwongse, Ph.D
Dean
Faculty of Graduate Studies

Asst. Prof. Panya Kaimuk, M.D.
Board of Orthopedic Surgery
Chair
Master of Science Programme
in Sports Science
College of Sports Science and Technology
Thesis entitled

EFFECT OF AEROBIC DANCE AND WATER AEROBIC EXERCISE ON PHYSICAL FITNESS

was submitted to the Faculty of Graduate Studies, Mahidol University for the degree of Master of Science (Sports Science) on April 17, 2002

Ms. Kanita Tepkaew
Candidate

P. Kaew M.D.
Asst. Prof. Panya Kaimuk, M.D.
Board of Orthopedic Surgery Chair

Assoc. Prof. Thyon Chentanez, Ph.D.
Member

Lect. Suwat Sidhilaw, Ph.D.
Member

Prof. Liangchai Limlomwongse, Ph.D
Dean
Faculty of Graduate Studies
Mahidol University

Asst. Prof. Panya Kaimuk, M.D.
Board of Orthopedic Surgery Director
College of Sports Science and Technology
Mahidol University
ACKNOWLEDGEMENTS

I wish to express my sincerest appreciation and profoundest gratitude to Asst. Prof. Panya Kaimuk, my advisor, for his attention, supervision, invaluable advice, helpful guidance and encouragement throughout this study.

I would like to thank Assoc. Prof. Thyon Chentanez, my co-advisor, for his kindness, supporting and constructive comments. He was always nice and friendly. Also, I would like to thank Lect. Suwat Sidhilaw for his excellence suggestions and support with respect.

My success in this completing this study became a reality with kind of Physical Education Department, Mahidol Wittayanusorn School and girl students who participated in.

Last of all, but most on my mind, I wish to acknowledge the generosity and ingenuity of Mr. Boonlerd Tepkaew, my daddy. He was my first inspiration. My dearest mom and my lovely sisters who strengthened me to persevere and resist all hostile environments.

Kanita Tepkaew
The purpose of this study was to compare the effect of normal aerobic dance and water aerobic exercise on physical fitness. Thirty healthy female teenagers (15 to 17 yrs) were selected to participate in this study and were randomly assigned to NE (control group: n = 10), AE (aerobic dance group: n = 10), and WE (water aerobic group: n = 10). Both AE and WE exercised at the same intensity (60% to 70% HRR), frequency (3 times/week), and duration (40-45 min) for 8 weeks. Physical fitness testing was done before and after exercise training and included measurements of maximum oxygen consumption (VO2max), leg strength, flexibility, percent of body fat (%BF), leg volume, and agility. Pair t-test and one way ANOVA were used to analyze the data. The results showed that the exercise training groups had significant (P<0.05) improvement in maximum oxygen consumption (VO2max), leg strength, and agility. In contrast, %BF was decreased and leg volume did not change. There was no significant difference for maximum oxygen consumption (VO2max), leg strength, flexibility, percent of body fat (%BF), leg volume, and agility between AE and WE, however maximum oxygen consumption (VO2max) and leg strength of WE tended to be higher than AE.

These results suggest that both aerobic dance and water aerobic exercise improve physical fitness and mental fitness. The water exercise provides an alternative means of exercising for overweight, injured or ill individuals. Studies, with a longer training duration, higher training intensity, different gender and age groups, water exercise with osteoporosis patients or handicapped, and effect on axial load are recommended for the future research.
4237898 SPSS/M : สาขาวิชา : วิทยาศาสตร์การกีฬา ; ว.ม. (วิทยาศาสตร์การกีฬา)

ศึกษา เทพเจริญ : ผลของการดANCE AND WATER AEROBIC EXERCISE ON PHYSICAL

(EFFECT OF AEROBIC DANCE AND WATER AEROBIC EXERCISE ON PHYSICAL
FITNESS) คณะกรรมการควบคุมวิทยานิพนธ์ : ปัญญา ไข่มุก, M.D., โอดอน รินเทน, Ph.D.
134 หน้า ISBN 974-05-1058-2

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อเปรียบเทียบผลของการต้นแอโรบิกบนและในน้ำที่มี
ต่อสมรรถภาพทางกาย กลุ่มตัวอย่าง เป็นวัยรุ่นหญิงจำนวน 30 คน (อายุ 15 ถึง 17 ปี) ให้รับการคัด
เลือกและแบ่งออกเป็น 3 กลุ่ม ได้แก่ กลุ่มควบคุม จำนวน 10 คน กลุ่มต้นแอโรบิกบน จำนวน
10 คน และกลุ่มต้นแอโรบิกในน้ำ จำนวน 10 คน ซึ่งกลุ่มต้นแอโรบิกบนและในน้ำจะเข้าร่วม
โปรแกรมการฝึกที่เท่ากันคือ ความหนัก ( 60% ถึง 70% ของอัตราการเต้นที่สูงสุด) ความ
บอย (3 วัน/สัปดาห์), และ ความยาว (40 ถึง 45 นาที ) ระยะเวลาการฝึกครั้งละ 8 สัปดาห์ ทั้ง
กลุ่มและหลังการทดลอง ทำการทดสอบสมรรถภาพทางกาย ได้แก่ สมรรถภาพการต้นแอโรบิกบนสูง
สุด, ความแข็งแรงของกล้ามเนื้อ, ความยืดหยุ่น, ปริมาณออกซิเจน, และความคล่องแคล่ว การ
วิเคราะห์ข้อมูลทางสถิติ ใช้ คำ "ทิ" (Pair t-test) และ การวิเคราะห์ความแปรปรวนทางดีayı (one
way ANOVA) ผลการวิจัยพบว่า กลุ่มที่เข้าร่วมโปรแกรมการฝึกทั้งสองกลุ่ม สมรรถภาพทางกายมีการปรับ
ปรุงเพิ่มขึ้น โดยมีนักต้นแอโรบิกที่ควบคุมกลุ่มควบคุม อย่างไรก็ตามเพื่อเปรียบเทียบระหว่าง
กลุ่มต้นแอโรบิกบนและในน้ำ พบว่า ไม่มีความแตกต่างโดยมีนักต้นแอโรบิกที่ควบคุมการจับ
ออกซิเจนสูงสุด และความแข็งแรงของกล้ามเนื้อกลุ่มต้นแอโรบิกในน้ำจะมีแนวโน้มที่มากกว่ากลุ่ม
t้นแอโรบิกบนทั้งหมด

จากผลการวิจัยครั้งนี้แสดงให้เห็นว่า การออกกําลังกายแบบแอโรบิกทั้งสองแบบ ทำให้สมรรถภาพทางกายดีขึ้น ส่วนการออกกําลังกายในน้ำ เป็นอีกทางเลือกในการออกกําลังกายของแต่
ละบุคคล, ผู้ที่มีนักนักกิจกรรม, ผู้ที่ได้รับการบาดเจ็บ, หรือผู้ที่มีสุขภาพไม่แข็งแรง ต่อไปน่าจะ
เพิ่มระยะเวลา หรือความหนักในการออกกําลังกาย ปรับค่าความต้องการออกกำลัง เพศ หรือ ศักยภาพในผู้เป็น
โรคกระดูกบาง, ควบคับการ หรือผลระดับที่มีต่อความต้านทานตามเกณฑ์ของการออกกําลังกาย เป็นต้น
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xvi</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>I INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>II OBJECTIVES</td>
<td>4</td>
</tr>
<tr>
<td>III LITERATURE REVIEW</td>
<td>5</td>
</tr>
<tr>
<td>1. AEROBIC DANCE EXERCISE</td>
<td></td>
</tr>
<tr>
<td>2. WATER AEROBIC EXERCISE</td>
<td></td>
</tr>
<tr>
<td>3. PHYSICAL FITNESS</td>
<td></td>
</tr>
<tr>
<td>IV MATERIALS AND METHODS</td>
<td>37</td>
</tr>
<tr>
<td>V RESULTS</td>
<td>46</td>
</tr>
<tr>
<td>VI DISCUSSION</td>
<td>92</td>
</tr>
<tr>
<td>VII CONCLUSION</td>
<td>107</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>109</td>
</tr>
<tr>
<td>APPENDIX</td>
<td>121</td>
</tr>
<tr>
<td>BIOGRAPHY</td>
<td>134</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table                                                                                           Page
1. Location and percent of aerobic dance injuries.                                               2
2. Exercise programs conducted to music traditional aerobics, low-impact                       7
   aerobics, aerobic dancing. (under 30 years of age)
3. Sites and frequency of injuries (%) among aerobic dance students and                        11
   instructors—reported in 4 studies.
4. Number of injuries per 100 hours of aerobic dance.                                          12
5. Standardized sites and direction of folds for skinfold measurements                          41
6. General physical characteristics of the control group (NE), the aerobic                    54
   dance group (AE), and water aerobic group (WE). Values are presented as means and the
   standard errors of the means.
7. Means, SEMs of physical fitness parameters of the control group (NE), aerobic dance        55
   group (AE) and water aerobic group (WE) compare before exercise training.
8. Means, SEMs of VO₂max (L/min) of the control group (NE), aerobic dance group (AE)          56
   and water aerobic group (WE) compare before and after exercise training.
9. Means, SEMs of leg strength (kg) of the control group (NE), aerobic dance group (AE)        57
   and water aerobic group (WE) compare before and after exercise training.
10. Means, SEMs of flexibility (cm) of the control group (NE), aerobic dance group (AE)        58
    and water aerobic group (WE) compare before and after exercise training.
LIST OF TABLES (CONT.)

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Means, SEMs of %BF of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before and after exercise training.</td>
<td>59</td>
</tr>
<tr>
<td>12. Means, SEMs of leg volume (ml) of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before and after exercise training</td>
<td>60</td>
</tr>
<tr>
<td>13. Means, SEMs of agility (times/20s) of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before and after exercise training</td>
<td>61</td>
</tr>
<tr>
<td>14. Means, SEMs of physical fitness parameters of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare after exercise training.</td>
<td>62</td>
</tr>
<tr>
<td>15. Number and percentage of psychological responses concerning exercise satisfaction of aerobic dance group (AE) after exercise training.</td>
<td>63</td>
</tr>
<tr>
<td>16. Number and percentage of psychological responses concerning exercise satisfaction of water aerobic group (WE) after exercise training.</td>
<td>65</td>
</tr>
<tr>
<td>17. Means, SEMs of psychological responses concerning exercise satisfaction of aerobic dance group (AE) and water aerobic group (WE) compare after exercise training.</td>
<td>67</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Location, number, and percent of aerobic dance injuries.</td>
<td>13</td>
</tr>
<tr>
<td>2. Loading of the lower limb when walking partially immersed: Implications for clinical practice.</td>
<td>18</td>
</tr>
<tr>
<td>3. Changing intensity by altering length of resistance arm; a knee lift is easier to perform than a straight leg lift to the front.</td>
<td>19</td>
</tr>
<tr>
<td>4. a summary of the major, intermediate, and minor physiological factors in the specificity of aerobic training and exercise. The interaction among the various components is indicated by double-headed arrows</td>
<td>29</td>
</tr>
<tr>
<td>5. Six truncated segments of the leg and sites from which the antropometric measurement.</td>
<td>43</td>
</tr>
<tr>
<td>6. Nine-square test area.</td>
<td>44</td>
</tr>
<tr>
<td>7. Experimental procedures</td>
<td>45</td>
</tr>
<tr>
<td>8. Comparison of means(±SEMs) values of age among control (NE), aerobic dance (AE) and water aerobic (WE) groups at the beginning.</td>
<td>68</td>
</tr>
<tr>
<td>9. Comparison of means (±SEMs) values of BMI among control (NE), aerobic dance (AE) and water aerobic (WE) groups at the beginning.</td>
<td>68</td>
</tr>
<tr>
<td>10. Comparison of means (±SEMs) values of RHR among control (NE), aerobic dance (AE) and water aerobic (WE) groups at the beginning.</td>
<td>69</td>
</tr>
</tbody>
</table>
LIST OF FIGURES (CONT.)

Figure                                      Page

11. Comparison of means (±SEMs) values of blood pressure (BP) among control (NE), aerobic dance (AE) and water aerobic (WE) groups at the beginning. 70

12. Comparison of means (±SEMs) values of VO₂max among control (NE), aerobic dance (AE) and water aerobic (WE) groups before exercise training. 71

13. Comparison of means (±SEMs) values of leg strength among control (NE), aerobic dance (AE) and water aerobic (WE) groups before exercise training. 71

14. Comparison of means (±SEMs) values of flexibility among control (NE), aerobic dance (AE) and water aerobic (WE) groups before exercise training. 72

15. Comparison of means (±SEMs) values of %BF among control (NE), aerobic dance (AE) and water aerobic (WE) groups before exercise training. 72

16. Comparison of means (±SEMs) of values leg volume among control (NE), aerobic dance (AE) and water aerobic (WE) groups before exercise training. 73

17. Comparison of means (±SEMs) values of agility among control (NE), aerobic dance (AE) and water aerobic (WE) groups before exercise training. 73
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.</td>
<td>Comparison of means (±SEMs) values of VO$_2$max among control (NE), aerobic dance (AE) and water aerobic (WE) groups after exercise training.</td>
<td>74</td>
</tr>
<tr>
<td>19.</td>
<td>Comparison of means (±SEMs) values of leg strength among control (NE), aerobic dance (AE) and water aerobic (WE) groups after exercise training.</td>
<td>74</td>
</tr>
<tr>
<td>20.</td>
<td>Comparison of means (±SEMs) values of flexibility among control (NE), aerobic dance (AE) and water aerobic (WE) groups after exercise training.</td>
<td>75</td>
</tr>
<tr>
<td>21.</td>
<td>Comparison of means (±SEMs) values of %BF among control (NE), aerobic dance (AE) and water aerobic (WE) groups after exercise training.</td>
<td>75</td>
</tr>
<tr>
<td>22.</td>
<td>Comparison of means (±SEMs) values of leg volume among control (NE), aerobic dance (AE) and water aerobic (WE) groups after exercise training.</td>
<td>76</td>
</tr>
<tr>
<td>23.</td>
<td>Comparison of means (±SEMs) values of agility among control (NE), aerobic dance (AE) and water aerobic (WE) groups after exercise training.</td>
<td>76</td>
</tr>
<tr>
<td>24.</td>
<td>Comparison of means (±SEMs) values of VO$_2$max among control (NE), aerobic dance (AE) and water aerobic (WE) groups before and after exercise training.</td>
<td>77</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES (CONT.)

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>25. Comparison of means (±SEMs) values of leg strength among control (NE), aerobic dance (AE) and water aerobic (WE) groups before and after exercise training.</td>
<td>77</td>
</tr>
<tr>
<td>26. Comparison of means (±SEMs) values of flexibility among control (NE), aerobic dance (AE) and water aerobic (WE) groups before and after exercise training.</td>
<td>78</td>
</tr>
<tr>
<td>27. Comparison of means (±SEMs) values of %BF among control (NE), aerobic dance (AE) and water aerobic (WE) groups before and after exercise training.</td>
<td>78</td>
</tr>
<tr>
<td>28. Comparison of means (±SEMs) values of leg volume among control (NE), aerobic dance (AE) and water aerobic (WE) groups before and after exercise training.</td>
<td>79</td>
</tr>
<tr>
<td>29. Comparison of means (±SEMs) values of agility among control (NE), aerobic dance (AE) and water aerobic (WE) groups before and after exercise training.</td>
<td>79</td>
</tr>
<tr>
<td>30. Comparison of means (±SEMs) values of VO$_{2}$max within control group (NE) “before” and “after” exercise training. (without actual programmed exercise).</td>
<td>80</td>
</tr>
<tr>
<td>31. Comparison of means (±SEMs) values of leg strength within control group (NE) “before” and “after” exercise training. (without actual programmed exercise).</td>
<td>80</td>
</tr>
</tbody>
</table>
### LIST OF FIGURES (CONT.)

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>32. Comparison of means (±SEMs) values of flexibility within control group (NE) “before” and “after” exercise training. (without actual programmed exercise).</td>
<td>81</td>
</tr>
<tr>
<td>33. Comparison of means (±SEMs) values of %BF within control group (NE) “before” and “after” exercise training. (without actual programmed exercise).</td>
<td>81</td>
</tr>
<tr>
<td>34. Comparison of means (±SEMs) values of leg volume within control group (NE) “before” and “after” exercise training. (without actual programmed exercise).</td>
<td>82</td>
</tr>
<tr>
<td>35. Comparison of means (±SEMs) values of agility within control group (NE) “before” and “after” exercise training. (without actual programmed exercise).</td>
<td>82</td>
</tr>
<tr>
<td>36. Comparison of means (±SEMs) values of VO₂max within aerobic dance group (AE) “before” and “after” exercise training.</td>
<td>83</td>
</tr>
<tr>
<td>37. Comparison of means (±SEMs) values of leg strength within aerobic dance group (AE) “before” and “after” exercise training.</td>
<td>83</td>
</tr>
<tr>
<td>38. Comparison of means (±SEMs) values of flexibility within aerobic dance group (AE) “before” and “after” exercise training.</td>
<td>84</td>
</tr>
<tr>
<td>39. Comparison of means (±SEMs) values of %BF within aerobic dance group (AE) “before” and “after” exercise training.</td>
<td>84</td>
</tr>
</tbody>
</table>
### LIST OF FIGURES (CONT.)

