DEVELOPMENT OF OMNI PERCEIVED EXERTION SCALE FOR AEROBIC EXERCISES IN THAI ELDERLY

BY

JANEJIRA WONGKOOMNGOEN

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Exercise and Sport Science at Mahasarakham University

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The examining committee has unanimously approved this thesis, submitted by Miss Janejira Wongkoomngoen, as a partial fulfillment of the requirements for the Master of Seienee degree in Exercise and sport scienees at Mahasarakham University.

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BIODATA

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APPENDIX

APPENDIX A

Lists of the Experts

Lists of the experts

1. Miss Boonta Khakai	Institute of Physical Education Mahasarakham.
2. Miss Benja Sealim.	Queen sirikit heart centre of the northeast, Khon Kaen University.
3. Mr. Montree Yasud	Queen sirikit heart centre of the northeast, Khon Kaen University.

Appendix B

Consent Form

Consent Form (In Thai)

ใบยินยอมเข้าร่วมโครงการวิจัย

โครงการวิจัยเรื่อง การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิก ในผู้สูงอายุไทย

วันที่ให้คำยินยอม วันที่………………..เดือน……………………พ.ศ……………………...

ข้าพเจ้าได้รับการอธิบายจากผู้วิจัยชื่อ น.ส.เจนจิรา วงศ์ขุมเงิน เบอร์โทร 086-8580675 ถึงวัตถุประสงค์ของการวิจัย และวิธีการวิจัย ในโครงการวิจัย ซึ่งได้จัดทำขึ้นเพื่อพัฒนาและทดสอบความเที่ยงตรงของมาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิก ในผู้สูงอายุไทย และผลการวิจัยนี้จะเป็นประโยชน์ต่อการกำหนดขนาดและระดับความหนักในการออกกำลังกายแบบแอโรบิกในผู้สูงอายุโดยใช้แบบวัดระดับความเหนื่อยต่อไป การวิจัยในครั้งนี้ประกอบข้าพเจ้าจะได้ทำการออกกำลังกาย 3 ประเภท คือ การเดิน การก้าวขึ้นลงบันได และการใช้ตารางเก้าช่อง โดยให้ออกกำลังกำลังกายอย่างต่อเนื่อง และทุกสามนาที ผู้วิจัยจะทำการวัดอัตราการเต้นของหัวใจ การเจาะเลือดที่ปลายนิ้วเพื่อนำตัวอย่างเลือดไปวิเคราะห์หาระดับความเข้มข้นของกรดแลคติกในเลือด และการประเมินระดับความเหนื่อยโดยใช้แบบวัดระดับความเหนื่อย Borg ที่มีค่าคะแนนอยู่ในช่วง 6 – 20 คะแนน และแบบวัดระดับความเหนื่อย OMNI ทีมีค่าคะแนนอยู่ระหว่า 1-10 และให้ออกกำลังกายไปจนถึงระดับเหนื่อยมากที่สุด ซึ่งการวิจัยครั้งนี้จะไม่ก่อให้เกิดการบาดเจ็บ แต่อย่างไรก็ตามอาจจะมีอาการปวดเมื่อยหรือการระบมของกล้ามเนื้อบ้างภายหลังการทำวิจัย และอาจเกิดความเจ็บปวดที่ปลายนิ้วขณะทำการเจาะเลือดแต่จะเป็นช่วงระยะเวลาสั้นๆ เท่านั้น

ข้าพเจ้ายินยอมด้วยความสมัครใจที่จะเข้าร่วมในการวิจัยครั้งนี้ และข้าพเจ้าสามารถถอนตัวออกจากงานวิจัยได้ ในกรณีที่ไม่พึงประสงค์จะเข้าร่วมงานวิจัยนี้อีกต่อไปหรือมีเหตุผลอื่นอันสมควร ผู้วิจัยยินดีที่จะตอบข้อสงสัย คำถามใดๆที่ข้าพเจ้าอาจมีตลอดระยะเวลาในการเข้าร่วมการศึกษาครั้งนี้ด้วยความเต็มใจ ไม่ปิดบัง ซ่อนเร้นจนข้าพเจ้าพอใจ ผู้วิจัยรับรองว่าจะเก็บข้อมูลส่วนตัวของข้าพเจ้าเป็นความลับ จะเปิดเผยได้เฉพาะในรูปแบบของการสรุปผลการวิจัยเท่านั้น และหากเกิดอันตรายใดๆจากการวิจัย ข้าพเจ้าจะได้รับการดูแลรักษาพยาบาลอย่างดีที่สุด

ข้าพเจ้าเข้าใจถึงสิทธิประโยชน์ที่จะได้รับ อัตราเสี่ยง และสิทธิในการถอนตัวออกจากงานวิจัยแล้ว และได้ยินดีลงนามเข้าร่วมในการวิจัยครั้งนี้ด้วยความเต็มใจ

ลงนาม………………………………………..ผู้ยินยอม

(......……………………………………)

ลงนาม………………………………………..ผู้ทำวิจัย

(………………………………………….)

ลงนาม………………………………………..พยาน

(…...…...…………………………………)

APPENDIX C

Subject screening questionnaire

แบบสอบถามเลขที่................................

แบบสอบถามสำหรับคัดเลือกอาสาสมัครในการวิจัย

เรื่อง การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิก ในผู้สูงอายุไทย

Development of OMNI Perceived Exertion Scale for Aerobic Exercises in Thai Elderly

คำชี้แจง :

แบบสอบถามนี้เป็นส่วนหนึ่งของการทำวิทยานิพนธ์ ในหลักสูตรวิทยาศาสตร์มหาบัณฑิต สาขาวิทยาศาสตร์การออกกำลังกายและการกีฬา เพื่อให้ข้อมูลจากการศึกษานี้เกิดประโยชน์ตรงตามวัตถุประสงค์ โปรดกรอกข้อมูลและตอบคำถามต่อไปนี้ตามความเป็นจริง ข้อมูลทั้งหมดในแบบสอบถามนี้จะถูกเก็บไว้เป็นความลับ และใช้ในงานวิจัยเท่านั้น

แบบสอบถามฉบับนี้ประกอบด้วย 4 ส่วน คือ

ตอนที่ 1 ข้อมูลทั่วไป

ตอนที่ 2 : ข้อมูลเกี่ยวกับประวัติสุขภาพ

ตอนที่ 3 : ประวัติการออกกำลังกาย (Physical activity history)

ตอนที่ 4 : ประเมินระดับกิจกรรม

ผู้วิจัยขอขอบพระคุณทุกท่านที่ให้ความร่วมมือในการให้ข้อมูลและรายละเอียดเป็นอย่างยิ่ง

ตอนที่ 1 : ข้อมูลทั่วไป

1. ชื่อ-สกุล...
2. เพศ ( ) ชาย ( ) หญิง
3. วัน เดือน ปี เกิด.. อายุ.............................ปี
4. ที่อยู่ปัจจุบัน...
5. เบอร์โทรติดต่อ...
6. การศึกษา ( ) ประถมศึกษา ( ) มัธยมศึกษา
   ( ) ปริญญาตรี ( ) สูงกว่าปริญญาตรี
7. อาชีพ ( ) ทำไร่ทำนา ( ) ค้าขาย
   ( ) รับจ้าง ( ) ข้าราชการ
   ( ) พ่อบ้าน/แม่บ้าน ( ) อื่นๆ....................................
8. น้ำหนัก...................................กิโลกรัม ส่วนสูง..เซนติเมตร
9. ดัชนีมวลกาย (BMI).............................กิโลกรัม/เมตร^2
10. อัตราการเต้นของหัวใจสูงสุด (220-อายุ)…………………………………………ครั้ง/นาที

ตอนที่ 2 : ข้อมูลเกี่ยวกับประวัติสุขภาพ

1. ท่านมีโรคประจำตัวหรือไม่
   ( ) ไม่มี ( ) ไม่เคยตรวจ ( ) มี โปรดระบุ.........................เป็นมานาน ....ปี
2. ท่านป่วยเป็นโรค ได้แก่ โรคหัวใจ โรคความดันโลหิตสูง โรคเบาหวาน โรคไต หรือไม่
   ( ) ไม่ใช่ ( ) ใช่ โปรดระบุ...................................เป็นมานาน................ปี
3. ท่านป่วยเป็นโรคระบบทางเดินหายใจ เช่น โรคภูมิแพ้ โรคหอบ โรคปอดอุดกั้นเรื้อรังหรือไม่
   ( ) ไม่ใช่ ( ) ใช่ โปรดระบุ...................................เป็นมานาน................ปี
4. ท่านป่วยเป็นโรคเกี่ยวกับกระดูก ข้อต่อและกล้ามเนื้อหรือไม่
   ( ) ไม่ใช่ ( ) ใช่ โปรดระบุ...................................เป็นมานาน................ปี
5. ท่านเคยได้รับอุบัติเหตุหรือบาดเจ็บรุนแรงหรือไม่

( ) ไม่เคย ( ) เคย โปรดระบุ..................................เป็นมานาน...............ปี

6. ท่านมีอาการเจ็บหน้าอกอย่างรุนแรงหรือไม่

( ) ไม่เคย ( )เคย โปรดระบุ..................................เป็นมานาน...............ปี

7. ปัจจุบันท่านต้องรับประทานยาเป็นประจำหรือไม่

( ) ไม่ใช่ ( )ใช่ โปรดระบุ..................................ระยะเวลาที่ใช้...............ปี

8. การติดต่อกรณีฉุกเฉิน

แพทย์ประจำตัว...เบอร์โทรศัพท์.....................................

9. ประวัติการสูบบุหรี่และประวัติการดื่มแอลกอฮอล์

( ) ไม่สูบบุหรี่ ( ) สูบบุหรี่เป็นบางครั้ง ( ) สูบบุหรี่เป็นประจำ ระบุ..................มวน/วัน

( ) ไม่ดื่มเลย ( ) ดื่มเป็นบางครั้ง ( ) ดื่มเป็นประจำ ระบุ..................วัน/สัปดาห์

10. ท่านต้องใช้แว่นตาหรือมีปัญหาเกี่ยวกับสายตาหรือไม่

( ) ไม่ต้องใช้ ( ) ใช้เมื่ออ่านหนังสือ ( ) ต้องใช้ตลอดเวลา

ตอนที่ 3 : ประวัติการออกกำลังกาย (Physical activity history)

1. ท่านให้เวลากับการออกกำลังกายมากน้อยเพียงใด

( ) ไม่ได้ออกกำลังกายมาเป็นเวลามากกว่า 3เดือน

( ) ออกกำลังเป็นบางครั้ง เมื่อมีโอกาส

( ) ออกกำลังกายเป็นประจำ ทุกครั้งเมื่อมีโอกาส

( ) ออกกำลังกายสม่ำเสมอ

2. โดยเฉลี่ย ท่านออกกำลังกาย หรือเล่นกีฬากี่วัน/สัปดาห์

( ) น้อยกว่า 1 ครั้ง/สัปดาห์

( ) 1 ครั้ง/สัปดาห์

( ) 2-3 ครั้ง/สัปดาห์

( ) มากกว่า 3 ครั้ง/สัปดาห์

( ) ทุกวัน

3. ระยะเวลาของการออกกำลังกาย เล่นกีฬาที่ท่านปฏิบัติในแต่ละครั้ง

( ) น้อยกว่า 20 นาที

( ) 20 – 30 นาที

( ) 30 – 60 นาที

( ) มากกว่า 60 นาที

4. ลักษณะของการออกกำลังกายแต่ละครั้ง

( ) ไม่ต่อเนื่อง (พักนาน มากกว่า 15 นาที)

( ) ไม่ต่อเนื่อง (พักไม่นาน ไม่เกิน 15 นาที)

( ) ต่อเนื่อง

5. ระดับความหนักของการออกกำลังกาย/เล่นกีฬาที่ท่านปฏิบัติ

( ) เบา (เริ่มรู้สึกเหนื่อย, ไม่มีเหงื่อออก)

( ) ปานกลาง (รู้สึกเหนื่อย, เหงื่อออกเล็กน้อย)

( ) หนัก (รู้สึกเหนื่อยมาก, เหงื่อออกค่อนข้างมาก,กระหายน้ำมาก)

( ) หนักมาก (รู้สึกเหนื่อยมาก, เหงื่อออกมาก, กระหายน้ำมาก,ชีพจรเต้นเร็ว, ปวดเมื่อยกล้ามเนื้อ

ตอนที่ 4 : ประเมินระดับกิจกรรม (คำอธิบาย : กรุณาเลือกระดับกิจกรรมตามความเป็นจริง)

ข้อมูล	**ระดับกิจกรรม**			
	สม่ำเสมอ	**บ่อย**	**บางครั้ง**	**ไม่เคย**
1.ท่านเลือกที่จะเดินมากกว่านั่งรถ				
2.ท่านออกกำลังกายมากกว่า 1 ครั้ง/สัปดาห์				
3.ท่านออกกำลังกายอย่างหนัก				
4.ท่านเลือกที่จะเดินขึ้นบันไดมากกว่าการใช้ลิฟท์หรือบันไดเลื่อน				
5.ท่านออกกำลังกายเบาๆ				

ข้อมูล	ระดับกิจกรรม			
	สม่ำเสมอ	บ่อย	บางครั้ง	ไม่เคย
6.ท่านมักทำกิจกรรมต่างๆด้วยตัวเองทุกวัน				
7.ท่านมักทำกิจกรรมต่างๆในวันว่างแทนที่จะนั่งดูโทรทัศน์				
8.ท่านเล่นกีฬาอย่างน้อย 1 ครั้งต่อสัปดาห์				

ลงชื่อ..

วันที่...............เดือน.................พ.ศ. ....

APPENDIX D

Assessment Form for Instruments Quality

แบบประเมินความเห็นในการตรวจสอบเครื่องมือสำหรับผู้เชี่ยวชาญ

ชื่อวิทยานิพนธ์ การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI

สำหรับการออกกำลังกายแบบแอโรบิก ในผู้สูงอายุไทย

ชื่อวิทยานิพนธ์ การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิก ในผู้สูงอายุไทย

ชื่อผู้วิจัย นางสาวเจนจิรา วงศ์ขุมเงิน

ชื่อผู้เชี่ยวชาญ ....

คำชี้แจง ขอความกรุณาท่านผู้เชี่ยวชาญได้ประเมินความถูกต้องและเหมาะสมของเครื่องมือ โดยการให้คะแนนตามมาตรวัด ดังนี้ +1 คือ เห็นด้วย, 0 คือ ไม่แน่ใจ,-1 คือ ไม่เห็นด้วย โดยการทำเครื่องหมายถูก (/) ลงในช่องคะแนนตามความคิดเห็นของท่าน หรือหากท่านมีข้อเสนอแนะอื่นๆ ในการนำไปพิจารณาปรับปรุงเครื่องมือเพื่อใช้ในงานวิจัยต่อไป

1. ชื่อเครื่องมือ แบบวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายด้วยวิธีการเดินในผู้สูงอายุ

ที่	**เนื้อหาในการประเมิน**	**ความคิดเห็นของผู้เชี่ยวชาญ**			**ข้อเสนอแนะ**
		เห็นด้วย	**ไม่แน่ใจ**	**ไม่เห็นด้วย**	
1	ความเหมาะสมของขนาดรูปภาพ				
2	ความเหมาะสมของการวางตำแหน่งรูปภาพ				
3	ความเหมาะสมของท่าทาง				
4	ความเหมาะสมของสีหน้า				
5	ความเหมาะสมของการนำไปใช้				

ข้อเสนอแนะเพิ่มเติมอื่นๆ

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2. ชื่อเครื่องมือ แบบวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายด้วยวิธีการก้าวขึ้นลงบันไดในผู้สูงอายุ

ที่	**เนื้อหาในการประเมิน**	**ความคิดเห็นของผู้เชี่ยวชาญ**			**ข้อเสนอแนะ**
		เห็นด้วย	**ไม่แน่ใจ**	**ไม่เห็นด้วย**	
1	ความเหมาะสมของขนาดรูปภาพ				
2	ความเหมาะสมของการวางตำแหน่งรูปภาพ				
3	ความเหมาะสมของท่าทาง				
4	ความเหมาะสมของสีหน้า				
5	ความเหมาะสมของการนำไปใช้				

ข้อเสนอแนะเพิ่มเติมอื่นๆ

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3. ชื่อเครื่องมือ แบบวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายด้วยวิธีการตารางเก้าช่องในผู้สูงอายุ

ที่	**เนื้อหาในการประเมิน**	**ความคิดเห็นของผู้เชี่ยวชาญ**			**ข้อเสนอแนะ**
		เห็นด้วย	**ไม่แน่ใจ**	**ไม่เห็นด้วย**	
1	ความเหมาะสมของขนาดรูปภาพ				
2	ความเหมาะสมของการวางตำแหน่งรูปภาพ				
3	ความเหมาะสมของท่าทาง				
4	ความเหมาะสมของสีหน้า				
5	ความเหมาะสมของการนำไปใช้				

ข้อเสนอแนะเพิ่มเติมอื่นๆ

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ขอขอบพระคุณเป็นอย่างสูง

แบบสรุปแบบประเมินความเห็นในการตรวจสอบเครื่องมือสำหรับผู้เชี่ยวชาญ

ชื่อวิทยานิพนธ์ การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกาย แบบแอโรบิกในผู้สูงอายุไทย

1. ชื่อเครื่องมือ : แบบวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายด้วยวิธีการเดิน ในผู้สูงอายุไทย

ข้อที่	**คะแนนของผู้เชี่ยวชาญคนที่**			**คะแนนรวม**	**ค่า IOC**
	1	**2**	**3**		
1	1	1	1	3	1
2	1	1	1	3	1
3	1	0	1	2	0.67
4	1	1	1	3	1
5	1	1	1	3	1

ข้อเสนอแนะเพิ่มเติม

1. คำอธิบายควรเปลี่ยนจากคำว่า หนัก เป็นเหนื่อย

2. ความเหมาะสมของสีหน้า ใส่หยดเหงื่อให้ชัดเจนในผู้สูงอายุจะชัดเจนขึ้น

2. ชื่อเครื่องมือ : แบบวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายด้วยวิธีการเดินในผู้สูงอายุไทย

ข้อที่	**คะแนนของผู้เชี่ยวชาญคนที่**			**คะแนนรวม**	**ค่า IOC**
	1	**2**	**3**		
1	1	1	1	3	1
2	1	1	1	3	1
3	1	0	1	2	0.67
4	1	1	1	3	1
5	1	1	1	3	1

ข้อเสนอแนะเพิ่มเติม

1. คำอธิบายควรเปลี่ยนจากคำว่า หนัก เป็นเหนื่อย

2. ความเหมาะสมของสีหน้า ใส่หยดเหงื่อให้ชัดเจนในผู้สูงอายุจะชัดเจนขึ้น

3. ชื่อเครื่องมือ : แบบวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายด้วยวิธีการเดินในผู้สูงอายุไทย

ข้อที่	**คะแนนของผู้เชี่ยวชาญคนที่**			**คะแนนรวม**	**ค่า IOC**
	1	**2**	**3**		
1	1	1	1	3	1
2	1	1	1	3	1
3	1	0	1	1	0.67
4	1	1	1	3	1
5	1	1	1	3	1

ข้อเสนอแนะเพิ่มเติม

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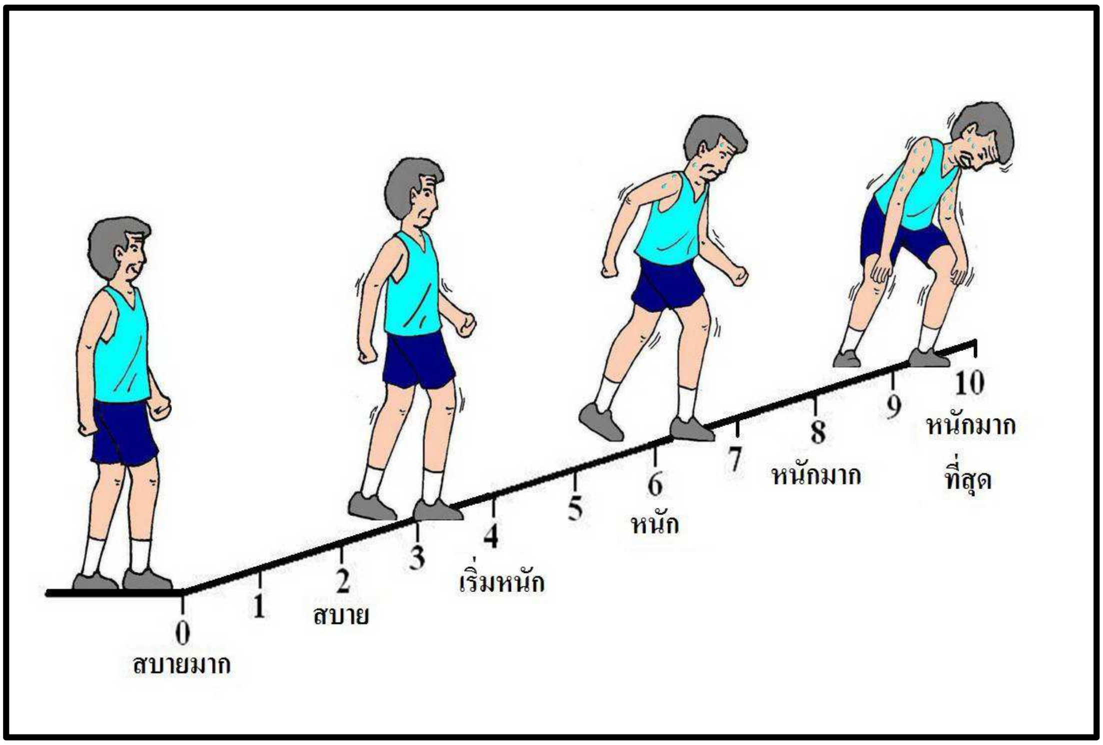
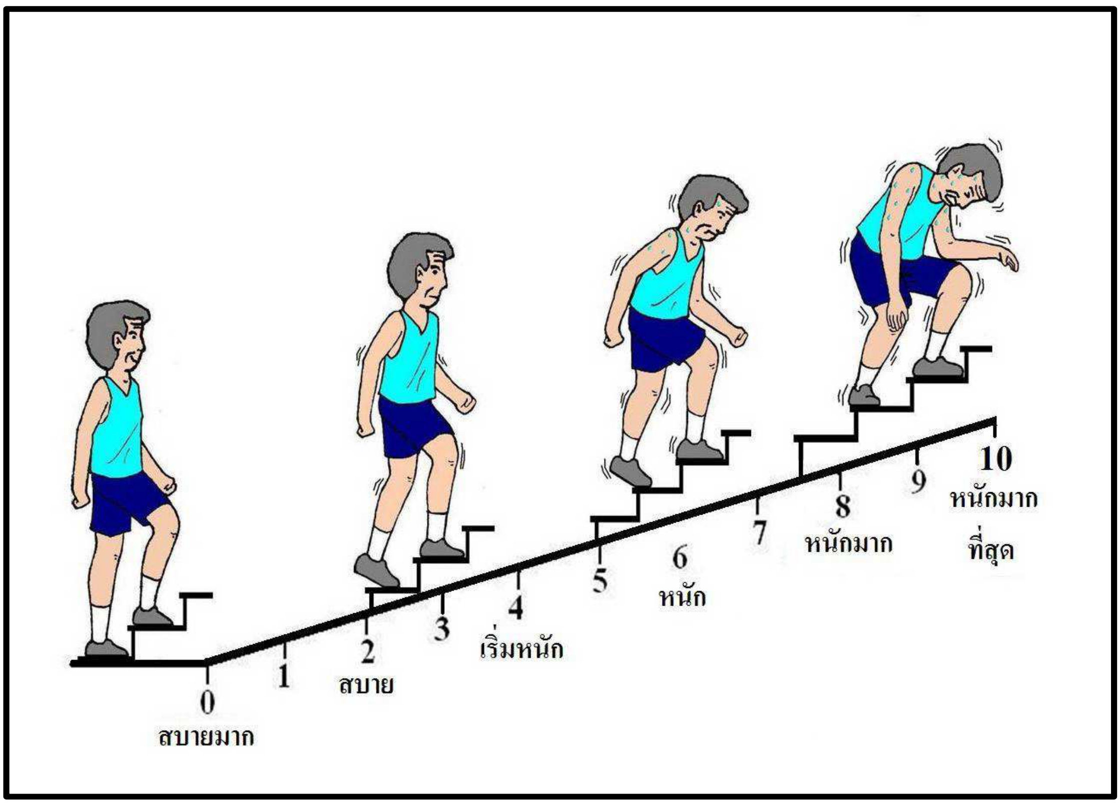
APPENDIX E

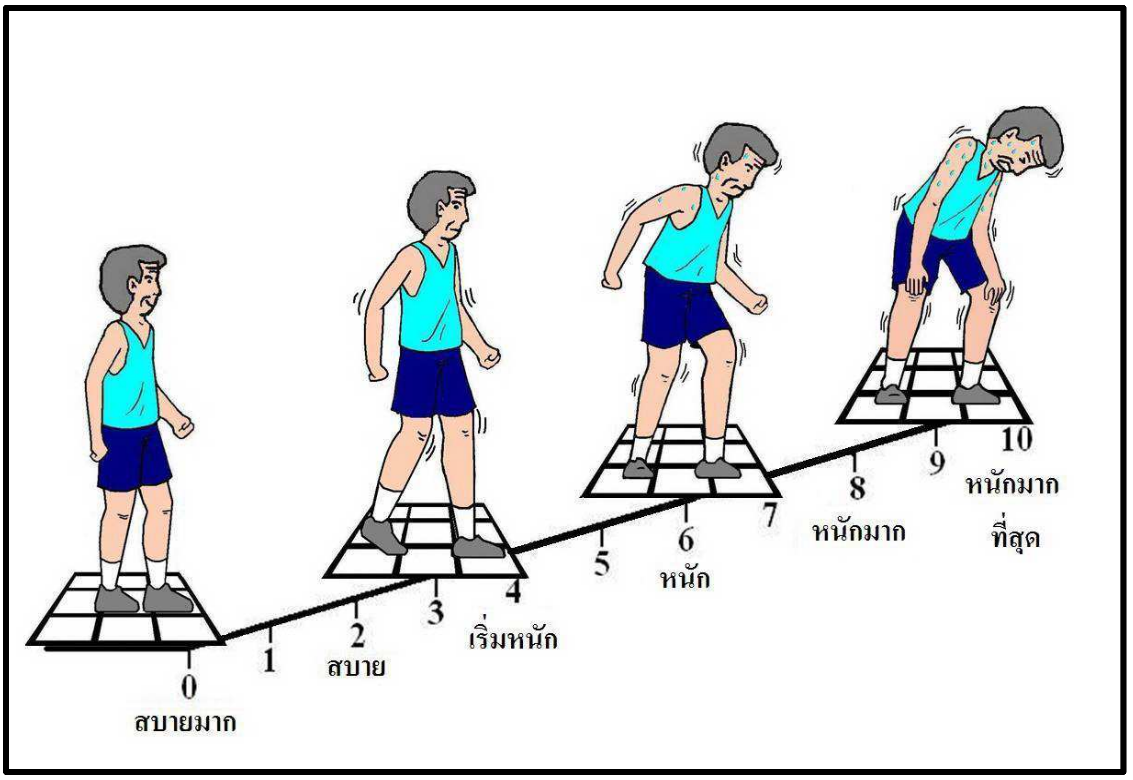
Thai OMNI Scale RPE for three aerobic exercise modes



OMNI-walk/run Scale of perceived exertion.



OMNI- stepping Scale of perceived exertion.



OMNI- nine square Scale of perceived exertion.

APPENDIX F

Reliability Testing

Reliability Testing

The results of reliability testing with pilot group (Thai elderly 5 persons without the subjects)

Pilot group are 5 persons of Thai elderly.