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>40. Comparison of means (±SEMs) values of leg volume within aerobic dance group (AE) “before” and “after” exercise training.</td>
<td>85</td>
</tr>
<tr>
<td>41. Comparison of means (±SEMs) values of agility within aerobic dance group (AE) “before” and “after” exercise training.</td>
<td>85</td>
</tr>
<tr>
<td>42. Comparison of means (±SEMs) values of VO$_2$max within water aerobic group (WE) “before” and “after” exercise training.</td>
<td>86</td>
</tr>
<tr>
<td>43. Comparison of means (±SEMs) values of leg strength within water aerobic group (WE) “before” and “after” exercise training.</td>
<td>86</td>
</tr>
<tr>
<td>44. Comparison of means (±SEMs) values of flexibility within water aerobic group (WE) “before” and “after” exercise training.</td>
<td>87</td>
</tr>
<tr>
<td>45. Comparison of means (±SEMs) values of %BF within water aerobic group (WE) “before” and “after” exercise training.</td>
<td>87</td>
</tr>
<tr>
<td>46. Comparison of means (±SEMs) values of leg volume within water aerobic group (WE) “before” and “after” exercise training.</td>
<td>88</td>
</tr>
<tr>
<td>47. Comparison of means (±SEMs) values of agility within water aerobic group (WE) “before” and “after” exercise training.</td>
<td>88</td>
</tr>
<tr>
<td>48. Comparison of means (±SEMs) values of VO$_2$max among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.</td>
<td>89</td>
</tr>
</tbody>
</table>
**LIST OF FIGURES (CONT.)**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>49.</td>
<td>Comparison of means (±SEMs) values of leg strength among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.</td>
<td>89</td>
</tr>
<tr>
<td>50.</td>
<td>Comparison of means (±SEMs) values of flexibility among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.</td>
<td>90</td>
</tr>
<tr>
<td>51.</td>
<td>Comparison of means (±SEMs) values of %BF among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.</td>
<td>90</td>
</tr>
<tr>
<td>52.</td>
<td>Comparison of means (±SEMs) values of leg volume among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.</td>
<td>91</td>
</tr>
<tr>
<td>53.</td>
<td>Comparison of means (±SEMs) values of agility among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.</td>
<td>91</td>
</tr>
</tbody>
</table>
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACL</td>
<td>anterior cruciate ligament</td>
</tr>
<tr>
<td>ACSM</td>
<td>American College of Sports Medicine</td>
</tr>
<tr>
<td>AE</td>
<td>aerobic dance group</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of variance</td>
</tr>
<tr>
<td>ASIS</td>
<td>anterior superior iliac spine</td>
</tr>
<tr>
<td>ATP</td>
<td>adenosine triphosphate</td>
</tr>
<tr>
<td>% BF</td>
<td>percent of body fat</td>
</tr>
<tr>
<td>BMI</td>
<td>body mass index</td>
</tr>
<tr>
<td>BP</td>
<td>blood pressure</td>
</tr>
<tr>
<td>BPM</td>
<td>beats per minute</td>
</tr>
<tr>
<td>cm</td>
<td>centimeters</td>
</tr>
<tr>
<td>e.g.</td>
<td>exampli gratia</td>
</tr>
<tr>
<td>et al</td>
<td>Et alii</td>
</tr>
<tr>
<td>etc.</td>
<td>et cetera</td>
</tr>
<tr>
<td>FT</td>
<td>fast twitch</td>
</tr>
<tr>
<td>h</td>
<td>height</td>
</tr>
<tr>
<td>HRR</td>
<td>heart rate reserve</td>
</tr>
<tr>
<td>i.e.</td>
<td>id est</td>
</tr>
<tr>
<td>kg</td>
<td>kilograms</td>
</tr>
<tr>
<td>kg/m²</td>
<td>kilograms per meter square</td>
</tr>
<tr>
<td>L/min</td>
<td>liters per minute</td>
</tr>
<tr>
<td>LA</td>
<td>lactic acid</td>
</tr>
</tbody>
</table>
LIST OF ABBREVIATIONS (CONT.)

lb pound
m meters
min minutes
ml milliliters
mm millimeters
mmHg millimeters mercury
n number
NE control group
O₂ oxygen
RHR resting heart rate
ROM range of motion
rpm round per minute
s seconds
SEM standard error of mean
ST slow twitch
times/20s times per twenty seconds
V₇₉ volume of leg
VO₂ oxygen consumption
VO₂max maximum oxygen consumption
WE water aerobic group
wk week
yr year
CHAPTER 1
INTRODUCTION

The activity referred to as aerobic dance is undergoing changing, mostly a broadening of the definition. The focus is less on the spandex, thong leotard, dance imagery and more on inclusion of the general population, including men, seniors, and overweight individuals. Aerobic dance, defined as continuous and rhythmic movement to music, was introduced by Jackie Sorenson in 1969. The combination of vigorous dance steps and exercises performed to popular music in a group setting soon became one of the fastest growing leisure activities in the United States. Today more than 25 million exercise enthusiasts participate in this multimillion dollar industry.

Virtually every community offers some form of aerobic class. Even home exercisers can participate in this physically demanding activity by following popular group exercise leaders on television programs and videotapes (1). The benefits of a well developed, comprehensive program include an increase in strength, flexibility, and endurance while promoting a healthy cardiovascular system (2). Some researchers have found significant decreases in body weight or body fat (3,4).

However, sports magazines and training experts offer suggestions for injury prevention in aerobics, including adequate warm-up, proper stretching techniques, appropriate shoes, the use of a resilient floor surface, and avoidance of daily strenuous activity (5,6,7). As indicated in Table 1 (8), injuries to the lower extremities were the most frequent (60%), with shin (24.5%) and ankle (12.2%) injuries being the most prevalent. The lower back was also frequently reported as an injuries site (12.9%).
In addition, many exercises performed on land may have the potential of increasing intradiscal pressure, thereby reinjuring the low back (9). Non-weight bearing activities are potentially of value to individuals who may be at risk of such injury, such as the aged, or to individuals who already have a soft tissue injury. Water is suitable medium for supporting body weight (10).

Table 1. Location and percent of aerobic dance injuries (8).

<table>
<thead>
<tr>
<th>Location</th>
<th>% of injuries</th>
<th>Location</th>
<th>% of injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>shin</td>
<td>24.2</td>
<td>neck</td>
<td>4.4</td>
</tr>
<tr>
<td>ankle</td>
<td>12.2</td>
<td>shoulder</td>
<td>5.5</td>
</tr>
<tr>
<td>foot</td>
<td>5.5</td>
<td>arm</td>
<td>1.0</td>
</tr>
<tr>
<td>calf</td>
<td>6.4</td>
<td>upper back</td>
<td>2.5</td>
</tr>
<tr>
<td>knee</td>
<td>9.2</td>
<td>abdomen</td>
<td>1.2</td>
</tr>
<tr>
<td>thigh</td>
<td>2.4</td>
<td>elbow</td>
<td>0.6</td>
</tr>
<tr>
<td>hip</td>
<td>2.9</td>
<td>wrist</td>
<td>1.4</td>
</tr>
<tr>
<td>lower back</td>
<td>12.9</td>
<td>hand</td>
<td>0.6</td>
</tr>
<tr>
<td>head</td>
<td>0.2</td>
<td>others</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Water aerobics is a relatively new form of aquatic exercise that involves performing continuous rhythmic exercise routines in waist to chest deep water. According to Evans, Cureton and Purvis (1978), the dual effects to buoyancy and resistance make possible high levels of energy expenditure with relatively little movement or strain on lower-joint extremities (11). While water buoyancy reduces the weight bearing for the subject, movement against the resistance of the water...
increases the work load (15). Hydrostatic pressure of the water on the portion of the body submerged underwater increases the venous return of blood to the heart. This increased venous return may result in a greater stroke volume and perhaps a lower heart rate during water exercise depending on the intensity of the exercise (16).

Many studies regarding physiological response and adaptation to water aerobic exercise tend to suggest that water aerobics is best suited for individuals with low initial working capacities and should be considered as an alternative mode of exercise for those who may not be able to participate in more traditional fitness activities (12,13,14).

For Thailand, is mostly hot and humid climate, water exercise should be appropriate mode of exercise because water dissipates heat faster than air does so water’s freshness keeps the body cool and soothed as if by massage (17). The lack of study concerning water aerobic exercise in Thailand make this investigation very useful to provide in depth knowledge of advantage of water aerobic exercise become clearer for the population.
CHAPTER II

OBJECTIVES

The purpose of this study was:

1. To study the effect of aerobic dance and water aerobic exercise on physical fitness.
2. To compare the effect of aerobic dance and water aerobic exercise on physical fitness.
3. To build up the motivation to exercise for population in Thailand.
CHAPTER III

LITERATURE REVIEW

Aerobic exercises are endurance activities which don’t require excessive speed or strength but do require that place demands on cardiovascular system. There are many forms of aerobic exercise: brisk walking, running, swimming, dancing, and cycling are the most popular, but there are others too. All these forms of exercise have one common objective: to increase the maximum amount of oxygen that the body can process within a given time. This is called aerobic capacity. It involves the ability to rapidly take in large amounts of air; ability to forcefully circulate large volumes of blood; and ability to effectively deliver increased supplies of oxygen, via the blood, to all parts of the body (18).

1. Aerobic Dance Exercise

1.1 Aerobic Dance Defined

Aerobic dance is vigorous, oxygenated large muscle exercise which stimulates heart and lung activity for a specific period of time to bring about beneficial changes in the cardiovascular system (18). Aerobic dance, defined as continuous and rhythmic movement to music (19). The main objective of dance aerobics, like any other form of aerobics, is to increase the maximum amount of oxygen that the body can process in a given amount of time (20).
The aerobic effect depends on the body’s ability to (a) rapidly breathe large amounts of air, (b) forcefully deliver large volumes of blood, and (c) effectively deliver oxygen to all parts of the body. In simplest terms, the aerobic effect is large muscle activity that brings about a reduction in resting heart rate (18, 20, 21).

1.2 Aerobic Dance Form

1.2.1 Low-Impact Aerobics

This form is more appropriate for beginners. Even though it goes by such tamer-sounding names as "controlled-impact", "low-percussive", "protective", "no bounce", "soft" and "fluid" it’s mistake to regard it as an exercise for softies, the infirm, and pregnant women. Beginners should find a low-impact class aimed at their skill level. It will be lower in intensity than classes aimed at intermediate or advanced dancers. The workout is less intense even though the dance routine may be similar to the one offered in intermediate classes. On the other hand, a beginner might compensate for this low-intensity by attending longer classes or more classes per week (18).

1.2.2 High-Impact Aerobics

Some critics have dubbed this exercise "killer aerobics". This traditional form of aerobic dance is characterized by pounding and pounding, and shinsplints, stress fractures, and tendinitis are common among the faithful. Still, there are plenty of women who are fit enough to attempt this high-intensity workout and indeed would feel lost without it. They love it enough to risk its dubious safety record. In fact, many medical authorities don’t oppose high-impact workouts for those in shape for it. Rather, they recommend that students alternate high and low-
impact classes. Two low-impact classes interspersed with two high-impact classes per week, for example (18).

Table 2. Exercise programs conducted to music traditional aerobics, low-impact aerobics, aerobic dancing. (under 30 years of age) (18).

<table>
<thead>
<tr>
<th>Week Number</th>
<th>Time in minute</th>
<th>Target Heart Rate Beats per Minute</th>
<th>Frequency per week</th>
<th>Point per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>124-134</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>124-143</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>134-143</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>134-153</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>134-162</td>
<td>3-4</td>
<td>12-16</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>134-162</td>
<td>3-4</td>
<td>12-16</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td>134-162</td>
<td>3-4</td>
<td>18-24</td>
</tr>
<tr>
<td>8</td>
<td>30</td>
<td>134-162</td>
<td>4-5</td>
<td>24-30</td>
</tr>
</tbody>
</table>

1.2.3 Non-impact Aerobics

Non-impact aerobics is a third form of dance exercise. Neither foot ever leaves the ground. Although it's too mind to be an aerobic conditioner, it can still be beneficial to the very obese of the elderly (18).
1.3 Aerobic Dance Phases

Effective aerobic exercise will involve vigorous movement sustained for at least fifteen to twenty minutes (22). Each phase has its own purposes, without which the workout is incomplete. Each phase of the program is necessary if aerobic dance is to provide the desired benefits (23).

1.3.1 Warm-up and pre-stretch (10 minutes)

The purpose of the warm-ups is to increase blood flow to the muscles, increase the rate of oxygen exchange between blood and muscles, increase the speed and force of muscle contraction, increase muscle elasticity as well as the flexibility of tendons and ligaments, and reduce the risk of cardiac abnormalities (1,23,24). Using a moderate tempo, movements during the warm-up should include rhythmic, full-range-of-motion exercises designed to prepare the body for movements used during the aerobic routines. The initial warm-up should concentrate on large movements for the shoulders, arms, and legs. A warm-up routine might consist of shoulder rolls, arm circles, marches, step touches, and toe and heel raises. After the muscles have been warmed, static stretching exercises should be performed to increase joint range of motion. Stretching positions should be held for at least 10 seconds, paying special attention to muscles of the shoulders, chest, hips, low back, thighs, calves, and feet (1,25).

1.3.2 Aerobic activity (20-30 minutes)

The purpose of the aerobic dance phase is to improve cardiovascular endurance. The physiological benefits of aerobic activity include increased heart and lung efficiency and decreased body fat. Aerobic benefits are achieved by using prolonged and continuous movement of the large muscles. Ideally,
the aerobic phase of class will last 20-30 minutes performed at an intensity of 60 % to 75 % of the heart rate reserve \(^{(1)}\).

The aerobic segment consists of movement patterns choreographed to music. Movement patterns can be extremely varied, ranging from calisthenic exercises such as jumping jacks to dance movements such as leaps and lunges. Instructors can enhance their movement repertoire by using steps common to other dance forms, including jazz, modern, folk, and ballet or by borrowing movement patterns used in sports and games, such as basketball dribbling \(^{(26,27)}\).

1.3.3 Cool down (2-5 minutes)

The purpose of the cool-down is to lower the heart rate gradually toward normal, prevent excessive pooling of blood in the lower extremities, and promote removal of metabolic waste products from the muscles \(^{(1)}\). Slow but continued rhythmic contraction of the leg muscles is important to help return the blood from the lower extremities to the heart. A cool-down of 2 to 5 minutes can consist of walking around the room while gently swinging the arms or doing a slow aerobic dance routine \(^{(1,26,27)}\).

1.3.4 Strength exercises (5–10 minutes)

Muscular strength is important for preventing injuries by helping the participant maintain proper alignment and body mechanics. It is therefore important to strengthen the muscles that help maintain good posture and aid in the proper execution of aerobic dance routines and floor exercises. Weak upper back muscles (upper trapezius and rhomboids) contribute to rounded shoulders, while weak abdominals can lead to a swayback posture. Aggravated by vigorous movements on the feet, these anatomical deviations can result in neck, shoulder, and...
low back pain. Therefore, it is prudent to strengthen the upper back muscles and abdominals in each class session. Rowing exercises and prone shoulder raises can be used to strengthen the upper back while curl-ups, diagonal curls, reverse curls, and pelvic tilts help strengthen the abdominals (1).

To encourage controlled movements during the strength exercises, music tempos should be moderately paced and participants should be instructed to adjust the tempo (half time or double time) and the number of repetitions required to meet their personal levels of strength (28).

1.3.5 Post-Stretch or Floor exercise (5-10 minutes)

The purpose of the final stretch is to improve overall flexibility, which helps maintain good posture and proper body mechanics throughout the day. Stretching after a vigorous exercise session is often easier than stretching before because the joints are well lubricated and the temperature of the muscles is increased following the aerobic workout. It is best to perform these stretches on the floor, allowing participants an opportunity to relax and concentrate on each stretch. The post-stretch is most effective when performed to slow background music that does not have a strong beat. Flexibility exercises, held for 10 to 30 seconds, should include stretches for muscles of the arms, shoulders, chest, back, hips, thighs, and calves (1, 26,27,28).

1.4 Aerobic Dance Injuries

Injuries resulting from aerobic dancing have reported for both dance instructors and students.
Francis et al in 1985 (29) reported the results of a questionnaire given to instructors attending a workshop dealing with aerobic dance safety. Based on the responses of 135 instructors, the authors characterized the injuries seen in both aerobic dance instructors and students. They emphasized the fact that 76.3% (103-105) of the instructors had sustained or aggravated one or more injuries as a result of aerobic dancing: more than 60% had taught aerobic dance for more than 2 years. Table 3 presents the frequency with which various anatomical sites were involved. The injuries rate for these instructors would be 0.22 injuries per 100 hrs. of exposure. (Table 4)

Table 3. Sites and frequency of injuries (%) among aerobic dance students and instructors—reported in 4 studies (30).