No.	Name	Age	Weight	Height
1		60	55	155
2		61	52	150
3		61	56	162
4		63	51	152
5		62	57	154
Average		61.40	54.20	154.60

The first results of reliability testing with pilot group (Walking Exercise)

Pilots	Before Exercise	During Exercise used OMNI Scale RPE (Minutes)					During Exercise used BORG (6-20) Scale RPE (Minutes)					During Exercise Heart Rate (HR)(bpm) (Minutes)					After Exercise
	BLC	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	BLC
1	2.2	0	2	3	6	7	6	9	10	13	15	83	87	90	95	103	3.7
2	2.3	0	4	5	7	9	6	10	13	14	17	87	94	97	106	110	2.7
3	4.5	0	4	6	7	10	6	9	11	15	16	80	83	87	90	92	5.9
4	4.1	0	4	5	6	9	6	9	12	15	17	87	92	97	103	105	4.7
5	3.1	0	3	5	7	9	6	7	11	12	16	84	88	90	94	98	3.8
Average	3.24	0.00	3.40	4.80	6.60	8.80	6.00	8.80	11.40	13.80	16.20	84.20	88.80	92.20	97.60	101.60	4.16

The second results of reliability testing with pilot group (Walking Exercise)

Pilots	Before Exercise	During Exercise used OMNI Scale RPE (Minutes)					During Exercise used BORG (6-20) Scale RPE (Minutes)					During Exercise Heart Rate (HR)(bpm) (Minutes)					After Exercise
	BLC	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	BLC
1	2.5	0	3	4	6	8	6	9	11	13	15	86	89	91	96	106	3.4
2	2.6	0	4	5	7	9	6	10	13	14	17	85	97	99	105	108	3.3
3	3.8	0	3	7	8	9	6	9	12	15	17	88	89	92	94	96	5.9
4	4.5	0	3	5	7	9	6	9	13	15	17	89	90	98	103	107	4.7
5	3.9	0	3	6	7	9	6	8	12	14	17	90	93	94	97	99	3.8
Average	3.46	0.00	3.20	5.40	7.00	8.80	6.00	9.00	12.20	14.20	16.60	87.60	91.60	94.80	99.00	103.20	4.22

Correlation during first and second of results of walking exercise.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POST_BLC & PRE_BLC	5	.846	.071
Pair 2	post_omni3 & PRE_OMNI3	5	.375	.534
Pair 3	post_omni6 & PRE_OMNI6	5	.881	.049
Pair 4	post_omni9 & PRE_OMNI9	5	.645	.239
Pair 5	post_omni12 & PRE_OMNI12	5	.919	.028
Pair 6	post_borg3 & PRE_Borg3	5	.968	.007
Pair 7	post_omni6 & Pre_Borg6	5	.038	.951
Pair 8	post_borg9 & Pre_borg9	5	.733	.159
Pair 9	post_borg12 & Pre_borg12	5	.802	.103
Pair 10	postHR0 & HR0	5	-.147	.813
Pair 11	postHR3 & HR3	5	.700	.188
Pair 12	postHR6 & HR6	5	.928	.023
Pair 13	postHR9 & HR9	5	.990	.001
Pair 14	postHR12 & HR12	5	.959	.010

The first results of reliability testing with pilot group (Bench-stepping Exercise)

Pilots	Before Exercise	During Exercise used OMNI Scale RPE (Minutes)					During Exercise used BORG (6-20) Scale RPE (Minutes)					During Exercise Heart Rate (HR)(bpm) (Minutes)					After Exercise
	BLC	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	BLC
1	2.7	0	3	6	7	9	6	9	11	15	17	91	114	117	119	120	3.4
2	3.3	0	4	5	8	10	6	10	13	14	17	85	92	97	103	109	3.5
3	3.4	0	3	6	7	9	6	9	13	15	18	87	93	95	98	102	4.7
4	3.6	0	4	5	8	9	6	9	12	14	17	84	91	95	100	105	3.7
5	3.5	0	3	6	7	9	6	9	12	15	17	89	94	98	104	108	4.3
Average	3.30	0.00	3.40	5.60	7.40	9.20	6.00	9.20	12.20	14.60	17.20	87.20	96.80	100.40	104.80	108.80	3.92

The second results of reliability testing with pilot group (Bench-stepping Exercise)

Pilots	Before Exercise	During Exercise used OMNI Scale RPE (Minutes)					During Exercise used BORG (6-20) Scale RPE (Minutes)					During Exercise Heart Rate (HR)(bpm) (Minutes)					After Exercise
	BLC	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	BLC
1	2.5	0	3	5	7	9	6	9	12	15	18	89	94	111	117	122	3.8
2	3.7	0	3	5	8	9	6	11	13	14	17	83	94	99	105	116	4.2
3	2.9	0	3	6	7	9	6	10	13	15	18	82	87	93	97	108	4.7
4	3.2	0	4	6	8	9	6	9	12	15	18	85	92	95	102	107	3.8
5	3.8	0	3	7	8	9	6	9	13	15	18	91	95	97	103	114	4.6
Average	3.22	0.00	3.20	5.80	7.60	9.00	6.00	9.60	12.60	14.80	17.80	86.00	92.40	99.00	104.80	113.40	4.22

Correlation during first and second of results of Bench-stepping exercise.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POST_BLC & PRE_BLC	5	.506	.384
Pair 2	post_omni3 & PRE_OMNI3	5	.612	.272
Pair 3	post_omni6 & PRE_OMNI6	5	.327	.591
Pair 4	post_omni9 & PRE_OMNI9	5	.667	.219
Pair 5	post_omni12 & PRE_OMNI12	5	.	.
Pair 6	post_borg3 & PRE_Borg3	5	.875	.052
Pair 7	post_borg6 & Pre_Borg6	5	.764	.133
Pair 8	post_borg9 & Pre_borg9	5	.612	.272
Pair 9	post_borg12 & Pre_borg12	5	.250	.685
Pair 10	postHR0 & HR0	5	.699	.189
Pair 11	postHR3 & HR3	5	.285	.642
Pair 12	postHR6 & HR6	5	.973	.005
Pair 13	postHR9 & HR9	5	.978	.004
Pair 14	postHR12 & HR12	5	.937	.019

The first results of reliability testing with pilot group (Nine-square stepping Exercise)

Pilots	Before Exercise	During Exercise used OMNI Scale RPE (Minutes)					During Exercise used BORG (6-20) Scale RPE (Minutes)					During Exercise Heart Rate (HR)(bpm) (Minutes)					After Exercise
	BLC	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	BLC
1	3.4	0	3	6	8	9	6	10	12	16	18	91	95	113	118	124	3.9
2	3.6	0	2	5	7	10	6	10	14	16	18	78	85	89	98	115	4.7
3	2.7	0	3	6	8	9	6	11	13	17	19	83	89	97	108	110	4.6
4	4.6	0	3	6	8	9	6	9	13	16	18	81	97	102	107	108	4.8
5	3.1	0	2	5	7	9	6	10	13	16	19	92	97	104	105	110	4.7
Average	3.48	0.00	2.60	5.60	7.60	9.20	6.00	10.00	13.00	16.20	18.40	85.00	92.60	101.00	107.20	113.40	4.54

The second results of reliability testing with pilot group (Nine-square stepping Exercise)

Pilots	Before Exercise	During Exercise used OMNI Scale RPE (Minutes)					During Exercise used BORG (6-20) Scale RPE (Minutes)					During Exercise Heart Rate (HR)(bpm) (Minutes)					After Exercise
	BLC	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	BLC
1	2.5	0	3	6	8	9	6	10	13	17	18	80	83	114	117	124	3.4
2	3.1	0	2	6	7	10	6	11	14	16	19	89	91	90	100	115	4.5
3	3.9	0	3	6	8	10	6	11	13	17	19	82	87	97	108	111	3
4	3.2	0	3	6	7	9	6	10	12	17	18	87	96	103	107	108	3.8
5	4.2	0	3	5	8	10	6	10	14	16	19	85	93	104	105	111	4.9
Average	3.38	0.00	2.80	5.80	7.60	9.60	6.00	10.40	13.20	16.60	18.60	84.60	90.00	101.60	107.40	113.80	3.92

Correlation during first and second of results of Nine-square stepping exercise.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POST_BLC & PRE_BLC	5	.245	.692
Pair 2	post_omni3 & PRE_OMNI3	5	.612	.272
Pair 3	post_omni6 & PRE_OMNI6	5	.612	.272
Pair 4	post_omni9 & PRE_OMNI9	5	.167	.789
Pair 5	post_omni12 & PRE_OMNI12	5	.408	.495
Pair 6	post_borg3 & PRE_Borg3	5	.645	.239
Pair 7	post_borg6 & Pre_Borg6	5	.423	.478
Pair 8	post_borg9 & Pre_borg9	5	.408	.495
Pair 9	post_borg12 & Pre_borg12	5	.667	.219
Pair 10	postHR0 & HR0	5	-.663	.223
Pair 11	postHR3 & HR3	5	.238	.700
Pair 12	postHR6 & HR6	5	.998	.000
Pair 13	postHR9 & HR9	5	.998	.000
Pair 14	postHR12 & HR12	5	.997	.000

APPENDIX G

Graph

BLC (mmol/L)

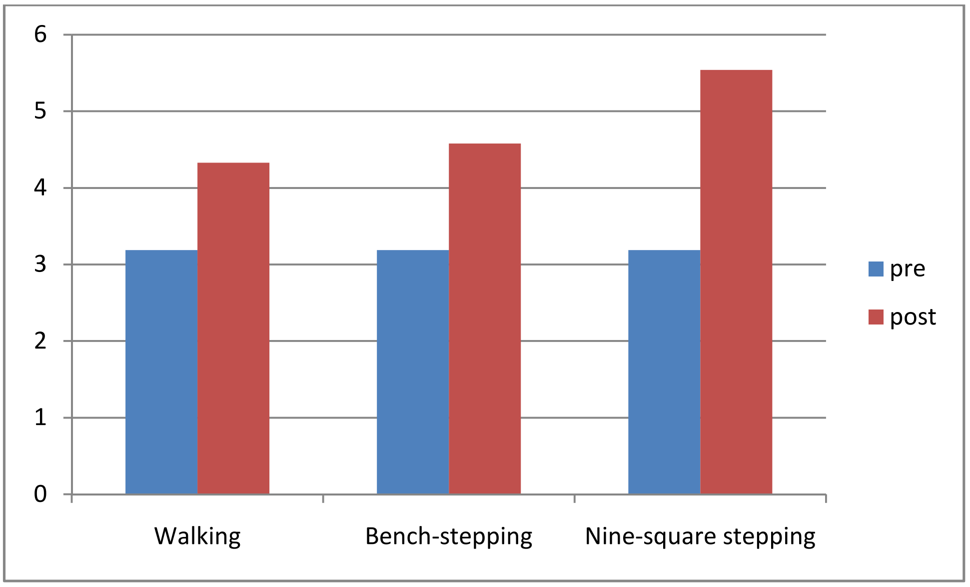


Figure 18 Compared pre and post of the BLC from three mode aerobic exercise for each times.

HR (bpm)

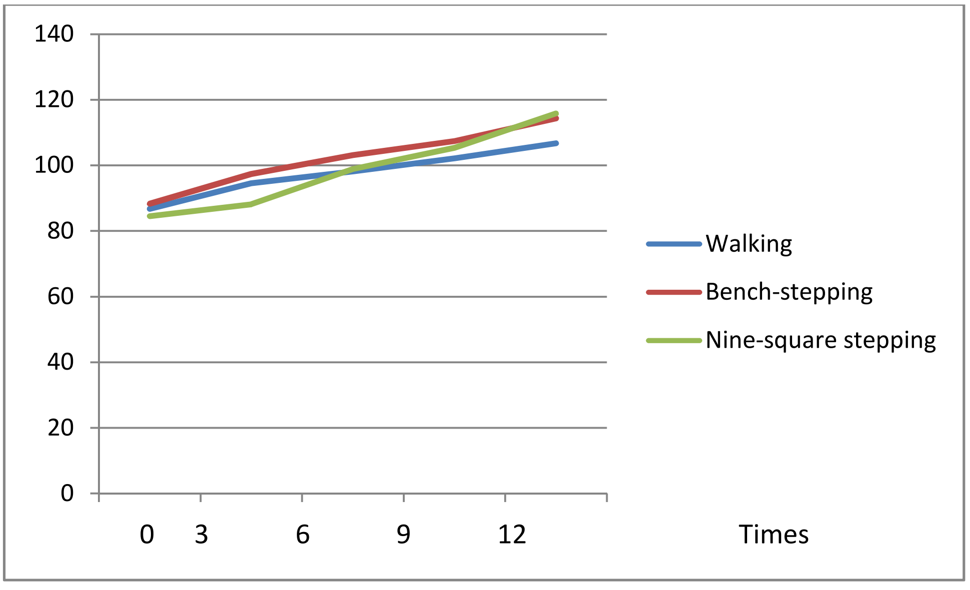


Figure 19 Compare the hearth rate (HR) from three mode aerobic exercise for each times.

BORG Scale RPE

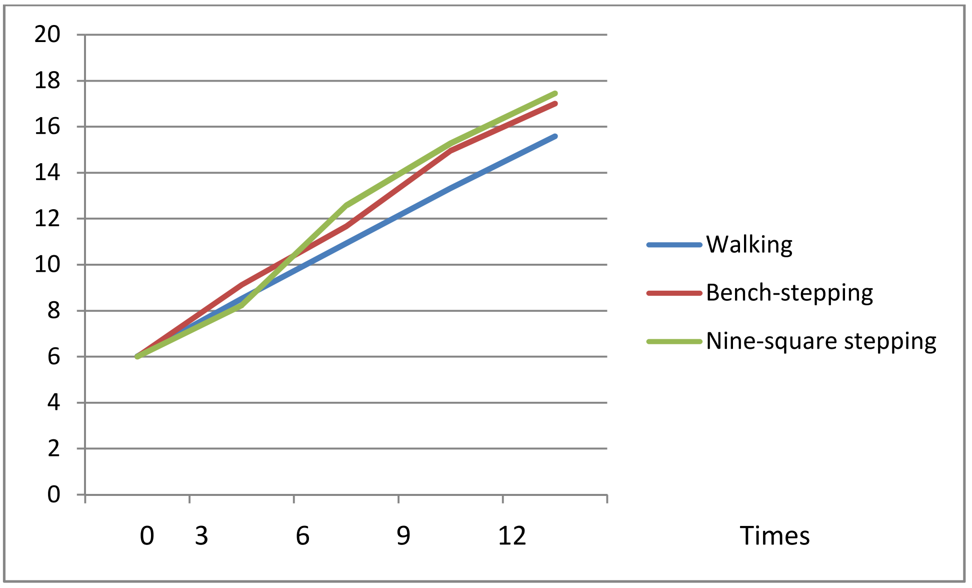


Figure 20 Compare the BORG Scale RPE from three mode aerobic exercise for each times.

OMNI Scale RPE

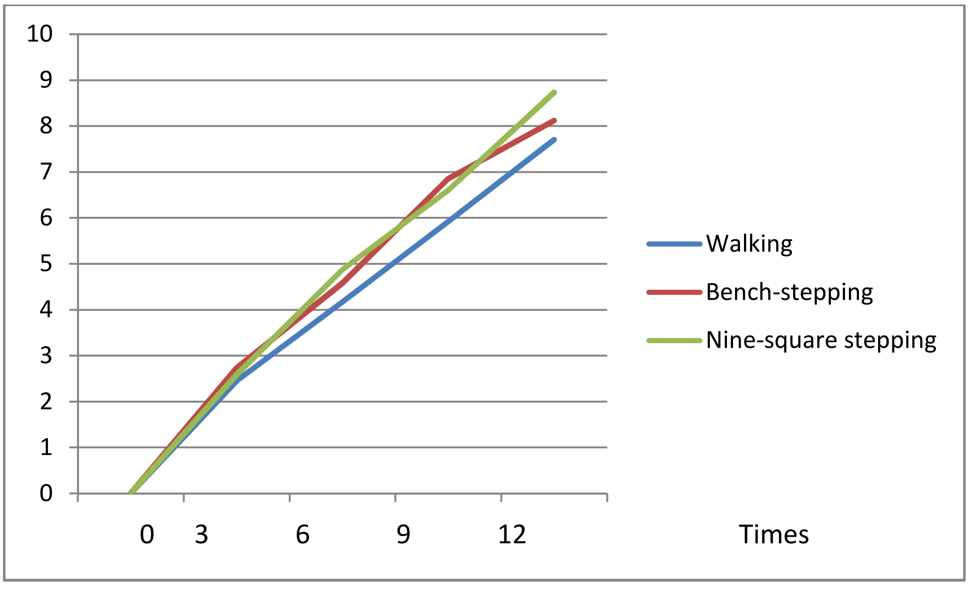
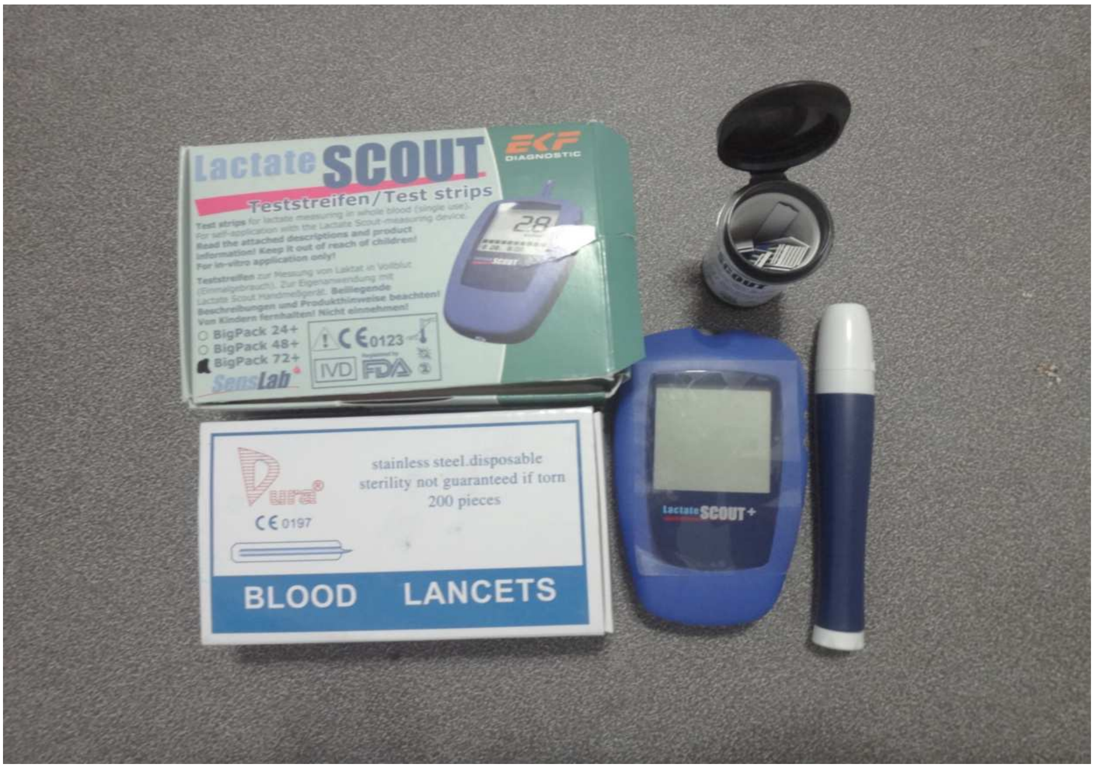


Figure 21 Compare the OMNI Scale RPE from three mode aerobic exercise for each times.

The first results of reliability testing with pilot group (Walking Exercise)

Pilots	Before Exercise	During Exercise used OMNI Scale RPE (Minutes)					During Exercise used BORG (6-20) Scale RPE (Minutes)					During Exercise Heart Rate (HR)(bpm) (Minutes)					After Exercise
	BLC	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	BLC
1																	
2																	
3																	
4																	
5																	
Average																	



Lactate Scout-analyzer, Germany

PHASE heart rate monitoring , Germany.

APPENDIX H

Missive for this study

บันทึกข้อความ

ส่วนราชการ งานวิชาการและบัณฑิตศึกษา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม โทร. 6080

ที่ ศธ 0530.5(2)/2318 **วันที่** 28 พฤษภาคม 2555

เรื่อง ขอความอนุเคราะห์เป็นผู้เชี่ยวชาญตรวจสอบเครื่องมือที่ใช้ในการทำวิทยานิพนธ์

เรียน นางสาวบุญตา ค้าขาย

ด้วย นางสาวเจนจิรา วงศ์ขุมเงิน นิสิตระดับปริญญาโท สาขาวิชาวิทยาศาสตร์การออกกำลังกายและการกีฬา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม กำลังศึกษาและทำวิทยานิพนธ์ เรื่อง "การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิกในผู้สูงอายุ" ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรการศึกษามหาบัณฑิต (วท.ม.) โดยมี อาจารย์ ดร.ชัยรัตน์ ชูสกุล เป็นประธานกรรมการควบคุมวิทยานิพนธ์ และอาจารย์ ดร.ดวงไกร ทวีสุข เป็นกรรมการควบคุมวิทยานิพนธ์ในครั้งนี้

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม พิจารณาแล้วเห็นว่าท่านเป็นผู้มีความรู้ ความสามารถ และมีประสบการณ์ในเรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์จากท่านเป็นผู้เชี่ยวชาญตรวจสอบเครื่องมือที่ใช้ในการศึกษาค้นคว้าอิสระในครั้งนี้ เพื่อที่นิสิตจะได้ดำเนินการในขั้นตอนต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม หวังเป็นอย่างยิ่งว่าคงได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณมา ณ โอกาสนี้

(อาจารย์ ดร.สุธรรม ธรรมทัศนานนท์)
หัวหน้าภาควิชาการบริหารการศึกษา
รักษาราชการแทน คณบดีคณะศึกษาศาสตร์

ที่ ศธ 0530.5(2)/ว.2317

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม
อำเภอเมือง จังหวัดมหาสารคาม 44000

28 พฤษภาคม 2555

เรื่อง ขอความอนุเคราะห์เป็นผู้เชี่ยวชาญตรวจสอบเครื่องมือที่ใช้ในการทำวิทยานิพนธ์

เรียน นางสาวเบญจา แซ่ลิ้ม

ด้วย นางสาวเจนจิรา วงศ์ขุมเงิน นิสิตระดับปริญญาโท สาขาวิชาวิทยาศาสตร์การออกกำลังกายและการกีฬา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม กำลังศึกษาและทำวิทยานิพนธ์ เรื่อง "การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิกในผู้สูงอายุ" ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรการศึกษามหาบัณฑิต (วท.ม.) โดยมี อาจารย์ ดร.ชัยรัตน์ ชูสกุล เป็นประธานกรรมการควบคุมวิทยานิพนธ์ และอาจารย์ ดร.ดวงไกร ทวีสุข เป็นกรรมการควบคุมวิทยานิพนธ์ในครั้งนี้

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม พิจารณาแล้วเห็นว่าท่านเป็นผู้มีความรู้ ความสามารถ และมีประสบการณ์ในเรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์จากท่านเป็นผู้เชี่ยวชาญตรวจสอบเครื่องมือที่ใช้ในการศึกษาค้นคว้าอิสระในครั้งนี้ เพื่อที่นิสิตจะได้ดำเนินการในขั้นตอนต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม หวังเป็นอย่างยิ่งว่า คงได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(อาจารย์ ดร.สุธรรม ธรรมทัศนานนท์)
หัวหน้าภาควิชาการบริหารการศึกษา
รักษาราชการแทน คณบดีคณะศึกษาศาสตร์

ฝ่ายวิชาการและบัณฑิตศึกษา คณะศึกษาศาสตร์
โทร. 0-4375-4322 ถึง 40 ต่อ 6080

ที่ ศธ 0530.5(2)/ว.2317

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม
อำเภอเมือง จังหวัดมหาสารคาม 44000

28 พฤษภาคม 2555

เรื่อง ขอความอนุเคราะห์เป็นผู้เชี่ยวชาญตรวจสอบเครื่องมือที่ใช้ในการทำวิทยานิพนธ์

เรียน นายมนตรี ยาสุด

ด้วย นางสาวเจนจิรา วงศ์ขุมเงิน นิสิตระดับปริญญาโท สาขาวิชาวิทยาศาสตร์การออกกำลังกายและการกีฬา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม กำลังศึกษาและทำวิทยานิพนธ์ เรื่อง "การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิกในผู้สูงอายุ" ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรการศึกษามหาบัณฑิต (วท.ม.) โดยมี อาจารย์ ดร.ชัยรัตน์ ชูสกุล เป็นประธานกรรมการควบคุมวิทยานิพนธ์ และอาจารย์ ดร.ดวงไกร ทวีสุข เป็นกรรมการควบคุมวิทยานิพนธ์ในครั้งนี้

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม พิจารณาแล้วเห็นว่าท่านเป็นผู้มีความรู้ ความสามารถ และมีประสบการณ์ในเรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์จากท่านเป็นผู้เชี่ยวชาญตรวจสอบเครื่องมือที่ใช้ในการศึกษาค้นคว้าอิสระในครั้งนี้ เพื่อที่นิสิตจะได้ดำเนินการในขั้นตอนต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม หวังเป็นอย่างยิ่งว่า คงได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(อาจารย์ ดร.สุธรรม ธรรมทัศนานนท์)
หัวหน้าภาควิชาการบริหารการศึกษา
รักษาราชการแทน คณบดีคณะศึกษาศาสตร์

ฝ่ายวิชาการและบัณฑิตศึกษา คณะศึกษาศาสตร์
โทร. 0-4375-4322 ถึง 40 ต่อ 6080

ที่ ศธ 0530.5(2)/ว.2319

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม
อำเภอเมือง จังหวัดมหาสารคาม 44000

28 พฤษภาคม 2555

เรื่อง ขอความอนุเคราะห์ทดลองใช้เครื่องมือที่ใช้ในการทำวิทยานิพนธ์

เรียน

ด้วย นางสาวเจนจิรา วงศ์ขุมเงิน นิสิตระดับปริญญาโท สาขาวิชาวิทยาศาสตร์การออกกำลังกายและการกีฬา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม กำลังศึกษาและทำวิทยานิพนธ์ เรื่อง "การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิกในผู้สูงอายุ" ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรการศึกษามหาบัณฑิต (วท.ม.) โดยมี อาจารย์ ดร.ชัยรัตน์ ชูสกุล เป็นประธานกรรมการควบคุมวิทยานิพนธ์ และอาจารย์ ดร.ดวงใกร ทวีสุข เป็นกรรมการควบคุมวิทยานิพนธ์ในครั้งนี้

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม พิจารณาแล้วเห็นว่าท่านเป็นผู้มีความรู้ ความสามารถ และมีประสบการณ์ในเรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์จากท่านได้โปรดอนุญาตให้ นางสาวเจนจิรา วงศ์ขุมเงิน ทดลองใช้เครื่องมือกับผู้สูงอายุในสังกัดของท่าน ทั้งนี้จะทดลองใช้เครื่องมือดังกล่าว ตั้งแต่เดือน มิถุนายน 2555 เป็นต้นไป เพื่อนำข้อมูลที่ได้ไปดำเนินการในขั้นตอนต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม หวังเป็นอย่างยิ่งว่า คงได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(อาจารย์ ดร.สุธรรม ธรรมทัศนานนท์)
หัวหน้าภาควิชาการบริหารการศึกษา
รักษาราชการแทน คณบดีคณะศึกษาศาสตร์

ฝ่ายวิชาการและบัณฑิตศึกษา คณะศึกษาศาสตร์
โทร. 0-4375-4322 ถึง 40 ต่อ 6080

ที่ ศธ 0530.5(2)/ว.2321

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม
อำเภอเมือง จังหวัดมหาสารคาม 44000

28 พฤษภาคม 2555

เรื่อง ขอความอนุเคราะห์เก็บรวบรวมข้อมูลที่ใช้ในการทำวิทยานิพนธ์

เรียน ผู้อำนวยการโรงพยาบาลเมืองสรวง

ด้วย นางสาวเจนจิรา วงศ์ขุมเงิน นิสิตระดับปริญญาโท สาขาวิชาวิทยาศาสตร์การออกกำลังกายและการกีฬา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม กำลังศึกษาและทำวิทยานิพนธ์ เรื่อง "การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิกในผู้สูงอายุ" ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรการศึกษามหาบัณฑิต (วท.ม.) โดยมี อาจารย์ ดร.ชัยรัตน์ ชูสกุล เป็นประธานกรรมการควบคุมวิทยานิพนธ์ และอาจารย์ ดร.ดวงไกร ทวีสุข เป็นกรรมการควบคุมวิทยานิพนธ์ในครั้งนี้

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม พิจารณาแล้วเห็นว่าท่านเป็นผู้มีความรู้ ความสามารถ และมีประสบการณ์ในเรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์จากท่านได้โปรดอนุญาตให้ นางสาวเจนจิรา วงศ์ขุมเงิน เก็บรวมรวมข้อมูลกับผู้สูงอายุในสังกัดของท่าน ทั้งนี้จะทดลองใช้เครื่องมือดังกล่าว ตั้งแต่เดือน มิถุนายน 2555 เป็นต้นไป เพื่อนำข้อมูลที่ได้ไปดำเนินการในขั้นตอนต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม หวังเป็นอย่างยิ่งว่า คงได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(อาจารย์ ดร.สุธรรม ธรรมทัศนานนท์)
หัวหน้าภาควิชาการบริหารการศึกษา
รักษาราชการแทน คณบดีคณะศึกษาศาสตร์

ฝ่ายวิชาการและบัณฑิตศึกษา คณะศึกษาศาสตร์
โทร. 0-4375-4322 ถึง 40 ต่อ 6080

ที่ ศธ 0530.5(2)/ว.2321

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม
อำเภอเมือง จังหวัดมหาสารคาม 44000

28 พฤษภาคม 2555

เรื่อง ขอความอนุเคราะห์เก็บรวบรวมข้อมูลที่ใช้ในการทำวิทยานิพนธ์

เรียน

ด้วย นางสาวเจนจิรา วงศ์ขุมเงิน นิสิตระดับปริญญาโท สาขาวิชาวิทยาศาสตร์การออกกำลังกายและการกีฬา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม กำลังศึกษาและทำวิทยานิพนธ์ เรื่อง “การพัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแบบแอโรบิกในผู้สูงอายุ” ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรการศึกษามหาบัณฑิต (วท.ม.) โดยมี อาจารย์ ดร.ชัยรัตน์ ชูสกุล เป็นประธานกรรมการควบคุมวิทยานิพนธ์ และอาจารย์ ดร.ดวงไกร ทวีสุข เป็นกรรมการควบคุมวิทยานิพนธ์ในครั้งนี้

คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม พิจารณาแล้วเห็นว่าท่านเป็นผู้มีความรู้ ความสามารถ และมีประสบการณ์ในเรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์จากท่านได้โปรดอนุญาตให้ นางสาวเจนจิรา วงศ์ขุมเงิน เก็บรวมรวมข้อมูลกับผู้สูงอายุในสังกัดของท่าน ทั้งนี้จะทดลองใช้เครื่องมือดังกล่าว ตั้งแต่เดือน มิถุนายน 2555 เป็นต้นไป เพื่อนำข้อมูลที่ได้ไปดำเนินการในขั้นตอนต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา คณะศึกษาศาสตร์ มหาวิทยาลัยมหาสารคาม หวังเป็นอย่างยิ่งว่า คงได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณมา ณ โอกาสนี้

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CHAPTER 5

CONCLUSION

The results lead to conclusion, discussion, and recommendations which are as follow :

Research Objective

1. To develop an instrument of OMNI Perceived Exertion Scale for Aerobic Exercise in the Thai Elderly.
2. To evaluate and test the newly developed Thai OMNI Perceived Exertion Scale instrument for Thai Elderly in terms of validity and reliability in the three modes of aerobic exercises, walking exercise, bench stepping exercise and nine-square stepping exercise.

Conclusions

The results of the developed OMNI perceived exertion scale for aerobic exercise in the Thai Elderly are as follow:

1. The subjects (10 males, 50 females) presented the following characteristics : age average 63.22 years old, weight 53.05 kg, height 1.58 meters and BMI 33.55. Physiological analyses have show that results of Borg scale RPE (6 – 20) and OMNI scale RPE from three aerobic exercise modes have sequentially increased each time.
2. The OMNI scale RPE has a positive relationship with the Borg (6 – 20) scale RPE in the three aerobic exercise modes. That means the OMNI scale RPE has validity. Thai OMNI Perceived Exertion Scale instrument for Thai Elderly in the three aerobic exercise modes has reliability (alpha coefficient during 0.708 – 0.749).

3. The heart rate can predict the OMNI scale RPE and the Borg (6 – 20) scale RPE was the heart rate (HR) while the blood lactate concentration (BLC) can predict the Borg scale RPE only.

Discussion

The results can be discussed in the following manner:

1. The physiological samples from the three mode of aerobic exercise, walking, bench-stepping and nine-square stepping show the Thai elderly had changed of physiology, the heart rate (HR) had increased longer duration and the results of the blood lactate concentration (BLC) after exercise had increased as well. The physiology changes show by the results of aerobic exercise were consistent with Jarouporn Thoranin (Apichat Pholsean. 2001 : 7 ; citing Jarouporn Thoranin. 1982). He explained that a normal heart rate for males was 70/minute in average and for females 75/minute exercise. Then the heart rate increases rapidly until stop exercising. Within 2-3 minutes the heart rate recovery will be gradual and slow down to a normal level. The blood lactate concentration (BLC) increase after exercise was consistent with McGee (Aruthaya Thanommeak. 2012 : 24 ; citting McGee. 1992). He explained that it was normal that the blood lactate concentration after exercise will increase because the elderly hard exercises at other ages. The heart rate (HR) and the blood lactate concentration (BLC) increases were consistent with Borg, Ljunggren and Ceci (1985 : 343-349). They examined the relationship between perceived exertion, perception of aches and pains in the legs, HR, and blood lactate during bicycle ergometry. Twenty-eight healthy males performed an incremental exercise bout on the cycle ergometer, where workload was increased by 40 Watts every 4 minutes until voluntary exhaustion. Heart rate, RPE (on both the Borg's 6-20 point scale and the CR10 scale), and blood lactate were recorded during the last minute of each workload stage, as well as at the point when the subjects terminated the test. The results showed that HR increased linearly as a function of workload, while RPE, perception of aches and pains in the legs, and blood lactate increased exponentially. Correlation coefficients

between HR, RPE, perception of aches and pains in the legs, and blood lactate were high, particularly during the higher workloads of the test.

2. The OMNI scale RPE has a positive relationship with the Borg (6 – 20) scale RPE in the three aerobic exercise modes, which means that the OMNI scale RPE has validity consistent with Broccatelli et al (2010 : 214 - 224). They examined the concurrent and constructed validity of a newer ratings of perceived exertion (RPE) Scale, called OMNI - Cycle Scale, using elderly men and women. Seventy - six participants (34 men, 42 women) performed a load - incremented cycle ergometer exercise test. The results founded that OMNI - RPE was positively (p < .01) and linearly related to Borg RPE in elderly men (r = .97) and women (r = .96). Thai OMNI Perceived Exertion Scale instrument for Thai Elderly in three aerobic exercise modes has reliability (alpha coefficient during 0.708 – 0.749).

3. The heart rate can predict the OMNI scale RPE and the Borg (6 – 20) scale RPE while the blood lactate concentration (BLC) can predict the Borg scale RPE only. This results were consistent with Green et al (2006 : 167 - 172). They examined the relationship between HR, RPE, and blood lactate responses during repeated high intensity interval cycling. Significant correlations were found for HR and RPE response as well as blood lactate and RPE response during both the high-intensity period and the recovery period of the interval, and consistent with Irving et al (2006 : 1348 - 1352) examined the utility of the Borg (6-20) and adult OMNI walk/run (0-10) ratings of perceived exertion (RPE) scales as markers of the blood lactate response to exercise. They had found that both the Borg and OMNI walk/run scales demonstrated predictive utility as markers of the blood lactate response to incremental exercise in individuals with the metabolic syndrome.

Recommendations

1. Recommendations for the results.

1.1 There should be a physical fitness test for the Thai Elderly before using the OMNI scale RPE and choosing the right mode of aerobic exercises for Thai Elderly.

1.2 Before exercise should be described and understood the impact of aging on aerobic exercise for Thai Elderly in various fields, and observed the health of Thai Elderly before and after exercise to know about the changes that occur.

1.3 Priority should be given to warm up before exercising and relaxing after exercise, to reduce the potential for injury to Thai Elderly.

2. Recommendations for a future study.

2.1 The OMNI scale RPE for other exercises of Thai Elderly should be created the OMNI scale RPE for other exercises of Thai Elderly in order to achieve clarity in the perceived exertion for Thai elderly. The data obtained from the measurements is so clear that it must be trust. All that will be beneficial in maintaining the health and fitness of Thai Elderly.

2.2 The OMNI scale RPE for males or females should be created that will be beneficial in specific applications.

2.3 Other variables such as VO_2; oxygen consumption (L/min), VE; minutes ventilation ((L/min), RR; respiratory rate (b/min)

2.4 The OMNI scale RPE should be constructed separately for elderly men and women and examined concurrently.

2.5 The rate of intensity of exertional signals from the overall, legs and chest during exercise.

2.6 The OMNI scale RPE for patients with chronic diseases should be created along with the development of physical fitness of the patient, to improve physical fitness of the patient at the same time.

2.7 The test-retest reliability of OMNI RPE scales should be examined to establish the consistency and repeatability of RPE measured during exercise and physical activity.

CHAPTER 4

RESULTS

The results can be presented respectively as follows.

1. Statistic symbols of data analyzes
2. Steps to present the results
3. Results of data analyzes

Statistic symbols of data analyzes

n	=	Samples
$\bar{X}$	=	Mean
S.D.	=	Standard Deviation
r_{xy}	=	Pearson' s Correlation Coefficient
α	=	Cronbach's Alpha Coefficient
χ^2	=	Chi – square
p – value	=	Significantly Level

Steps to present the results

Steps to present the results are as follows :

1. Part 1 Physical Characteristics
2. Part 2 Investigated validity and reliability of the newly developed Thai OMNI Perceived Exertion Scale instrument for Thai Elderly
3. Part 3 Investigation predictive variables

Results of data analyzes

Part 1 Physical Characteristics

1. Descriptive characteristics of subjects (n = 60; 10 males, 50 females) in Table 2 as mean and standard deviation (S.D.).

Table 2 Descriptive characteristics of subjects values are mean and S.D.

Variable	$\overline{X}$	S.D.
Age (yrs)	63.22	2.25
Weight (kg)	53.05	1.58
Height (m)	1.58	0.49
BMI	33.55	3.47

Table 2 presents that the samples were 63.22 years old (S.D. = 2.25) weight 53.05 kg (S.D. = 1.58) height 1.58 meters (S.D. = 0.49) and BMI 33.55 (S.D. = 3.47)

2. Physiological variables responses and rating of perceived exertion

Physiological variables responses from HR and RPE from Borg scale RPE and OMNI scale RPE at each time of three aerobic exercise modes, during walking exercise, bench - stepping exercise and nine – square stepping exercise for Thai Elderly. Results are presented in Table 3 :

Table 3 Physiological variables responses from HR and RPE from Borg (6-20) scale RPE and OMNI scale RPE at each time.

Exercise	Variable	Time									
		Pre		after 3 minutes		after 6 minutes		after 9 minutes		after 12 minutes	
		$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Walking (n = 60)	HR (b/min)	86.78	4.85	94.55	7.61	98.22	8.14	102.22	7.72	106.77	7.39
	BLC (mmol/L)	3.19	1.08	-	-	-	-	-	-	4.33	1.88
	BORG RPE (6-20)	6.02	0.13	8.53	0.96	10.93	0.97	13.33	1.07	15.58	0.85
	OMNI RPE	0.00	0.00	2.45	0.72	4.17	0.76	5.92	0.79	7.70	1.01
Bench – stepping (n = 60)	HR (b/min)	88.33	7.05	97.40	9.29	103.17	9.28	107.45	14.95	114.32	10.42
	BLC (mmol/L)	3.19	1.08	-	-	-	-	-	-	4.58	1.08
	BORG RPE (6-20)	6.00	0.00	9.12	0.87	11.67	0.93	14.95	0.83	17.00	0.82
	OMNI RPE	0.00	0.00	2.76	0.67	4.58	0.96	6.85	0.82	8.12	0.52
Nine – square stepping (n = 60)	HR (b/min)	84.53	5.11	88.18	5.98	98.88	12.58	105.40	8.55	115.80	6.47
	BLC (mmol/L)	3.19	1.08	-	-	-	-	-	-	5.54	2.07
	BORG RPE (6-20)	6.00	0.00	8.23	0.72	12.58	1.39	15.28	0.83	17.45	0.99
	OMNI RPE	0.00	0.00	2.58	0.53	4.87	0.77	6.60	0.60	8.73	0.76

Table 3 shows that results of Brog scale RPE (6 – 20) from three aerobic exercise modes have sequentially increased each time. Walking exercise ($\overline{X}$ = 6.02, 8.53, 10.93, 13.33, 15.58) bench – stepping ($\overline{X}$ = 6.00, 9.12, 11.67, 14.95, 17.00) and nine – square stepping ($\overline{X}$ = 6.00, 8.23, 12.58, 15.28, 17.45). The results of OMNI scale RPE from three aerobic exercise modes have sequentially increased each time. Walking exercise ($\overline{X}$ = 0.00, 2.45, 4.17, 5.92, 7.70) bench – stepping ($\overline{X}$ = 0.00, 2.73, 4.58, 6.85, 8.12) and nine – square stepping ($\overline{X}$ = 0.00, 2.58, 4.87, 6.60, 8.73).

Part 2 Investigated validity and reliability of the newly developed Thai OMNI Perceived Exertion Scale instrument for Thai Elderly

1. Investigated validity of Thai OMNI scale RPE for Thai Elderly

Pearson ' s Correlation Coefficient was used to check the validity of OMNI scale RPE and Chi – square was used to compare the validity by z-score between Brog (6 – 20) scale RPE and OMNI scale RPE.

Table 4 Validity of Thai OMNI scale RPE for Thai Elderly after exercising 3 minutes the three modes of aerobic exercise (during Brog (6 – 20) scale RPE and OMNI scale RPE)

Exercise	Correlation		Chi - square	
	r_{xy}	p-value	χ^2	p-value
Walking	0.282*	0.29	-1.670	0.095
Bench – stepping	0.388**	0.002	-6.855**	0.000
Nine – square stepping	0.317*	0.014	-4.363**	0.000

* significantly at the .05 level, ** significantly at the .01 level

Table 4 the correlation of walking exercise after 3 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.05 level (r_{xy} = 0.282*) and not different.

The correlation of Bench - stepping exercise after 3 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.05 level (r_{xy} = 0.388**) and different with statistically significant at 0.01 level.

The correlation of Nine – square stepping after 3 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.05 level (r_{xy} = 0.317**) and different statistically at 0.01 level.

Table 5 Validity of Thai OMNI scale RPE for Thai Elderly after exercising 6 minutes the three modes of aerobic exercise (during Brog (6 – 20) scale RPE and OMNI scale RPE)

Exercise	Correlation		Chi - square	
	r_{xy}	p-value	χ^2	p-value
Walking	0.404**	0.001	-0.487	0.626
Bench – stepping	0.344**	0.007	-1.114	0.265
Nine – square stepping	0.588**	0.000	-1.984*	0.47

* significantly at the .05 level, ** significantly at the .01 level

Table 5 the correlation of walking exercise after 6 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.01 level (r_{xy} = 0.404**) and not different.

The correlation of Bench - stepping exercise after 6 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.01 level (r_{xy} = 0.344**) and not different.

The correlation of Nine – square stepping after 6 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.01 level (r_{xy} = 0.588**) and different statistically at 0.05 level.

Table 6 Validity of Thai OMNI scale RPE for Thai Elderly after exercising 9 minutes the three modes of aerobic exercise (during Brog (6 – 20) scale RPE and OMNI scale RPE)

Exercise	Correlation		Chi - square	
	r_{xy}	p-value	χ^2	p-value
Walking	0.275*	0.033	-0.745	0.456
Bench – stepping	0.290*	0.025	-0.895	0.371
Nine – square stepping	0.345**	0.007	-0.783	0.434

* significantly at the .05 level, ** significantly at the .01 level

Table 6 The correlation of walking exercise after 9 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.05 level (r_{xy} = 0.275*) and not different.

The correlation of Bench - stepping exercise after 9 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.05 level (r_{xy} = 0.290*) and not different.

The correlation of Nine – square stepping after 9 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.01 level (r_{xy} = 0.345**) and not different.

Table 7 Validity of Thai OMNI scale RPE for Thai Elderly after exercising 12 minutes the three modes of aerobic exercise (during Brog (6 – 20) scale RPE and OMNI scale RPE)

Exercise	Correlation		Chi - square	
	r_{xy}	p-value	χ^2	p-value
Walking	0.305*	0.018	-0.959	0.338
Bench – stepping	0.481**	0.000	-5.513**	0.000
Nine – square stepping	0.390**	0.002	-0.199	0.842

* significantly at the .05 level, ** significantly at the .01 level

Table 7 The correlation of walking exercise after 12 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.05 level (r_{xy} = 0.305*) and not different.

The correlation of Bench - stepping exercise after 12 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.01 level (r_{xy} = 0.481**) and different at 0.01 level.

The correlation of Nine – square stepping after 12 minutes, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.01 level (r_{xy} = 0.390**) and not different.

Table 8 Validity of Thai OMNI scale RPE for Thai Elderly in the three modes of aerobic exercise (during Brog (6 – 20) scale RPE and OMNI scale RPE)

Exercise	Correlation		Chi - square	
	r_{xy}	p-value	χ^2	p-value
Walking	0.953**	0.000	-0.226	0.821
Bench – stepping	0.976**	0.000	-1.995	0.146
Nine – square stepping	0.960**	0.000	-9.43	0.346

* significantly at the .05 level, ** significantly at the .01 level

Table 8 The correlation of walking exercise, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.01 level (r_{xy} = 0.953**) and not different.

The correlation of Bench - stepping exercise, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.01 level (r_{xy} = 0.976**) and not different.

The correlation of Nine – square stepping exercise, Thai OMNI scale RPE and Brog (6 – 20) scale RPE was statistically significant at 0.01 level (r_{xy} = 0.960**) and not different.

2. Reliability of the newly developed Thai OMNI Perceived Exertion Scale instrument for Thai Elderly

Alpha coefficient was used for computing the reliability of the OMNI scale RPE.

Table 9 Reliability of the Thai OMNI Perceived Exertion Scale instrument for Thai Elderly

Exercise	Alpha coefficient (α)
Walking	0.749
Bench – stepping	0.722
Nine – square stepping	0.708

Table 9 shows that reliability of the Thai OMNI scale RPE for walking exercise, bench – stepping exercise and nine – square stepping exercise were 0.708 – 0.749.

Part 3 Investigation predictive variables

Regression analysis was used for investigating the heart rate (HR) and blood lactate concentration (BLC) to predict the Borg (6-20) scale REP and the OMNI scale RPE.

Table 10 Regression analysis of RPE (OMNI Scale and Borg Scale) expressed as a function of HR and BLC

<table>
<tr><th rowspan="2">Exercises Mode</th><th colspan="2">Variable</th><th rowspan="2">R</th><th rowspan="2">R^2</th><th rowspan="2">R^2_{adj}</th><th rowspan="2">SE_{est}</th><th rowspan="2">F</th><th rowspan="2">sig</th></tr>
<tr><th>RPE Predictor</th><th>Criterion</th></tr>
<tr><td rowspan="4">Walking</td><td rowspan="2">OMNI</td><td>HR</td><td>.703</td><td>.494</td><td>.492</td><td>1.98106</td><td>290.431**</td><td>.000</td></tr>
<tr><td>BLC</td><td>.221</td><td>.049</td><td>.032</td><td>0.99695</td><td>2.971</td><td>.090</td></tr>
<tr><td rowspan="2">Borg</td><td>HR</td><td>.687</td><td>.472</td><td>.471</td><td>2.54563</td><td>266.745**</td><td>.000</td></tr>
<tr><td>BLC</td><td>.255</td><td>.065</td><td>.049</td><td>0.82858</td><td>4.026*</td><td>.049</td></tr>
<tr><td rowspan="4">Bench-stepping</td><td rowspan="2">OMNI</td><td>HR</td><td>.656</td><td>.431</td><td>.429</td><td>2.25226</td><td>225.677**</td><td>.000</td></tr>
<tr><td>BLC</td><td>.279</td><td>.078</td><td>.062</td><td>.50725</td><td>4.896*</td><td>.031</td></tr>
<tr><td rowspan="2">Borg</td><td>HR</td><td>.696</td><td>.485</td><td>.483</td><td>2.89484</td><td>280.127**</td><td>.000</td></tr>
<tr><td>BLC</td><td>.038</td><td>.001</td><td>-.016</td><td>.82985</td><td>0.085</td><td>.772</td></tr>
<tr><td rowspan="4">Nine square-stepping</td><td rowspan="2">OMNI</td><td>HR</td><td>.850</td><td>.723</td><td>.722</td><td>1.69235</td><td>779.113**</td><td>.000</td></tr>
<tr><td>BLC</td><td>.101</td><td>.010</td><td>-.007</td><td>0.75871</td><td>.601</td><td>.441</td></tr>
<tr><td rowspan="2">Borg</td><td>HR</td><td>.847</td><td>.717</td><td>.716</td><td>2.32669</td><td>755.398**</td><td>.000</td></tr>
<tr><td>BLC</td><td>.257</td><td>.066</td><td>.050</td><td>.97354</td><td>4.092*</td><td>.048</td></tr>
</table>

* Significantly at the .05 level, ** Significantly at the .01 level

Table 10 shows that the heart rate (HR) can predicted the OMNI scale RPE and Borg scale RPE in the three aerobic exercise modes at significantly .01 level. The blood lactate concentration (BLC) can predict the Borg scale RPE in walking exercise and Nine square – stepping exercise at significantly 0.05 level. The blood lactate concentration (BLC) can predict the Borg scale RPE in bench – stepping exercise at significantly 0.05 level.

CHAPTER 3

METHODOLOGY

This chapter presents the research methodology, which consists of studies of population and sample, instrumentation, procedure and statistical analysis. The purpose of this research focuses on the evaluations and testing of the newly developed Thai OMNI Perceived Exertion Scale instrument for Thai elderly in terms of validity and reliability in the three modes of aerobic exercise, (walking exercise, bench stepping exercise and nine-square stepping exercise).

Study Design

The concurrent validation was employed within a subject cross-sectional design, in which undertook two experimental trials. Each subject performed orientation and estimation trials. The trials were separated by a minimum of 48 hours and a maximum of 72 hours and aim to assess validity of OMNI Perceived Exertion Scale in the three modes of aerobic exercise for exercises in Thai Elderly.

Population and Sample

Population :

The target population of this research are 60 years old and above Thai elderly people who live in the community of Primary Care Unit, Muang Suang Hospital, Muang Suang, Roi-Et (Primary care unit of Muang Suang Hospital : 2010). They were recruited by following inclusion criterias :

1. Healthy elderly
2. Aged 60 years old or above
3. Able to communicate and write in Thai
4. Independently living in community
5. Without any contra indication and/or disability in exercise test

6. Exercise regularly

Sample :

60 elderly was recuited by purposive random sampling and then randomly assigned to each group. Subjects had a period to become familiar with the RPE scale and each mode of exercise. The different exercise modes consisted of :

1. Walking exercise
2. Stepping exercise
3. Nine square exercise

Instrumentation

1. Heart rate monitoring by use Polar S810
2. Blood lactate analyzer by use Accusport from Germany
3. Rating perceived exertion scales

3.1 Borg's perceived exertion scale (6-20 scale) (Wongphaet. 1998 : 122)

3.2 Thai OMNI perceived exertion scale for elderly which has been developed by the researcher.

Procedure

1. Development OMNI-RPE scale

1.1 Review literature from document

A review literature will be conducted to summarize and compare all documents in regards with perceived exertion scale, OMNI perceived exertion scale, aerobic exercise for elderly and the validity for perceived exertion. Based on this information, the researcher had summarized and developed the Thai OMNI perceived exertion scale for elderly (Robertson. 2004 : 1-20).

1.2 OMNI-RPE scale anchor design

The newly generate Thai perceive exertion scale for elderly retain all of the characteristics of the original OMNI perceived exertion scale. The following construction points of Thai perceived exertion scale for elderly are :

1.2.1 A graphic designer will be produce pictorial descriptors illustrating an elderly person at various levels of exertion while performing the activities. A set of four pictures was drawed for each exercise, and based on previous formats of the OMNI Scale of Perceived Exertion. The body position of the pictorials indicates a progression of exertion from rest to maximal.

1.2.2 Single and combined words will be accepted as responses, but were only valid if they described exertion, intensity of exercise or work, or either body signals or symptoms of exercise comfort or discomfort.

1.2.3 The number of verbal and numerical descriptors is similar to OMNI RPE scales in Thai language (Nakkanung et al. 2012 : 114).

1.2.4 Balanced, interval scale criteria, are displayed along the scale; the six discrete verbal cues are placed at equal intervals along 0 to 10. The four pictures shows also position along the numerical rating range. The exertion depiction in OMNI scale will be gradually increased from start scale (0) until to top scale (10).

1.3 Content validity from expert panels

1.3.1 Following the original instrument format (Robertson. 2004), each of the measurement items have been already translated to Thai version (Nakkanung et al. 2012 : 114). The Thai OMNI perceived exertion scale for elderly is measured on a 6 - verbal descriptor. Verbal descriptor and numerical descriptor are assessed from “0” (Extremely Easy), “2” (Easy), “4” (Somewhat Easy), “6” (Somewhat Hard) “8” (Hard) and “10” (Extremely Hard) .

1.3.2 The researcher will develop pictorials of the body position for 4 pictures of each protocol from rest to maximal exercise.

1.3.3 Three experts consisting of a physical therapist, a physiologist and a sport scientist have considered the first draft of Thai OMNI perceived exertion scale for elderly .

1.3.3.1 Miss Boonta Khakai. Sport Scientist at the Institute of Physical Education Mahasarakham.

1.3.3.2 Miss Benja Sealim. Physiotherapist at the Queen Sirikit heart centre of the Northeast, Khon Kaen university.

1.3.3.3 Mr.Montree Yasud. Physiotherapist at the Queen Sirikit heart centre of the Northeast, Khon Kaen university.

The experts were requested to identify the content relevance of each item and its related scale, to verify the item uniqueness of each sub-scale, the pictorial of each scales and to evaluate the clarity of the item's meaning in Thai cultural context.

The experts evaluation results were computed by using the IOC value. The result IOC value during 0.67 - 1.00 means to the OMNI RPE scale for three modes aerobic exercises were measuring validity.

1.3.4 Conduct a pilot study

A pilot study of each exercise test was used to determine exercise intensity and exercise duration, the variable (OMNI RPE) from test-retest was used to determine the quality of instruments.

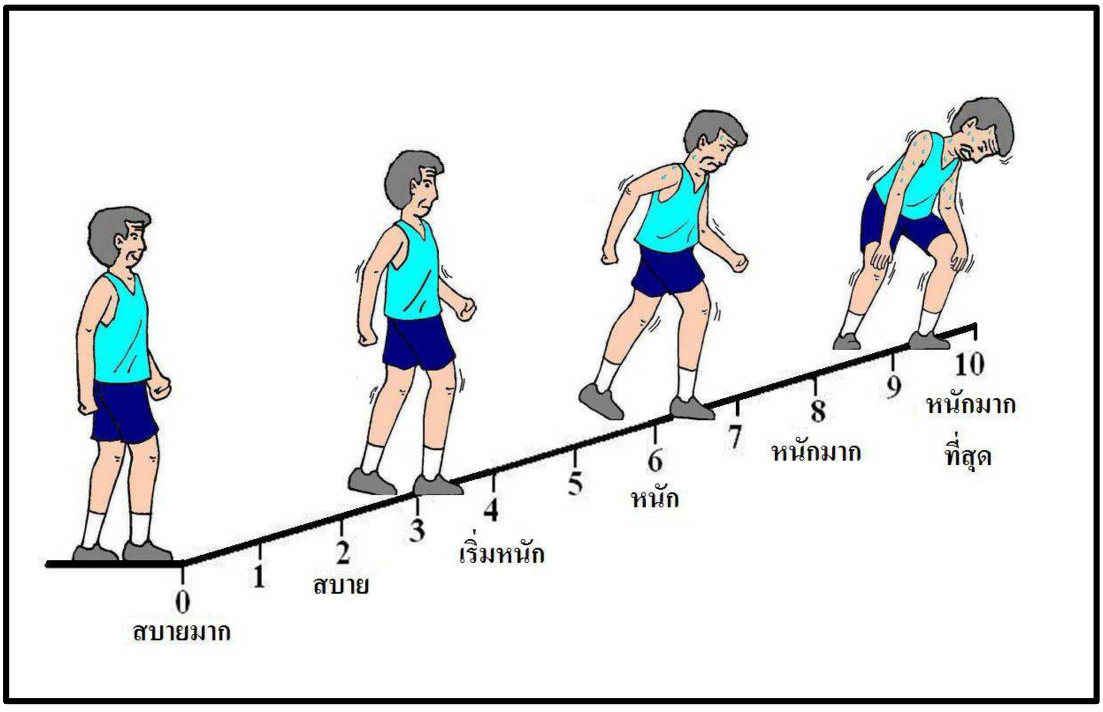
1.3.5 Reliability testing

The inter - rater reliability was conducted by a researcher and two assistants. The value of reliability used the test-retest method computed from the pilots study. The result of OMNI's reliability (Appendix F) were follows:

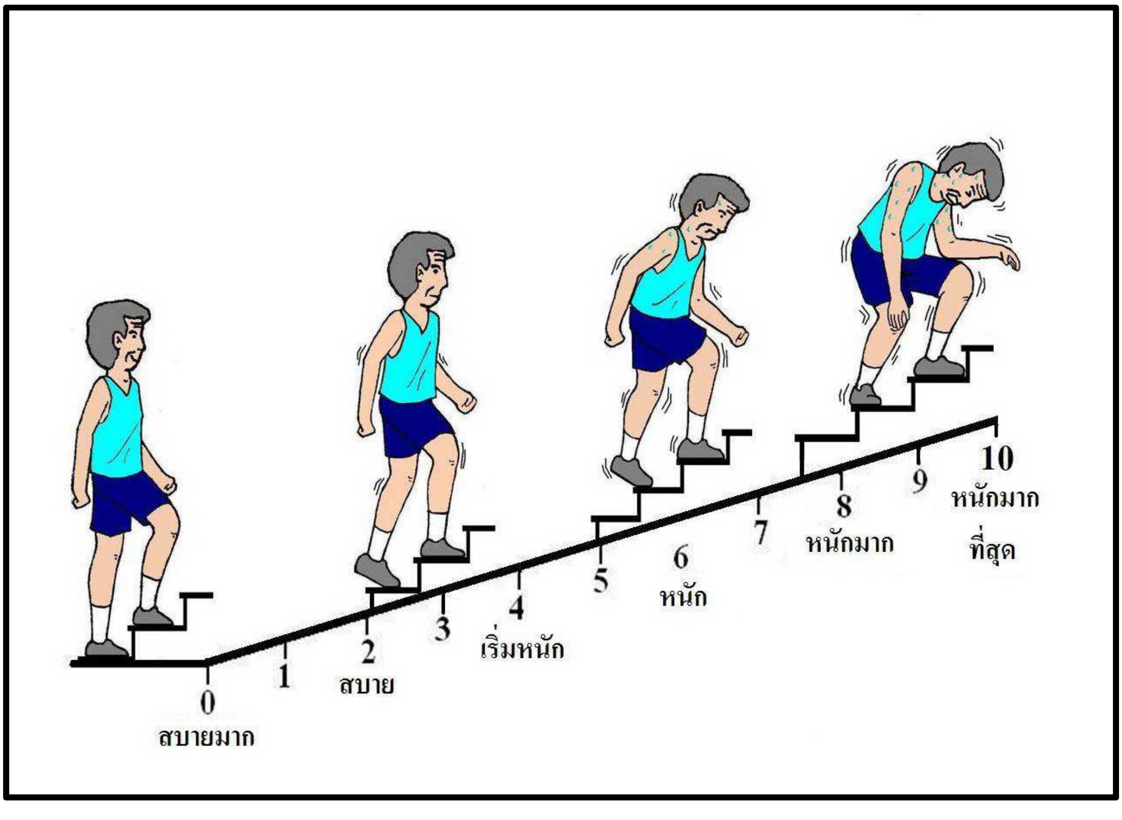
1.3.5.1 The value of reliability (r_{tt}) of OMNI RPE from walk exercise was between 0.43 - 0.69.