<table>
<thead>
<tr>
<th>Injury site</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>4.1%</td>
</tr>
<tr>
<td>Spine</td>
<td>14.0%</td>
</tr>
<tr>
<td>Hip</td>
<td>2.9%</td>
</tr>
<tr>
<td>Thigh</td>
<td>2.8%</td>
</tr>
<tr>
<td>Knee</td>
<td>8.9%</td>
</tr>
<tr>
<td>Leg/calf/achilles</td>
<td>38.2%</td>
</tr>
<tr>
<td>Ankle</td>
<td>7.1%</td>
</tr>
<tr>
<td>Foot</td>
<td>13.5%</td>
</tr>
<tr>
<td>Other</td>
<td>8.5%</td>
</tr>
</tbody>
</table>

a. Case included on instructors.
b. All cases required formal medical care.
Richie and associates (31) also reported the results of a survey of aerobic dance participants. 534 participants reported 1,075 injuries (43.3% of the students and 75.9% of the instructors). One hundred (9.3%) of the injuries were reported to instructors. Anatomical sites of injuries for both groups are showed on Table 2. Assuming 1-hr. classes, the students logged a total of 106,112 hr. of participation, resulting in an injury rate of 1.01 injuries per 100 hr. of participation. The rate for instructors as 0.32 per 100 hr. of participation. (Table 4)

Table 4. Number of injuries per 100 hours of aerobic dance (30).

<table>
<thead>
<tr>
<th>Study</th>
<th>No. Injuries / 100 hr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Francis (1985)</td>
<td>(instructors)</td>
</tr>
<tr>
<td>Richie (1985)</td>
<td>(students and instructors)</td>
</tr>
<tr>
<td>Garrick (1986)</td>
<td>(students)</td>
</tr>
<tr>
<td></td>
<td>(instructors)</td>
</tr>
<tr>
<td></td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>1.01</td>
</tr>
<tr>
<td></td>
<td>1.16</td>
</tr>
<tr>
<td></td>
<td>0.96</td>
</tr>
</tbody>
</table>

In 1986, Garrick et al (32) reported the results of the first perspective, epidemiologic study of aerobic dance injuries. The study encompassed both students and instructors who amassed 29,924 hr. of collective aerobic dance activity, for an average of 59.8 hr. per student and 148.7 hr. per instructor. Among the students, 155 reported 244 complaints; 45 instructors reported 83 problems. Injury rates for students were 1.16 per 100 hr. of activity and 0.96 per 100 hr. of activity for instructors (Table 4). The sites of the injuries in both students and instructors are presented in Table 3.
Rothenberger et al, 1988 (8) reported the results of prevalence and types of injuries in aerobic dancers. Forty-nine percent of the subjects (726 aerobic dancers) reported a history of at least one injury related to aerobic dancing. Most of injuries were to the shin (24.5%), lower back (12.9%), and ankle (12.2%). Among those subjects injured, 23% reportedly saw a physician because of their injury. The frequency with which subjects exercised was associated with a history of injury. Subjects who exercised fewer than four times per week reported fewer injuries (43%) than those who exercised four times per week (60%) or more (66%). (Figure 1)

![Image of body parts and injuries](#)

**Figure 1.** Location, number, and percent of aerobic dance injuries (8).
1.5 Safety concerns

To ensure the safety of class participants, instructors should comply with the following guidelines (1, 28, 33, 34).

1.5.1 Screen participants for common anatomical problems, such as kyphosis, lordosis, and excess pronation of the feet. Also evaluate them for tight or weak muscles. Early detection and correction of such problems can reduce the risk of aerobic dance injuries.

1.5.2 Encourage appropriate body alignment throughout the class period. Proper posture includes: head up, shoulders back, chest up, buttocks tucked under the hips, and knees relaxed.

1.5.3 Avoid or minimize the use of the following potentially harmful exercise positions: (a) sustained and unsupported forward flexion in a standing position, (b) unsupported forward flexion in a standing position with rotation, (c) trunk rotation against a fixed axis, (d) neck hyperextension, (e) fast head circles, (f) the yoga plough, (g) deep knee bends, (h) hurdler stretch, (i) hyperextension of the elbows and knees, (j) straight-leg sit-up, (k) double leg raises, and (l) side leg lifts supported on the knees and hands or elbows.

1.5.4 Avoid ballistic stretching. Static stretching is effective and tends to be safer than bobbing or bouncing techniques.

1.5.5 Insist that participants wear shoes during the aerobic phase of class.

1.5.6 Be aware of the placement of class members to avoid collisions during rapid movements across the floor.
1.5.7 Encourage participants to control the placement of their arms, avoiding any flinging motions. Shoulder injuries are becoming increasingly common in aerobic dance.

1.5.8 Avoid having the participants keep their arms at or above shoulder level for a prolonged period of time. This increases blood pressure, places stress on the tendons and muscles of the shoulder, and increases heart rate in a manner not beneficial to increased cardiovascular conditioning.

1.5.9 Avoid prolonged and excessive deep knee flexion. Make sure the knees of participants remain over the first and second toes.

1.5.10 Be cautious of lateral movements on carpeted surfaces. The added friction associated with carpet can result in ankle inversion sprains.

1.5.11 Avoid dancing on concrete surfaces.

1.5.12 Reduce the risk of common musculoskeletal injuries during aerobic activity by progressing slowly and by not exceeding intensity levels of 75% heart rate reserve, exercise duration of 30 minutes, and exercise frequencies of 4 days per week on alternate days.

1.5.13 Avoid too many consecutive movements on one foot, such as dozens of hops.

1.5.14 Avoid rapid changes of direction.

1.5.15 Participants should avoid staying on the balls of their feet for extended periods of time. The lowering of the heels to the floor provides additional shock absorption for the feet.

1.5.16 Face the class as often as possible to effectively observe everyone’s performance.
1.5.17 Do not allow the participants to hold their breath while performing strength exercises. Encourage them to exhale on exertion.

1.5.18 Control the movement of hand and ankle weights at all times.

1.5.19 Be aware of exercise restrictions and modifications for special populations. For example, people with high blood pressure should not perform isometric contractions and should avoid keeping the arms above shoulder level for extended period of time.

2. Water Aerobic Exercise

Land exercise offers tremendous benefits, but too often those benefits are accompanied by aches and pain, overheating, sweating, and feeling of exhaustion (35). Water exercise provides an ideal and safe form of working out for just about everyone (36).

Water aerobics (also called aqua aerobics, aquatic exercise, or other similar titles) has been a fundamental part of aquatic and fitness centers for many years. It has played a major role in reestablishing aquatic therapy as a viable treatment option in rehabilitation. For many years, water aerobics programs served the needs of people who were uncomfortable with or unable to exercise on land. The physically challenged, the obese, and the elderly constituted the largest group of participants; however, the number of apparently healthy adults participating in these programs continues to grow (37).
2.1 Properties of Water

2.1.1 Buoyancy

Archimedes' principle of buoyancy states that a body partially or completely immersed in a fluid will experience an upward thrust equal to the weight of the fluid that was displaced. Buoyancy is defined as the upward thrust acting in the opposite direction of gravity; it is related to the specific gravity of the immersed object (38). The force of the buoyancy will vary depending on water depth; the amount of body surface area immersed in the water; and body weight, height, bone density, and composition (39).

Gravitational forces decrease as a body goes deeper into the water: (a) at waist depth (with lungs not submerged), gravity decreases by 50 percent; the feet are used as a base of support, (b) when the water is above the nipple (the lungs are submerged), gravity decreases by 85 percent; feet are still a base of support but less stable, (c) when the water is neck deep, gravity decreases by 90 percent. If the person is not wearing buoyancy equipment, the feet are still a base of support but less stable. If the person is wearing buoyancy equipment and is suspended in the water, the feet are not a base of support (39).

The relationship of the depth of immersion and the height of the person is referred to as "percentage immersion" (40). To determine the weight-bearing forces experienced during aquatic therapy in shallow water, it is necessary to look at the relationship between percentage immersion and the type and speed of movement.
Harrison et al (1992) (40) studied partial weight bearing walking at different levels of immersion to determine the “percentage weight-bearing” while standing (static), slow walking, and fast walking. Percentage weight-bearing was defined by the researchers as the “maximum measured load against the subject’s weight on dry land”. The measured load refers to measurements taken while the subject walked across a load-measuring platform. Three anatomical landmarks were selected for comparison: the ASIS (anterior superior iliac spine), the xiphisternum, and the level of the C-7 vertebral body. Based on measurements for nine healthy individuals, percentage weight-bearing varied considerably for the activities of standing, slow walking, and fast walking. Percentage weight-bearing increased from standing, to slow walking, to fast walking. (Figure 2)

**Figure 2.** Loading of the lower limb when walking partially immersed: Implications for clinical practice (40).
2.1.2 Resistance

Water provides resistance because of its viscosity. Viscosity is a measure of the frictional resistance caused by cohesive or attractive force between the molecules of a liquid. Resistance is created by the viscosity of the liquid and is proportional to the velocity of movement through a liquid: from drag, turbulence, eddy currents, speed, leverage, action/reaction, and inertia. Small changes in these resistance variables can have marked effects on exercise intensity (9,41,42).

Figure 3. Changing intensity by altering length of resistance arm; a knee lift is easier to perform than a straight leg lift to the front (42).
Form drag relates to the surface area and the shape of the object moving through the water (43). Drag acts to resist motion. It increases as an object’s surface area increases, and the intensity of work required to move the object through water also increases. Reducing the surface area and streamlining will decrease drag. Limbs, the position of the body, or equipment can be dragged through the water to change the body’s shape, thus changing the work intensity (41).

Turbulence is moving, choppy water with multidirectional force. It is created by objects moving through the water. Faster speeds and objects that are not streamlined create greater turbulence (41).

Eddy currents are created as the body moves through the water. As you move forward, the water flows from an area of higher pressure in front of the body to an area of reduced pressure behind the body. These currents create drag on the body, thus increasing resistance to movement. Speed, leverage, action/reaction, and inertia are other variables that influence resistance (41).

2.1.3 Hydrostatic Pressure

Pascal’s law states that, at any given depth, the pressure from the liquid is exerted equally on all surfaces of the immersed object (38). As the density and depth of the liquid increases, so does the volume of liquid overhead and, therefore, the hydrostatic pressure.

Hydrostatic pressure against the body increases with depth. It affects the body in the following ways: (a) when the lungs are submerged, the increased hydrostatic pressure makes breathing more difficult. Breathing and inflating the lungs against the pressure help participants maximize lung volume and adjust to the feeling of pressure against the chest, (b) The increase of pressure aids
venous circulation and contributes to the reduction of edema, especially in the lower body. In the vertical position, the greatest pressure is at the feet, and (c) Systolic blood pressure may increase initially upon immersion as a response to hydrostatic pressure on the body. In deep water exercise heart rate decreases as stroke volume increases (41).

2.2 Types of Aquatic Exercise Programs

2.2.1 Water walking

Water walking is simply striding in waist to chest deep water at a pace fast enough to create the overload necessary for cardiorespiratory benefits. The type of stride used should vary to ensure use of all the major muscle groups in the lower body. Most frequently, the foot action involves a heel strike, followed by rolling onto the ball of the foot and finishing with a strong push off the toes. Stride length will vary according to the participant’s height, leg length, strength, and stride, as well as the water depth. The type of walking—for instance forward, sideways, or backward, with toes pointed in or out, with legs straight or bent, or on toes or heels—determines the muscles being used. Upper-body muscles also should be varied by using stroke, backstroke, figure eights, punching, and jogging arms. Walking sideways usually offers less resistance and can be less exertive. Arm and directional variations also can vary the intensity (44).

2.2.2 Shallow-Water Jogging

Shallow-water jogging is much like water walking, but it is done with bounding or leaping steps. Participants who jog in the water are pushing up and partially out of the water and bouncing as they move through the water, as opposed to walkers who stride with no bounce. Like water walkers, joggers also vary their stride
by moving backward, forward, and sideward, and sideways with heels kicking up behind, knees high in front, knees out to the sides, legs straight, or jogging on toes or heels. Long, slow strides should be varied with short, fast strides. Arm movements also should be varied, using backstroke, stroke, side push, punching, and jogging arms to provide upper body muscle balance. The water-jogging program should follow the format for an aerobic-conditioning class and cardiorespiratory warm-up, followed by the aerobic portion, the cooldown, toning, and post stretch (44).

2.2.3 Water Aerobics

Water aerobics includes a wide variety of dance and calisthenic moves performed in water. Water aerobics range from a very basic program, with extensive repetitions of kicks, jogs, and kneelifts, to a highly choreographed program, combining intricate dance and calisthenic moves (44).

2.2.4 Water Toning

Water-toning programs are created specifically to improve muscular endurance. Students work a specific muscle group with one move for 15 to 60 repetitions and then move to another muscle group. Upper-body and lower-body exercises usually are alternated, with middle-body or trunk (obliques and abdominals) exercises interspersed throughout. Students usually stand at the pool edge or are supported by buoyant devices during the class (44).

2.2.5 Strength Training

Strength training in the water is a program aimed specifically at body building. Actual weight-lifting moves, such as squats, bicep curls, knee extensions, and elbow presses, are done in the pool during this workout. In order to attain muscular balance and reduce the risk of injuries, all major muscle groups
should be strengthened during a workout, including quadriceps, hamstrings, low back, abdominals, chest, upper back, shoulders, biceps, and triceps. Working all major muscle groups is important for a comprehensive and safe workout. Training just some of the muscles produces less significant results, encourages muscle imbalance, and may cause muscle injuries (44).

2.2.6 Flexibility Training

Flexibility-training participants stretch different muscle groups to improve their long-term flexibility. Flexibility often is an ignored component of fitness. If a muscle is only trained to contract, it loses its ability to stretch as far as it should, resulting in permanently shortened muscles. Most aquatic-fitness programs, such as toning, aerobics, and weight training, concentrate only on training the muscles to contract. Each aquatics program should include a flexibility segment (44).

2.2.7 Aqua-Power Aerobics

Aqua-power aerobics is a program that combines cardiorespiratory conditioning (aerobics), strength training, and muscle toning in the aerobic portion of the workout (44).

2.2.8 Sport-Specific and Sports-Conditioning Workout

Sport-specific workouts are aerobic workouts that are designed to assist sports enthusiasts in developing the muscle strength and flexibility, skills, agility, balance, and co-ordination needed in their sport (44).

2.2.9 Bench or Step Aerobics

Bench aerobics or step workouts are aerobic workouts that mimic the Harvard Step Test for cardiorespiratory fitness. (During that test, participants step up and down on a bench for three minutes and then check working and recovery
Rather than have participants step up and down on a bench for just three minutes, the step workout makes up the entire aerobic portion of the class. Participants use stairs in the pool or weighted benches taken into the pool to step up and down in a rhythmic fashion. Moving the body vertically against gravity creates an intense aerobic workout that forces on the lower body. It is a high-intensity, low-impact workout (44).

2.2.10 Interval Training

Interval training is an exertive exercise program usually reserved for well-conditioned athletes. The program can, however, be modified for less-conditioned people. Interval training simply means a workout that combines high-intensity portions with moderate-or-low intensity segments. During continuous aerobic training, the exercise program is organized so the workout intensity remains in the target heartrate zone during the entire workout. The intensity begins at the low end of the target zone and gradually increases to moderate and high intensity before tapering back to the low end. Interval training is unique in that it is based on short bouts of intense exercise, during which the workout intensity is at the top end of the target zone. These high-intensity is at the top end of the target zone. These high-intensity bouts are separated by recovery periods, during which the workout intensity is at the low to moderate portions of the target zone. This technique trains the athlete to maintain near-maximum heartrate for a longer total time than would be possible with continuous training. This type of training uses the anaerobic metabolic pathway. The primary fuel is intramuscular glycogen (44).
2.2.11 Deep Water Exercise

Deep-water exercise refers to any type of water exercise program done in the diving well of the pool or in water depth above a participant’s head. It is a completely nonimpact workout. With every footfall on land, the legs bear two to five times the body’s weight; in deep water, the legs bear none (44).

2.2.12 Circuit Training

Circuit training is an aerobic workout that combines strength training and aerobic conditioning. Circuit training takes place during the aerobic portion of a cardiorespiratory workout. The program follows the format for all cardiorespiratory workouts defined earlier in this chapter. The complete warm-up (thermal, stretch, and cardiorespiratory) is followed by a 20-to-40 minute circuit-training aerobic portion. Participants work one muscle group, usually with equipment, for 30-60 seconds, and then move to aerobics for 1 to 3 minutes. Following the aerobic interval, participants work another muscle group. This is continued until all major muscle groups have been used for 20 to 40 minutes. The cooldown follows, with the poststretch or flexibility segment at the end (44).