1.3.5.2 The value of reliability (r_{tt}) of OMNI RPE from bench-stepping exercise was between 0.36 - 0.56.

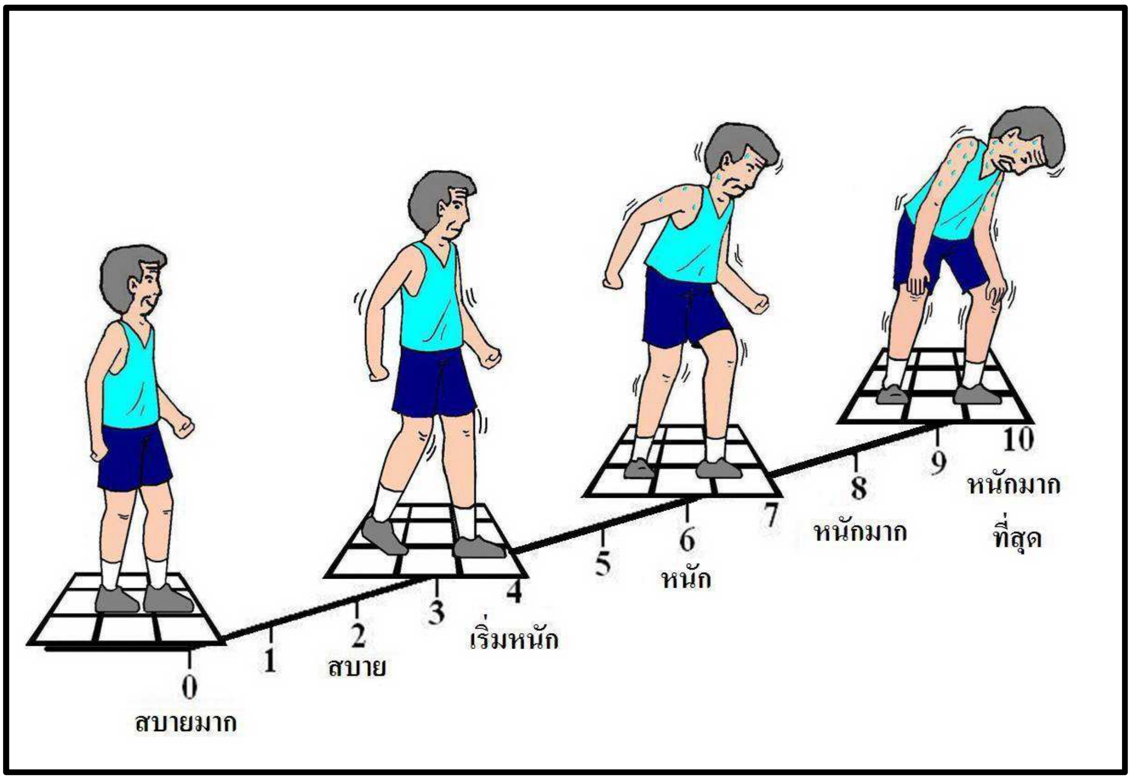
1.3.5.3 The value of reliability (r_{tt}) of OMNI RPE from nine-square stepping exercise was between 0.37 - 0.66.



OMNI-walk/run scale of perceived exertion



OMNI- stepping scale of perceived exertion



OMNI- nine square scale of perceived exertion

Data Collection

The data collection process were as follows:

1. The researcher requested permission letters from the faculty of Education, Mahasarakham university to be sent to the director of Muang Suang hospital for data collection.

2. The researcher made an appointment with the subjects to come to Muang Suang hospital for exercise testing. Subjects are volunteer to participate in the experiment. A consent form was signed by each subject.

3. The researcher interviewed and recorded demographic and basic health information, physical activity information, and daily food consumption. The subjects have been excluded if they had any exclusion criteria. Pre-test instruction were as follow :

3.1 Subjects were requested not to consume food, tobacco, and caffeine for at least 3 hours prior to the testing session as well as to refrain from alcohol for at least 24 hours prior to testing.

3.2 Subjects were requested to be adequately hydrated and to not engage in exercise or strenuous physical activity for 24 hours prior to testing.

3.3 Subjects were requested to wear exercise clothing, consisting of shorts, T-shirt and appropriate shoes.

3.4 Before exercise testing, researcher instructed participants about OMNI-RPE as following: a standard definition of perceived exertion and separate instructional sets for the Borg and OMNI scales were also read to the subjects immediately before the exercise test. The researcher read the instruction to the subjects about Borg and OMNI scales and both scales separate views. Both scales are anchor using a combination of exercise and memory procedures. This procedure requires the subject to cognitively establish a perceived intensity of exertion that is consonant with that depicted visually by the figure of exercise at the bottom (i.e., low anchor, rating 0) and top (i.e., high anchor, rating 10) of the hill as present in the OMNI-RPE Scale illustrations.

3.5 Anthropometric measurements:

Body weight (kg) and height (cm) were measured using standard scale and attached studiometer.

3.6 Exercise test

3.6.1 Walking exercise

Using a self paced walk. This test was conducted on an indoor track except if the subjects asked to walk at a “brisk but comfortable” (Grant et al. 2002 : 276 - 281).

3.6.2 Stepping exercise

Using a 20 cms (8 inches) stepping platform with the stepping pattern (steeping up and down, swinging the arms besides the trunk) (Ayabe. 2003 : 207 - 215)

3.6.3 Nine - square exercise: using nine-square (90 x 90 cm^2)

Using nine - square (90 x 90 cm^2). Subjects were stepped in four points as the previous study (Loilong. 1994 : 75 - 78).

3.7 On blood lactate concentration, measuring blood sample was obtained from the fingertip using a standard hygienic finger puncture method (Declan et al. 2003). The puncture was induced using Accu-chek Softelix lancet device, set at optimal penetration depth to reduce discomfort by avoiding contact with nerve. During blood collection, subject was instructed to relax his hand. After finger selection, fingertip was cleaned with alcohol. Drops of blood were placed on a lactate test strip and then analyzed immediately by using a portable analyzer (Lactate Scout-analyzer, Germany). The result of blood lactate concentration (mmol/L) was shown within 1 minute. After blood sampling collection, bleeding was stopped using a brief compression. Series of blood sample were collected for pre exercise and post-exercise (end of 12 minutes).

3.8 Immediately before the familiarization test, participants were instructed regarding the use of the OMNI Scale of perceived exertion and were asked to estimate their rating of perceived exertion corresponding to the overall body during the final 15 seconds of each stage of the test. For estimate trail, before undertaking exercise, the subject's resting HR and BLC in the exercise post were measured. The test began with a 2 - 3 min warm-up to familiarize them with the exercise equipment and to prepare the subjects for the exercise test. Exercise intensity by stepping rate (ascends/min) base on pilot test stepping rate was established at the beginning. The test was terminated when the subjects self-reported maximal exertion - fatigue (RPE 7 or 8) conducted within the exercise intensity which subjects couldn't maintain step cadence for more than 10 seconds. Subjects had also at least 70% of age predict HR_{max} established as the standard criteria to end the test. After the exercise trial, the subjects entered the cool-down period, the purpose to allow the subject's HR to return to below 120 beats per minute. The exercise test permitted to obtained data of physiological concurrent variables ; HR and construct variable ; Borg 6-20 RPE at each test stage and OMNI Rating Perceived Exertion Scale at each test stage.

Statistical Analysis

The researcher had to express the statistical analysis software (SPSS).

1. Descriptive data for perceptual and physiological variables are calculated as means ($\bar{X}$) and standard deviations (S.D.).

2. Criterion related validity (r_{xy} : Pearson ' s Correlation Coefficient) applied to investigated validity during Borg (6-20) scale RPE (BO) and the OMNI scale RPE (OM) and use Chi – square (χ^2) to investigate the validity.

3. Alpha Coefficient by Cronbach (α) is applied to investigated reliability of the newly development Thai OMNI Perceived Exertion Scale.

4. Regression analysis is applied to investigated heart rate (HR) and blood lactate concentration (BLC) to predict Borg (6 – 20) scale RPE and the OMNI scale RPE.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews related literature covering the following topics:

1. Perceived Exertion Scale
    1.1 Definition of Perceived Exertion
    1.2 Concept for development of Perceived Exertion
    1.3 Theory of Perceived Exertion
    1.4 Development of Perceived Exertion
    1.5 Benefit of Perceived Exertion Scale
2. OMNI Perceived Exertion Scale
    2.1 The OMNI System of Perceived Exertion Scale
    2.2 Development of the OMNI Picture System
    2.3 OMNI scale validity and reliability
    2.4 Children OMNI Scale of Perceived Exertion
    2.5 Adult OMNI Scale of Perceived Exertion
    2.6 Elderly OMNI - Aerobic Exercise Scale
    2.7 Thai OMNI Perceived Exertion Scale
3. Aerobic Exercise in Elderly
    3.1 Definition of elderly
    3.2 Exercise for elderly
    3.3 Types of Exercise for Elderly
    3.4 Aerobic Exercise for Elderly
4. Related Research Articles
5. Conceptual Framework

Perceived Exertion Scale

Perceived Exertion

1. Definition of Perceived Exertion

O'Sullivan (1984 : 343) summarized the definition of perceived exertion as the subjective rating of the intensity of physical work and has been the subject of increasing attention.

Borg (1998 : 8) defined perceived exertion as the degree of heaviness and strain experienced in physical work as estimated according to a specific rating method.

Robertson (2004 A : 7) gave the meaning of perceived exertion, which combines both active and passive processes; it is defined as the subjective intensity of effort, strain, discomfort, and/or fatigue that the subject experiences during exercise.

Borg (2007 : 30) gave the definition of perceived exertion as the perception of how the body is working during exercise, based on many sensory cues and perception.

Lambrick (2010 : 28) concluded that perceived exertion may be defined as the act of detecting and interpreting various sensations which may arise from the body during physical exercise. This may include the subjective intensity of effort, discomfort, strain and fatigue.

Plowman and Smith (2011 : 397) gave definition of perceived exertion referred as a subjective impression of overall physical effort, strain, and fatigue during acute exercise.

In conclusion, Perceived exertion is defined as the perception of effort, strain, discomfort or fatigue that subject feel during exercise.

2. Concept for development of Perceived Exertion

Borg (1998 : 2 - 3) gave the concept of perceived exertion as:

2.1 The content and meaning of perceived exertion are primarily given by common sense, personal experiences, and empirical studies. Experiences such as effort, breathlessness, fatigue, aches in working muscle, feelings of warmness, and so on help to capture the concept.

2.2 Perceived exertion are subjective weight and heaviness, subjective force, arousal, and exercise intensity. The perception of perceived exertion (and effort), on the other hand, at very high intensities is also connected with diminishing working capacity, but at low or moderate intensities may be related to a state of activation, an "arousal" that has a positive effect on performance. Studying fatigue and exertion only from a physiological perspective is as impossible as dealing with color, emotion, or motivation in primarily physical or only physiological terms. This is exertion and fatigue are a state with both physiological and psychological aspects. A concept related to fatigue and exertion is exercise intensity. Exercise intensity is interpreted in several different ways. It may be given a physical measurement such as power, work and energy, torque, velocity, and so on. It may be interpreted physiologically, in absolute terms such as VO_2 or by relative values such as heart rate (HR).

2.3 To evaluate exercise intensity in term of rating of subjective intensity as perceived by the subject, the latter method gives an individualized measure of exercise intensity.

Robertson (2004 A : 2 - 3) referred to the perceived exertion concepts developed sequentially as :

1. A standardized definition of perceived exertion was developed that conformed to the accepted practices of health - fitness and clinical exercise practitioners.

2. A system for classifying and anatomically locating the original of exertional ratings was devised. The physiological, psychological, clinical, and performance events that affect the intensity of exertion ratings within each classification were then identified and explained.

3. The concept of perceived exertion was applied in a wide range of health - fitness, clinical, and sport settings. The scaling systems fundamental to each of these steps were developed with emphasis placed on their validity, reliability, and utility.

Hutchison (2004 : 3) concluded the concept of "perceived exertion" as a subjective complement to the objective responses during physical work, and developed a scale to measure this concept, known as the Rating of Perceived Exertion (RPE) scale.

To summarize, the concept of perceived exertion was applied in a wide range of health - fitness, clinical, and sport settings to evaluate exercise intensity in term of rating of subjective sensation of the amount of physical work performed.

3. Theory of Perceived Exertion

The theoretical rationale underlying the applications of RPE are based on the functional interdependence of perceptual and physiological responses during exercise. The three main effort continua are physiological, perceptual and performance. The effort continua depict the relationship between the physiological demands of exercise performance. It is expected that as the intensity of exercise performance increases, corresponding and interdependent changes occur in both the perceptual and physiological processes. The functional links between the three effort continua indicate that a perceptual response provides much of the same information about exercise performance as a physiological response does. Therefore, decisions about the intensity and duration of exercise performance can be based on the functional interaction between the perceptual and physiological continua (Robertson. 2004 : 3).

Borg (2007 : 30) summarized that the “overall” perceived exertion should be regarded as a “gestalt” consisting of many cues, sensations from the organs of circulation and respiration, from the muscles, the skin, the joints, etc” together with perceptions of “pedal resistance, effort, fatigue, strain exertion, heat, pressure, pain or anxiety, etc.” Still, overall perceived exertion may be viewed as a unidimensional continuum and its intensity may be scaled. Alternatively, it may be viewed as a multidimensional construct of many perceptual qualities. In dealing with physical work, we need to integrate information from three main effort domains: the perceptual, the performance and the physiological.

To summarize, the main effort of perceived exertion is consisting of three efforts that are the perceptual, the performance and the physiological.

1. Perceptual domain

The overall perceived exertion is built up from many different body symptoms. Cues include those of more peripheral character originating from the skin, moving muscle and joints (local factor) as well as those of more central character coming from the cardiopulmonary system (Central factors)

(Borg. 2007 : 30). Perception of effort is a complex psychological process that integrates a number of exertional symptoms, each of which is presumed to be linked to an underlying physiological or psychological mediator. The linguistic expression of these exertional symptoms forms a perceptual reliability that allows for a global measurement of the physiological and psychological factors that influence exercise performance. One of the most pronounced symptoms of exertional intolerance is fatigue. In addition, aches, cramps, muscular and articular pain and heaviness, and dyspnea (a feeling of breathlessness) are all somatic symptoms experienced during both aerobic and resistance exercise. A number of psychological symptoms such as task aversion and low motivation also directly affect RPE. Often, clusters of exertional symptoms interact from the client's perceptual style, which becomes part of the perceptual cognitive reference filter. This filter contains sensory information and experience that reflect a bord range of psychosocial and cognitive process. From an operational standpoint, the contents of the perceptual cognitive reference filter shape the intensity of perceptual signals as they travel from their physiological/neuromotor origins to conscious expression as an RPE. In this way, the sensory content of the reference filter exerts a strong influence on the client's RPE (Robertson. 2004 A : 6 - 7).

2. Performance domain

Physical performance may be measured, for example, as a maximal or peak value obtained under certain circumstances, like the maximum work capacity (Watt) performed in a bicycle ergometer test. Often, physiological correlates are used to measure physical work capacity. One commonly used physiological measure of an individuals' maximal work capacity is maximal oxygen uptake (the volume of oxygen, at standard temperature and pressure extracted from inspired air when performing an exercise test to maximum). The reason is that oxygen uptake is very closely related to the oxygen consumption of the working muscles. Oxygen uptake (VO_2), usually measured in liters per minute, is commonly measured by collecting the expired air during an exercise test with, so called, Douglas bags. It is regarded as a valid and highly reliable measure. The procedure to measure oxygen uptake is, however, somewhat time consuming and the apparatus rather expensive. There are also difficulties arising when stressing participants to their absolute maximum (Borg. 2007 : 30).

3. Physiological domain

Overall perceived exertion has been shown to have several important physiological correlates. Examples are heart rate (HR), oxygen uptake, carbon dioxide production, pulmonary ventilation, Blood lactate [La], blood pH, blood pressure, potassium ions (K^+),electrical muscle activity as measured by electromyography (EMG), mechanical activity as measured by mechanomyography (MMG), rectal temperature, and skin temperature. Heart rate is usually regarded as a good correlate for central, cardio - pulmonary factors. Its increase follows the oxygen demands in the muscles and grows approximately linearly with power output for physical work on bicycle ergometer. Lactate is produced as a natural part of the carbohydrate metabolism and has been suggested to play a major role (even if not directly casual) in “muscle fatigue” and the pain experience during exercise. It may therefore functions as a correlate to perceived muscle activity (Borg. 2007 : 31).

In a review by Allen and Westerbld (2004 : 1112 - 1113), it is argues that while lactic acid creates an extracellular acidosis, that “probably contributes to the painful sensation of “muscle fatigue” experienced by athletes”, it also has beneficial effects on the performance of fatigued muscles by affecting importantion channels in the muscle cells. It should be emphasized, however, that causality has yet to be established regarding what physiological mechanisms lie behind the decline in muscle function, as muscles are used intensively and repeatedly.

There are a number of physiological factors that influence RPE during exercise. It is important to have an understanding of these underlying mediators as the application of RPE in health - fitness settings relies on the concomitant increase in several objectively measured physiological variables. The physiological factors that influence perceived exertion can be classified as 1) respiratory - metabolic, 2) peripheral and 3) non - specific (Robertson. 2004 A : 5 - 6).

3.1 Respiratory - Metabolic Mediators

Respiratory - metabolic signals of perceived exertion are mediated by physiological response that influences ventilatory drive during exercise (VE), oxygen consumption (VO2), carbon dioxide production, heart rate (HR), and blood pressure.

3.2 Peripheral Mediators

Peripheral physiological mediators are localized in the limbs and trunk active muscles. They include Metabolic acidosis (pH and lactic acid), Blood glucose, blood flow to muscle, muscle fiber type, free fatty acids and muscle glycogen.

3.3 Nonspecific Mediators

Nonspecific physiological mediators are generalized as systemic physiological events that occur during exercise related to hormonal regulation (catecholamine's and β - endorphins), temperature regulation (core and skin), pain, cortisol, serotonin and cerebral blood flow and oxygen.

Physiological factors mediate perceptual signals of physical exertion by acting either individually or collectively to alter the tension - producing properties of skeletal muscle. In turn, changes in peripheral and respiratory muscle tension are monitored through a common neurophysiological pathway that transmits exertional signals from the motor to the sensory cortex. It is these neurophysiological signals that are consciously interpreted by the sensory cortex as effort sensation. The pathway for signals of perceived exertion involves a combined feed - forward and feedback mechanism. As exercise intensity increases, the number of central motor feed - forward commands required to increase motor unit recruitment and firing frequency in both peripheral and respiratory skeletal muscle must also increase. Corollary discharges diverge from the descending motor commands to the terminates in the sensory cortex. The greater the frequency of the collar signals, the more intense the perceived physical exertion. In addition, afferent feedback from muscles and joints helps to refine and calibrate central motor outflow commands. The resulting sensory integration of feed - forward and feedback pathways fine - tunes the exertional response.

Schafer (2007 : 11) concluded that there are several interrelated elements that produce a person's perception of exertion during dynamic exercise. Physiological responses to an exercise stimulus serve as the initial mediators that shape the intensity of the perceptual signals. The effect of these signals mediators is to alter tension - producing properties of the skeletal muscle. An increase in peripheral and/or respiratory muscle tension during exercise is brought about by a greater discharge of the central feed - forward commands arising from the motor cortex. Corollary pathways carrying a copy of these central commands terminate in the sensory cortex. These corollary discharges are subsequently interpreted as perceptual signals of exertion. The final mediating step in the exertional process occurs when the signal arising from the sensory cortex is matched with the contents of the perceptual cognitive reference filter. As the signal passes through the reference filter it is finely tuned, its intensity modulated according to the matrix of past and present events that reflect the individual's psychological characteristics and perceptual style.

To summarize, the effort continua depict the relationship between the physiological demands of exercise performance and perception of exercise performance and the perception of the exertion associated with the performance. It is expected that the intensity of exercise appears in both the perceptual and physiological processes.

4. Development of Perceived Exertion

The first scale for measuring perceived exertion was developed in the early 1960s by psychologist Gunnar Borg at the University of Stockholm. Borg's early collaborators in the development and validation of the scale included Bruce J. Noble of the University of Pittsburgh and William P. Morgan of the University of Wisconsin. Since this initial pioneering work, a number of scales for quantifying perceived physical exertion have been developed and validated. With these scales, users select the number that they feel corresponds to the intensity of their physical exertion. This number, called the rating of perceived exertion, or RPE, is used by exercise and clinical practitioners to describe the range of indicators that make up an individual's perception of physical exertion during aerobic or resistance exercise (Robertson. 2004 : 2).

Faulkner and Eston (2008 : 1) summarized the development of Perceived exertion that in the early 1960's, Gunnar Borg developed: the 6 - 20 Rating of Perceived Exertion (RPE) scale. This scale has been widely applied as a valuable, reliable, and easily understood means of quantifying, monitoring and evaluating the exercise tolerance and magnitude of exertion in healthy adult populations and other groups.

The relationship between perceived exertion and human performance has been an area of considerable scientific and clinical interest over the last 50 years and has become a focus of extensive research in the exercise and sport sciences.

The Borg, 15 - grade or 6 - 20, RPE scale was constructed in the later 1960's, and then was modified in 1980 . The last version of the Borg 6 - 20 RPE scale (1980's) includes a numerical range of 6 to 20 along with nine verbal descriptors spanning the exertional continuum from "6," "No exertion at all" and ending with "Maximal exertion" which corresponds to a numerical rating of "20" According to Borg, the rationale for choosing "6" as the starting point on the scale, is because when multiplied by 10, it corresponds to a typical resting heart rate. The other numbers on the Borg 6 - 20 RPE scale can also be multiplied by 10, giving the equivalent heart rate expected for normal, healthy, middle - aged men or across the entire range of exercise intensities. The validation of the Borg 6 - 20 RPE scale was performed by comparing RPE with a physiological variable, initially heart rate and then later with oxygen uptake. The concurrent validation process was performed during cycle ergometer exercise, and later during treadmill running. Correlation coefficients between RPE and heart rate were reported to be around .85 with for both exercise modalities (Borg. 1998 : 29 - 38).

6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Figure 1 Fifteen - category Borg Perceived exertion scale (Borg. 1998 : 47)

In Thailand, Borg 6 - 20 RPE has been translated in Thai language in 1998 and assesses the validity of using translated Borg scale for estimating exercise intensity in twenty - six Thai normal subjects. Recorded rate of perceived exertion and heart rate during the last 30 seconds of each steps of the continuous graded exercise were done on leg cycle ergometer. Regression analysis showed linear relation among heart rate, RPE and exercise intensity>the correlation coefficient were 0.8 between heart rate and RPE 0.79 between exercise intensity (watt) and RPE.Linear regression calculation showed regression coefficient approximate to other previous studies, so the validity of using translated Borg's scale to measure exercise intensity during continous graded exercise in normal subjects was confirmed (Wongphaet. 1998 : 121 - 125)

6
7 รู้สึกสบาย
8
9 ไม่เหนื่อย
10
11 เริ่มรู้สึกเหนื่อย
12
13 ค่อนข้างเหนื่อย
14
15 เหนื่อย
16
17 เหนื่อยมาก
18
19 เหนื่อยที่สุด
20

Figure 2 Fifteen - category Borg Perceived exertion scale in Thai language

5. Benefit of Perceived exertion scale

When measuring RPE, it is important to use scales and scaling methods that are appropriate for the individual being evaluated. At note earlier, the assessment of exertional perceptions in health - fitness, clinical and sport setting (Robertson. 2004 : 5 - 6).

5.1 Health - fitness setting

Rating of perceived exertion can be used to meet the goals of health - fitness clients and the professional obligations of exercise practioner.

Zeni and others (1996 : 237 - 241) examined the relationships among three of these training intensity variables, heart rate (HR), rating of perceived exertion (RPE) and blood lactate concentration ([La]) for six modes of rhythmic exercise. Design: Ten healthy women subjects underwent a 4 - weeks habituation period to become familiar with the RPE scale and exercise on a treadmill, cycle ergometer, rowing ergometer, airdyne, stairstepper, and cross - country skiing simulator. Following habituation, each subject underwent graded discontinuous exercise testing on each mode. HR was measured during the last minute of each 4 - minute stage. Immediately after each stage, RPE was requested and blood was collected for analysis of [La]. Data were analyzed with repeated measures ANOVA. Results: For given RPE values, the treadmill induced higher ($p < .05$) HR values compared with the cycle and rowing ergometers, and the cycle ergometer induced lower ($p < .05$) HR values compared with the treadmill, airdyne, stairstepper, and cross - country skiing simulator. The relationships of [La] with RPE were similar among modes except for the cross country skiing simulator, which induced a lower ($p < .05$) [La] for a given RPE. Of the relationships examined in this study, the HR - RPE relationship might be of the greatest practical importance because HR and RPE are the variables that currently are used most typically to establish exercise intensity.

Grant and others (2002 : 276 - 281) compared the physiological responses and ratings of perceived exertion to aerobic dance and walking sessions completed at a self selected pace. Methods: Six women and six men with a sample mean (SD) age of 68 (7) years completed aerobic dance and walking sessions in random order. A treadmill test was performed by each subject from which peak oxygen uptake (VO_2) and maximum heart rates (HRmax) were determined. During the aerobic dance and walking sessions, heart rates and VO_2 were measured continuously throughout. Rate of perceived exertion (RPE) was measured every three minutes throughout the session. Results: The sample means (SD) for %peakVO_2 were 67 (17)% for the aerobic dance sessions and 52 (10)% for the walking sessions, and the %HRmax sample means (SD) were 74 (12)% for the aerobic dance sessions and 60 (8)% for the walking sessions. The sample mean (SD) RPE for the aerobic dance sessions was 11 (2), and for the walking sessions it was 10 (2). Conclusions: %peak VO_2, %HRmax, and RPE were significantly higher for aerobic dance than for walking. However, both the aerobic dance and walking sessions were of adequate intensity to improve aerobic fitness in most subjects.

Batte (2003 : 300 - 305) evaluated the physiologic response during exercise on an elliptical fitness cross - trainer at a prescribed level of perceived exertion. Twenty recreational exercisers (8 males, 12 females) were habituated to the elliptical cross - trainer and then assessed for their peak oxygen utilization (VO(2)) and peak heart rate (HR) using an incremental protocol. The point of volitional fatigue during the maximal test was used to anchor a modified Borg Category Ratio (CR - 10) scale. Following a rest period of 48 - 72 hours, a second exercise session was performed at a prescribed perceived exertion level of 6. The subjects were instructed to manipulate the resistance and striding cadence to maintain the prescribed perceived exertion level for 15 min, during which VO(2) and HR were analyzed. The results from this study demonstrated that at exercise steady state, which occurred 4 min after the start of the protocol, relative VO(2) averaged 75.2+/ - 12.9% and relative HR was 91+/ - .01%. Oxygen utilization and HR values were found to be significantly higher than a corresponding relative RPE in 20 recreational exercises when exercising on an elliptical fitness cross - trainer.

Lambrick and others (2009 : 1) assessed the utility of a single, continuous exercise protocol in facilitating accurate estimates of maximal oxygen uptake (VO_{2max}) from submaximal heart rate (HR) and the ratings of perceived exertion (RPE) in healthy, low - fit women, during cycle ergometry. Eleven women estimated their RPE during a continuous test (1 W 4 s(- 1)) to volitional exhaustion (measured VO_{2max}). Individual gaseous exchange thresholds (GETs) were determined retrospectively. The RPE and HR values prior to and including an RPE 13 and GET were extrapolated against corresponding oxygen uptake to a theoretical maximal RPE (20) and peak RPE (19), and age - predicted HRmax, respectively, to predict VO_{2max}. There were no significant differences ($p > 0.05$) between measured (30.9 +/ - 6.5 ml kg (- 1) min(- 1)) and predicted V(O) (2max) from all six methods. Limits of agreement were narrowest and intraclass correlations were highest for predictions of VO_{2max} from an RPE 13 to peak RPE (19). Prediction of V(O)(2max) from a regression equation using submaximal HR and work rate at an RPE 13 was also not significantly different to actual VO_{2max} (R(2) = 0.78, SEE = 3.42 ml kg(- 1) min(- 1), $p > 0.05$). Accurate predictions of VO_{2max} may be obtained from a single, continuous, estimation exercise test to a moderate intensity (RPE 13) in low - fit women, particularly when extrapolated to peak terminal RPE (RPE19).

The RPE is a valuable tool that can be easily employed as an adjunct to HR, and provides supplementary clinical information that is superior to using HR alone.

Fontes (2010 : 1 - 5) verified the relationship between rating of perceived exertion (RPE) and electromyography (EMG) increases during exhaustive constant - load cycling bouts and, to compare and to correlate the power outputs corresponding to perceived exertion threshold (PET) and neuromuscular fatigue threshold (NFT). 11 men completed 3 – 4 different exhaustive constant - load cycling bouts on a cycle ergometer, being RPE and EMG measured throughout the bouts. The linear regression of the RPE slope and EMG slope against the power output identified the PET and NFT intensity, respectively. There was a significant relationship between RPE slope and EMG slope (R 2 = 0.69; $P < 0.01$). However, the linearity of RPE slope (R 2 = 0.93 ± 0.07) was significantly higher ($P < 0.001$) than EMG slope (R 2 = 0.63 ± 0.25). In addition, the RPE slope and EMG slope were related to time to exhaustion (r = − 0.59 and r = − 0.60; $P < 0.001$). There was no significant difference ($P = 0.42$) between PET (201.5 ± 27.9W) and NFT (210.3 ± 22.6W) and they were significantly correlated (r = 0.78; $P = 0.005$). Therefore, the RPE and EMG increases during exhaustive constantload cycling bouts are related and, PET and NFT intensities are similar and closely associated.