2.3 Format for Cardiorespiratory Conditioning Classes

The format of aquatic exercise programs varies, depending on their goals. Almost any program or program variation follows either the aerobic or nonaerobic class format. Programs focusing on cardiorespiratory conditioning, such as water aerobics, water walking, deep-water programs, and circuit training, follow the aerobic class format. Programs that focus on muscular endurance, strength, or flexibility follow a nonaerobic class format (45).
2.3.1 Warm-up

The warm-up is a combination of three different class segments that increases body temperature. The warm-up allows the exerciser to safely exercise at a high intensity. Water cardiorespiratory (aerobic) classes usually begin with a warm-up lasting 5-10 minutes. Three types of warm-ups needed for program safety include the musculoskeletal warm-up (called the thermal warm-up), the prestretch, and the cardiorespiratory warm-up (45).

2.3.2 The Cardiorespiratory Workout

The aerobic portion of the workout is considered the “calorie-burning” portion (45). The goal of this portion is to improve the cardiorespiratory system. The American College of Sports Medicine (ACSM) has made recommendations for the quantity and quality of training for developing and maintaining cardiorespiratory fitness, body composition and muscular strength, and endurance in the healthy adult (46).

2.3.3 Cool-down

The cooldown usually lasts about five minutes and uses large, lower-intensity, rhythmic movements. The purpose of the cooldown is to aid the return of blood to the heart at a low enough intensity to allow the heart to move toward a resting level. The cooldown prevents the pooling of blood in the extremities, reduces muscle soreness, and assists in the elimination of metabolic wastes (45).

The cool down in a pool is especially important because of water pressure. If a participant leaves the pool while still in the aerobic portion of the workout, dizziness can occur. When exercising at a challenging intensity, blood vessels dilate to allow for increased bloodflow during the workout. In water exercise
classes, it is thought that blood vessels are pressurized by the water and do not dilate to the extent they would during land-based exercise. When exiting the pool, the lessened effect of air pressure compared to water pressure allows the blood vessels to dilate further, causing a drop in blood pressure. This can cause the participant to feel light-headed or dizzy or the actually pass out (45).

2.3.4 Toning

If toning or calisthenics is included in the workout it usually follows the cooldown. Trunk, upper-body, and lower-body exercises are done at pool edge or with buoyant devices that hold the participant off the bottom of the pool. The toning portion of the workout can last 5 to 15 minutes. Upper-body toning often is incorporated. Upper-body toning often is incorporated into the cooldown to conserve time. Because of the buoyancy of water, participants must be strongly encouraged to put forth the necessary effort to make water exercise effective. It is easy to cheat during water exercise because of the buoyancy and the relaxing effects of the water (45).

2.3.5 Flexibility

The water aerobics class should always end with a poststretch or flexibility section that lasts about five minutes. If the water is warm (over 86 degrees F), this section can be extended. All the major muscles used or toned during the workout should be stretched during this time (45).
3. Aerobic Training

All training programs must be designed to develop the specific physiological capacities required to perform a given sport skill or activity. Concerning aerobic to endurance sports, this primarily involves the skeletal muscles, the cardiorespiratory system, and/or neuromuscular function (47). Generally, most endurance activities rely heavily on the aerobic energy systems of skeletal muscle (Krebs Cycle, electron transport system, and beta-oxidation).

The cardiorespiratory or oxygen transport system is responsible for the transport and exchange of oxygen and carbon dioxide between the environment and the working muscles. Because oxygen must be shuttled to the muscles in quantities sufficient to allow energy production to continue via aerobic metabolism, the cardiorespiratory system is more important during low-intensity, long-duration exercises than during very high-intensity, short-duration exercise (47).

The neuromuscular basis for specificity of training addresses the different motor units or fiber types found in skeletal muscle and their specific recruitment patterns during the performance of various kinds of exercises. While fiber recruitment is controlled mainly by the central nervous system (i.e., the brain and spinal cord), fiber types (Type I [slow-oxidative] and Type IIB [fast-glycolytic]) have metabolic specificity. Recall that Type I fibers have a high aerobic capacity and a low anaerobic capacity whereas Type IIB fibers have a low aerobic capacity and a high anaerobic capacity. Therefore, Type I fibers, and to some extent Type IIA fibers, are predominantly recruited for aerobic-type activities. This level of specificity dictates that the exercises used during a training regimen should simulate as closely as possible the movement patterns required to perform a specific athletic task (47).
Figure 4. A summary of the major, intermediate, and minor physiological factors in the specificity of aerobic training and exercise. The interaction among the various components is indicated by double-headed arrows (47).

A summary of the major, intermediate, and minor contributing factors involved in the specificity of aerobic training is presented in Figure 4.
3.1 Intensity

Exercise intensity is usually expressed as a percentage of either the individual’s maximal aerobic capacity (\( \dot{V}O_2 \) max) or functional aerobic capacity (\( \dot{V}O_2 \) peak). Intensity and duration of exercise are inversely related. In other words, the higher the exercise intensity, the shorter the duration of exercise and vice versa. Part of the art of exercise prescription is being able to select an exercise intensity that is adequate to stress the cardiovascular system without overtaxing it (48).

According to ACSM (1995) (49), the initial exercise intensity for apparently healthy adults is 50 to 85% (\( \dot{V}O_2 \) max). Lower intensity exercise (40 to 50% (\( \dot{V}O_2 \) max), however, may be sufficient to provide important health benefits for sedentary clients with low initial cardiorespiratory fitness levels. As a general rule, the more fit the individual, the higher the exercise intensity needs to be to produce further improvement in cardiorespiratory fitness. Exercise intensity can be prescribed using the MET, heart rate, or RPE methods.

3.2 Duration

As an exercise specialist, you must prescribe an appropriate combination of exercise intensity and duration so that the individual adequately stresses the cardiorespiratory system without overexertion. As mentioned earlier, intensity and duration of exercise are inversely related (the lower the exercise intensity, the longer the duration of the exercise) (48).

The ACSM (1995) (49) recommended 20 to 30 minutes of continuous aerobic activity. Apparently healthy individuals usually can sustain exercise intensities of 60 to 85% (\( \dot{V}O_2 \) max) for 20 to 30 minutes. During the improvement stage, duration can be increased every 2 to 3 weeks until participants can exercise...
continuously for 30 minutes. Poorly conditioned individuals may be able to exercise at low intensity (40% VO₂ max) for only 10 minutes. They may need to perform multiple sessions in a given day to accumulate 20 to 30 minutes of aerobic exercise. An alternative way of estimating the duration of exercise is to use the caloric cost of the exercise. To achieve health benefits, ACSM (1995) (49) recommends minimal caloric thresholds of 150 to 300 kilocalories (kcal) per exercise session or 800 to 900 kcal per week.

During the initial stage of the exercise program, however, weekly exercise caloric expenditure may be considerable lower (200 to 600 kcal per week). Throughout the improvement stage, the goal is to increase your client’s caloric expenditure from 800 to 2000 kcal per week by gradually increasing the frequency, intensity, and duration of the exercise. For example, in order for a 60-kg (132 lb.) woman, who is exercising at an intensity of 7 METs, 5 times per week, to reach a weekly caloric threshold of 1500 kcal per week, she needs to expend 300 kcal per exercise session (1500 kcal/5 = 300 kcal). You can estimate the caloric cost of her exercise (kcal.min⁻¹) knowing her exercise intensity (7 METs) and knowing that 1 MET is equal to 1 kcal.kg⁻¹.hr⁻¹. She will expend 420 kcal.hr⁻¹. (7METs 3 60 kg of body weight) or 7 kcal.min⁻¹. Therefore, she needs to exercise approximately 43 minutes (300 kcal/7kcal.min⁻¹), 5 times per week, in order to achieve her weekly caloric expenditure goal.

### 3.3 Frequency

The frequency of the exercise sessions depends in part on the health and fitness level of the individual (48). Normal, sedentary individuals (functional capacity equals 5 to 8 METs) should exercise a minimum of 3 times per week to
produce significant changes in cardiorespiratory endurance (49). As the fitness level increases, however, the frequency should be increased to 5 times per week for continued improvement (50). For individuals with functional capacities less than 5 METs, several daily exercise sessions are advisable. Once the desired level of cardiorespiratory fitness is reached, it may be maintained by exercising 2 to 4 days per week, providing the intensity and duration of the workouts are similar to that used to achieve the current fitness level (51,52).

In terms of improving VO\textsubscript{2} max, the sequence of exercise sessions seems to be less important than the total work performed during the training. Similar improvements were noted for individuals who trained every other day (Monday-Wednesday-Friday) and 3 consecutive days (Monday-Tuesday-Wednesday)(53). The ACSM (1995) recommends exercising on alternate days during the initial stages of training to lessen the chance of bone or joint injury (49).

3.4 Rate of Progression

Physiological changes associated with aerobic endurance training enable the individual to increase the total work performed. The greatest conditioning effects occur during the first 6 to 8 weeks of the exercise program. Aerobic endurance may improve as much as 3% per week during the first month, 2% per week for the second month, and 1% per week or less thereafter (54). In order to make continued improvements, the cardiorespiratory system must be overloaded by adjusting the intensity and duration of the exercise to the new level of fitness. The degree of improvement is dependent on the age, health status, and initial fitness level of the participant. For the average person, aerobic fitness while elite athletes may improve only 5% because they begin at a level much closer to their genetic limits. The rate of
improvement is also age-related. The three stages of progression for cardiorespiratory exercise programs are the initial conditioning, improvement, and maintenance stages (49).

3.4.1 Initial Conditioning Stage

The initial conditioning stage typically lasts four to six weeks and consists of stretching exercises, light calisthenics, and low-level aerobic activity. The ACSM (1995) suggests that the initial exercise intensity be set at 40 to 60% VO₂ max. The duration of the aerobic exercise during this stage should be at least 12 to 15 minutes, increasing to 20 minutes in 4 to 6 weeks. Active individuals with good to excellent initial conditioning stage of the program (49).

3.4.2 Improvement Stage

The improvement stage usually lasts 16 to 20 weeks. During this stage, the rate of progression is more rapid. Increase the exercise intensity gradually, and increase the duration of exercise every 2 to 3 weeks. Increase the frequency of exercise from 3 to 5 times per week. Intensity, duration, and frequency of exercise should always be increased independently. Rate of progression during this stage depends on a number of factors. Cardiac patients, elderly, and less fit individuals may need more time for the body to adapt to a higher conditioning intensity. In such cases, the exercise duration should be at least 20 to 30 minutes before increasing the exercise intensity (49).

3.4.3 Maintenance Stage

After achieving the desired level of cardiorespiratory fitness, an individual enters the maintenance stage of the exercise program. This stage usually begins 6 months after the start of training and continuous on a regular, long-term basis.
if the individual has made a lifetime commitment to exercise (49).

4. Physical Fitness

4.1 Definition

Physical fitness is defined as: (a) the capacity for movement, (b) a set of attributes that people have or achieve that relates to the ability to perform physical activity, (c) the ability to do one’s work and have energy remaining for recreational activities, (d) the ability to perform moderate-to-vigorous levels of physical activity without undue fatigue, and (f) a relation between task and the capacity to perform it (55,56,57).

4.2 Components of Physical Fitness

There are five major aspects or components of physical fitness:

4.2.1 Major components of Physical Fitness

4.2.1.1 Cardiorespiratory endurance is the body’s ability to sustain sub-maximal exercise for extended periods of time. Another common definition of cardiorespiratory endurance is the ability to the heart and vascular system to transport adequate amounts of oxygen to working muscles, allowing activities that involve large muscle masses, such as walking, running, or bicycling, to be performed over prolonged period of time (58). Oxygen consumption has a positive linear relationship to energy production. As oxygen consumption increases, aerobic energy production increases to the point of maximal oxygen consumption (\(VO_2\) max) or maximal aerobic energy production (58).
4.2.1.2 **Muscular Strength** is defined as the ability of the muscular system to exert external force or oppose a given resistance. Muscular strength is often evaluated by one-repetition maximum (1 RM) which is the maximum amount of weight that can be lifted one time. Strength can also be evaluated with a relative measure such as a strength-to-weight ratio, calculated by dividing strength by body weight (58).

4.2.1.3 **Muscular Endurance** is the ability of the muscular system to exert external force or oppose a resistance for a given number of repetitions and/or for a given period of time. Muscular endurance can be expressed in absolute or relative terms. Absolute endurance infers that a person can lift a given weight a prescribed number of repetitions and/or for a period of time. Relative endurance, on the other hand, expresses muscular endurance in terms of the percent of an individual’s maximum ability (58).

4.2.1.4 **Body Composition** refers to the composition of the various components of the human body. In exercise science there are two major components of the body that are of interest: fat-free mass (lean body mass: muscle, bone, organs, water, etc.) and fat mass. A person with a high amount of lean body mass compared to fat mass is considered lean. Conversely, a person who carries excess body fat compared to fat-free mass is considered obese. A body composition evaluation can provide valuable information about both of these two important components of the human body (58).

4.2.1.5 **Flexibility** is the ability to move a specific body part through a prescribed joint range of motion, and is dependent on the looseness or suppleness of the muscles, tendons, and ligaments that surround a given joint. The integrity of the
joint capsule itself can also affect flexibility. Limited flexibility is usually the result of muscles, tendons that are too tight; however, excess fat can also be a contributing factor (58).

4.2.2 Minor components of Physical Fitness

Other components of fitness listed by sports physiologists are called minor components or skill-related components. Skill-related fitness is related to performing motor skills, such as playing soccer or walking a tightrope (58).

4.2.2.1 Speed is the ability to perform a movement in a short period of time.

4.2.2.2 Power is the ability to transfer energy into force at a fast rate (a combination of strength and speed in one explosive action).

4.2.2.3 Reaction Time is the amount of time elapsed between stimulation and reaction to that stimulation.

4.2.2.4 Agility is ability to rapidly and accurately change the position of the entire body.

4.2.2.5 Coordination is integration of separate motor activities in the smooth, efficient execution of a task.

4.2.2.6 Balance is the maintenance of equilibrium while stationary or moving (static and dynamic balance).
CHAPTER IV
MATERIALS AND METHODS

Equipments

1. Aerobic dance place (College of Sports Science and Technology, Mahidol University)
2. Swimming pool with chest depth (College of Sports Science and Technology, Mahidol University)
3. Sphygmomanometer (AIL, KII, Japan)
4. Stethoscope (Hico Medical Co. Ltd., Tokyo, Japan)
5. Weight and height scale (Lionbrand, Shugui, Japan)
6. Cycle ergometer (Monark, USA)
7. Metronome (Dison, Taiwan)
8. Stopwatch (Hahart profite J, W. German)
9. Heart rate monitor (Polar, Finland)
10. Leg and back dynamometer (Takei Kiki Co., Ltd., Japan)
11. Flexible tape
12. Sit and reach box
13. Nine square test area
14. Physical activity questionnaires
15. Audio tape
Subjects

Thirty Thai female teenagers, 15-17 years old, were divided three groups in this study, group I (n = 10) participated in aerobic dance program, group II (n = 10) participated in water aerobic program and group III (n = 10) was control group. Informed consent was obtained for each subject.

Criteria for Subject Selection

1. almost the same height
2. range of BMI is 20 – 24.9 (49)
3. healthy, did no serious have the disease history
4. low physical fitness

Experimental procedures

All subjects were scheduled to come prior to the beginning of both of exercise programs for measurements.

1. Vital signs

1.1 Resting heart rate was determined by palpating the right radial artery, which was located on the flexor surface of the wrist laterally.

1.2 Blood pressure was determined by sphygmomanometer and stethoscope.

2. Physical fitness components

2.1 Maximal oxygen consumption (VO2max) was assessed by Astrand-Rhyming Bicycle Ergometer Submaximal Test Protocol.
2.1.1 Measure the subject’s body weight. Then, had the subject on the bicycle ergometer and adjusted the saddle height appropriate for the subject.

2.1.2 Set the metronome at 100 (for a cadence rate of 50 rpm) and start.

2.1.3 Asked the subject to begin cycling at 0 watt at the proper cadence (i.e. 50 rpm) for 4 min for warming up.

2.1.4 Found a work rate that produces a heart rate between 130 and 150 bpm as mentioned above. Had the subject cycling at such work rate for 6 min.

2.1.5 During the test, recorded the heart rate every minute and the average heart rate between the 5th and 6th minutes. If the difference between these two heart rates exceeds 5 bpm, prolong the exercise bout until a steady-state heart rate was achieved. If the steady-state heart rate was less than 130 bpm, increased the work load by 50 W and performed another 6 min exercise.

2.1.6 Estimated VO₂ max from the heart rate and the work rate data by using the modified Astrand-Ryhming nomogram. If the subject was over age 25, the following age-correction factor should be used to corrected for the decrease in VO₂ max with age.

2.2 Leg strength was measured by leg and back dynamometer.

2.2.1 The feet were placed by 6 inches apart. The handlebar was held in the center (at the level of pubis) with both palms facing downward, adjusted the chain in a straight line.

2.2.2 The knees were bent to angle of 130-140 degrees.

2.2.3 Without using the back, the knees should be nearly straight at the end of the pull. Chain may be readjusted until a maximum lift is obtained.
2.2.4 The highest of three readings was recorded in kilograms.