Alberton (2010 : 1 - 6) examined in correlation the rating of perceived exertion (RPE) with cardiorespiratory and neuromuscular variables during the execution of stationary running in water at different cadences. The sample consisted of 12 apparently healthy women (age: 22.33 6 0.57 years). During the assessment session, the subjects performed the stationary running exercise in water at 3 different cadences: 60, 80, and 100 bpm. The heart rate (HR), oxygen uptake (VO_2), ventilation (Ve), and electromyographic (EMG) signal of the vastus lateralis (VL), biceps femoris (BF), rectus femoris (RF), and semitendinosus (ST) muscles were measured during the exercise, and the overall body RPE was measured immediately following the end. Pearson’s linear correlation and multiple linear regression were used, with p , 0.05. The analyses demonstrate a high and significant relationship between RPE and HR (r = 0.65;

p , 0.001), RPE and %HR maximal (r = 0.65; p , 0.001), RPE and_ VO2 (r=0.60; p=0.001), RPE and %VO_2 maximal (r=0.71;p , 0.001), and RPE and Ve (r = 0.77; p , 0.001). However, there was no relationship between the RPE and the EMGs of the VL, BF, RF, and ST muscles. With regard to the regression, the model was significant (p, 0.001) with an r2 = 0.79, whereas the variables that explained better the RPE were%VO_2 maximal and Ve. Hence, these results suggest an association between the perception of exertion and cardiorespiratory variables, which was not the case with the neuromuscular variables evaluated in this study. Therefore, the Borg scale of RPE can be used when prescribing stationary running exercise in water for young women.

5.2 Clinical setting

There are several studies evaluating the usefulness of rating perceived exertion and examining the relationship of rating perceived exertion with other physiological response.

Chida and others (1991 : 390 - 393) evaluated the usefulness of ratings of perceived exertion (RPE) as an indicator of exercise intensity in patients with chronic obstructive pulmonary disease (COPD). The subjects were ten male patients with COPD, whose mean forced expiratory volume in 1 s was 1.091, SD 0.41, and ten healthy middle - aged men. Ramp incremental exercise on a cycle - ergometer was performed and RPE was determined by the Borg 15 - point scale. The absolute oxygen uptake at each RPE was significantly greater in the healthy subjects than in the patients with COPD. However, oxygen uptakes calculated as a percentage of maximal at any RPE did not differ significantly between the two groups. Arterial blood lactate concentration at points 15 to 19 on the RPE scale was increased in healthy subjects ($p<0.05$–$p<0.001$), while the dyspnoea index at points 11 to 19 on the RPE scale was higher in patients with COPD ($p<0.05$–$p<0.001$). The main complaints on stopping exercise were dyspnoea in the patients with COPD and fatigue in the healthy subjects. Although the nature of RPE may have been different in the two groups, RPE could be a possible indicator of exercise intensity when physicians prescribe exercise to patients with COPD.

Eston and Thompsonassess (1997 : 114 - 119) studied the efficacy of Borg's rating of perceived exertion (RPE) scale to predict maximal exercise levels to control exercise intensity in patients taking atenolol for the treatment of essential hypertension. Normally, a standard formula (220 - age) is used for calculating a percentage of exercise intensity, but beta blockade can cause reductions in maximal heart rate of between 20 and 30%. METHODS: Patients were split into a control group - 10 men and 10 women, aged 50 (SD 12) and 46 (9) respectively, who had risk factors for cardiovascular disease but were not taking any drug, and a treatment group - 11 men and 11 women, aged 53 (13) and 55 (13) respectively, who were established on 25 - 100 mg of atenolol. All patients performed two submaximal tests on a cycle ergometer. Test 1 was an estimation test, during which the RPE was reported for each increment in work rate. Test 2 was an RPE production test, during which the patient regulated the work rate according to his/her perception of effort at four predetermined points on the RPE scale (RPE 9, 13, 15, 17). RESULTS: In both tests the individual correlations (r) between RPE, heart rate, and work rate ranged from 0.96 to 0.99. Analysis of variance showed no significant difference in maximal heart rate and maximal power output for the control group when predicted from the regression lines of RPE versus heart rate and RPE versus power output in the estimation test. However, the prediction of maximal power output was lower for the women in the control group and patients in the treatment group when this was predicted from the effort production protocol ($p < 0.01$). When exercise intensity at each RPE was expressed relatively to maximal power output, there were no differences between treatment and control groups. CONCLUSION: The findings from this study confirmed the strong positive relation between RPE, heart rate, and work rate in these patients in both passive effort estimation and active effort production protocols. However, caution in applying these procedures is required because the prediction of maximal exercise levels may be lower when effort production procedures are used.

Mockova and Radvansky (2003 : 1 - 3) investigated relationships Between % of HRmax, % of VO2max % of VEmax and Borg's

Rating of Perceived Exertion in a population of elderly people with cardiovascular disorders. Eighteen female and thirteen male patients treated with selective beta - blockers (or a combination of drugs involving a beta - blocking agent) as a result of ischaemic heart disease and/or hypertension participated in this study (age = 61.1 8.58, BMI = 28.44 4.31). Each patient performed one graded exercise test (GXT) protocol on an electronically braked bicycle ergometer. The test consisted of three grades (0.5, 1 and 1.5 W/kg) of steady - state exercise, each lasting 3 to 4 minutes, depending on achievement of the steady - state All data were analyzed using non - parametric statistical techniques. Spearman Rank - Difference Correlation was used to describe the relationships and the Wilcoxon Paired Test was used for group comparisons. All levels of significance were established at $p < 0.05$. The results confirm that the Borg's RPE scale may serve as an aid in exercise testing for individuals being treated with beta - blockers. High correlation coefficients (r = 0.8 - 0.87) between RPE and the objective physiological parameters expressed in relative terms of exercise intensity (i.e. % VO2max, % VEmax, % HRmax) obtained during graded exercise tests showed a strong positive linear relationship between subjective and objective assessments of exercise strain. Conclusion of this study found that RPE scale is a beneficial approach for monitoring exercise intensity in patients on beta - blockade, since it is a parameter no weaker than the conventionally used HR.

Barker (2003 : 1319 - 1323) investigated the efficacy of using ratings of perceived exertion (RPEs) to regulate exercise intensity for patients with chronic back pain while they undergo hydrotherapy. Twenty - six patients (16 women, 10 men) with chronic low back pain of more than 12 months in duration were selected. All were referred for hydrotherapy after attending a back pain triage clinic. Borg Ratings of Perceived Exertion Scale expressed as a percentage of age predicted maximum heart rate, computed from readings using heart rate monitors, Oswestry Disability Questionnaire, and pain score from a visual analog scale. Results: At workloads below 55% of age - predicted maximum heart rate, great variability was found in the relation between RPE and exercise intensity. However, for workloads between 55% and 85% of age -

predicted maximum heart rate, RPE had a strong correlation with relative exercise intensity during hydrotherapy. Conclusions: At workloads sufficient to induce an aerobic training response, and yet be safe for patients with chronic back pain, RPE was an accurate predictor of exercise intensity.

Grange and others (2004 : 611 - 619) examined, in a restricted randomized trial, the effects of a 6 - week arm - crank rehabilitation training program in elderly osteoarthrosis patients after total hip arthroplasty, first on physiological and perceptual responses and second on physical function. Two groups of patients were studied: a training group (N = 7, mean age = 74.9 yr, standard deviation [SD] = 5.0 yr) who followed a training program in addition to traditional rehabilitation, and a control group who followed traditional rehabilitation only (N = 7 mean age = 75.4 yr, SD = 5.1 yr). At the beginning of the training program, the heart rate and the perceived exertion were not significantly correlated during the exercise session. However, at the end of the training program, five patients had a significant heart rate/perceived exertion relationship ($p < 0.05$). Furthermore, positive effects of the arm - crank rehabilitation training program were observed on cardioventilatory and functional responses in the training group compared with the control group. These results suggest that after an habituation period, most of our elderly osteoarthrosis patients experienced physical sensations that were connected to physiological responses. Therefore, perceived exertion could be useful in these patients to regulate exercise intensity, especially at the end of and after the rehabilitation period.

Stanish and Aucoin (2007 : 230 - 239) studied the usefulness of the Children's OMNI Scale as a subjective measure of intensity for adults with intellectual disabilities (ID). Heart rate, workload, and RPE were monitored during a progressive walking protocol on a motorized treadmill in 18 adults with ID. Statistical analyses on individual data revealed that significant positive relationships among RPE, heart rate, and workload existed in most participants. However, results were highly variable. Results imply that some individuals with ID are able to provide a subjective estimate of exercise intensity while others may not be able to report accurately. The findings have significant practical implications for exercise programming in this population.

Lewis and others (2007 : 1205 - 1211) examined the relationship between psychologic cues of somatic stress and physiologic responses to exercise in persons with paraplegia and tetraplegia. Forty - two subjects between 18 and 69 years of age with motor - complete spinal cord injury (SCI) resulting in paraplegia or tetraplegia (American Spinal Injury Association grades A and B). Subjects underwent peak graded arm ergometry during which heart rate, oxygen consumption (VO2), minute ventilation (VE), and ratings of perceived exertion (RPE) (Borg Categorical 6 - 20 Scale) were measured at successive work rate increments from baseline to fatigue. In the results, there were inconsistent associations among the outcomes. For subjects with tetraplegia, RPE related positively to heart rate at the initial work rate, but there were no other significant correlations. For subjects with paraplegia, RPE did not correlate significantly with heart rate, VO2, or VE. VO2 and Ve related positively at the first and last work rates. In general, heart rate, VO2, and Ve increased as the exercise intensity increased, and were more pronounced in subjects with paraplegia. While RPE values increased with increasing work rates for each group, we found no differences between groups. In this study, findings contradict the well - accepted relationships between RPE and both heart rate and VO2 during exercise by people without disabilities, and challenge the use of RPE as a valid psychophysiologic index of perceived exertion in persons with SCI.

Al - Rahamneh and others (2010 : 273 - 277) investigated the strength of the relationship between ratings of perceived exertion (RPE) and oxygen uptake (Vo(2)), heart rate, ventilation (Ve) and power output (PO) during an arm - crank ramped exercise test to volitional exhaustion in men and women who differed in physical status. Each participant completed an arm - crank ramp exercise test to volitional exhaustion. PO was increased by 15 W.min(- 1) and 6 W.min (- 1) for men and women able - bodied participants, respectively; for the poliomyelitis participants, 9 W.min(- 1) and 6 W.min(- 1) increments were used for men and women, respectively. Able - bodied participants (n=16; 9 men, 7 women) and participants with poliomyelitis (n=15, 8 men, 7 women) volunteered for the study. Strength of the relationship (R(2) values) between RPE and Vo(2), heart rate, Ve and PO. The results found that there were significantly higher values for maximum Vo(2) and maximum PO for able - bodied men compared with their counterparts with poliomyelitis ($p<.05$). However, when the data were controlled for age, there were no significant differences in these values ($p>.05$). Similar results were observed for the women who were able - bodied as well as for the women who had poliomyelitis ($p>.05$). The relationships between heart rate and RPE and Ve and RPE for able - bodied patients and patients with poliomyelitis were similar (R(2)>.87). The relationship between Vo(2) and RPE was stronger in the able - bodied participants compared with the participants with poliomyelitis, regardless of sex ($p<.05$). However, when the data were controlled for age, there was no significant difference in the strength of this relationship between able - bodied participants and those with poliomyelitis, regardless of sex ($p>.05$). The conclusion of this study found RPE is strongly related to physiologic markers of exercise intensity during arm exercise, irrespective of sex or participant's poliomyelitis status.

5.3 Sport setting

Recently, Rating of perceived exertion zone have been used to guide in sport training and sport competition .

Faulkner and others (2008 : 977 - 975) assessed the relationship of the rating of perceived exertion (RPE) with heart rate and pacing strategy during competitive running races of different distance and course elevation. Nine men and women competed in a 7 - mile road race (7 - MR) and the Great West Run half marathon (GWR; 13.1 miles). Heart rate, split mile time, and RPE were recorded throughout the races. The RPE was regressed against time and %time to complete the 7 - MR and GWR. Although the rate of increase in RPE was greater in the 7 - MR, there were no differences when expressed against %time (inferring that the brain uses a scalar timing mechanism). As the course elevation, distance, pacing strategy, and heart rate response varied between conditions, this study has provided evidence that the perceptual response may have distinct temporal characteristics during distance running. The results provide further evidence that RPE is related to the proportion of exercise time that remains.

Amtmann and others (2008 : 645 - 647) determined 1) the metabolic demands of the sport and 2) the effectiveness of the prebout interval training programs chosen to help prepare the competitors for this event in 6 male subjects training for and competing in a mixed martial arts event held in Butte, Montana. The training lactate measurements ranged from 8.1 to 19.7 $mmol \cdot L^{-1}$, and the training RPE levels ranged from 15 to 19 on Borg's Category Scale of perceived exertion, the scores of which ranged from 6 to 20. The postbout lactate measurements ranged from 10.2 to 20.7 $mmol \cdot L^{-1}$, and the post - bout RPE measurements ranged from 13 to 19. Of the 4 subjects that had both training and postbout lactate measurements, 3 had obtained lactate levels during training that exceeded lactate levels immediately after the bout. This indicated that, when using lactate measurements as a benchmark, the conditioning training was effective for these 3 athletes. When used RPE scores as a benchmark, the conditioning was effective for all 4 subjects because all subjects reached 18 - 19 during their training, which was at least as high as their reported post - bout RPE levels

Bridge (2009 : 485 - 493) investigated the physiological responses and perceived exertion during international Taekwondo competition. Eight male Taekwondo black belts (mean +/ - SD, age 22 +/ - 4 y, body mass 69.4 +/ - 13.4 kg, height 1.82 +/ - 0.10 m, competition experience 9 +/ - 5 y) took part in an international - level Taekwondo competition. Each combat included three 2 - min rounds with 30 s of recovery between each round. Heart rate (HR) was recorded at 5 - s intervals during each combat. Capillary blood lactate samples were taken from the fingertip 1 min before competition, directly after each round and 1 min after competition. Competitors' rating of perceived exertion (RPE) was recorded for each round using Borg's 6 - to - 20 scale. RESULTS: HR (round 1: 175 +/ - 15 to round 3: 187 +/ - 8 beats x min(- 1); $p < .05$), percentage of HR maximum (round 1: 89 +/ - 8 to round 3: 96 +/ - 5% HRmax; $p < .05$), blood lactate (round 1: 7.5 +/ - 1.6 to round 3: 11.9 +/ - 2.1 mmol x L(- 1); $p < .05$) and RPE (round 1: 11 +/ - 2 to round 3: 14 +/ - 2;

p < .05; mean +/ - SD) increased significantly across rounds. Conclusion: International - level Taekwondo competition elicited near - maximal cardiovascular responses, high blood lactate concentrations, and increases in competitors' RPE across combat. Training should therefore include exercise bouts that sufficiently stimulate both aerobic and anaerobic metabolism.

Douda and others (2006 : 78 - 88) examined ratings of perceived exertion (RPE) in relation to physiological responses during an incremental exercise test in elite and non - elite rhythmic gymnasts in order to determine the proper training intensity. Thirty - nine gymnasts were divided into two groups (elite: n=15, non - elite: n=24) and performed an incremental exercise test on a cycle - ergometer up to exhaustion in order to determine RPE (scale 6 - to - 20), oxygen uptake, heart rate and lactate responses. Elite - athletes presented higher RPE and VO2max values at a maximal effort (p<0.001) while heart rate and lactate values between elite and non - elite gymnasts were similar. In addition, when examining the same relative exercise intensity, the RPE response was higher in elite - athletes than non - elite athletes and a significant correlation was obtained between RPE and athletic performance (r=0.83, p<0.01), based on total performance rank in national competitions. These results suggest that RPE appears to be an applicable measure of exercise intensity mostly in highly trained rhythmic gymnasts and may provide accurate information to coaches for better training regimes.

Sinclair and others (2007 : 1 - 6) investigated the metabolic (BLa) and physiological (HR) responses of high - performance surf lifesavers to SWIM, BOARD and IRON events during a major 2 - day surf lifesaving competition. Seventeen (male = 9; female = 8) high - performance surf lifesavers (21.2±3.9 years) contested multiple rounds of team and individual events at a 2 - day surf lifesaving competition. Individual events consisted of the multi - discipline ironman (IRON), paddle board (BOARD) and surf swim (SWIM). Blood lactate (BLa), rating of perceived exertion (RPE) and heart rate (HR) were determined following heats, semi - finals and final. IRON HR and RPE following semi - finals (153.0±21.6 beats min^{-1} and 14.4±1.5) and final (171.0±9.1 beats min^{-1} and 19.1±0.2) were greater than heats (141.8±17.2 beats

$\text{min}^{-1}$and 12.0±1.9; $p < 0.05$) and final BLa (10.5±2.8 mmol L^{-1}) was greater than heats (5.8±3.6 mmol L^{-1}; $p < 0.05$). BOARD BLa and HR were greater after the final (9.0±2.8 mmol L^{-1} and 159.0±19.9 beats min^{-1}) compared to heats (4.7±2.4 mmol L^{-1} and 133.0±17.1 beats min^{-1}; $p < 0.05$). No significant differences were identified for SWIM. RPE—HR relationships were identified for pooled IRON and BOARD results following semi - finals (0.668; $p < 0.05$) and finals ($r = 0.741$; $p < 0.05$). In conclusion, high - performance surf lifesavers employ race strategies with all - out maximal exercise limited to semi - finals and finals.

In conclusion, Ratings of perceived exertion appear to be a useful tool for quantifying some of the perceptions experience during health - fitness, clinical and sport setting. Research on perceived exertion has been largely focused in the laboratory setting and needs to be applied more fully to the clinical setting to evaluate its usefulness.

OMNI Perceived Exertion Scale

1. The OMNI System of perceived exertion scale

Latin, the word *omnis* is equivalent to “totality.” This English version of this word *omni* has been incorporated into a series of newly developed perceptual scaling metrics. The OMNI system means that the RPE scales were developed with the purpose to be applied for all types of exercise modes, individual characteristics, or physical activity settings (Robertson. 2004 : 10).

The initial OMNI RPE scale was developed in an attempt to improve the rating of perceived exertion of children during aerobic exercise. Robertson and associates were concerned with the applicability of the previously developed RPE scales in this population because children may not understand the scales, thereby, leading to questionable validity of these scaling metrics for use in pediatrics cohorts. Therefore, the OMNI RPE scale was created to improve upon methodological and semantic limitations found when children rated their perceived exertion using scales designed for adults (Robertson. 2004 : 10).

2. Development of the OMNI Picture System

The procedures behind the development of the new OMNI RPE scales consisted of four steps. First, pictorials were drawn by an artist showing children and adults of both genders performing different exercises with different degrees of exertion. The pictures were made in shades of gray on white background to provide a wide generalization over the human skin tones. The exercise modalities selected were cycling, walk/run, stepping, and weightlifting. The subsequent step consisted of showing these mode - exercise specific pictures of children to young boys and girls, likewise pictures of adults exercising were shown to clinically normal adult males and females. Subjects were asked to provide verbal descriptors associated with the perceived exertion on each pictorial. The third step included a semantic differential analysis of those verbal descriptor; in which six descriptors were chosen separately for children and for adults. The most common root word for children was “tired,” while adults used the words “easy” and “hard” to define the level of effort depicted in the pictorials. Lastly, these six verbal cues were placed at equidistance along a narrow numerical range of 0 to 10. Similarly, the four pictorial descriptors were placed at equidistance on the scale. Verbal descriptors were placed on the zero as a starting point. In addition, numbers, pictorials, and verbal descriptors were aligned along a graded format providing additional visual evidence of increasing exercise intensity, and thereby, perceived exertion (Robertson. 2004 : 12).

3. OMNI scale validity and reliability (Robertson. 2004 : 14)

3.1 OMNI scale validity

A number of research experiments have established the concurrent validity of both the child and adult versions of the OMNI scale. A concurrent validation experiment employs a criterion (that is, a stimulus) variable and a concurrent (response) variable. For aerobic exercise, for example, the most common criterion variable are oxygen consumption, HR, and power output. The concurrent variable is always the RPE as derived from the various OMNI scales. When they were validating the OMNI pic

3.2 OMNI - Scale reliability

Establishing the response reliability of newly constructed perceived exertion rating scale is a very important step in the development process. (Pfeiffer and others. 2002 : 2057 - 2061) examined the intraclass and day - to - day reliability of both the OMNI and Borg 15 - category perceived exertion scales in subjects who performed graded treadmill exercise. The reliability coefficients ranged from r = 0.91 to 0.95 for the OMNI scale and r = 0.64 to 0.78 for the Borg scale. Both scales were shown to be reliable, but the OMNI cycling format's reproducibility was superior to that of the Borg scale when used with adolescent girls.

In this study, content validity and criterion - related validity in term of concurrent validity will be performed to test the validity of Thai OMNI - perceived exertion for elderly with HR and blood lactate concentration

4. Children OMNI scales of perceived exertion

The first OMNI RPE scale was developed in 2000, for use by children /adolescents while riding a cycle ergometer by Robertson and others (2000 : 452 - 458) employed an estimation paradigm with the purpose to establish concurrent validity. Rating of perceived exertion was the concurrent variable, whereas oxygen uptake and heart rate were the criterion variables. A submaximal estimation trial was then administered with children exercising at power outputs of 25, 50, 75 and 100 Watts. Regression analysis indicated that for the combined sample of subjects, RPE - O, L and C distributed as a positive linear function of both VO_2 (r = .85 - .94) and HR (r = .87 - .93) thus establishing concurrent validity. The linearity of RPE responses as an applied validation criterion is parallel to the basic tenants of Borg's Effort Continua Model. The investigation demonstrated a positive linear relation between the Children's OMNI Cycle Scale RPE responses and selected physiological variables. This finding is consistent with the application outcomes underlying Borg's Range Model. Additionally, when cohorts were examined separately by race and gender, significant correlations were observed for OMNI RPE - O, L and C with the physiological variables of VO2 (female African American: r = .85 - .94; male African American: r = .89 - .93; female white: r = .87 - .92; male white: r = .90 - .94) and HR (female African American: r = .88 - .94; male African American:

r = .90 - .92; female white: r =.87 - .90; male white: r = .87 - .92). These are important findings, as the use of the Children's OMNI Cycle Scale is valid for children age 8 - 12 yrs regardless of gender, race or fitness level.

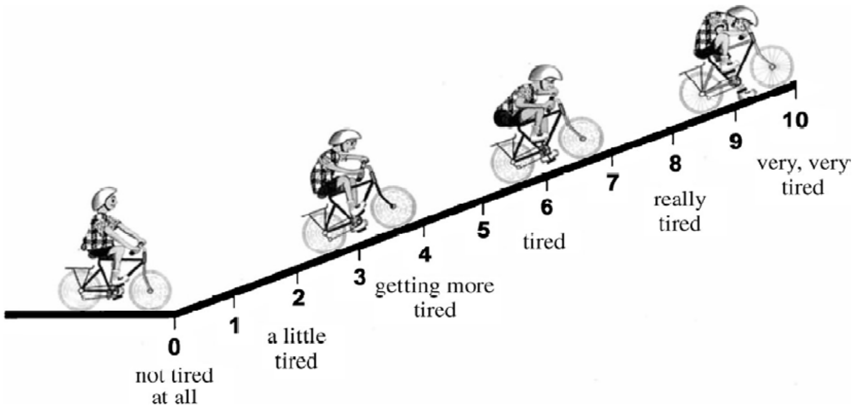


Figure 3 Children's OMNI Cycle Scale (Robertson and others. 2000)

A unique aspect of the OMNI Picture System of Perceived Exertion is the use of interchangeable pictures. Utter and colleagues (2002) developed a pictorial version of the OMNI scale for walking and running exercise. This scale utilized the same category scale properties of the Children's OMNI Cycle Scale; however, the pictorials were modified to represent children at varying levels of intensity while walking and running up a hill/incline. The paradigm examined male and female children age 6 - 13 yrs during a perceptual estimation protocol using a TM. Investigators examined correlations between undifferentiated RPE ratings and selected physiological variables (VO2, %VO2max, HR, VE, VE/VO2 ratio and respiratory rate (RR) that were averaged over the first five exercise stages. Correlation coefficients for RPE and the physiological variables were as follows: VO2: r = .32; %VO2max: r = .42; HR: r = .40; VE: r = .33; VE/VO2 ratio: r = .43; RR: r = .35. While the correlation coefficients were low, all physiological variables had a significant relationship with the undifferentiated RPE. This study demonstrated that the Children's OMNI Walk/Run Scale was a valid metric for determining RPE in children during walking and running exercise (Utter and others. 2002 : 139 - 144).

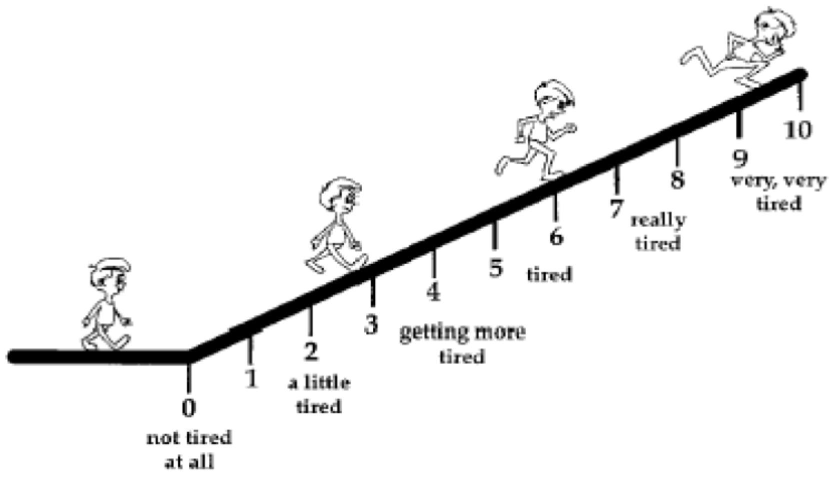


Figure 4 Children's OMNI Walk/Run Scale (Utter and others. 2002)

A study by Robertson and others (2005A : 819 - 826) continued to build upon the mode - specific exercise pictorials of the Children's OMNI scale. This investigation examined the concurrent validity of the Children's OMNI Resistance Exercise Scale (Figure 14). The study was similar to the study examining concurrent validity of the Adult OMNI Resistance Exercise Scale (Robertson and others. 2003). The children's study involved an initial orientation trial followed by subjects performing one set of single arm biceps curl (BC) and single leg knee extension (KE) during each of three experimental trials performed on separate days. Perceptions of exertion were assessed for RPE - O and active muscle (AM). Linear regression analyses indicated positive linear regression coefficients for males between total volume of weight lifted (WTtot) and RPE - O (males: BC: r = .80, KE: r = .88; females: BC: r = .87; KE: r = .80) and RPE - AM (males: BC: r = .81, KE: r = .75; females: BC: r = .88, KE: r = .72). Their finding established concurrent validity, as the differentiated and undifferentiated RPE increased as a function of volume loading resistance trials. Additionally, Robertson and colleagues (2005A) established that both male and female subjects were able to differentiate perceptions of exertion between RPE - O and RPE - AM. RPE - AM was significantly higher than RPE - O when averaged over the three sets for both BC and KE exercise. Clearly, this study strengthened the applicability of the OMNI Picture System of Perceived Exertion as it examined an entirely different mode of exercise, resistance training.

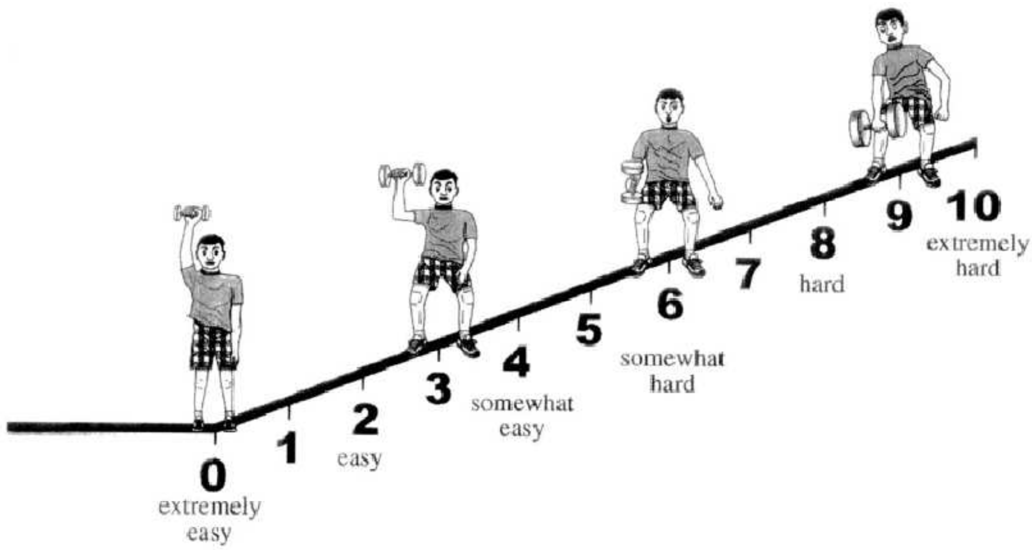


Figure 5 Children's OMNI Resistance Exercise Scale (Robertson and others. 2005A)

Previous Children's OMNI Scale investigations utilized a variety of paradigms to establish validity. An investigation by Robertson and colleagues (2005B : 290 - 298) was the first to combine concurrent and construct validity of RPE - O, L and C for an aerobic exercise modality in children. The Children's OMNI Step Scale was validated by examining the relation of differentiated and undifferentiated RPE responses with the criterion variables of VO2 and HR. Correlation analyses established a positive linear relationship between VO2 (r = .87 - .94) and HR (r = .81 - .89) for RPE - O, L and C for both male and female cohorts. Construct validity was based upon the relation between RPE obtained from the criterion metric (Children's OMNI Cycle Scale) and the conditional metric (Children's OMNI Step Scale) when RPE was obtained from mode specific protocols. Validity coefficients ranged from r = .93 - .95 for RPE - O, L and C. This study also demonstrated that RPE - O, L and C were not different for males (Figure 15) and females (Figure 16) when gender pictorials were used of the same or opposite gender. This is an important finding because it demonstrates that pictorials of male or female gender are both valid for determining RPE regardless of the subject's gender when a mode specific exercise is depicted.