2.3 Flexibility was assessed by sit and reach testing.

2.3.1 The subject was suggested to keep both legs in a fully extended posture and place both feet, in the totally contacted fashion, against sit-and-reach box.

2.3.2 Like a scoop position, subject sit on the floor and gradually bends forward as far as possible and both hands slid along the measuring scale.

2.3.3 Holding the final position for 2 seconds and, then, recorded the distance in centimeters.

2.3.4 Repeated the experiment and the highest value was observed.

2.4 Percent of body fat was assessed by Lange skinfold caliper for 2 skinfold sites (triceps, calf) to calculated percent of body fat from equations according to age and gender. (59)

2.4.1 Grasped the subject's skinfold and adjacent subcutaneous tissue with tips of thumb and index fingers of the left hand at specific sites on the body. Making sure that you had only two layers of skin and the underlying fat, the underneath muscle was excluded. (During skinfold measurement the subject was standing with the arms hanging freely at the side)

2.4.2 According to the standardization procedures for sites, and directions of skinfold measurement, raised the skinfold and apply the jaws of skinfold caliper at the right angle to the body surface. The contact faces of the caliper were placed about 1 cm below the point where the skinfold was raised

2.4.3 Read the skinfolds to the nearest ± 0.5 mm (Lange skinfold caliper). The assessment should be noted when the indicator stabilized which was approximately 2-4 seconds.
2.4.4 Take three skinfold measurements on each skinfold site.

Table 5. Standardized sites and direction of folds for skinfold measurements (59).

<table>
<thead>
<tr>
<th>Site</th>
<th>Direction of fold</th>
<th>Anatomical reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triceps</td>
<td>Vertical</td>
<td>Mid-point between shoulder and elbow</td>
</tr>
<tr>
<td>Calf</td>
<td>Vertical</td>
<td>Maximal calf circumference</td>
</tr>
</tbody>
</table>

2.4.5 Take all measurement once, then repeated the procedures to obtained the entire set of measurement. The difference between each measurement for each skinfold site were accepted within 5% accuracy: e.g., if the first measurement was 20 mm, the second measurement must be 20 mm ± 1 mm (5 x 20/100 = 1.0).

2.4.6 Slaughter et al's equation (1988) (59) was used for calculation of percent of body fat.

Girls (6-17 yrs):

\[
\% \text{BF} = 0.610 (\sum \text{SKF}) + 5.1
\]

2.5 Leg volume was calculated from circumferences and height of leg segments (120).

Subject's leg was divided in 6 landmarks: gluteal furrow, proximal 1/3 of thigh, the smallest circumference above knee joint, the smallest circumference below knee, the biggest circumference of calf and the smallest circumference of ankle. (Figure 4)

The distance from each landmark to floor was measured by using ruler, and calculated by using formula.

\[
V_{\text{leg}} = \frac{1}{3} h (a_1 + a_2 + \sqrt{a_1 a_2})
\]  

............ (1)
when; \( a_1 \) and \( a_2 \) = cross-sectional areas in centimeters of parallel areas of cone shape which is cut, can be calculated from proximal and distal circumferences of cone shape.

\[
h = \text{height between two circumferences because circumference (C) = } 2\pi r \quad (r = \text{radius})
\]

\[
r^2 = \left(\frac{C}{2\pi}\right)^2
\]

Therefore, cross-sectional area \( (\pi r^2) = \pi \left(\frac{C}{2\pi}\right) \)

Replace in formula (1)

\[
V_{leg} = \frac{h}{3} \left[ \frac{1}{6} \left( C_1^2 \right) + \left( h \right) \left( C_2^2 \right) + \frac{1}{3} \sqrt{\left( C_1^2 / 2 \right) + \left( C_2^2 / 2 \right)} \right] \tag{2}
\]

From formula (2)

\[
V = \left( \frac{h}{12} \right) \left( C_1^2 + C_1 C_2 + C_2^2 \right) \tag{3}
\]

when; \( C_1 \) and \( C_2 \) = proximal and distal circumferences of cone shape

\[
h = \text{height between proximal and distal circumferences}
\]

In addition, calculation of foot volume, the wedge shape formula was used.

Foot volume \( = \frac{1}{2} (l)(h)(b) \)

when; \( l \) = foot length from calcaneam to tip of the longest toe

\[
\frac{h}{b} = \text{height from sole to the smallest circumference of ankle level}
\]

\[
= \text{width of wedge shape calculated from the smallest circumference divided by } \pi
\]

Leg volume was sum of each segment volume and foot volume.

2.6 Agility was assessed by Nine-Square 20 seconds. (Figure 5) The square of 120 x 120 cm was divided into 9 equal squares. Firstly, the subject stood in the left corner, stepped sideways to the right by right foot, followed by left foot, stepped
forward by right foot, followed by left foot, stepped sideways to the left by left foot, followed by right foot, stepped backward by left foot, followed by right. The test was performed as quickly as possible in 10 seconds, then performed in the opposite direction next 10 seconds. Note that 2 steps (right and left) equal 1 time (83).

**Figure 5.** Six truncated segments of the leg and sites from which the antropometric measurement (120).
Figure 6. Nine-square test area (83).

For exercise training, both of two experimental groups were participated in exercise session at the same beat of music, 40-45 min, and 3 times per week for 8 weeks. All subjects were measured physical fitness components when exercise training completed. (Figure 7)

In addition, mental performance questionnaire was used to assess the psychological responses for exercise training subjects concerning with feeling and satisfaction of exercise.
### Statistical analysis

Statistical analyses were performed with SPSS 10.0 for Windows. The mean value and standard error of the means (SEM) of each test were calculated. Statistical analysis was used as follow:

1. **Pair t-test** was used to determine whether there was a statistically significant difference between the mean values obtained before and after the training period within the same subject.

2. **One Way ANOVA** (with Scheffe Multiple comparison method) for comparing the general physical characteristics and physical fitness parameters from the first week and the eighth week among the three groups.

3. A probability of 0.05 was selected as the criterion for statistical significance.
CHAPTER V

RESULTS

The General Physical Characteristics

The physical characteristics of the control group (NE), the aerobic dance group (AE), and the water aerobic group (WE) were shown in Table 6. The age of the WE (16.10±0.18 yr) was significantly higher than the NE (15.00±0.00yr) and the AE (15.00±0.00yr)(p<0.05). However, these values of the NE was no significant difference from the AE (Figure 8). The BMI among the NE (23.67±0.35 kg/m²), the AE (23.21±0.57 kg/m²), and the WE (22.46±0.43 kg/m²), there were no significant difference (Figure 9). The resting heart rate among the NE (90.6±1.40 bpm), the AE (90.6±1.67 bpm), and the WE (87±1.00 bpm), there were no significant difference (Figure 10). The systolic blood pressure among the NE (101±3.79 mmHg), the AE (104±2.21 mmHg), and the WE (106±4.76 mmHg), there were no significant difference (Figure 11). The diastolic blood pressure among the NE (66±3.40 mmHg), the AE (68.5±1.83 mmHg), and the WE (62±2.49 mmHg), there were also no significant difference (Figure 11).

Physical Fitness Parameters

All of the physical fitness parameters of the NE, the AE, and the WE before exercise training were shown in Table 7.
1. Maximum Oxygen Consumption (VO$_2$max)

The VO$_2$max of the NE (1.89±0.11 L/min) and the AE (1.88±0.17 L/min) were no significant difference from the WE (1.65±0.11 L/min) (Table 7, Figure 12).

2. Leg strength

The leg strength of the NE (57.70±3.00 kg) and the AE (60.70±2.44 kg) were no significant difference from the WE (55.8±4.84 kg) (Table 7, Figure 13).

3. Flexibility

The flexibility of the NE (9.85±1.03 cm) and the AE (11.23±3.84 cm) were no significant difference from the WE (8.60±2.62 cm) (Table 7, Figure 14).

4. Percent of Body Fat (%BF)

The %BF of the NE (30.87±1.15) and the AE (27.69±1.08) were no significant difference from the WE (26.57±1.68) (Table 7, Figure 15).

5. Leg volume

The leg volume of the NE (15056.05±592.18 ml) and the AE (13696.78±914.47 ml) were no significant difference from the WE (14138.78±956.83 ml) (Table 7, Figure 16).

6. Agility

The agility of the NE (29.90±0.72 times/20s) and the AE (30.80±1.27 times/20s) were no significant difference from the WE (33.1±1.03 times/20s) (Table 7, Figure 17).
Effects of Aerobic Exercise Training Program

1. Physical Fitness Parameters

1.1 Consideration Within Each Group

1.1.1 Maximum Oxygen Consumption (VO₂max)

Table 8 shows means and SEMs of VO₂max (L/min) of all subjects compare between the 1st and the 8th week period. At the end of 8 week, the VO₂max (L/min) value of the NE was no significant difference from the beginning (1.89±0.11 L/min to 1.92±0.13 L/min)(Figure 21,27). Whereas in the AE and the WE, the VO₂max (L/min) values were significantly (p<0.05) higher than the 1st week. (1.88±0.17 L/min to 2.45±0.11 L/min of the AE and 1.65±0.11 L/min to 2.53±0.15 L/min of the WE)(Figure 24,37,42)

1.1.2 Leg strength

Table 9 shows means and SEMs of leg strength (kg) of all subjects compare between the 1st and the 8th week period. At the end of 8 week, the leg strength (kg) value of the NE was no significant difference from the beginning (57.7±3.01 kg to 55.3±3.47 kg)(Figure 25,31). Whereas in the AE and the WE, the leg strength (kg) values were significantly (p<0.05) higher than the 1st week. (60.70±2.44 kg to 80.50±3.84 kg of the AE and 55.80±4.84 kg to 81.20±7.76 kg of the WE) (Figure 25,37,43)
1.1.3 Flexibility

Table 10 shows means and SEMs of flexibility (cm) of all subjects compare between the 1st and the 8th week period. At the end of 8 week, the flexibility (cm) value of the NE was no significant difference from the beginning (9.85±1.03 kg to 9.30±1.15 cm) (Figure 26,32). Whereas in the AE and the WE, the leg strength (cm) values were significantly (p<0.05) higher than the 1st week. (11.23±1.35 cm to 16.30±1.68 cm of the AE and 8.60±2.62 cm to 17.30±1.66 cm of the WE) (Figure 26,38,44)

1.1.4 Percent of Body Fat (% BF)

Table 11 shows means and SEMs of %BF of all subjects compare between the 1st and the 8th week period. At the end of 8 week, the %BF value of the NE was no significant difference from the beginning (30.87±1.15 to 31.01±1.08) (Figure 27,33). Whereas in the AE and the WE, the %BF values were significantly (p<0.05) higher than the 1st week. (27.69±1.08 to 24.01±1.18 of the AE and 26.57±1.68 to 22.76±1.36 of the WE) (Figure 27,39,45)

1.1.5 Leg volume

Table 12 shows means and SEMs of leg volume (ml) of all subjects compare between the 1st and the 8th week period. At the end of 8 week, the leg volume (ml) value of the NE was no significant difference from the beginning (15056.05±529.18 ml to 14980.02±519.32 ml) (Figure 28,38). Also, in the AE and the WE, the leg volume (ml) values were no significant difference from the 1st week. (13696.80±914.47 ml to 12251.20±1320.24 ml of the AE and 14138.78±956.08 ml to 13790.65±965.30 ml of the WE) (Figure 28,40,46)
1.1.6 Agility

Table 13 shows means and SEMs of agility (times/20s) of all subjects compare between the 1st and the 8th week period. At the end of 8 week, the agility (times/20s) value of the NE was no significant difference from the beginning (29.90±0.72 times/20s to 30.30±0.89 times/20s) (Figure 29,35). Whereas in the AE and the WE, the agility (times/20s) values were significantly (p<0.05) higher than the 1st week (30.80±1.27 times/20s to 35.30±1.24 times/20s of the AE and 55.80±4.84 ml to 81.20±7.76 ml of the WE) (Figure 29,41,47).

1.2 Consideration Among Groups

1.2.1 Maximum Oxygen Consumption (VO₂max)

At the end of 8 week, the results of VO₂max (L/min) of the WE (2.53±0.15 L/min), tended to be higher when compared to the AE (2.45±0.11 L/min), however it was no significant difference. Whereas the WE and the AE were significantly (p<0.05) higher than the NE. (1.92±0.13 L/min) (Table 14, Figure 18,24,48)

1.2.2 Leg strength

At the end of 8 week, the results of leg strength (kg) of the WE (81.20±7.76 kg), tended to be higher when compared to the AE (80.52±3.84 kg), however it was no significant difference. Whereas the WE and the AE were significantly (p<0.05) higher than the NE. (55.30±3.47 kg) (Table 14, Figure 19,25,49)
1.2.3 Flexibility

At the end of 8 week, the results of flexibility (cm) of the WE (17.30±1.66 cm), tended to be higher when compared to the AE (16.30±1.68 cm), however it was no significant difference. Whereas the WE and the AE were significantly (p<0.05) higher than the NE (9.30±1.15 cm)(Table 14, Figure 20,26,50)

1.2.4 Percent of Body Fat (% BF)

At the end of 8 week, the results of % BF of the WE (22.76±1.31), tended to be lower when compared to the AE (24.01±1.18), however it was no significant difference. Whereas the WE and the AE were significantly (p<0.05) lower than the NE (31.01±1.08)(Table 14, Figure 21,27,51)

1.2.5 Leg volume

At the end of 8 week, the results of leg volume (ml) of the WE (13790.65±965.30 ml) and the AE (12251.20±1320.24 ml) were no significant difference from the NE (14980.02±519.32 ml) (Table 14, Figure 22,28,52).

1.2.6 Agility

At the end of 8 week, the results of agility (times/20s) of the WE (22.76±1.31), tended to be higher when compared to the AE (24.01±1.18), however it was no significant difference. Whereas the WE and the AE were significantly (p<0.05) higher than the NE (31.01±1.08)(Table 14, Figure 23,29,53)
2. Psychological Responses Parameters

Table 15 shows the number and percentage of psychological responses concerning exercise satisfaction of the aerobic dance group (AE). Table 17 shows means, SEMs of psychological responses concerning exercise satisfaction of aerobic dance group (AE) and water aerobic group (WE) compare after exercise training. At the end of 8 week, the highest mean of the AE was exercise leader (4.20±0.20), music (3.90±0.23) and place (3.80±0.20) as the sequence.

Table 16 shows the number and percentage of psychological responses concerning exercise satisfaction of the water aerobic group (WE). Table 17 shows means, SEMs of psychological responses concerning exercise satisfaction of aerobic dance group (AE) and water aerobic group (WE) compare after exercise training. At the end of 8 week, the highest means of the WE were safety (4.20±0.20), place (4.20±0.20) and difficulty to perform (4.20±1.33). Exercise leader (4.10±0.18), enjoyment (4.00±0.21) and relaxing (4.00±0.21) to be next.

The results of place of the AE (3.80±0.20) was no significant difference from the WE (4.20±0.20). Enjoyment of the AE (3.80±0.20) was no significant difference from the WE (4.20±0.20). Exercise leader of AE (4.20±0.20) was no significant difference from the WE (4.18±0.18). Music of AE (3.90±0.23) was no significant difference from the WE (3.60±1.63). Physical fitness improvement of AE (3.30±0.21) was no significant difference from the WE (3.60±0.22). Movement of AE (3.40±0.27) was no significant difference from the WE (3.50±0.22). Stress decreasing of AE (3.70±0.26) was no significant difference from the WE (3.30±0.20). Relaxing of AE (3.60±0.16)
was no significant difference from the WE (4.00±0.21). Freshness of AE (3.60±0.31) was no significant difference from the WE (4.00±0.26). (Table 17)

However, the results of safety of WE (4.20±0.20) was significantly higher than the AE (3.40±0.27). Difficulty of perform of WE (4.20±1.33) was significantly higher than the AE (2.10±0.10). Exhaustion of WE (3.90±0.18) also was significantly higher than the AE (2.20±0.20). (Table 17)
Table 6. General physical characteristics of the control group (NE), the aerobic dance group (AE), and water aerobic group (WE). Values are presented as means and the standard errors of the means.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control Group (NE)</th>
<th>Aerobic Group (AE)</th>
<th>Water Group (WE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (N)</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>15±0.00</td>
<td>15±0.00</td>
<td>16.10±0.18</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.67±0.35</td>
<td>23.21±0.57</td>
<td>22.64±0.43</td>
</tr>
<tr>
<td>Resting heart rate (bpm)</td>
<td>90.6±1.40</td>
<td>90.6±1.67</td>
<td>87±1.00</td>
</tr>
<tr>
<td>Blood pressure (BP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-systolic (mmHg)</td>
<td>101±3.79</td>
<td>104±2.21</td>
<td>106±4.76</td>
</tr>
<tr>
<td>-diastolic (mmHg)</td>
<td>66±3.40</td>
<td>68.5±1.83</td>
<td>62±2.49</td>
</tr>
</tbody>
</table>

*significant different from other groups, *p*<0.05, One Way ANOVA*
Table 7. Means, SEMs of physical fitness parameters of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before exercise training.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control Group (NE)</th>
<th>Aerobic Dance Group (AE)</th>
<th>Water Aerobic Group (WE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO₂max (L/min)</td>
<td>1.89±0.11</td>
<td>1.88±0.17</td>
<td>1.65±0.11</td>
</tr>
<tr>
<td>Leg strength (kg)</td>
<td>57.7±3.00</td>
<td>60.7±2.44</td>
<td>55.8±4.84</td>
</tr>
<tr>
<td>Flexibility (cm)</td>
<td>9.85±1.03</td>
<td>11.23±3.84</td>
<td>8.6±2.62</td>
</tr>
<tr>
<td>% BF</td>
<td>30.87±1.15</td>
<td>27.69±1.08</td>
<td>26.57±1.68</td>
</tr>
<tr>
<td>Leg volume (ml)</td>
<td>15056.05±592.18</td>
<td>13696.78±914.47</td>
<td>14138.78±956.83</td>
</tr>
<tr>
<td>Agility (times/20s)</td>
<td>29.9±0.72</td>
<td>30.8±1.27</td>
<td>33.1±1.03</td>
</tr>
</tbody>
</table>
Table 8. Means, SEMs of of VO$_{2\text{max}}$ (L/min) of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before and after exercise training.

<table>
<thead>
<tr>
<th>Group</th>
<th>VO$_{2\text{max}}$ (L/min)</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE (n = 10)</td>
<td>1.89±0.11</td>
<td>1.92±0.13</td>
<td></td>
</tr>
<tr>
<td>AE (n=10)</td>
<td>1.88±0.17</td>
<td>2.45±0.11</td>
<td></td>
</tr>
<tr>
<td>WE (n=10)</td>
<td>1.65±0.11</td>
<td>2.53±0.15</td>
<td></td>
</tr>
</tbody>
</table>

☆ significant difference from before training, $p<0.05$, paired t-test
〇 significant difference from other groups, $p<0.05$, One Way ANOVA
**Table 9.** Means, SEMs of leg strength (kg) the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before and after exercise training.

<table>
<thead>
<tr>
<th>Group</th>
<th>Leg strength (kg)</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE (n=10)</td>
<td></td>
<td>57.70±3.01</td>
<td>55.30±3.47</td>
</tr>
<tr>
<td>AE (n=10)</td>
<td></td>
<td>60.70±2.44</td>
<td>80.5±3.84</td>
</tr>
<tr>
<td>WE (n=10)</td>
<td></td>
<td>55.80±4.84</td>
<td>81.20±7.76</td>
</tr>
</tbody>
</table>

☆ significant difference from before training, \( p<0.05 \), paired t-test

○ significant difference from other groups, \( p<0.05 \), One Way ANOVA
Table 10. Means, SEMs of flexibility (cm) of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before and after exercise training.

<table>
<thead>
<tr>
<th>Group</th>
<th>Flexibility (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
</tr>
<tr>
<td>NE (n=10)</td>
<td>9.85±1.03</td>
</tr>
<tr>
<td>AE (n=10)</td>
<td>11.23±1.35</td>
</tr>
<tr>
<td>WE (n=10)</td>
<td>8.60±2.62</td>
</tr>
</tbody>
</table>

☆ significant difference from before training, *p*<0.05, paired *t*-test

☆☆ significant difference from other groups, *p*<0.05, One Way ANOVA
Table 11. Means, SEMs of %BF of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before and after exercise training.

<table>
<thead>
<tr>
<th>Group</th>
<th>%BF</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE (n = 10)</td>
<td>30.87±1.15</td>
<td>31.01±1.08</td>
<td></td>
</tr>
<tr>
<td>AE (n=10)</td>
<td>27.69±1.08</td>
<td>24.01±1.18</td>
<td></td>
</tr>
<tr>
<td>WE (n=10)</td>
<td>26.57±1.68</td>
<td>22.76±1.36</td>
<td></td>
</tr>
</tbody>
</table>

☆ significant difference from before training, *p*<0.05, paired t-test

○ significant difference from other groups, *p*<0.05, One Way ANOVA
Table 12. Means, SEMs of leg volume (ml) of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before and after exercise training.

<table>
<thead>
<tr>
<th>Group</th>
<th>Leg volume (ml) Before</th>
<th>Leg volume (ml) After</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE (n=10)</td>
<td>15056.05±529.18</td>
<td>14980.02±519.32</td>
</tr>
<tr>
<td>AE (n=10)</td>
<td>13696.80±914.47</td>
<td>12251.20±1320.24</td>
</tr>
<tr>
<td>WE (n=10)</td>
<td>14138.78±956.08</td>
<td>13790.65±965.30</td>
</tr>
</tbody>
</table>
Table 13. Means, SEMs of agility (times/20s) of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare before and after exercise training.

<table>
<thead>
<tr>
<th>Group</th>
<th>Agility (times/20s)</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE (n = 10)</td>
<td></td>
<td>29.90±0.72</td>
<td>30.30±0.89</td>
</tr>
<tr>
<td>AE (n=10)</td>
<td></td>
<td>30.80±1.27</td>
<td>35.30±1.24</td>
</tr>
<tr>
<td>WE (n=10)</td>
<td></td>
<td>33.10±1.03</td>
<td>38.50±0.93</td>
</tr>
</tbody>
</table>

☆ significant difference from before training, p<0.05, paired t-test

◎ significant difference from other groups, p<0.05, One Way ANOVA
Table 14. Means, SEMs of physical fitness parameters of the control group (NE), aerobic dance group (AE) and water aerobic group (WE) compare after exercise training.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control Group (NE)</th>
<th>Aerobic Dance Group (AE)</th>
<th>Water Aerobic Group (WE)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VO₂max (L/min)</strong></td>
<td>1.92±0.13</td>
<td>2.45±0.11</td>
<td>2.53±0.15</td>
</tr>
<tr>
<td><strong>Leg strength (kg)</strong></td>
<td>55.30±3.47</td>
<td>80.50±3.84</td>
<td>81.20±7.76</td>
</tr>
<tr>
<td><strong>Flexibility (cm)</strong></td>
<td>9.30±1.15</td>
<td>16.30±1.68</td>
<td>17.30±1.66</td>
</tr>
<tr>
<td><strong>% BF</strong></td>
<td>31.01±1.08</td>
<td>24.01±1.18</td>
<td>22.76±1.36</td>
</tr>
<tr>
<td><strong>Leg volume (ml)</strong></td>
<td>14980.02±519.32</td>
<td>12251.20±1320.24</td>
<td>13790.65±965.30</td>
</tr>
<tr>
<td><strong>Agility (times/20s)</strong></td>
<td>30.30±0.89</td>
<td>35.30±1.24</td>
<td>38.50±0.93</td>
</tr>
</tbody>
</table>

○ significant difference from other groups, \( p<0.05 \), One Way ANOVA
Table 15. Number and percentage of psychological responses concerning exercise satisfaction of aerobic dance group (AE) after exercise training.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Score level</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highest (5)</td>
<td>High (4)</td>
</tr>
<tr>
<td>Place</td>
<td>1 (10)</td>
<td>6 (60)</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>1 (10)</td>
<td>5 (50)</td>
</tr>
<tr>
<td>Exercise leader</td>
<td>3 (30)</td>
<td>6 (60)</td>
</tr>
<tr>
<td>Music</td>
<td>3 (30)</td>
<td>5 (50)</td>
</tr>
<tr>
<td>Physical fitness improvement</td>
<td>-</td>
<td>4 (40)</td>
</tr>
<tr>
<td>Movement</td>
<td>1 (10)</td>
<td>3 (30)</td>
</tr>
<tr>
<td>Stress decreasing</td>
<td>1 (10)</td>
<td>6 (60)</td>
</tr>
</tbody>
</table>
Table 15. (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Score level</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highest (5)</td>
<td>High (4)</td>
<td>Average (3)</td>
<td>Low (2)</td>
<td>Lowest (1)</td>
<td>Total (%)</td>
</tr>
<tr>
<td>Relaxing</td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Safety</td>
<td>1 (10)</td>
<td>3 (30)</td>
<td>5 (50)</td>
<td>1 (10)</td>
<td></td>
<td>10 (100)</td>
</tr>
<tr>
<td>Freshness</td>
<td>2 (20)</td>
<td>3 (30)</td>
<td>4 (40)</td>
<td>1 (10)</td>
<td></td>
<td>10 (100)</td>
</tr>
<tr>
<td>Difficulty to perform</td>
<td>-</td>
<td>-</td>
<td>1 (10)</td>
<td>9 (90)</td>
<td></td>
<td>10 (100)</td>
</tr>
<tr>
<td>Exhaustion</td>
<td>-</td>
<td>-</td>
<td>3 (30)</td>
<td>6 (60)</td>
<td>1 (10)</td>
<td>10 (100)</td>
</tr>
</tbody>
</table>
### Table 16

Number and percentage of psychological responses concerning exercise satisfaction of water aerobic group (WE) after exercise training.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Score level</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highest (5)</td>
<td>High (4)</td>
<td>Average (3)</td>
<td>Low (2)</td>
<td>Lowest (1)</td>
<td></td>
<td>N (%)</td>
<td></td>
</tr>
<tr>
<td>Place</td>
<td>3 (30)</td>
<td>6 (60)</td>
<td>1 (10)</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Enjoyment</td>
<td>2 (20)</td>
<td>6 (60)</td>
<td>2 (20)</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Exercise leader</td>
<td>2 (20)</td>
<td>7 (70)</td>
<td>1 (10)</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Music</td>
<td>-</td>
<td>-</td>
<td>6 (60)</td>
<td>4 (40)</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Physical fitness improvement</td>
<td>1 (10)</td>
<td>4 (40)</td>
<td>5 (50)</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Movement</td>
<td>1 (10)</td>
<td>3 (30)</td>
<td>6 (60)</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Stress decreasing</td>
<td>1 (10)</td>
<td>1 (10)</td>
<td>8 (80)</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
Table 16. (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Score level</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highest (5)</td>
<td>High (4)</td>
<td>Average (3)</td>
<td>Low (2)</td>
<td>Lowest (1)</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
</tr>
<tr>
<td>Relaxing</td>
<td>2 (20)</td>
<td>6 (60)</td>
<td>2 (20)</td>
<td>-</td>
<td>-</td>
<td>10 (100)</td>
</tr>
<tr>
<td>Safety</td>
<td>3 (30)</td>
<td>6 (60)</td>
<td>1 (10)</td>
<td>-</td>
<td>-</td>
<td>10 (100)</td>
</tr>
<tr>
<td>Freshness</td>
<td>3 (30)</td>
<td>4 (40)</td>
<td>3 (30)</td>
<td>-</td>
<td>-</td>
<td>10 (100)</td>
</tr>
<tr>
<td>Difficulty to perform</td>
<td>2 (20)</td>
<td>8 (80)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10 (100)</td>
</tr>
<tr>
<td>Exhaustion</td>
<td>1 (10)</td>
<td>7 (70)</td>
<td>2 (20)</td>
<td>-</td>
<td>-</td>
<td>10 (100)</td>
</tr>
</tbody>
</table>
Table 17. Means, SEMs of psychological responses concerning exercise satisfaction of aerobic dance group (AE) and water aerobic group (WE) compare after exercise training.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Aerobic dance group (AE)</th>
<th>Water aerobic group (WE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place</td>
<td>3.80±0.20</td>
<td>4.20±0.20</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>3.70±0.21</td>
<td>4.00±0.21</td>
</tr>
<tr>
<td>Exercise leader</td>
<td>4.20±0.20</td>
<td>4.10±0.18</td>
</tr>
<tr>
<td>Music</td>
<td>3.90±0.23</td>
<td>3.60±1.63</td>
</tr>
<tr>
<td>Physical fitness improvement</td>
<td>3.30±0.21</td>
<td>3.60±0.22</td>
</tr>
<tr>
<td>Movement</td>
<td>3.40±0.27</td>
<td>3.50±0.22</td>
</tr>
<tr>
<td>Stress decreasing</td>
<td>3.70±0.26</td>
<td>3.30±0.21</td>
</tr>
<tr>
<td>Relaxing</td>
<td>3.60±0.16</td>
<td>4.00±0.21</td>
</tr>
<tr>
<td>Safety</td>
<td>3.40±0.27</td>
<td>4.20±0.20</td>
</tr>
<tr>
<td>Freshness</td>
<td>3.60±0.31</td>
<td>4.00±0.26</td>
</tr>
<tr>
<td>Difficulty to perform</td>
<td>2.10±0.10</td>
<td>4.20±1.33</td>
</tr>
<tr>
<td>Exhaustion</td>
<td>2.20±0.20</td>
<td>3.90±0.18</td>
</tr>
</tbody>
</table>

☆ significant difference, \( p<0.05 \), paired t-test
Figure 8. Comparison of means (±SEMs) values of age among control (NE), aerobic dance (AE) and water aerobic (WE) groups at the beginning.

Figure 9. Comparison of means (±SEMs) values of BMI among control (NE), aerobic dance (AE) and water aerobic (WE) groups at the beginning.

\( \bigcirc \) significant difference from other groups, \( p<0.05, \text{One Way ANOVA (Figure 8)} \)
Figure 10. Comparison of means (±SEMs) values of RHR among control (NE), aerobic dance (AE) and water aerobic (WE) groups at the beginning.
Figure 11. Comparison of means (±SEMs) values of blood pressure (BP) among control (NE), aerobic dance (AE) and water aerobic (WE) groups at the beginning.
Before

![Comparison of VO₂ max](image1)

**Figure 12.** Comparison of means (±SEMs) values of VO₂ max among control (NE), aerobic dance (AE), and water aerobic (WE) groups before exercise training.

![Comparison of leg strength](image2)

**Figure 13.** Comparison of means (±SEMs) values of leg strength among control (NE), aerobic dance (AE), and water aerobic (WE) groups before exercise training.
Figure 14. Comparison of means (±SEMs) values of flexibility among control (NE), aerobic dance (AE), and water aerobic (WE) groups before exercise training.

Figure 15. Comparison of means (±SEM) values of %BF among control (NE), aerobic dance (AE), and water aerobic (WE) groups before exercise training.
Figure 16. Comparison of means (±SEMs) values of leg volume among control (NE), aerobic dance (AE), and water aerobic (WE) groups before exercise training.

Figure 17. Comparison of means (±SEMs) values of agility among control (NE), aerobic dance (AE), and water aerobic (WE) groups before exercise training.
Figure 18. Comparison of means (±SEMs) values of VO\textsubscript{2}max among control (NE), aerobic dance (AE), and water aerobic (WE) groups after exercise training.

Figure 19. Comparison of means (±SEMs) values of leg strength among control (NE), aerobic dance (AE), and water aerobic (WE) groups after exercise training.

\( \circ \) significant difference from other groups, \( p<0.05 \), One Way ANOVA (Figure 18-23)
**Figure 20.** Comparison of means (±SEMs) values of flexibility among control (NE), aerobic dance (AE), and water aerobic (WE) groups after exercise training.

**Figure 21.** Comparison of means (±SEMs) values of %BF among control (NE), aerobic dance (AE), and water aerobic (WE) groups after exercise training.
Figure 22. Comparison of means (±SEMs) values of leg volume among control (NE), aerobic dance (AE), and water aerobic (WE) groups after exercise training.

Figure 23. Comparison of means (±SEMs) values of agility among control (NE), aerobic dance (AE), and water aerobic (WE) groups after exercise training.
Figure 24. Comparison of means (±SEMs) values of VO$_2$max among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.

Figure 25. Comparison of means (±SEMs) values of leg strength among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.

☆ significant difference from before training, $p<0.05$, paired $t$-test (Figure 24-29)

◇ significant difference from other groups, $p<0.05$, One Way ANOVA (Figure 24-29)
Figure 26. Comparison of means (±SEMs) values of flexibility among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.

Figure 27. Comparison of means (±SEMs) values of %BF among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.
Figure 28. Comparison of means (±SEMs) values of leg volume among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.

Figure 29. Comparison of means (±SEMs) values of agility among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.
**NE**

![Graph](image)

**Figure 30.** Comparison of means (±SEMs) values of VO$_2$max within control group (NE) “before” and “after” exercise training. (without actual programmed exercise)

![Graph](image)

**Figure 31.** Comparison of means (±SEMs) values of leg strength within control group (NE) “before” and “after” exercise training. (without actual programmed exercise)
Figure 32. Comparison of means (±SEMs) values of flexibility within control group (NE) “before” and “after” exercise training. (without actual programmed exercise)

Figure 33. Comparison of means (±SEMs) values of %BF within control group (NE) “before” and “after” exercise training. (without actual programmed exercise)
**Figure 34.** Comparison of means (±SEMs) values of leg volume within control group (NE) "before" and "after" exercise training. (without actual programmed exercise)

**Figure 35.** Comparison of means (±SEMs) values of agility within control group (NE) "before" and "after" exercise training. (without actual programmed exercise)
Figure 36. Comparison of means (±SEMs) values of VO\textsubscript{2max} within aerobic dance group (AE) “before” and “after” exercise training.