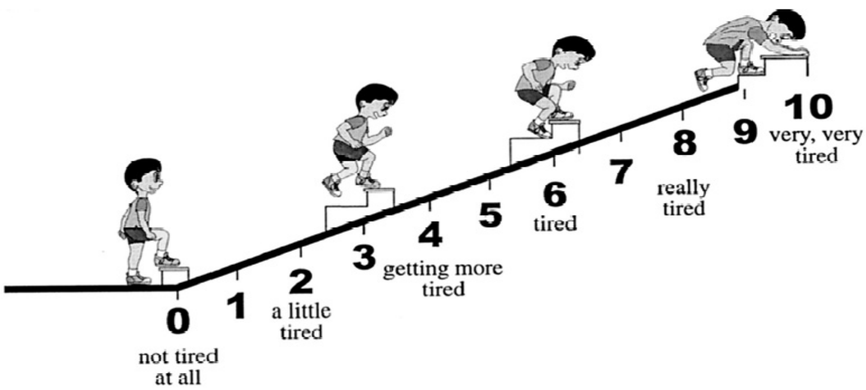


Figure 6 Children's OMNI Step Scale: Male pictorials (Robertson and others. 2005 B)

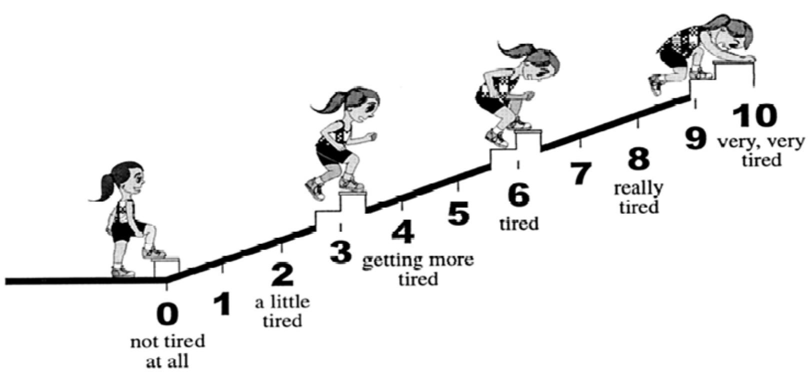


Figure 7 Children's OMNI Step Scale: Female pictorials (Robertson and others. 2005 B)

5. Adult OMNI scales of perceived exertion

A substantial body of research literature exists supporting the inclusion of illustrations to fine tune children's perceptions of exertion. However, including pictorials for adult subjects is a relatively new approach to perceived exertion scaling.

Robertson and Colleagues (2003 : 333 - 341) developed the Adult OMNI Resistance Exercise Scale (Figure 8), the first OMNI Picture System of Perceived Exertion for adult subjects. The scale has several similarities to the Children's OMNI Cycle Scale, most notably the same placement of verbal, numerical and pictorial descriptors. However, the scale depicts an adult "weightlifter" exercising with a progressively loaded barbell throughout the response range. Additionally, the verbal descriptors are appropriate for adult subjects (e.g., extremely easy, extremely hard).

The initial validation of the Adult OMNI Resistance Exercise Scale examined concurrent validity, employing a cross - sectional, perceptual estimation design in forty adult male and female recreational weight trainers (21.55 + 2.06 and 21.35 + 3.67 yrs). Subjects initially performed an orientation trial followed by the assessment of one repetition maximum (1 - RM) for bicep curls (BC) and knee extension (KE). Three experimental trials were then conducted on separate days. Subjects performed one set of submaximal (i.e., 65% of 1 - RM) BC and KE during each session with different repetitions being performed each session (i.e., 4, 8 and 12). Perceptions of exertion were assessed for RPE - AM following the end of the concentric phase of the middle and final repetition and RPE - O at the end of the final repetition. Positive linear regression coefficients were observed between RPE measures and WTtot for both male and female subjects ranging from r = .79 to .91. Additionally, blood lactate and RPE - AM for the final repetition were significantly correlated during BC exercise (r = .87) for combined male and female subjects. This finding established concurrent validity, as the RPE increased as a function of the volume of weight lifted and blood lactate. These are important findings for the practical application of the OMNI Resistance Scale for prescription and self - regulation of resistance exercise programs (Robertson and others. 2003).

Lagally and Colleagues (2006 : 252 - 256) examined the construct validity of the Adult OMNI Resistance Exercise Scale in forty moderately trained, recreationally active male and female subjects (22.3 + 2.6 and 21.4 +

2.3 yrs). Using a cross - sectional, perceptual estimation paradigm, subjects performed an initial orientation trial of the KE exercise with 1 - RM also being determined. Following the orientation trial, the experimental trial consisted of subjects performing 1 repetition at submaximal percentages (i.e., 40, 50, 60, 70, 80 and 90%) of their respective 1 - RM. RPE - AM and RPE - O were rated by subjects after each repetition using the Borg 15 Category Scale and the Adult OMNI Resistance Exercise Scale. For both male and female subjects, correlation coefficients ranged from r = .94 - .97 for RPE - AM and RPE - O. This finding indicates that the two perceived exertion scales provide similar information regarding perceived exertion (Lagally and Robertson. 2006).

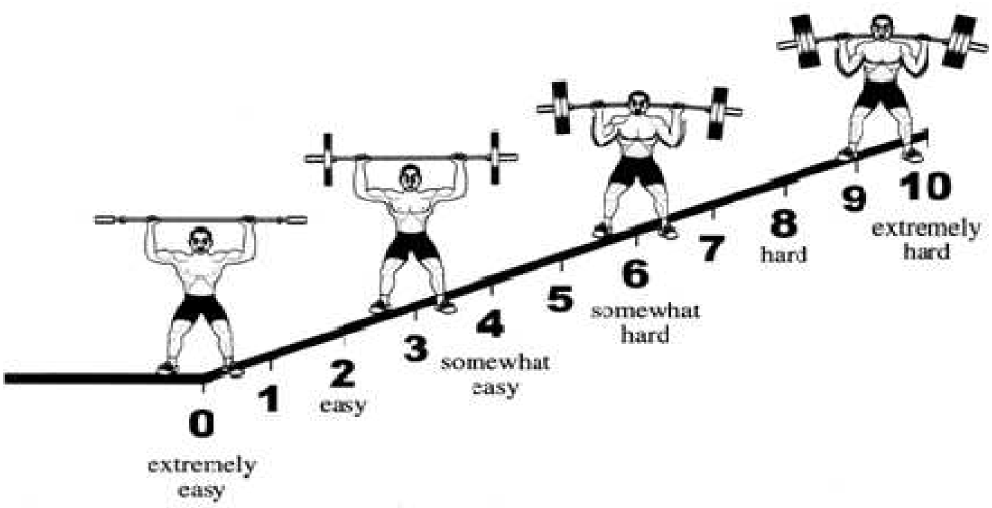


Figure 8 Adult OMNI Resistance Exercise Scale (Robertson and others. 2003)

Robertson and Colleagues (2004 : 102 - 108) were the first to develop an OMNI RPE scale for adults performing aerobic exercise. The Adult OMNI Cycle Scale (Figure 16) was developed for males and females (24.1 + 3.7; 21.1 + 3.8 yrs) using a cross - sectional, perceptual estimation paradigm. Concurrent and construct validity was determined for undifferentiated and differentiated RPE. Concurrent validity of the Adult OMNI Cycle Scale was established by regression analyses of RPE - O with VO2 (male: r = .94; female: r = .88) and HR (male: r = .90; female: r = .83), RPE - L with VO2 (male: r = .95; female:

r = .87) and HR (male: r = .86; female: r = .81) and RPE - C with VO2 (male: r = .95; female: r = .90) and HR (male: r = .88; female: r = .82).
This finding is in agreement with Borg's Range Model; response linearity was established between RPE and physiological variables from low to high exercise intensities. Additionally, the gender stratified analysis provides evidence that the gender pictorials do not appear to influence scale validity.

Construct validity was determined by correlating RPE derived from the criterion metric (Borg 15 Category Scale) with the conditional metric (Adult OMNI Cycle Scale). For both undifferentiated and differentiated RPE, a strong positive relationship was found between the scales for both male and female subjects (RPE - O: r = .97 and r = .96; RPE - L: r = .94 and r = .93; RPE – C: r = .92 and r = .94). The construct validity held over the wide range of metabolic responses associated with increasing exercise intensity during the load incremented cycle test. This finding indicates that the Adult OMNI Cycle Scale measured the same exertional properties as the Borg 15 Category Scale (Robertson and others. 2004). Additionally, subjects were able to differentiate between regional and global perceptual signals. This is an important finding because the mode of exercise can influence the perceptual response. Signal dominance of the activated region during exercise is important to precisely prescribe exercise intensity in a health - fitness setting. This study demonstrated that adult subjects could estimate RPE accurately during non - weight bearing exercise using the OMNI Picture System of Perceived Exertion.

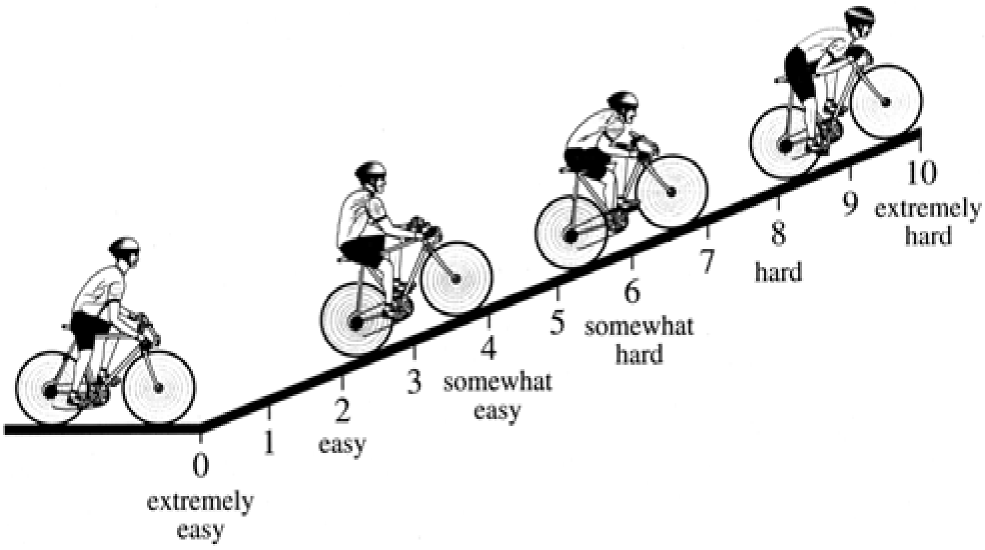


Figure 9 Adult OMNI Cycle Scale (Robertson and others. 2004)

Utter and Colleagues (2004 : 1776 - 1780) examined the validity of the Adult OMNI Walk/Run Scale during TM exercise. Similar to the study by Robertson and others (2004), a perceptual estimation paradigm was employed for males and females (18 - 36 yrs) during an incremental TM GXT to determine concurrent and construct validity. Concurrent validity examined the relationship between undifferentiated RPE and physiological variables of % VO2max, VE, HR, RR, and RER. Regression analyses indicated for both males and females, RPE - O from the Adult OMNI Walk/Run Scale distributed as a positive linear function with % VO2max (r2 = .74 and r2 = .72), VE (r2 = .61 and r2 = .63), HR (r2 = .57 and r2 = .70), RR (r2 = .48 and r2 = .45) and RER (r2 = .67 and r2 = .77). The linearity of the physiological and perceptual measures is consistent with Borg’s Effort Continua and Range Models.

Construct validity was also established by the positive relation between RPE derived from the Adult OMNI Walk/Run Scale and the Borg 15 Category Scale. For males and females, r values of .96 indicated that the Adult OMNI Walk/Run Scale measured the same properties of an exertional percept as the Borg 15 Category Scale (Utter and others., 2004). This study indicated that for a weight bearing aerobic modality, adult subjects were able to estimate RPE using the OMNI Picture System of Perceived Exertion.

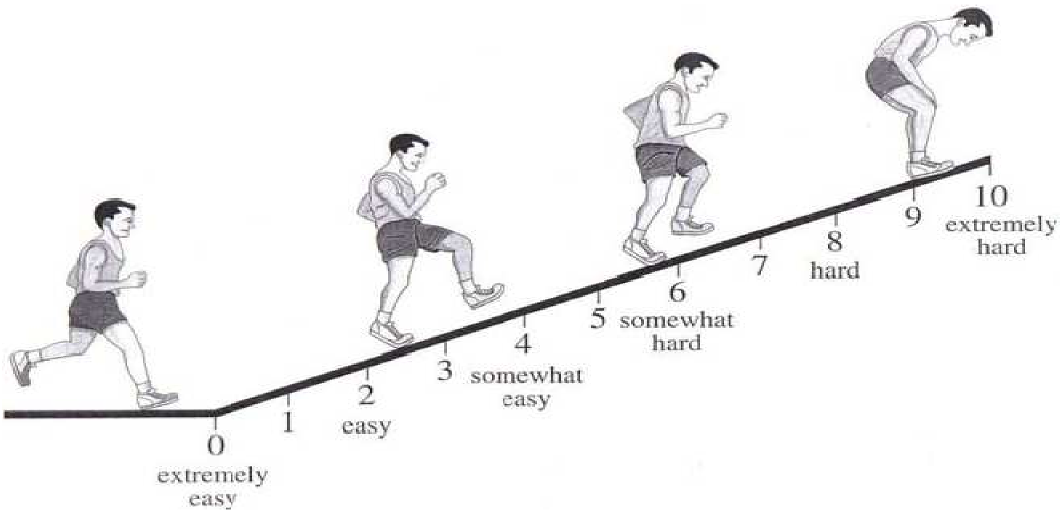


Figure 10 Adult OMNI Walk/Run Scale (Utter and others. 2004)

Mays (2009 : 1 - 74) examined concurrent and construct validity of two newly developed Adult OtracMNI Elliptical Ergometry ratings of perceived exertion scales. Fifty - nine sedentary to recreationally active, college - aged volunteers (males, n = 30; age = 21.3 + 3.3 yrs and females, n = 29; 22.3 + 3.5 yrs) participated in this study. A single observation, cross - sectional perceptual estimation trial was employed with subjects exercising to volitional fatigue on an elliptical ergometer. Oxygen consumption (VO2), heart rate (HR) and RPE - Overall Body (O), Legs (L) and Chest/Breathing (C) were recorded each stage from the Borg 15 Category Scale and two different OMNI RPE scale formats. One scale maintained the original format of the OMNI Picture System of Perceived Exertion. The second scale modified verbal, numerical and pictorial descriptors at the low end of the response range. Concurrent validity was established by correlating RPE - O, L and C from each scale with VO2 and HR obtained from each test stage during the estimation trial.

Construct validity was established by correlating RPE - O, L and C from the Adult OMNI Elliptical Ergometry Scales with RPE - O, L and C from the Borg Scale. The result found correlation analyses indicated the relation between RPE - O, L and C from each OMNI RPE Scale distributed as a positive linear function of both VO2 (males, r = .941 - .951 and females, r = .930 - .946) and HR (males, r = .950 - .960 and females, r = .963 - .966). A strong, positive relation was also exhibited between differentiated and undifferentiated RPE from the Adult OMNI Elliptical Ergometry Scales and the Borg 15 Category Scale (males, r = .961 - .972 and females, r = .973 - .977) (Mays. 2009). This study found that concurrent and construct validity were established for both formats of the Adult OMNI Elliptical Ergometry Scale during partial weight bearing exercise. Either scale can be used to estimate RPE during elliptical ergometer exercise in health - fitness settings.

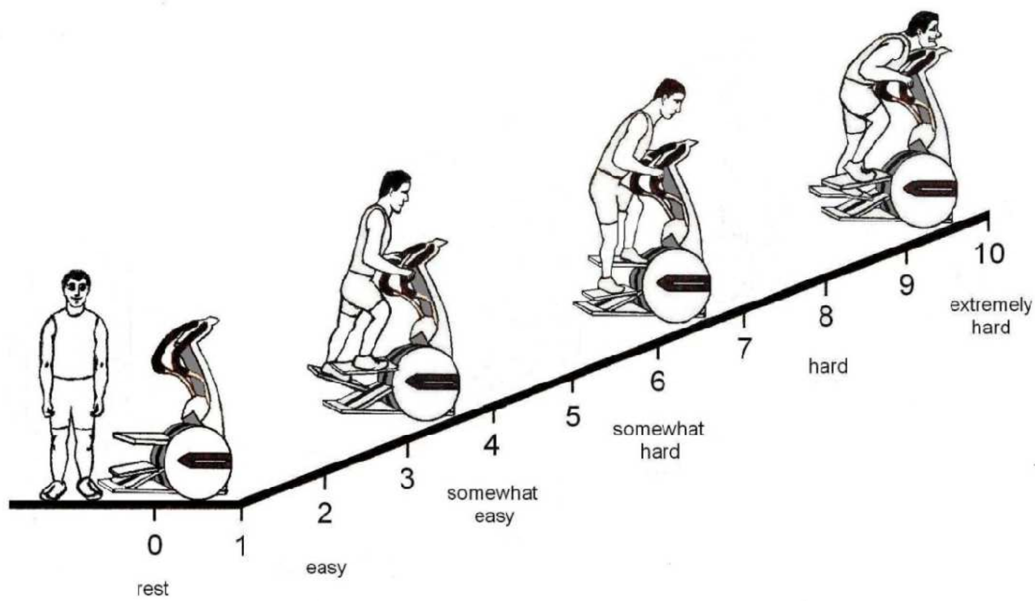


Figure 11 Modified format - Adult OMNI RPE Elliptical Ergometry Scale (Mays. 2009)

Krause (2010 : 1 - 76) developed and validated a modified OMNI Rating of Perceived Exertion (RPE) scale for use during bench stepping exercise (OMNI - BS) and examined the reliability of this scale. Participants were thirty females (age: 19.8±1.8yrs) who undertook two experimental trials, separated by 7 days. Concurrent validity was established by examining the relation between the physiological criterion variables, oxygen consumption (O2) and heart rate (HR), with the concurrent variable, RPE from OMNI - BS, during load incremental and load intermittent trials. The load incremental test consisted of 3 - min stages.

During the first stage subjects stood in front of the bench (resting measurement). Subsequently subjects stepped up and down on the bench at 120 beats per minute. The test was terminated owing to subject fatigue. Exercise intensity increased as bench height increased every 3 - min. The intermittent test consisted of three, 3 - min, exercise bouts, that reproduced exercise stages I (low intensity), III (moderate intensity), and V (high intensity) performed in the load incremental test. The order of these three exercise bouts was counterbalanced. Test re - test reliability between trials of the OMNI - BS RPE scale was examined by comparing RPEs obtained during stages I, III, and V. The result found Intraclass Correlatio*n* analysis from the load incremental and load intermittent trials indicated a strong positive association between RPE and O2 (r=0.96 and r=0.95) and HR (r=0.95 and r=0.95). Test re - test reliability also demonstrated a strong positive association of RPEs between trials (r=0.95) for the entire data set. However, separate correlation analysis conducted on each of the three stages indicated the following associations: 1) stage I: low intensity; r=0.475; p=0.009; 2) stage III: moderate intensity; r=0.559; p=0.002; and 3) stage V: high intensity; r=0.793, p<0.001. The Bland - Altman method indicated a moderate level of agreement in RPE between trials. In conclusion, concurrent validity and test re - test reliability for the OMNI - BS RPE scale were established for adult females performing bench stepping exercise.

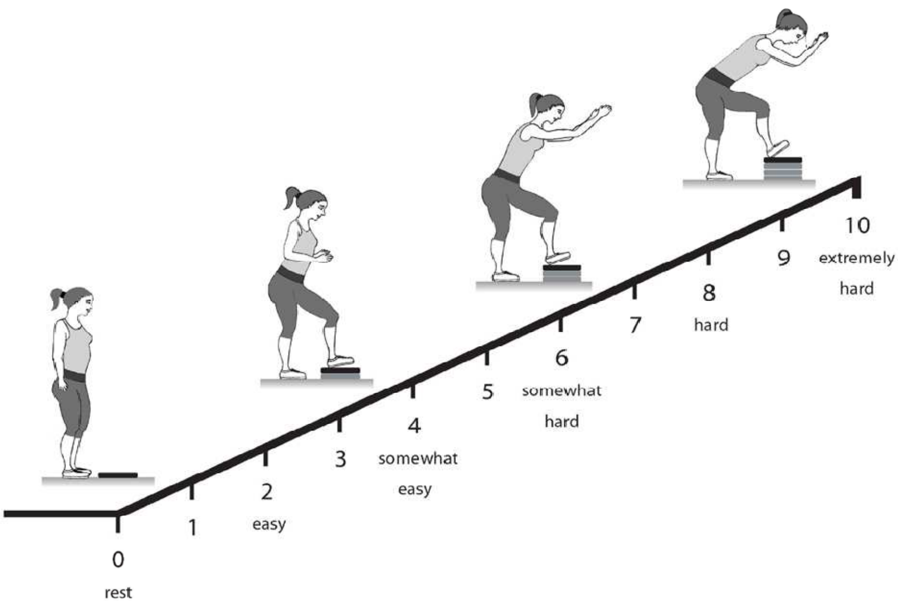


Figure 12 OMNI - Bench stepping Scale of perceived exertion (Krause. 2010)

In summary, the evidence from the concurrent and construct validation supports the utilization of the OMNI RPE scales in adult men and women. Therefore, the OMNI RPE scales can be used to evaluate individual responses to various exercise modalities, develop exercise prescriptions, self - regulate exercise intensity, monitor training, and evaluate changes in fitness in both non - weight bearing, partial weight bearing and weight bearing exercises for adult.

6. Elderly OMNI - Aerobic exercise scale

For elderly, there are a few study for OMNI - RPE in elderly.

Broccatelli and others (2010 : 214 - 224) examined the concurrent and construct validity of a newer ratings of perceived exertion (RPE) Scale, called OMNI - Cycle Scale, using elderly men and women. Seventy - six participants (34 men, 42 women) performed a load - incremented cycle ergometer exercise test. Concurrent validity was determined by correlating OMNI - Cycle Scale with oxygen uptake, relative peak oxygen uptake, pulmonary ventilation, heart rate, respiratory rate, and respiratory exchange ratio responses to a load - incremented cycle ergometer protocol. Construct validity was established by correlating RPE derived from the OMNI - Cycle Scale with RPE from the Borg (6 - 20) Scale. Multilevel, mixed linear regression models indicated that OMNI

RPE distributed as a significant ($p < .05$) positive linear function (r = .81 to .92) for all physiological measures. OMNI - RPE was positively ($p < .01$) and linearly related to Borg RPE in elderly men (r = .97) and women (r = .96). This study demonstrates both concurrent and construct validity of the OMNI - Cycle RPE Scale. These findings support the use of this scaling metric by elderly men and women to estimate RPE during cycle ergometer exercise.

Similarly and others (2011 : 201 - 210) examined translation of verbal descriptors from English to Italian affects the validity of the OMNI Scale of Perceived Exertion. 82 people 38 men (aged mean ± SD ,67.9±7.7) and 44 women (aged mean ± SD ,68.1 ±6.2) for whom Italian was the primary language performed an orientation trial and a maximal graded exercise test on a cycle ergometer. Ratings of perceived exertion for the overall body and physiological responses were measured during each exercise stage. Significant correlations were found between perceptual responses of the Italian version of the OMNI Cycle Scale of Perceived Exertion and oxygen uptake, pulmonary ventilation, heart rate, respiratory rate, and respiratory exchange ratio responses to a maximal graded exercise test on a cycle ergometer. These findings indicate that the Italian version of the OMNI Scale of Perceived Exertion for elderly gives a valid estimate of effort during cycle ergometer exercise.

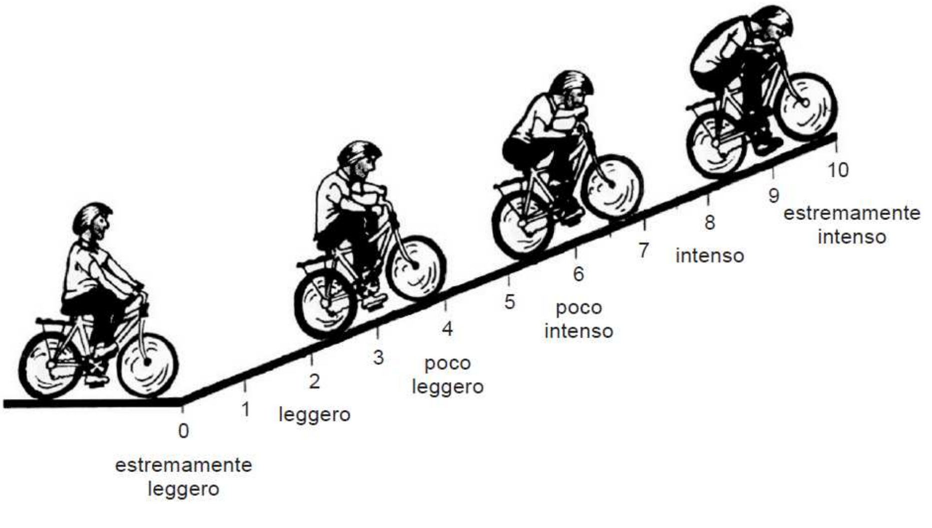


Figure 13 OMNI - Cycling Scale of perceived exertion in Italian version for elderly (Guidetti and others. 2011 : 205)

7. Thai OMNI Perceived Exertion Scale

Recently, Nakkanung and others (2012) translated verbal descriptors from English to Thai version and Validation of OMNI cycle ergometer exercise scale of perceived exertion among young healthy females (N = 17) (18 – 25 yrs). Methods: Heart rate (HR, b/min), oxygen consumption (VO_2, L/min), minute ventilation (VE, L/min), respiratory rate (RR, b/min) and ratings of perceived exertion (OMNI cycle Scale; RPE) for the overall body (RPE - O), legs (RPE - L), and chest (RPE - C) were determined at the end of each of 3 - min exercise stages in continuously administered exercise tests. Power output (PO) of cycling intensity started at 25 Watt (w) with 25 w incremented in every stage. Subjects performed the exercise test up to 100 w. Results: Exercise responses range was for HR: 99.9 - 153.9 b/min; VO_2: 0.56 - 1.43 L/min; VE: 15.1 - 41.7 L/min; RR: 22.3 - 33.2 b/min and OMNI RPE RPE - O, RPE - L, and RPE - C: 0.8 – 7.1. Linear regression analyses showed that RPE - O, RPE - L and RPE - C distributed as a positive linear function for all criterion measures (HR, VO_2, VE, and RR) ($p < 0.01$). Correlation between RPE and HR (r: 0.74 - 0.79, $p < 0.01$), RPE and VO_2 (r: 0.79 - 0.80, $p < 0.01$), RPE and VE (r: 0.82 - 0.83, $p < 0.01$), and RPE and RR (r: 0.47 - 0.49, $p < 0.01$) were statistically significant. Two - way ANOVA with repeated measures showed that RPE increased at each exercise stage and RPE - L were higher ($p < 0.01$) than RPE - O and RPE - C. Conclusion: The Thai translated version of the OMNI Scale of perceived exertion for cycle ergometer exercise concurrent validity is established.