Figure 37. Comparison of means (±SEMs) values of leg strength within aerobic dance group (AE) “before” and “after” exercise training.

☆ significant difference from before training, \( p<0.05 \), paired \( t \)-test (Figure 36-47)
Figure 38. Comparison of means (±SEMs) values of flexibility within aerobic dance group (AE) “before” and “after” exercise training.

Figure 39. Comparison of means (±SEMs) values of %BF within aerobic dance group (AE) “before” and “after” exercise training.
Figure 40. Comparison of means (±SEMs) values of leg volume within aerobic dance group (AE) “before” and “after” exercise training.

Figure 41. Comparison of means (±SEMs) values of agility within aerobic dance group (AE) “before” and “after” exercise training.
Figure 42. Comparison of means (±SEMs) values of VO$_2$max within water aerobic group (WE) “before” and “after” exercise training.

Figure 43. Comparison of means (±SEMs) values of leg strength within water aerobic group (WE) “before” and “after” exercise training.
Figure 44. Comparison of means (±SEMs) values of flexibility within water aerobic group (WE) “before” and “after” exercise training.

Figure 45. Comparison of means (±SEMs) values of %BF within water aerobic group (WE) “before” and “after” exercise training.
Figure 46. Comparison of means (±SEMs) values of leg volume within water aerobic group (WE) "before" and "after" exercise training.

Figure 47. Comparison of means (±SEMs) values of agility within water aerobic group (WE) "before" and "after" exercise training.
Figure 48. Comparison of means (±SEMs) values of VO$_2$max among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.

Figure 49. Comparison of means (±SEMs) values of leg strength among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.

☆ significant difference from before training, $p<0.05$, paired t-test (Figure 48-53)

○ significant difference from other groups, $p<0.05$, One Way ANOVA (Figure 48-53)
Figure 50. Comparison of means (±SEMs) values of flexibility among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.

Figure 51. Comparison of means (±SEMs) values of %BF among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.
Figure 52. Comparison of means (±SEMs) values of leg volume among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.

Figure 53. Comparison of means (±SEMs) values of agility among control (NE), aerobic dance (AE), and water aerobic (WE) groups before and after exercise training.
CHAPTER VI
DISCUSSION

All of subjects were selected by criteria for subject selection mentioned above. Table 6 shows the general physical characteristics namely the age, BMI, resting heart rate and blood pressure of the control group (NE), the aerobic dance group (AE), and water aerobic group (WE) were similar. However, the value of the age of WE was significantly higher than NE and AE which were in range of teenager which were shown to have quite stable of several physical fitness parameters.

As the criteria for subject selection before exercise training, the value of all physical fitness parameters: maximum oxygen consumption (VO$_2$max), leg strength, flexibility, percent of body fat (%BF), leg volume, and agility were no significant difference among NE, AE and WE. (Table 7) This make these groups of subjects very good for this type of longitudinal investigations of differences in the effects of different type of exercise.

The major aim of the study was to study the effects of aerobic exercise training on physical fitness during eight weeks and to compare the effects of aerobic dance and water aerobic exercise on physical fitness with the same intensity, frequency, and duration.
1. Physical Fitness Parameters

1.1 Maximum Oxygen Consumption (VO$_2$max)

One of the most important components of physical fitness is the cardiorespiratory endurance. Cardiorespiratory endurance is the ability to perform dynamic exercise involving large muscle groups at moderate to high intensity for prolonged period(49). Every physical fitness evaluation should include an assessment of cardiorespiratory function during both rest and exercise. Exercise physiologists consider directly measured maximum oxygen consumption (VO$_2$max) or peak VO$_2$ to be the most valid measure of functional capacity of the cardiorespiratory system(60).

This study used the Astrand-Rhyming bicycle ergometer submaximal exercise test protocol(61). To estimated VO$_2$max for this protocol, used the modified Astrand-Rhyming nomogram. This nomogram estimated VO$_2$max (in L/min) from submaximal treadmill, bicycle ergometer, and step test data. The correlation between measured VO$_2$max and the VO$_2$max estimated from this nomogram was $r = 0.74$, the prediction error was $\pm 10$ and 15%, respectively, for well-trained and untrained individuals (62).

The value of the VO$_2$max of the AE and WE were significantly higher than the beginning whereas there was no significant difference of NE. Endurance training programs that increase VO$_2$max involve a large muscle mass in dynamic exercise for twenty to sixty minutes per session, three to five times per week at an intensity of about 50% to 85% VO$_2$max (63). While endurance training programs of two to three months’duration cause an increase in VO$_2$max of about 15% the range of improvement can be as low as 2% to 3% for those who start the program with high
VO₂max values (64), and as high as 30% to 50% for those with low initial VO₂max values (64,65,66,67). The cardiorespiratory (systemic) changes induced by training include those that affect mainly the oxygen transport system which involves many circulatory, respiratory, and tissue-level factors, all working together for one common goal—to deliver oxygen to the working muscle(68). There are six main changes resulting from training that are apparent at rest: 1) an increased heart size (cardiac hypertrophy), 2) a decreased heart rate, 3) an increased stroke volume, 4) little or no change in resting lung measures, 5) an increased blood volume and hemoglobin, and 6) an increased capillary density and hypertrophy of skeletal muscle. (68) In part of an increased blood volume and hemoglobin, many researchers found that (69,70,71) total blood volume and the total amount of hemoglobin are both increased with endurance training. Both parameters are important to the oxygen transport system and are closely correlated with VO₂max (72,73). This result is supported by the study of Kravitz and others (1993)(74), they found that the eight weeks of step training improve 8% VO₂max which was similar to several aerobic dance studies (75,76,77). Moreover, investigations using single bouts of water exercise, in both shallow and deep water, indicated that training in water can improve cardiorespiratory endurance because participants can achieve training VO₂ within the range recommended by the ACSM (78,79,80). Duffield (1976) reported that, by making use of the water properties of turbulence and frictional resistance, work intensity can be increased by amplifying the resistance of the water acting against the body (81).

Considering between WE and AE, the result of the VO₂max of the WE was no significant difference from AE. However, this value of WE tended to be higher than AE. This may indicate that duration was not long enough. If the duration of aerobic
exercise training will be extended, the result of WE was possibly significantly higher than AE. Study (1991)(82) reported that the natural resistance of the water and the constant use of the arms create more of an anaerobic response, causing the higher lactate level response to exercise, especially in nonwater trained participants. This may be partly due to the subjects of WE had not moved forcefully enough through the water to increase their overall energy expenditure.

1.2 Leg strength

Muscle strength is one factor of physical fitness parameters. Strength is defined as the ability of a muscle group to develop maximal contractile force against a resistance in a single contraction (89). The force generated by a muscle or muscle group, however, is highly dependent on the velocity of movement. Maximal force is produced when the limb is not rotating (i.e., zero velocity). As the speed of joint rotation increases, the muscular force decreases. Thus, strength for dynamic movements is defined as the maximal force generated in a single contraction at a specified velocity (90). Strength can be assessed for static and dynamic muscular contraction. If the resistance is immovable, the muscle contraction is static or isometric (iso, same; metric, length), and there is no visible movement of the joint. Dynamic contractions, in which there is visible joint movement, are either concentric, eccentric, or isokinetic (89). In this study, leg strength were done while the muscle contracted isometrically. Development of muscle strength will gradually increase and the maximum strength is in the age of 20-30, then gradually decrease. After the age of 45, muscle strength will decrease about 5-10% every 10 years and after the age of 65, it will decrease about 20%. People who have high body weight will have more maximum strength than ones who have low body weight (83). Concentrally
isokinetic muscle strength are obviously different in accordance with age that is; the maximum strength is at the age of 20-29, next is 30-39 and 40-49 respectively (84).

The value of the leg strength of the AE and WE were significantly higher than the beginning whereas there was no significant difference of NE. With endurance training the overall aerobic potential of skeletal muscle is increased equally in both Type I and Type II fibers (85,86). This means that the inherent differences in oxidative capacity between the fiber types is not altered by training. In other words, the Type I fiber has a higher aerobic capacity than the Type II fiber, both before and after endurance training (68). Additionally, among both male and female endurance athletes, Type I fibers occupy a greater area of the muscle than do Type II fibers (87,86). The converse is true for anaerobically trained athletes, such as shot putters and sprinters. This information implies a selective hypertrophy dependent on the kind of training and/or sports activities performed by the athletes (68). Among healthy persons, most evidence suggests that there is no interconversion of Type I and Type II fibers as a result of aerobic training. With aerobic training, however, there can be a gradual conversion of Type IIB (fast glycolytic) to Type IIA (fast oxidative glycolytic) fibers without gross changes in the ratio between Type I and Type II fibers. In one study, subjects trained for eight weeks on a bicycle working at 81% of their aerobic capacity. Following training, Type IIA fibers were observed to have increased from 65% to 75% of all Type II fibers. The percentage of Type I (slow-oxidative) fibers remained the same as before (88).

Considering between WE and AE, the result of the leg strength of the WE was no significant difference from AE. However, this value of WE tended to be higher than AE. This may be caused from the exercise training was in period of the cool
season, thus the subjects of WE were not motivated to work as hard in water. The temperatures of water for functional water fitness classes targeting activities of daily living is 83-86 degrees F (29-30 degrees C) for moderate intensity (below 4.2 METs) and stop-and-go activities (93). If the water temperature is in the lower 70 degrees F and the class is to be held, it will be necessary to spend more time in the thermal warm up phase of class to prepare the joints and muscles and prevent them from being injured. On the other hand, if water temperature is in the 90 degrees F, other dangers arise. The body will not be able to effectively dissipate heat created during vigorous exercise, and heat-related injuries can develop (94). Tovin et al (1994) found that after the eight weeks exercise program, no significant difference for the strength between water and land exercise. Although exercise in water may not be as effective as exercise on land for regaining maximum muscle performance, rehabilitation in water may minimize the amount of joint effusion and lead to greater self-reports of functional improvement in subjects with intra-articular ACL reconstructions (91). Additionally, Howell (1988) studied the effects of a 10-week land and water exercise program. The result of the strength between land and water exercise was no significant difference (92). In contrast, Hoeger et al (1993) showing that shallow water rhythmic exercise produced greater muscular strength gains than a low impact aerobics class (104).

1.3 Flexibility

Flexibility is an important, yet often neglected, component of physical fitness. In many cases, the combination of poor muscle strength and lack of flexibility is the cause of these problems, particularly in sedentary, middle-aged, and older populations. Adequate flexibility in all joints of the body is important, especially in
older adults, to prevent musculoskeletal injury and to maintain functional independence with aging (96). Flexibility is the ability of a joint, or series of joints, to move fluidly through a full range of motion (ROM). Static flexibility is a measure of the total range of motion (ROM) at the joint; dynamic flexibility is a measure of the torque or resistance to movement. Both types of flexibility are important in performance of sport skills as well as activities of daily living. Standard sit-and-reach test was used to assessed flexibility in this study. The ACSM (1995)(49) recommends using the standard sit-and-reach test to evaluate low back and hip flexibility. Although most exercise specialists assume the standard sit-and-reach test to be a valid measure of low back and hip flexibility, Jackson and Baker (1986)(96) reported that the sit-and-reach scores of 13-to-15 year-old girls were only moderately correlated with hamstring flexibility (r = -0.16) and poorly correlated with hamstring flexibility (r = 0.64) and poorly correlated with criterion measures of total back (r = 0.07) upper back (r = -0.16), and lower back (r = 0.28) flexibility. They concluded that the sit-and-reach test does not validly assess lower back flexibility of teenage girls. Jackson and Landford (1989) (97) reported that the sit-and-reach test had excellent criterion-related validity as a test of hamstring flexibility (r = 0.89) but not only moderately related to lower back flexibility (r = 0.59) in men. For women, the sit-and-reach test had moderate criterion-related validity as a test of hamstring flexibility (r = 0.70) but was poorly related to lower back flexibility (r = 0.12).

The flexibility values of the AE and WE were significantly increased when compared the before and after the 8 weeks. Whereas the NE was no significant difference. This may be partly due to the program of aerobic exercise training put the static stretching in both warm up and cool down phase in this study. There are two
general stretching techniques: (1) static stretching (continuously holding a stretch position), and (2) dynamic stretching (sometimes referred to as ballistic stretching if movements are not controlled) (95). Although both techniques result in an improvement in flexibility, static stretching is considered to be superior to dynamic stretching because there is less chance of injury (98), static stretching causes less muscle spindle activity when compared to dynamic stretching, and there is less chance of muscle soreness. Stimulation of muscle spindles during dynamic stretching can produce a stretch reflex and therefore result in muscular contraction. This type of muscular contraction counteracts the desired lengthening of the muscle and may increase the chance of injury.

Research has shown that thirty minutes of static stretching exercises performed twice per week will improve flexibility within five weeks (99). It is recommended that the stretch position be held for ten seconds at the beginning of a flexibility program and increased to sixty seconds after several training sessions. Each stretch position should be repeated three to five times, with the number increased up to ten repetitions. Overload is applied by increasing the range of motion during the stretch position and increasing the amount of time the stretch position is held. Preceding a static stretch with an isometric contraction of the muscle group to be stretched is an effective means of improving muscle relaxation and may enhance the development of flexibility (99,100,101). This stretching technique is called proprioceptive neuromuscular facilitation (PNF). The physiological rationale for the use of PNF stretching is that muscular relaxation follows an isometric contraction because the contraction stimulates the Golgi tendon organs, which inhibit contraction during the subsequent stretching exercise. Wallin et al (1985) reported significantly
better improvement in the flexibility of the plantar flexors and hip adductors and extensors for subjects who trained using the PNF (11 to 25% increase) technique compared to ballistic stretching (3 to 7% increase) (102).

The value of the flexibility of WE was no significant difference from AE. This may mean that the major effects of aerobic exercise training may be to improve cardiorespiratory endurance, thus the exercise program in this study specified more aerobic phase than stretching phase. Therefore the causes for the difference of the result between WE and AE were not to be clear. Supporting evidence was reported by Barretta (1993) and Hoeger et al (1993) reported increases in hamstring and low-back flexibility. If water exercisers simply perform land stretches in the water, they should attain flexibility gains because of the ability to overload. However, a question still remains concerning the potential for movement using the water to affect flexibility. It seems that water should work to increase range of motion, but the research produces contradictory results (103,104).

1.4 Percent of Body Fat (%BF)

Body composition is a key component of an individual's health and physical fitness profile (105). Body composition is important both as a measure of nutritional status and as a basic on which to estimate nutrient and caloric needs. Acute or chronic illnesses may effect nutritional status by altering the body's metabolic rate, changing body composition, and changing the activity level (106). To classify level of body fatness, the relative body fat (%BF) is used. The average %BF is 15 for men and 23 for women. The standard of obesity that places an individual at risk for disease is body fat ≥25% for men and ≥32% for women. Minimal fat levels that place an individual at for disease associated with too little body fat are estimated to be
associated with too little body fat are estimated to be ≤5% for men and ≤8% for women (107).

The skinfold (SKF) method was used to assessed %BF in this finding. Sum of triceps and calf skinfolds were calculated %BF from equation of Slaughter et al (1988)(108). The result of %BF of AE and WE were significantly decrease from the beginning. Whereas, the result of NE was no significant difference. This may be mainly due to increasing energy expenditure and helping to create a negative energy balance for weight loss, daily exercise ensures that the weight loss is due to loss of fat rather than muscle tissue. In many studies showed the %BF was potentially reduced by an aerobic training regimen, Pavlou et al (1985) studied the contribution of exercise to the preservation of fat-free-mass in mildly obese males on a rapid weight-loss diet. The exercise group dieted and participated in an 8-week walking-jogging program, 3 days per a week. The nonexercise group dieted only. Although the total weight loss of the exercise (-11.8 kg) and nonexercise (-9.2) groups was similar, the composition of the weight loss differed significantly. The exercise group maintained FFM while the nonexercise group lost a significant amount of FFM. Also, the exercise group lost more fat (11.2 kg) than the nonexercise group (5.9 kg). In other words, for the nonexercising subjects, only 64% of the total weight loss was fat weight compared to 95% for the exercising subjects. The researchers concluded that the addition of aerobic exercise to the dietary regimen preserves existing FFM, increases fat utilization for energy production, and is more effective in reducing fat stores than diet alone (109). Sidney, Shephard, and Harrison (1977) (110) found that 3 months of aerobic training reduced the estimated percent body fat of 65-year-old subjects by an average of 2.7%, without any need for deliberate dietary restriction. In these
experiments, the average skinfold thickness decreased by 3.3 mm, corresponding to some 75% of the increment of subcutaneous fat that had occurred over the adult life of these subjects.

A substantially increased energy expenditure is needed to induce such responses, and a minimal aerobic exercise prescription with no control of diet may have little effect on a person with established obesity. Any exercise-induced changes of body composition reflect not only the energy cost of the activity that is undertaken, but also possible small, upward adjustments of postexercise metabolism (111), postprandial metabolism, and basal metabolic rate (112) relative to dieting without exercise. Fat loss seems to occur more readily in men than in women (113), perhaps because of gender differences in fat metabolism, and is facilitated if the subjects are exposed to a cold environment during the exercise sessions (114). In men, the fat loss occurs selectively from the trunk, particularly the abdomen (115,116), whereas in women, the larger portion of any fat loss is from the hips and thighs.

Consideration the result of %BF between the WE and AE, there were no significant difference. This may indicate that both two types of aerobic exercise equally decrease in %BF. Supported this result by Pollock et al (1975)(117), compared cycling, running, and walking of equal frequency, duration, and intensity. All three program produced significant reductions in %BF and body weight. Despres et al (1985) (115) reported that a 20-week cycling program (4 to 5 times a week) resulted in significant reductions in body weight %BF, and fat cell weight in a group of sedentary men. These studies suggest that aerobic exercise modes are equally effective in altering body composition.
1.5 Leg volume

The volumes of arm and leg would be different due to different in age, body weight, height and ethnic group that affect the volumes of arm and leg (118). The Thai have a lower weight and height than European. Additionally, technique of measuring also affects the outcomes. The tape measure should be flexible, nonstretchable, approximately 0.7 cm wide, and easily retractable. Preferable, the tape should be in metric units on one side and inches on the other. The tension on the tape should be snug around the body part but not too tight to compresses the subcutaneous fat layer (119). In this study used the method of Jones and Pearson (1969) (120) to calculated the leg volume from circumferences and height of leg segments. The value of leg volume of all subjects in AE, WE, and NE were no significant changes from the beginning. In addition, the value of leg volume of among AE, WE and NE were also no significant difference. This may mean the intensity was not enough for exercise training in this study. The result of AE and WE tended to be lower than the beginning. This may be caused from the aerobic training affected to reduced %BF (109,110), therefore the value of the leg volume of exercise training groups tended to decreased.

1.6 Agility

Agility is the ability to rapidly change direction of the body and part of it. It is the combination of several factors; including reaction time, speed, coordination, power, and strength (121). This specific skill-related fitness is essential to performance in games and sports as well as to working efficiency. One who posses skills can work more effectively, enjoy leisure time through sports and games, and react positively to emergency situations.
The result of the agility of the AE and the WE were significantly higher from the beginning. However, the NE was no significant difference. This may be due to higher brain centers (motor cortex, basal ganglia, cerebellum) prepare to execute a motor task and send action potentials through lower brain centers and spinal nuclei to influence the cardiorespiratory and sympathetic nervous system responses to exercise. As more motor units are recruited to develop the greater tension needed to accomplish a work task, larger physiological responses are required to sustain the metabolism rate of the muscles (66,122). For example, if some muscle fibers are prevented from contracting, addition muscle fibers must be recruited to maintain tension. This generates higher heart rate responses to the work task (123). The ability to perform a fixed submaximal exercise bout for a prolonged period of time is dependent on the recruitment of a sufficient number of motor units to meet the tension (work) requirements through oxidative phosphorylation. Prior to endurance training, more mitochondria-poor motor units must be recruited to carry out a work task at a given VO2. This results in a greater “central” drive to the cardiorespiratory control centers, which causes higher sympathetic nervous system, heart rate, and ventilation responses. The feedback from chemoreceptors at the untrained muscle would also stimulate the cardiorespiratory control center. With the increase in mitochondrial number following endurance training, local factors (H+, adenosine compounds, etc.) do not change as much. This leads to less local stimulation of blood flow and a reduced chemoreceptor input to the cardiorespiratory centers. In addition, the higher number of mitochondria allows the tension to be maintained with fewer motor units involved in the activity. This reduced “feed forward” input from the higher brain centers and reduced “feedback” from the muscle results in lower sympathetic nervous
system output, heart rate, and ventilation responses to exercise (66,122,123). In many studies shown the agility was increased by the exercise training and physical education activities.

The result of the agility of WE was no significant difference from AE. This may indicate that aerobic dance and water aerobic exercise are equally effective in altering agility.

2. Psychological Response Parameters

As the result of psychological response concerning exercise satisfaction, this studied can be concluded that aerobic exercise not only improves the physical performance, it can also improves the mental performance. Although, the result of overall physical fitness parameter indicated that the WE and AE were no significant difference. There were three psychological response parameters of WE significantly higher than AE.

Firstly, the safety of the WE was significantly higher than the AE. This may be due to water’s buoyancy. Gravitational forces are reduced in water due to its density and the buoyancy of the human body in water. Buoyancy acts as support for the spine or extremities that may be weakened due to disease, injury, surgery, or immobilization (11,15,37).

The difficulty to perform of the WE was significantly higher than the AE. This may be caused from water’s resistance (9,17,41,42). Three-dimensional resistance is created as the body pushes the water out of its way. Moreover, water is denser than air, the muscles work harder in water than on land.

Finally, the exhaustion of the WE was also significantly higher than the AE. Supporting this evidence was reported by Evans, Bureton, and Purvis (1978)(11), the
dual effects to buoyancy and resistance make possible high levels of energy expenditure with relatively little movement or strain on lower-joint extremities. Napoletan and Hicks (1995)(124) made comparisons in energy expenditure between walking on a land treadmill and on a treadmill in the water at two different depths (mid-thigh and xiphoid level). The study suggested that walking at a speed miles per hour at both water levels required greater energy expenditure than land treadmill walking at the same speed.

Data obtained from this study indicated that water aerobics provided tremendous advantages over traditional forms of fitness activities. The exercise program can be individualized and adapted to fit all kinds of needs and abilities. Furthermore, the water provided a cushioned environment to decreased the risk of injuries and at the same time it was an excellent exercise alternative for people with a wide range of joint problem. Overuse injuries were especially common among beginners who choose such types of exercise. Activities that involved excessive pounding or jarring had to be reduced for individuals with joint problems or arthritis, the elderly, or those who were obese.

With water aerobics did not have to be highly skilled to gain fitness benefits. Since most exercises were done while standing in armpit water level, even non-swimmers, with lifeguard supervision, could participate.
CHAPTER VII

CONCLUSION

The Effects of Aerobic Dance and Water Aerobic Exercise on Physical Fitness.

The VO\textsubscript{2}max of AE and WE were significantly increase after 8 weeks of training. The leg strength of AE and WE were significantly increase from the beginning. The flexibility of AE and WE were significantly increase from the beginning. The %BF of AE and WE were significantly increase from the beginning. The agility of AE and WE were also significantly increase from the beginning. Whereas, the leg volume of AE and WE were no significant changes from the beginning.

Comparison between Aerobic Dance and Water Aerobic Exercise on Physical Fitness.

The VO\textsubscript{2}max between WE and AE were not significantly different after 8 weeks of training. The leg strength between WE and AE were not significantly different. The flexibility between WE and AE were not significantly different. The %BF between WE and AE were not significantly different. The leg volume between WE and AE were not significantly different. The agility between WE and AE were also not significantly different.
The exercise training improve overall physical fitness. Moreover, the aerobic exercise improve the mental fitness. The water exercise provides an alternative means of exercising for overweight, injured or ill individuals. Studies, with a longer training duration, higher training intensity, different gender and age groups, water exercise with osteoporosis patients or handicapped, and effect on axial load are recommended for the future research.
REFERENCES


11. Evans BW, Cureton KJ, Purvis JW. Metabolic and circulatory responses to


13. Vickery SR, Cureton KJ, Langstaff JL. Heart rate and energy expenditure during

14. Croisant P. Effect of a water exercise program upon the fitness of older
individuals. Abs Res Papers AAHPERD 1986; 221.


16. Darby LA, Yaekle BC. Physiological responses during two types of exercise
performed on land and in the water. J Sports Med Phys Fitness 2000; 40
: 303-11.

17. Huey L, Forster R, P.T. The complete waterpower workout book. 1<sup>st</sup> ed. New

; 1988.


21. Stoll SK, Beller JM. The professional's guide to teaching aerobics. NJ:

; 1985.

23. Jacobson PC. Aerobic dance: sport for life. USA: Brigham Young
University; 1988.


50. Pollock ML. The quantification of endurance training programs. Exercise and

51. Brynteson P, Sinning WE. The effects of training frequencies on the retention of

52. Hickson RC, Rosenkoetter MA. Reduced training frequencies and maintenance

53. Moffat RJ, Stamford BA, Neill RD. Placement of tri-weekly training sessions:
Importance regarding enhancement of aerobic capacity. Res Quart 1977
; 48 : 583-91.


55. American College of Sports Medicine. Guidelines for Exercise Testing and

56. Bosco JS, Gustafson WF. Measurement and evaluation in physical education,

57. Heyward VH. Advanced fitness assessment and exercise prescription. 2nd ed.


59. Slaughter et al. Skinfold equations for estimation of body fatness in children and

60. Heyward VH. Advanced fitness assessment and exercise prescription. 3rd ed. IL :
Human kinetics ; 1998. p. 47-78

61. Astand PO, Ryhming I. A nomogram for calculation of aerobic capacity (physical
fitness) from pulse rate during submaximal work. J Appl Physiol 1954 ;
7 : 218-221.


83. ศูนย์รัฐวิสาหกิจการศึกษา. การกีฬาแห่งประเทศไทย, 19-62.


APPENDIX A

PHYSICAL ACTIVITY QUESTIONNAIRE

Please answer the questions as frankly and accurately as possible. ALL INFORMATION OBTAINED IN THIS STUDY WILL BE KEPT CONFIDENTIAL AND USED FOR THIS RESEARCH PROJECT ONLY.

(i) Name-Surname .................................. Nickname .......... Age ...... yrs
(ii) Body weight ...... kg                 Height ...... cm       Gender ........
(iii) Level of education ................. ID ......................
(iv) Advisor’s name ................................
(v) Address ..............................................................
(vi) Phone number ....................... Mobile phone / pager number ..............
(vii) E-mail address ............................................
(viii) Current medication .....................
(ix) Medication history

- heart problem
- high blood pressure
- low blood pressure
- chest pain
- respiratory problem
- bone / joint problem
- neural disorders
- diabetic problem
- muscle pain
- operation (please indicate) ..........................................................
- others .................................................................
(x) Smoking and drinking history

- Have you ever smoked cigarettes, cigars, or a pipe?
  □ Yes □ No

- How many cigarettes do you smoke per day now? ............. per day

- During the past month, on how many days did you drink alcoholic beverages? ..................

- On the average, how many glasses of beer, wine or cocktails do you consume a week? ............... glasses

(xi) Exercise activity

- On the average, how frequently are you engaged in physical exercise.
  □ less than once per week
  □ once per week
  □ 2-3 times per week
  □ more than 3 times per week

- Type of the exercise that you would prefer in regular exercise program for yourself .................

- How many minutes on the average is each of your exercise workouts? ............... Minutes

- Have you ever experienced unexplained pain during exercise? ...............
APPENDIX B

PERSONAL PHYSICAL FITNESS PROFILE

(BEFORE)

<table>
<thead>
<tr>
<th>Name-Surname</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight</td>
<td>Height</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Resting Heart Rate</td>
</tr>
</tbody>
</table>

1. **VO₂ max (L/min)**

<table>
<thead>
<tr>
<th>Time elapsed (min)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate (bpm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. **Leg strength (kg)**

<table>
<thead>
<tr>
<th>Trial</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force (kg)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. **Flexibility (cm)**

<table>
<thead>
<tr>
<th>Trial</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (cm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. %BF

<table>
<thead>
<tr>
<th>Trial</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triceps skinfold (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf skinfold (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Leg volume (ml)

- Right leg volume (ml)

<table>
<thead>
<tr>
<th>segment</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumference (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Left leg volume (ml)

<table>
<thead>
<tr>
<th>segment</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumference (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Right foot volume (ml)

<table>
<thead>
<tr>
<th>Circumference (cm)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (cm)</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
</tr>
</tbody>
</table>
### Left foot volume (ml)

<table>
<thead>
<tr>
<th>Circumference (cm)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (cm)</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
</tr>
</tbody>
</table>

### Agility (times/20s)

<table>
<thead>
<tr>
<th>Start with</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right leg</td>
<td></td>
</tr>
<tr>
<td>Left leg</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

PERSONAL PHYSICAL FITNESS PROFILE

(AFTER)

Name-Surname ......................................... Group ..............................

Body weight .......... kg  Height .......... cm

Blood Pressure .......... mmHg  Resting Heart Rate .......... bpm

1. VO$_2$max (L/min)

<table>
<thead>
<tr>
<th>Time elapsed (min)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate (bpm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Leg strength (kg)

<table>
<thead>
<tr>
<th>Trial</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force (kg)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Flexibility (cm)

<table>
<thead>
<tr>
<th>Trial</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (cm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. **%BF**

<table>
<thead>
<tr>
<th>Trial</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triceps skinfold (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf skinfold (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. **Leg volume (ml)**

- **Right leg volume (ml)**

<table>
<thead>
<tr>
<th>Segment</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumference (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Left leg volume (ml)**

<table>
<thead>
<tr>
<th>Segment</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumference (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Right foot volume (ml)**

<table>
<thead>
<tr>
<th>Circumference (cm)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Left foot volume (ml)

<table>
<thead>
<tr>
<th>Circumference (cm)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (cm)</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
</tr>
</tbody>
</table>

6. Agility (times/20s)

<table>
<thead>
<tr>
<th>Start with</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right leg</td>
<td></td>
</tr>
<tr>
<td>Left leg</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

EXERCISE SATISFACTION QUESTIONNAIRE

Name-Surname ........................................
Exercise training group .........................

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Score level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highest</td>
</tr>
<tr>
<td></td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Lowest</td>
</tr>
<tr>
<td></td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Place</td>
<td></td>
</tr>
<tr>
<td>Enjoyment</td>
<td></td>
</tr>
<tr>
<td>Exercise leader</td>
<td></td>
</tr>
<tr>
<td>Music</td>
<td></td>
</tr>
<tr>
<td>Physical fitness improvement</td>
<td></td>
</tr>
<tr>
<td>Movement</td>
<td></td>
</tr>
<tr>
<td>Stress decreasing</td>
<td></td>
</tr>
<tr>
<td>Relaxing</td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td></td>
</tr>
<tr>
<td>Freshness</td>
<td></td>
</tr>
<tr>
<td>Difficulty to perform</td>
<td></td>
</tr>
<tr>
<td>Exhaustion</td>
<td></td>
</tr>
</tbody>
</table>

Copyright by Mahidol University
APPENDIX E

AEROBIC EXERCISE PROGRAM

WARM-UP AND PRE-STRETCHING

The purpose is to activate circulatory system and progressively prepare your body for upcoming high-intensity activities. (7 to 10 minutes, 120 to 140 bpm)

- gastrocnemius stretch + triceps stretch
- squad + deltoid stretch
- quadriceps stretch + gluteal stretch
- abdominal stretch
- head up / head down
- shoulder elevation / depression
- alternating shoulder circles
- side to side + arm lift
- side to side + arm down
AEROBIC / CARDIORESPIRATORY WORKOUT

The purpose of the aerobic or cardiorespiratory workout phase of class is to:

1) evaluate the heart rate to the target zone, and keep it there for 12 to 30 minutes, 2) strengthen the heart muscle, 3) stress the circulatory system, which yields cardiorespiratory endurance, 4) improve and increase muscular endurance, and 5) improve and increase lung ventilation. (12 to 30 minutes, 130 to 150 bpm)
two steps + three jumps
↓
two steps + elbow to knee
↓
cross country skier + jumping jack
↓
cross country skier + straight jump
↓
can-can + knee lift
↓
can-can + leg swing

COOL DOWN AND STRENGTHENING

The purpose of this phase is to and the return of blood to the heart at low enough intensity to allow the heart to move toward a resting level. The strengthening is to increase the strength, endurance, tone, and flexibility of the muscles. (5 to 10 minutes, 120 to 140 bpm)

marching + clap
↓
easy walk + arm lift
↓
membo + arm lift
↓
heel side
↓
leg kick
↓
POST-STRETCHING

The purpose of the post-stretching is to stretch the muscles so that injury and stiffening are prevented. (5 to 10 minutes, under 100 bpm)

- side leg lift
- leg front and back
- hip up
- twist two steps
- biceps curls
- press downs
- triceps kickbacks
- squeezes
- window wash

- gastrocnemius stretch + tricep stretch
- squad + deltoid stretch
- quadricep stretch + gluteal stretch
- abdominal stretch
BIOGRAPHY

NAME
Ms. Kanita Tepkaew

DATE OF BIRTH
30 May 1976

PLACE OF BIRTH
Siriraj Hospital, Bangkok, Thailand

INSTITUTIONS ATTENDED
Kasetsart University, 1994-1997:
  Bachelor of Arts (Physical Education)
Mahidol University, 1999-2002
  Master of Science
    (Sports Science: Sports Physiology)

RESEARCH GRANT
Support in part by the Thesis Grant, Faculty of Graduate Studies, Mahidol University