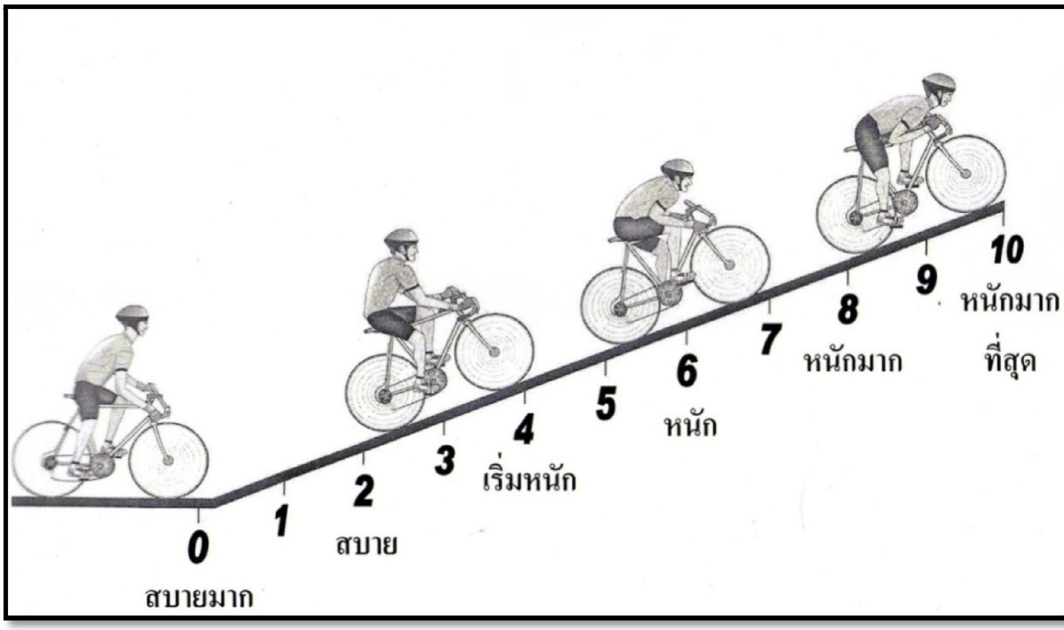


Figure 14 Adult OMNI - cycle scale in Thai language (Nakkanung and others. 2012)

In this present study will be use the same verbal and numerical of OMNI - scale in Thai language.

Aerobic Exercise in Elderly

1. Definition of Elderly

The word "Elderly" was given many definitions such as:

Yurick and others (1984 : 5) categorized the population according to age group: the older population (55 or 60 and over); the elderly (65 and over); the aged (75 and over); and the extreme aged (85 and over). The use of age 65 to define the elderly in most Western countries, usually in the USA, goes back to the original Social Security Act of 1935. It is generally considered to be the age of elderliness. The most common age for senior discounts and benefits is 62 or 65. Hence, the elderly are frequently identified simply as 65 - and - over (Burnside. 1998 : 8).

In Thailand, government officials retire at the age of 60. It is therefore considered to be the beginning of old age (Kuramasuwan. 1993 : 7).

The Institute for Population and Social Research, Mahidol University (2011 : 11) gave the definition of the elderly as a person who ages 60 years and older both male and female.

For this research study, the definition of elderly defined as persons ages 60 years and older both male and female.

2. Exercise for elderly

The American College of Sports Medicine (ACSM. 2009 : 1511) review of physical activity and exercise and related concepts are adopted, and give definition of physical activity and exercise are as follow :

Physical activity refers to bodily movement that is produced by the contraction of skeletal muscle that substantially increases energy expenditure.

Exercise refers to a type of physical activity, defined, planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness.

In this present study exercise for elderly is any type of physical activities which exerts muscles that is planned, structured, and repetitive, and has an objective to improve and maintain fitness, and is appropriate for elderly.

3. Types of Exercise for Elderly

There is now sufficient evidence to show that exercise is important to the health and well - being of all elderly. The benefits of exercise are varied and include: improved health and functional status; reduction in symptoms of many chronic medical problems; improved quality of life; and improved overall sense of well - being (Resnick and Spellbring. 2000).

Mcdermott and Mernitz (2004 : 119) suggests that four types of exercises help older adults to improve physical fitness and gain health benefits, including : aerobic exercise, resistance training, flexibility, and lifestyle modification.

1. Aerobic exercise is any repetitive activity that increases the heart rate for an extended period of time. To improve aerobic fitness, exercise must utilize large muscle groups over prolonged periods in activities that are rhythmic

and aerobic in nature. Some aerobic activities are walking, jogging, cycling, swimming, dancing, and hiking.

2. Resistance training or progressive resistance training (PRT) uses body weight, machines, or free weights to apply resistance against which a muscle or muscle group must generate force to move or resist. PRT maintains or improves muscle mass and neurologic integration, increasing protein stores essential to survival in the face of sickness and disease. While PRT does little to improve aerobic capacity, improved muscle strength and endurance enhance the ability to perform aerobic exercise and ADLs, such as rising from a seated position, carrying bags of groceries, or handling objects above shoulder level. Muscle power is a strong predictor of functional status and declines more rapidly than strength with advancing age.

3. Flexibility is the range of motion (ROM) around a joint and is associated with injury prevention through all life stages. Of particular importance in aging is the maintenance of lower back, posterior thigh, and ankle flexibility. Adequate flexibility can ward off chronic lower back pain and maintain the ability to perform ADLs and prevent falls. Activities that improve flexibility include exercises that lengthen the muscles such as swimming, tai chi, yoga, and stretching.

4. Lifestyle modification encourages individuals to find opportunities within their existing daily routine to increase activity, such as walking stairs, manually opening doors, carrying groceries, or gardening. Lifestyle modifications can increase stamina and improve cardiovascular fitness or improve muscle strength and balance, depending on the type and duration of activity. At all ages, total fitness requires a combination of activities, or a “cross - training” program.

4. Aerobic exercise for elderly

4.1 Definition of Aerobic exercise

ACSM (2009 : 1511) defined aerobic exercise as exercises in which the body’s large muscles move in a rhythmic manner for sustained periods.

Mcdermott and Mernitz (2004 : 119) refer aerobic exercise to any repetitive activity that increases the heart rate for an extended period of time. To improve aerobic fitness, exercise must utilize large muscle groups over prolonged periods in activities that are rhythmic and aerobic in nature.

In this study, aerobic exercise refer to any repetitive activity in which the body's large muscles move in a rhythmic manner that increases the heart rate for an extended period of time.

4.2 Quantification of aerobic exercise intensity

Exercise intensity can be defined as the magnitude of stress being placed upon the body during exercise. For aerobic exercise, intensity may be expressed as a percentage of maximum oxygen uptake (% of VO2max). Quantification of exercise intensity is important when formulating exercise prescriptions for individuals ranging from clinical populations to athletes, because it gives an objective evaluation of performance and physiological measures. An exercise specialist can monitor how an individual responds to various intensities during, immediately after or several hours after an exercise session in order to evaluate which intensities do or do not produce physiological changes that will help the individual reach his/her desired fitness goals. Three parameters that are commonly used to quantify intensity and exertion during aerobic exercise are RPE, heart rate (HR) and blood lactate concentration (BLC) (Brooks and others. 2005 : 503). The purpose of this study is to evaluated and test the newly developed Thai OMNI Perceived Exertion Scale instrument in terms of validity and reliability. Concurrent validity will be determined by correlating OMNI - RPE scale and the Borg (6–20) RPE Scale HR and blood lactate concentration (BLC) during exercise test protocol.

Rating Perceived Exertion zone for the older adults

The goal of an exercise program for older adults should be to improve functional performance, functional capacity or a combination of the two. These functionally based exercise programs stimulate the cardiovascular, neuromuscular, and skeletal systems. In general, the exercise intensity is lower when the goal is to improve functional performance and higher when the goal is to improve functional capacity. Light to moderate intensity lifestyle activities optimize health. Moderate or high intensity exercise may be required to improve aerobic fitness and decrease risk (ACSM. 2009 : 1510 - 1523). Whether the conditioning goal is to increase functional performance or functional capacity, RPE training zones can play key role in helping older adult regulate the intensity of their conditioning program by making daily exercise enjoyable and easy to perform and eliminating troublesome and sometimes expensive electronic HR - monitoring devices. Because RPE zones automatically guide exercise intensity, the older's attention does not need to focus on the exercise task, which promotes interaction between clients during activity sessions (Roberson. 2004 : 102 - 103).

A general list of conditioning activities classified by training outcome for older clients appears in Table 1.

Table 1 RPE Aerobic Training Zones for the Older Client

Estimated functional capacity	RPE zones		Intensity (%)	Duration (min)	Frequency
	OMNI	Borg 6 - 20			
High	7 - 8	15 - 17	70 - 85%	20 - 40	3 - 5/week
Intermediate	5 - 7	12 - 16	60 - 75%	20 - 30	1 - 2/day
Low	3 - 7	10 - 16	40 - 75%	10 - 30	2 - 3/day

(Roberson. 2004 : 102)

4.3 Heart Rate (HR)

Heart rate is defined as the number of heart beats per minute (complete cardiac cycle) (William and Wilkins. 2004 : 461)

Wilmore (2008 : 162 - 163) suggested that Heart rate (HR) is one of the simplest and yet most informative of the cardiovascular parameters. Measuring HR involves simply taking the subject's pulse, usually at the radial or carotid artery. Heart rate is a good indicator of the intensity of exercise. When exercise begins, HR increases directly in proportion to the increase in exercise intensity until near maximal exercise is achieved. As maximal exercise intensity is approaching a maximum value, the maximum heart rate (HR max) is the highest HR value achieved in all - out effort to the point of exhaustion. This is a highly value that remains constant from day to day.

However, this value changes slightly from year to year due to the normal age - related decline in HR max.

Plowman and Smith (2011 : 393) recommend that exercise intensity can be expressed as a percentage of either maximal heart rate (% HR max) or heart rate reserve (%HRR). Both techniques, explained below, require HRmax to be know or estimated. The methods are most accurate if the HRmax is actually measured during an incremental exercise test to maximum. If such a test cannot be performed, HRmax can be estimated.

During aerobic exercise, HR increases in a relatively linear function with exercise intensity and oxygen consumption (Brooks. 2005 : 345 ; Whaley, Brubaker and Otto. 2006 : 143). In the context of a training program, HR can be used to quantify intensity during an exercise session, as well as adequacy of recovery after the session is complete (Brooks and others. 2005 : 503). Using HR to quantify intensity also gives an immediate and objective measure of how the body responds to a particular workload during exercise training.

In order to use the direct method to calculate a THR range corresponding to a particular exercise intensity range, a plot of HR as a function of VO_2 is created. These values can be measured during a VO2max test, during which both VO_{2max} and maximum HR could be determined. One can then calculate a range of percentage of VO_{2max} and then find the corresponding HR range on the plot. This HR range would correspond to the THR range for the exercise prescription. This method is especially appropriate for certain populations, such as cardiac rehabilitation patients who may be taking medications which may affect the HR response to exercise The second method for calculating THR range is to calculate the maximum HR for an individual and then calculate straight percentages of those values. Intensity ranges of 70 - 80% of maximum HR approximate 50 - 70% VO2max, which is within the range to stimulate improvements in VO2max for most individuals. However, this method can be an inaccurate quantification of lower intensities because a THR at a low percentage of maximum HR may yield a result that is actually below the resting HR. A third method for calculating THR range is to use the HRR method, also known as the Karvonen method. Target HR is calculated by using the Karvonen formula, where THR = (220 - age - resting HR)*(% intensity) + resting HR. This method is often preferred for calculating exercise intensity ranges for an exercise prescription because it is closely linked to the percentage of VO2 reserve (the difference between VO2max and resting VO2) across the entire range of fitness levels, an important point when considering individuals of lower fitness levels (Whaley and others. 2006 : 144 - 145).

4.5 Blood Lactate Concentration

Lactate is produced by skeletal muscle as a byproduct of anaerobic glycolysis, and the amount produced by the skeletal muscle, which is then transported into the bloodstream, is proportional to exercise intensity. Blood lactate refers to the accumulation of lactate in the bloodstream. A blood lactate concentration of 4 mmol/L is often considered to be the lactate threshold, the level at which lactate production mechanisms surpass lactate clearance mechanisms, and blood lactate levels begin to rise exponentially (Brooks and others. 2005 : 503 - 504). Intensities that elicit lactate production above the lactate threshold become difficult to maintain for extended periods of time and contribute to fatigue. Although 4 mmol/L is often synonymous with the lactate threshold (LT), exercise training can push this threshold to higher levels. Numerous studies support blood lactic acid concentrations as a physiological mediator for ratings of perceived exertion. However, such studies have often employed incremental exercise tests. Demello and colleagues (1987 : 354 - 362) showed that RPE was not different in trained and untrained subjects when compared at the lactate threshold or at various percentages of VO2max, indicating a strong link to the metabolic and gas exchange alterations initiated at the lactate threshold. Thus, it was concluded that the lactate threshold appears to be an important anchor point for perception of exertion during exercise that is not affected by state of training. Furthermore, no significant differences in RPE were found between exercise modalities during leg exercise (cycle and treadmill) (Hetzler. 1991 : 88 - 92).

This finding also lead to the conclusion that a strong relation exists between RPE and blood lactate concentrations. Overall, it appears that blood lactic acid concentration is linked to the intensity of exertional perceptions by its relation with exercise intensity during progressively incremented test protocols.

4.6 Benefit of aerobic exercise for elderly

ACSM (2009 : 1510 - 1530) assessed literature found that the benefit of aerobic exercise for elderly are as follow :

4.6.1 Long - term of aerobic exercise in elderly athletes.

Compared to their sedentary, age matched peers, older athletes exhibit a broad range of physiological and health advantages. These benefits include, but are not limited to the following:

4.6.1.1 a more favorable body composition profile, including less total and abdominal body fat, a greater relative muscle mass (% of body mass) in the limbs, and higher bone mineral density (BMD) at weight bearing sites.

4.6.1.2 more oxidative and fatigue - resistant limb muscles.

4.6.1.3 a higher capacity to transport and use oxygen.

4.6.1.4 a higher cardiac stroke volume at peak exertion and a ‘‘younger’’ pattern of left ventricular filling (increased early - to - late inflow velocity, E/A ratio).

4.6.1.5 less cardiovascular and metabolic stress during exercise at any given submaximal work intensity.

4.6.1.6 a significantly reduced coronary risk profile (lower blood pressure, increased HR variability, better endothelial reactivity, lower systemic inflammatory markers, better insulin sensitivity and glucose homeostasis, lower triglycerides, LDL, and total cholesterol, higher HDL, and smaller waist circumference).

4.6.1.7 faster nerve conduction velocity.

4.6.1.8 slower development of disability in old age.

4.6.2 Aerobic exercise in sedentary elderly

4.6.2.1 Aerobic exercise capacity

Aerobic exercise training (AET) - induced increases in VO_{2max} maximal cardiac output and systemic arteriovenous O2 difference have been reported in healthy elderly.

4.6.2.2 Cardiovascular effects.

The most consistently reported cardiovascular adaptations include the following: 1) a lower HR at rest and at any submaximal exercise workload 2) smaller rises in systolic, diastolic, and mean blood pressures during submaximal exercise 3) improvements in the vasodilator and O_2 uptake capacities of the trained muscle groups and 4) numerous cardioprotective effects, including reductions in atherogenic risk factors (reduced triglyceride and increased HDL concentrations), reductions in large elastic artery stiffness, improved endothelial and baroreflex function, and increased vagal tone. Evidence for improved myocardial contractile performance (i.e., left ventricular systolic and diastolic function), increased maximal exercise stroke volume, and cardiac hypertrophy.

4.6.2.3 Body composition.

AET shown to be effective in reducing total body fat, moreover AET can have significant effects on fat loss from the intra - abdominal (visceral) region (e.g., 920%). In contrast to its effects on body fat, most studies report no significant effect of AET on fat - free mass (FFM). The lack of impact on FFM accretion by AET reflects the fact that this form of training, which involves repetitive, but low - force muscular contractions, does not generally stimulate significant skeletal muscle growth or improve strength.

4.6.2.4 Metabolic effects.

AET, independent of dietary changes, can induce multiple changes that enhance the body’s ability to maintain glycemic control at rest, to clear atherogenic lipids (triglycerides) from the circulation after a meal, and to preferentially use fat as a muscular fuel during submaximal exercise. Healthy elderly seem to retain the capacity to regulate the cellular processes that facilitate these respective training effects. However, the impact of AET on metabolic control measured at the whole body level and the residual metabolic effects after exercise (throughout the day) may depend on the intensity of the training stimulus. For example, although both moderate - and high - intensity AET are shown to increase glucose transporter content in the muscles of older humans, it is the higher - intensity AET programs that may result in greater improvement in whole - body insulin action.

4.6.2.5 Bone health

Low - intensity weight bearing activities such as walking (3 - 5 day/week) for periods of up to 1 yr have modest, if any, effect on BMD in postmenopausal women (0%–2% increase in hip, spine BMD). However, such activities seem beneficial from the standpoint of counteracting age - related losses and lowering hip fracture risk. Studies involving higher - intensity bone loading activities such as stair climbing/descending, brisk walking, walking with weighted vests, or jogging, generally report more significant effects on BMD in postmenopausal women, at least during the short term (1 to 2 yr). Research on the effectiveness of exercise for bone health in older men is still emerging, but one prospective study found that middle aged and older men who ran nine or more times per month exhibited lower rates of lumbar bone loss than men who jogged less frequently.

4.6.3 Aerobic exercise and psychological well - being in aging

There is now considerable evidence that regular physical activity is associated with significant improvements in overall psychological health and well - being. Both higher physical fitness and participation in AET are associated with a decreased risk for clinical depression or anxiety. Exercise and physical activity have been proposed to impact psychological well - being through their moderating and mediating effects on constructs such as self - concept and self - esteem. However, other pathways may also be operative, such as reduction in visceral adiposity along with associated elevation in cortisol and inflammatory adipokines that have been implicated in hippocampal atrophy, cognitive, and affective impairments. In addition, for many seniors, aging is associated with a loss of perceived control. Because perceptions of control over one’s own life are known to be related to psychological health and well - being, exercise scientists have begun to focus on the relationship between activity and various indices of psychosocial control, self - efficacy, and perceived competency. McAuley and Katula (2000 : 608 - 617) reviewed the literature examining the relationship between physical activity and self - efficacy in older adults. They conclude that most well - controlled exercise training studies result in significant improvements in both physical fitness and self efficacy for physical activity in older adults. Several studies suggest that moderate - intensity physical activity may be more effective than either low - or high - intensity training regimens. There is growing recognition that physical activity self - efficacy is not only an important outcome measure as a result of participation in activity, it may also be an important predictor of sustained behavioral change in sedentary populations.

4.6.4 Aerobic exercise and cognitive functioning for elderly

Both cross - sectional and prospective cohort studies of Experimental trials of exercise interventions in older adults demonstrate that acute exposure to a single bout of aerobic exercise can result in short - term improvements in memory, attention, and reaction time have linked participation in regular physical activity with a reduced risk for dementia or cognitive decline in older adults. Examples include the Study of Osteoporotic Fractures, which reported that activity level was linked to changes in Mini - Mental Status Examination scores, and the Canadian Study of Health and Aging, which demonstrated that physical activity was associated with lower risk of cognitive impairment and dementia. It also seems that decreases in physical mobility are linked to cognitive decline. Experimental trials of exercise interventions in older adults demonstrate that acute exposure to a single bout of aerobic exercise can result in short - term improvements in memory, attention, and reaction time. These studies found cognitive benefits to be larger with the combined cognitive and aerobic training paradigms. The mechanism for the relationship between physical activity and exercise and cognitive functioning is not well understood; however, several researchers have suggested that enhanced blood flow, increased brain volume, elevations in brain - derived neurotrophic factor, and improvements in neurotransmitter systems and IGF - 1 function may occur in response to behavioral and aerobic training.

4.6.5 Aerobic exercise and quality of life (QOL) for elderly

QOL is a psychological construct, which has commonly been defined as a conscious judgment of the satisfaction an individual has with respect to his/her own life. In a review of the literature that has examined the relationship between physical activity and QOL in old age, Rejeski and Mihalko (2001 : 23 - 35) conclude that the bulk of the evidence supports the conclusion that physical activity seems to be positively associated with many but not all domains of QOL. Researchers have consistently shown that when physical activity is associated with significant increases in self - efficacy, improvements in health related QOL are most likely to occur.

In conclusion, aerobic exercise can improve health and functional capacity and both long - term exercise functional ability for sedentary elderly. There is also emerging evidence for significant psychological well - being and cognitive functioning and quality of life benefits accruing from aerobic exercise participation by elderly.

4.7 Exercise prescription for elderly

Exercise prescription for elderly should be individualized and should include specific recommendation for frequency, intensity, duration and mode of training, based on the results of exercise testing, and any limitations that may be imposed by the musculoskeletal system or disease/health status.

The American College of Sports Medicine (ACSM. 1998 : 17) ‘s guideline/standards define that the quantity and quality of training for developing and maintaining physical fitness in healthy adult include;

4.7.1 A training frequency of 3 - 5 days per week

4.7.2 An intensity of 55 - 90% of maximal HR (HR max) or 40 - 85% of VO_{2max}

4.7.3 An exercise duration of 15 - 60 minutes of continuous aerobic activity

4.7.4 Any mode of continuous activity, utilizing large muscle groups, that is rhythmic and aerobic in nature. The American Heart Association

(AHA)'s statement on exercise provides minimum recommendations for exercise training :

4.7.4.1 Frequency: A minimum of 3 days/week

4.7.4.2 Intensity : 50 - 60% of VO_{2max}

4.7.4.3 Duration : minimum of 30 minutes

Each exercise workout of the aerobic exercise prescription and program should include the following phase (Heyward. 2010 : 104)

- Warm - up

The purpose of the warm - up is to increase blood flow to the working cardiac and skeletal muscle, increase body temperature, decrease the chance of muscle and joint injury and lessen the chance of abnormal cardiac rhythms. During the warm – up, the tempo of the exercise is gradually increased to prepare the body for higher intensity of exercise performed during the conditioning phase. The warm - up starts with 5 to 10 minutes of low - intensity (<40% VO2 reserve [VO_2R]) to moderate - intensity (40 - 60% VO_2R) aerobic activity.

- Endurance conditioning

During the endurance phase of the workout, the aerobic exercise is performed according to the exercise prescription following the FITT principal (i.e. F=frequency; I= intensity; T= time, duration; T=type, mode of activity). This phase usually lasts 20 to 60 min, depending on the exercise intensity. Exercise bots of 10 min are acceptable as long as older adults accumulate at least 20 to 60 min that day. The conditioning phase is followed immediately by the cool - down phase.

- Cool - down

A cool - down phase immediately after endurance exercise is needed to reduce the risk of cardiovascular complications caused by stopping exercise suddenly. During cooldown, the individual continue exercising (e.g. walking, jogging, or cycling) at a low intensity for about 5 to 10 min. This light activity allows the heart rate (HR) and blood pressure (BP) to return to near baseline levels, prevents the pooling of blood in the extremities, and reduces the possibly of dizziness and fainting. The continued pumping action of the muscle increases the venous return and speeds up the recovery process.

Stretching

The stretching phase usually lasts at least 10 min and is performed after the warm - up or cool down phase. Usually at least 10 min is performed after the warm - up or cool - down phase. Usually static stretching exercise for the legs, lower back, abdomen, hips, groin and shoulders are included. Stretching exercises after the cool - down phase may help to reduce the chance of muscle cramps or muscle soreness.

4.8 Preparticipation Screening

History and physical examination

Before initiating an exercise program, most older adults should undergo a history and physical examination directed at identifying cardiac risk factors, exertion signs/symptoms, and physical limitations. (Nied. 2002 : 421)

Therefore, before engaging in regular physical activity, blood pressure, pulse rate and rhythm, body weight, and baseline blood lipids should be assessed.

An awareness of fluid consumption during exercise is important for elderly. Given the daily fluid intake recommendations in the elderly ($\leq$ 2 quarts per day in addition to water from foods), plus a less effective thirst mechanism for sensing mild dehydration, monitoring fluids before, during (8 ounces every 15 minutes), and after workouts is crucial. Elderly exercisers should be encouraged to drink even when not thirsty (McDermott. 2004 : 117 - 128)

4.9 Types of aerobic exercise for elderly

If the primary goal of the exercise program is to develop and maintain cardiorespiratory fitness, aerobic activities prescribe using large muscle groups in a continuous, rhythmical fashion. In the initial and improvement stages of the exercise program, it is important to closely monitor the exercise intensity. Therefore, participant should select the type of exercise that allow the individual to maintain a constant exercise intensity and are not highly dependent on the participant’s skill.

4.9.1 Walking exercise

Walking is most popular especially among middle - aged and elderly people. Anyone can perform walking at any time alone or with friends as an easy exercise. It is thought to be useful for preventing life - style diseases by improving insulin resistance, increasing muscle and blood flow, and decreasing adipose tissue (Izumi. 2003 : 9 - 15).

Shin (1999 : 146 - 154) evaluated the effects of an outdoor walking exercise program on the cardiorespiratory function, the flexibility, and the emotional state of elderly Korean women. A nonequivalent control group, pretest - posttest design was used to measure the effects of the exercise program. The subjects were 27 females between the ages of 60 to 75 years. The intensity of the walking program was 40–60% of the target heart - rate with a duration of 50–60 min, 3 times per week at an outdoor track for 8 weeks. The effects of the program were assessed by maximal oxygen uptake (VO_2max), resting pulse rate, blood pressure, Forced Vital Capacity (FVC), Forced Expiratory Volume per 1 second (FEV_1) for cardiorespiratory function, the “sit and reach test” for flexibility, and by the Profile of Mood States (POMS) for emotional state. The physical function and the emotional state of the experimental group improved significantly more than that of the control group except FEV_1 and the anger factor of POMS. The VO_2max and the flexibility of elderly women in the experimental group progressively improved as the duration of the exercise period continued. The results of this study suggest a practical and easy method of exercise to enhance the health of older women.

Dubbert (2002 : 733 - 740) investigated effects of nurse counseling on walking for exercise in elderly primary care patients. After receiving individualized nurse counseling to begin a program of walking for health, 60 - to 80 - year - old primary care patients were randomized to one of three levels of telephone contacts over 10 months: (i) 20 nurse - initiated calls, (ii) 10 nurse - initiated calls plus 10 motivational calls programmed through an automated phone calling system, or (iii) no program - initiated phone contacts. Self - reported (diary) walking adherence was the primary outcome; other activity, social support, health quality of life, and measured walking performance, mobility, and body mass index and girths were also assessed during the initiation (months 1–6) and maintenance (months 7–10) phases of the trial. Results were as follow : Average adherence for the 181 participants to the goal of walking at least 20 minutes on 3 or more days per week was 44% for initiation and 42% for maintenance. Participants receiving the combination of nurse - initiated personal and automated phone calls walked significantly more frequently than those with no phone contacts. Fitness improved in all three groups; changes were generally correlated with self - reported walking. Having a companion was associated with more frequent walking. Perceived quality of physical and mental health did not change. Conclusions. Simple and relatively inexpensive nurse contacts can motivate elderly primary care patients to walk for exercise, and this activity is associated with measurable health benefits.

Kimura and others (2006 : 508 - 513) studied the effects of walking exercise training (five 30 - min walking sessions/week at 80% VT) on salivary secretory IgA (SIgA) and plasma lymphocyte subpopulations were studied in elderly subjects. Thirty sedentary, elderly subjects (8 men, 22 women; age 66.7 ± 7.4 years) performed walking exercise for 3 months. Aerobic power, body composition, and immune function were examined before (Pre) and after training (3 months). Salivary SIgA fl ow rate were measured by enzyme linked immunosorbent assay (ELISA), while lymphocyte subpopulations were measured by flow cytometry. SIgA flow rate significantly increased at 3 months, especially in 64 - year - olds and under (U - 64), 65~85 - year - olds (65 - 85), and female elderly subjects. Number of total lymphocytes, NK cell, and memory - Th cell significantly decreased in 3 months. In conclusion, 3 months of walking provides enhancement of mucosal immune function in elderly subjects, although it is not associated with an improvement in lymphocytes.

Sirikarnjanakovit (2006 : 30 - 71) investigated to compare the effect of interval walking and continous walking on health - related physical fitness in elderly women. Thirty volunteered females (ages 55 - 60) participated in this investigation. Subjects were divided by simple random sampling into 2 experimental groups. The first experimental group (n=15) was performing interval walking exercised using 3 minutes of high intensity phase (80 - 90% of heart rate reserve) followed by 3 minutes of low intensity phase (30 - 40% of heart rate reserve), the second experimental group (n=15) was performing continuous walking at 60 - 70 % of heart rate reserve. Both group exercised for 30 minutes/day, 3 days/week for 10 weeks. The health - related physical fitness test was assessed before and after walking exercise at the completion of intervention in both groups. The obtained data were analyzed in term of means and standard deviation while t - test was also employed to determine the significant different. The results were that the interval walking group exhibited significantly higher peak oxygen up take when compared to the continuous walking group ($p<0.05$). However, other physiological variables such as percent body fat resting heart rate, resting blood pressure, flexibility, and leg muscle strength were not statically difference between groups. In conclusion the interval walking program has been shown to improve peak oxygen consumption when compared to the continuous walking program.

In summary, walking exercise has been shown to can improve health benefit for the elderly.

1. Bench step exercise

Mori and others (2006 : 570 - 576) examined the effects of a twelve - week home - based bench step exercise program on aerobic capacity, lower extremity power and static balance in elderly subjects. Thirty - eight elderly men and women participated in this study (age: 75±4 years, mean±SD). The subjects were randomly assigned, according to the area in which they resided, into either the exercise group (EG: 11 men, 8 women) or the control group (CG: 14 men, 5 women). The EG performed a 12 - week home - based bench step exercise program (7 sessions/week, 20 - 30 minutes/session, bench height 15.0 - 20cm). They recorded the length of exercise and their physical condition. Before and after the intervention a sub - maximum bench step test, a leg extension power test and a one - leg balance test with eyes open (balance test) were performed to assess the subjects' aerobic capacity, as determined by the lactate threshold (LT), as well as lower extremity power and static balance ability. Results ; The LT and leg extension power significantly increased while the balance test also tended to increase in the EG. Conversely, these parameters did not significantly change in the CG. Based on the diary data, the subjects in the EG exercised an average of 164±56 minutes/week for twelve weeks. This study showed that a bench step exercise program effectively improved not only aerobic capacity but also lower extremity power and static balance ability in elderly subjects.

Ayabe and others (2006 : 536 - 543) examined the alterations in heart rate blood lactate accumulation and perceived exertion (RPE) at lactate threshold (LT) as a consequence of bench stepping exercise training in elderly. METHODS. Thirty - seven elderly aged >65 yr., served as training group (n=20) and control group (n=17). All participants performed the submaximal bench stepping test before and after the twelve - week intervention in order to determine the metabolic equivalents (METs), heart rate, lactate concentration and RPE at LT. The subjects in the training group performed the bench stepping exercise at LT for 20 minutes or more every day during the intervention. RESULTS. After the intervention, METs and heart rate at LT significantly increased compared with those at baseline level in the training group ($p<0.01$), whereas neither RPE nor lactate concentration at LT changed significantly. Furthermore the increase of heart rate at LT significantly correlated with the increase of METs at LT or heart rate at LT for baseline level ($p<0.01$).

Recently (2012 : 36 - 41) examined the effect of bench step exercise on arterial pulse wave velocity (PWV) and the associated contribution of insulin - like growth factor (IGF) - 1 bioactivity and nitric oxide (NO). Twenty - six elderly (post - menopausal) women were randomly allocated to a bench step exercise group or a control group. The participants in the bench step exercise group practiced a 12 - week home - based bench step exercise for 10 - 20min, 3 times daily (i.e., for a total of 140 min/week at the intensity level of lactate threshold (LT)). In addition to conventional risk factors of atherosclerosis, PWV, IGF - 1/IGF binding protein (IGFBP) - 3 molar ratio (an index for IGF - 1 bioactivity), and urinary nitrite/nitrate (NO(x)) excretion were measured before and after the intervention. BMI, systolic blood pressure, fasting plasma glucose, low - density lipoprotein cholesterol, LT, and PWV were significantly improved in the bench step exercise group. A significant positive correlation between changes in PWV and IGF - 1/IGFBP - 3 molar ratio, and a significant negative correlation between changes in IGF - 1/IGFBP - 3 molar ratio and urinary NO(x) excretion were found in the bench step exercise group. The bench step exercise leads to improvements in not only the classical risk factors of atherosclerosis but also the arterial stiffness in elderly women, partly through NO production via IGF - 1 bioactivity.

2. Nine square exercise

Loilong (1994 : 1 - 65) studied the physiological change due to the effect of nine - square exercise and bicycle exercise on physical fitness in older adult. Sample Subjects were government officer of Kasetsart University, 16 males between 55 - 60 years old who had good health by checking the Electrocardiography (EKG). The subjects were divided into two groups. The first group exercised by nine - square exercise and the other bicycle exercise. Both groups were treated with equal exercise work load at the 70 % of maximum heart rate. The experiment was taken for eight weeks with three days a week and fifteen minutes a day. Maximum oxygen uptake, resting heart rate and blood pressure were collected. As the result, the exercise by nine - square test and bicycle exercise increased the maximum oxygen uptake at the significantly different level of .05, but decreased the resting heart rate and blood pressure in non - significantly different.

Ronnarithivichai and others (2009 : 68 - 77) compared physical fitness of the elderly before and after participation in a 9 - square - table aerobic exercise and rubber ring stretching exercise program. Subjects consisted of 69 members, aged above 55 years old both men and women, in the Health Promotion Program for the Elderly, Faculty of Nursing, Mahidol University. The subjects exercised under this program 3 days per week, one hour per day for three consecutive months. Data on physical fitness and bone density were collected before and after participation in the exercise program. Percentage, mean, standard deviation and dependent t - test were applied to analyze data. Results of the study revealed that overall physical fitness of the elderly before attending the exercise program were in the level between low to middle. After attending the 3 months exercise program, the overall physical fitness had significantly increased ($p<.05$). Muscle strength and endurance, muscle and joint flexibility, cardio respiratory endurance and bone density after exercise program were significantly higher than before the exercise program ($p <.05$). Subject opinions after participation in the exercise program showed that the elderly found themselves much better in health, relaxation, agility, concentration, muscle strength and balance on walking.

In this study, will be used a pattern similar to the nine square stepping pattern of Loilong (1994 : 75 - 78) : follow figures 15 - 16.

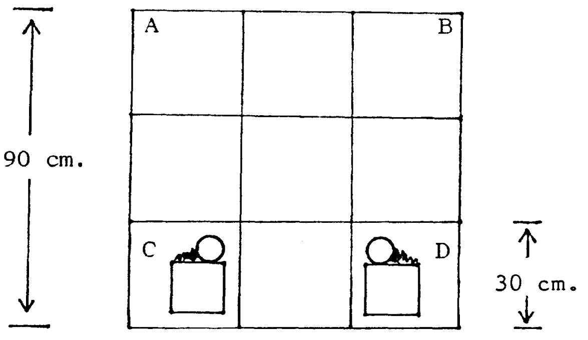


Figure 15 Preparing pattern of nine - square stepping

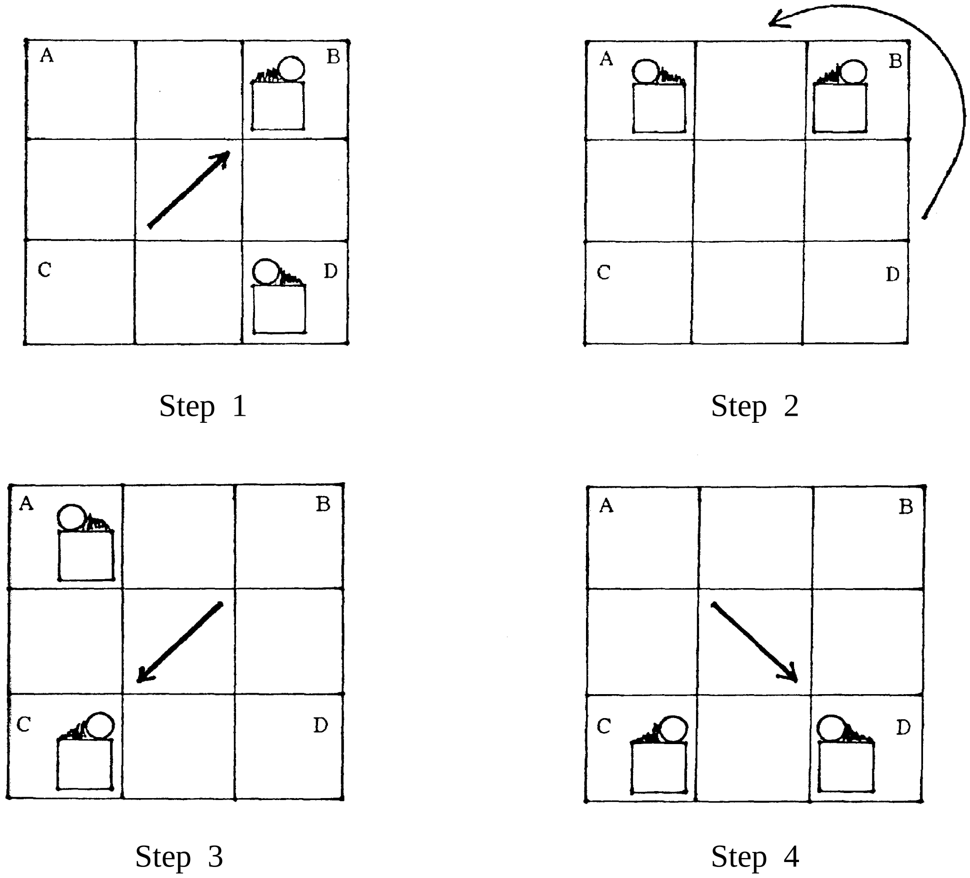


Figure 16 Pattern of nine - square stepping exercise

In conclusion, the aerobic exercise in elderly, walking exercise, bench stepping exercise and nine square are inexpensive and have benefit for health of elderly.

Related Research Articles

Borg, Ljunggren and Ceci (1985 : 343 - 349) examined the relationship between perceived exertion, perception of aches and pains in the legs, HR, and blood lactate during bicycle ergometry. Twenty - eight healthy males performed an incremental exercise bout on the cycle ergometer, where workload was increased by 40 Watts every 4 minutes until voluntary exhaustion. Heart rate, RPE (on both the Borg's 6 - 20 point scale and the CR10 scale), and blood lactate were recorded during the last minute of each workload stage, as well as at the point when the subjects terminated the test. The results showed that HR increased linearly as a function of workload, while RPE, perception of aches and pains in the legs, and blood lactate increased exponentially. Correlation coefficients between HR, RPE, perception of aches and pains in the legs, and blood lactate were high, particularly during the higher workloads of the test. In a similar study, Borg, Hassmen and Lagerström (1987 : 679 - 685) compared HR, RPE, and blood lactate responses to arm crank ergometry with those from cycle ergometry in 8 healthy males. Exercise bouts involved stepwise increases in intensity of 40 - 70 - 100 - 150 - 200 watts for the cycle ergometer, and 20 - 35 - 50 - 70 - 100 watts for the arm crank ergometer. The subjects exercised at each intensity in 4 minute increments, and at the end of each increment, HR, blood lactate, and RPE (on both the Borg's 6 - 20 point scale and the CR10 scale) were measured. Heart rate and RPE scores from Borg's 6 - 20 point scale showed linear increases as a function of exercise intensity for both cycling and arm cranking, while blood lactate and RPE scores from Borg's CR10 scale showed exponential increases as a function of exercise intensity for both cycling and arm cranking. A plot of RPE response from Borg's 6 - 20 point scale and RPE from the CR10 scale as a function of HR showed nearly - linear relationships, as did RPE responses as a function of blood lactate. A separate analysis was done to investigate the relationship between RPE response from the CR10 scale as a function of a combined HR - blood lactate response, which also showed a positive linear relationship.

Zeni (1996 : 237 - 241) examined the relationships among three of these training intensity variables - - HR, RPE, and blood lactate concentration for six modes of rhythmic exercise in ten healthy women subjects who underwent a 4 - week habituation period to become familiar with the RPE scale and exercise on a treadmill, cycle ergometer, rowing ergometer, airdyne, stairstepper, and cross - country skiing simulator. Following habituation, each subject underwent graded discontinuous exercise testing on each mode. HR was measured during the last minute of each 4 - minute stage. Immediately after each stage, RPE was requested and blood was collected for analysis of blood lactate concentration. Results: For given RPE values, the treadmill induced higher ($p < .05$)

HR values compared with the cycle and rowing ergometers, and the cycle ergometer induced lower ($p < .05$) HR values compared with the treadmill, airdyne, stairstepper, and cross - country skiing simulator. The relationships of blood lactate concentration with RPE were similar among modes except for the cross country skiing simulator, which induced a lower ($p < .05$) blood lactate concentration for a given RPE. Conclusions: Since the relationships of HR and blood lactate concentration with RPE are not the same for all forms of rhythmic exercise that use a large muscle mass, we conclude that mode specificity should be considered when prescribing aerobic.

Green and others (2006 : 167 - 172) examined the relationship between HR, RPE, and blood lactate responses during repeated high intensity interval cycling. Twelve physically active males completed a series of high intensity cycling bouts at a workload above what was needed to elicit a 4 mmol/L blood lactate response. The intervals consisted of five 2 - minute periods of high - intensity cycling followed by 3 minutes of recovery cycling. Heart rate, RPE (using Borg's 6 - 20 point scale), and blood lactate were measured at the end of each 2 - minute high intensity cycling period and also at the end of each 3 - minute recovery cycling period. Significant correlations were found for HR and RPE response as well as blood lactate and RPE response during both the high - intensity period and the recovery period of the interval. Irving and others (2006) studied the utility of two different RPE scales as markers of the blood lactate response to exercise in 26 females and 10 males with the metabolic syndrome. Subjects completed a treadmill protocol to determine VO_{2peak} and lactate threshold. Subjects began walking on a treadmill at 60 m/min, which was increased by 10 m/min in 3 minute stages until volitional fatigue. Heart rate and blood lactate were measured at the end of each stage, and RPE scores, using Borg's 6 - 20 point scale and the OMNI walk/run 0 - 10 point scale, were measured at 2:15 and 2:45 of each stage. The correlation coefficients within and between the two RPE scales and the treadmill speeds associated with the lactate threshold, blood lactate concentrations of 2.5 mmol/L, 4.0 mmol/L, and peak were 0.82 - 0.93 ($p<0.01$). These results indicate that RPE can contribute to the prediction of the blood lactate response to incremental exercise.

Irving and others (2006 : 1348 - 1352) examine the utility of the Borg (6 - 20) and adult OMNI walk/run (0 - 10) ratings of perceived exertion (RPE) scales as markers of the blood lactate response to exercise. Methods : Thirty - six (26 females and 10 males) individuals with the metabolic syndrome (mean ± SEM: age, 45.8 ± 2.0 yr; height, 168.4 ± 1.3 cm; weight, 100.4 ± 3.6 kg) completed a continuous peak oxygen uptake (V?O2peak)/lactate threshold (LT) treadmill protocol. V?O2 (mL·kg - 1·min - 1), blood lactate concentration (BLC, mM), and heart rate (bpm) were measured at the end of each stage. RPE were assessed at 2:15 and 2:45 of each 3 - min stage using both RPE scales presented in a counterbalanced order. Participants were read standardized instructions specific to each scale. The LT and BLC of 2.5 and 4.0 mM were determined from the blood lactate - velocity relationship. Results: The mean Borg, OMNI, and standardized (to the Borg scale) OMNI - RPE values at the LT and BLC of 2.5 mM, 4.0 mM, and peak ranged from 10.1 to 16.9, 3.1 to 8.2, and 9.9 to 17.1, respectively. No differences were observed between Borg and standardized OMNI - RPE at any exercise intensity. The correlation within and between Borg - and OMNI - RPE and the velocities associated with LT, BLC of 2.5 mM, 4.0 mM, and peak ranged from r = 0.82 to 0.93 (P < 0.01). Mean differences (95% CI) between the Borg - and standardized OMNI - RPE at LT, and BLC of 2.5 mM, 4.0 mM, and peak were 0.27 (- 2.26, 2.80), - 0.48 (- 3.14, 2.18), - 0.29 (- 2.92, 2.35), and 0.10 (- 1.65, 1.84), respectively. Conclusion: Both the Borg and OMNI walk/run scales demonstrate predictive utility as markers of the blood lactate response to incremental exercise in individuals with the metabolic syndrome.

From literature reviews and related research articles, therefore, in this present study, will be developed an instrument of OMNI Perceived Exertion Scale and evaluation of the of the newly developed Thai OMNI Perceived Exertion Scale instrument in terms of validity and reliability in three mode aerobic exercise, during walking exercise, bench stepping exercise and nine - square stepping exercise for Thai Elderly. The development of new pictorials specific to three mode exercise is part of the propose project. The original format of the OMNI Picture System of Perceived Exertion was used for the development of one scale; the scale maintained the same verbal and pictorial descriptor placement on the gradient incline, with similar more specific intensity pictorials. Concurrent validity will be determined by correlating OMNI - RPE scale and the Borg (6 - 20) RPE Scale responses with Heart Rate (HR) and Blood lactate concentration (BLC) during exercise test protocol. The results of this research are supplement findings on the effects of useful application in both exercise testing and training in term of the potentially Perceived Exertion Scale.

Conceptual Framework

This present study aims to assess validity of Thai OMNI Perceived Exertion Scale relation with Physiological variable such as heart rate, blood lactate concentration in three mode aerobic exercise for walking exercise, stepping exercise and nine square exercise in Thai Elderly.

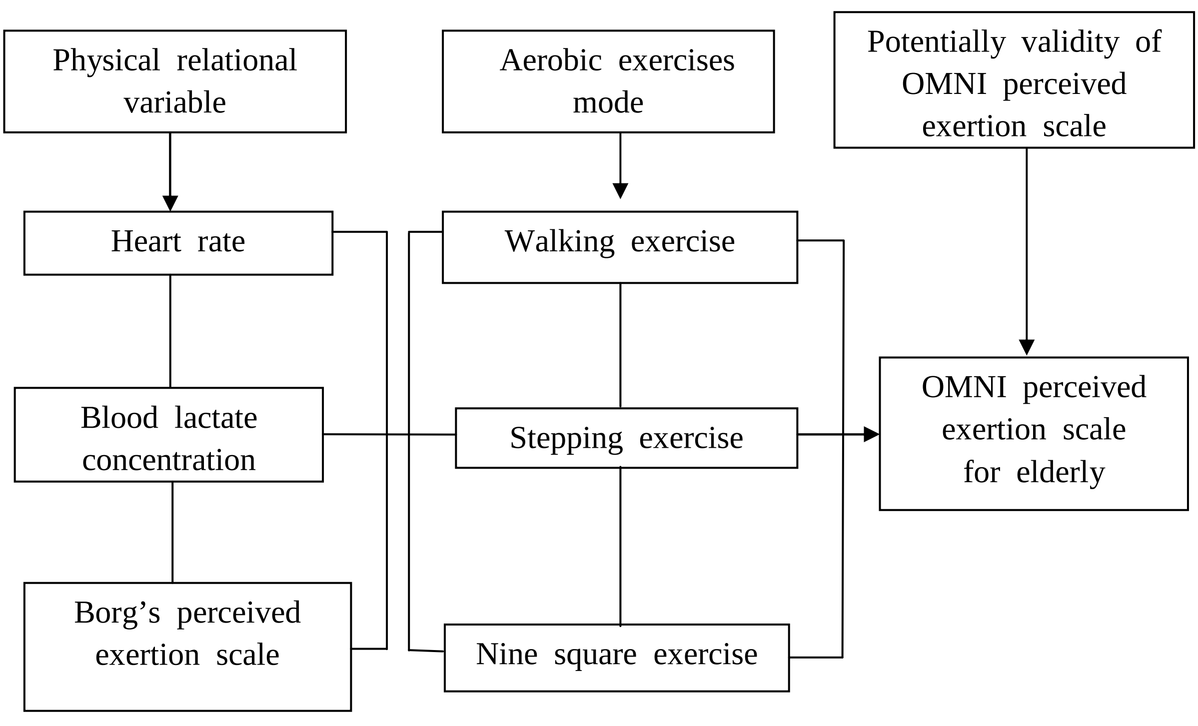


Figure 17 Conceptual Framework

CHAPTER 1

INTRODUCTION

Background of the Study

As the aging population of Thailand has been continually increasing, the most recent estimated number of the elderly in 2011 was 7.79 millions or 12.19% of the total population (Institute for Population and Social Research, Mahidol University. 2011 : 11). Beyond age-associated physiologic declines and independent of disease burden, changes in function and disability have long been recognized for their association with aging (Bean, Vora and Frontera. 2004 : 31)

Exercise, especially, aerobic activities and strength training, can improve health, functional ability, and quality of life of older persons, even in the presence of frailty and chronic illness. Aerobic exercise is any repetitive activity that increases the heart rate for an extended period of time. To improve aerobic fitness, exercise must utilize large muscle groups over prolonged periods in activities that are rhythmic and aerobic in nature. Higher levels of aerobic activity are associated with increased physical fitness, decreased total mortality, and improvements in cardiovascular risk profile (Mernitz and McDermott. 2004 : 106 ; McDermott. 2004 : 119). The exercise prescription involves four basic factors that are the mode or type of exercise, frequency of participation, duration of each exercise bout and intensity of exercise bout. Exercise intensity bout appears to be the most important factor. Exercise intensity can be quantified on basis of the training heart rate (THR), the metabolic equivalent (MET), or the rating of perceived exertion (RPE) (Wilmore, Costill and Kenny. 2008 : 456 - 459).

Perceived exertion, which combines both active and passive processes, is defined as the subjective intensity of effort, strain, discomfort, and/or fatigue that the subject experiences during exercise (Robertson. 2004 : 7). These sensations are generally classified as being derived from either cardiopulmonary or peripheral factors. Cardiopulmonary factors include variables such as heart rate (HR), oxygen uptake (VO_2), respiration rate and minute ventilation, while peripheral/metabolic factors include blood lactate concentration, blood pH, mechanical strain, skin and core temperature (Groslambert and Mahon. 2006 : 912). Since Borg introduced a 15-points rating of perceived exertion scale nearly 4 decades ago, it has been adopted by exercise physiologists as the standard instrument for evaluating the perception of whole-body exertion during exercise (Hampson and others. 2001 : 935). The relationship between perceived exertion and human performance has been an area of considerable scientific and clinical interest over the last 50 years and has become a focus of extensive research in the exercise and sport sciences (Faulkner, Parfill and Eston. 2008 : 1). However, the limitations of the Borg RPE scale may be attributed to its nonspecific mode design ; this perceptual scaling metric includes only numbers (i.e., 6 - 20) and verbal descriptors (i.e., no exertion at all to maximal exertion) and therefore lends itself to cognitive limitations in rating exertion (Mays. 2009 : 2).

The OMNI Scale of Perceived Exertion (RPE) is the most recent advancement in the discipline of perceived exertion research (Schafer. 2007 : 4). The original OMNI scale was developed for use in children of mixed gender and race (Robertson and others. 2003 : 333 - 341). This investigation demonstrated the Children's OMNI RPE scale has valid metric for assessing perceptions of exertion during cycle ergometer exercise in children while improving upon the methodological and semantic limitations of previous RPE scales (Robertson and others. 2005A : 819 - 826). The OMNI scale employed pictures of an individual exercising at different intensity levels. The pictures are combined with short verbal cues and arranged along a numerical scale ranging from 0 – 10 that depicts gradually increasing exercise intensity such as that encountered when going up a hill (Robertson and others. 2005B : 290 - 298). Additionally, the term OMNI is short for *omnibus* which suggests applicability to a wide range of clients and physical activity settings (Robertson and others. 2004 : 102 - 108). A strong point of the OMNI scale is therefore its ability to assess exertional perceptions of various population cohorts engaged in dynamic exercise modes and has undergone validation paradigms for cycling for children (Robertson and others. 2002 : 1168 - 1175), walking and running exercise for children (Utter and others. 2002 : 139 - 144), resistance training for children (Robertson and others. 2005A : 819 - 826), stepping exercise for children (Robertson and others. 2005B : 290 - 298), resistance training in young adults (Robertson and others. 2003 : 333 - 341), cycling for young adults (Robertson and others. 2004 : 102 - 108), walking and running exercise for adults (Utter and others. 2004 : 1776 - 1780), elliptical ergonomy for adults (Mays. 2009 : 1 - 74) and bench stepping exercise for young adult women (Krause. 2010 : 1 - 76). In adults particularly, an established theme has been to assess the construct validity of the Adult-OMNI scales of exertion with the Borg 6 - 20 RPE scale. These groups have overwhelmingly observed a strong, positive, linear relationship between the Adult-OMNI scales of exertion and the Borg 6 - 20 RPE scale. For elderly adult, recently, (Broccatelli and others. 2010 : 214 - 224) were study examined the concurrent and construct validity of the OMNI-Cycle Rating of Perceived Exertion (RPE) Scale, the study demonstrates both concurrent and construct validity of the OMNI-Cycle RPE Scale. Recently, Nakkanung and others (2012 : 14 - 18) has translated the OMNI - cycle ergometer exercise scale format and examined the validity of the newly translated version of the OMNI RPE in Thai for perceived exertion among young healthy females. However, OMNI - RPE Scale in Thai elderly is not examined. More specificly, there could be, also, concerned in using of OMNI – RPE scale.

Therefore the purpose of this study was to develop instrument of OMNI Perceived Exertion Scale and evaluate the newly developed Thai OMNI Perceived Exertion Scale instrument in terms of validity and reliability in three aerobic exercise mode (walking exercise, bench stepping exercise and nine-square stepping exercise) for Thai elderly. In this study OMNI-RPE had been developed for Thai elderly.

The development of new pictorial specifics to three aerobic exercise modes is part of the objectives in the current study. The original format of the OMNI Picture System of Perceived Exertion was used for the development of one scale; the scale maintained the same verbal and pictorial descriptor placement on the gradient incline, with similar mode specific intensity pictorials. Concurrent validity had been determined by the correlation between OMNI-RPE scale and the Borg (6 - 20) RPE scale responses with heart rate (HR) and blood lactate concentration (BLC) during exercise protocols. The results of this research are supplement findings on the effects of useful application in both exercise testing and training in term of the potentially Rating Perceived Exertion Scale (RPES).

Research Objectives

1. To develop an instrument of OMNI Perceived Exertion Scale for Aerobic Exercise in Thai elderly.
2. To evaluate and test of the newly developed Thai OMNI Perceived Exertion Scale instrument for Thai elderly in terms of validity and reliability in three modes of aerobic exercises, which each during walking exercise, bench stepping exercise and nine-square stepping exercise.

Research Questions

The main research question of this study was “whether the instrument of Thai OMNI perceived exertion scale measures possible potentially implication with Thai elderly ?”.

Expect Outcome and Benefits

1. The application of the newly developed OMNI Perceived Exertion Scales for aerobic exercise may be beneficial for individualize prescription of optimal exercise intensity leading to health enhancement in Thai elderly.
2. To expand the knowledge base regarding the perception of physical exertion.
3. To be useful in further development of the potential instrument which can evaluate exercise intensity for Thai elderly.

Scopes of Research

1. Study design

The current study is a cross-sectional design and aimed to assess validity of OMNI Perceived Exertion Scale in three aerobic exercise modes for walking exercise, stepping exercise and nine square exercise in Thai Elderly.

2. Population and Sample

2.1 Population :

The target population of this research are Thai elderly people (aged at least 60 years) who lived in community of the primmary care unit at Muang Suang Hospital, Muang Suangt, Roi-Et. (Muang Suang Hospital. 2010 : 24).

2.2 Sample :

The sample had been selected from questioning the volunteer program participants after the interview and invitation. Participants underwent an initial examination by a physician and did not present any clinical contra indication, neuromotor, or cognitive nature for undergoing exercise test**.**

2.3 Variable of the study are as follow

2.3.1 Physiological variables;

2.3.1.1 Heart rate

2.3.1.2 Blood lactate concentration

2.3.1.3 Borg 6-20 Rating Perceived Exertion Scale

2.3.2 Potentially validity of OMNI Perceived Exertion Scale;

Thai OMNI Rating Perceived Exertion Scale at each test stage.

Limitations of Research

1. This research does not control life style of the participants.

2. This research does not classify skill and movement performance of the participants.

Definition of Terms :

1. Development is the production of OMNI Perceived Exertion Scale in three aerobic exercise modes (walking, stepping and nine square) for Thai elderly.

2. Elderly means a 60 years old or above person. Age was counted by using the year of birth that appeared on Identification Card of the people living in community dwell of Primary Care Unit Muang Suang Hospital, Muang Suang District, Roi-Et Province.

3. Aerobic exercise is any repetitive activity that use oxygen for an extended period of time, in this present study refered to walking, stepping and nine square exercise.

4. Perceived Exertion is physical effort performed by the body in response to a particular exercise.

5. Borg's Rate of Perceived Exertion (RPE) Scale is a category scale ranging from 6 to 20, where a rating of 6 is equivalent to "no exertion" and 20 is equivalent to "maximal exertion." Subjects are showed the scale at various intervals during an exercise test, and are instructed to point to the number on the scale which most closely describes how intensely they feel they are working at a given time.

6. Thai OMNI Rate of Perceived Exertion (RPE) Scale is a standard set of numerical categories and verbal descriptors. The scale's pictorial descriptors are interchangeable in order to be generally consistent with the type of exercise to be performed. The scale's numerical categories range from 0 to 10 and depict gradually increasing exercise intensity. The OMNI Scale pictures show individuals participating in different types of physical exercise, yet the verbal cues and their corresponding numerical ratings are always the same.

7. Heart rate is the number of cardiac cycle per minute. The heart rate can be determined by heart rate monitoring.

8. Blood lactate concentration is produced as a natural part of carbohydrate metabolism. It is playing a major role in "Muscle Fatigue" (Measured in milli Molar (mM)) and pain experienced during exercise.

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บทคัดย่อ

การวิจัยครั้งนี้ มีความมุ่งหมายเพื่อ 1) พัฒนามาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแอโรบิกในผู้สูงอายุไทย 2) ประเมินและทดสอบมาตรวัดการรับรู้ความเหนื่อย OMNI สำหรับการออกกำลังกายแอโรบิกในผู้สูงอายุไทยที่พัฒนาขึ้น โดยการหาความเที่ยงตรงและความเชื่อมั่น ใช้การออกกำลังกายแอโรบิก 3 รูปแบบ คือ การเดิน การก้าวขึ้น-ลงบันได และตารางเก้าช่อง กลุ่มตัวอย่างที่ใช้ในการศึกษาเลือกจากการสอบถามผู้เข้าร่วมโครงการอาสาสมัคร จำนวน 60 คน โดยกลุ่มตัวอย่างจะออกกำลังกายแอโรบิก 3 รูปแบบ คือ การเดิน การก้าวขึ้น-ลงบันได และตารางเก้าช่อง เครื่องมือที่ใช้ในการทดลองและเก็บรวบรวมข้อมูล คือ เครื่องวัดอัตราการเต้นของหัวใจ เครื่องตรวจปริมาณแลกเตทในเลือด และมาตรวัดการรับรู้ความเหนื่อย ได้แก่ มาตรวัดการรับรู้ความเหนื่อยของ BORG และมาตรวัดการรับรู้ความเหนื่อย OMNI ที่ผู้วิจัยสร้างขึ้น สถิติที่ใช้ในการวิเคราะห์ข้อมูล ได้แก่ ค่าเฉลี่ย ส่วนเบี่ยงเบนมาตรฐาน ตรวจสอบความเที่ยงตรงและความเชื่อมั่นของเครื่องมือโดยใช้สัมประสิทธิ์สหสัมพันธ์ของเพียร์สัน (r_{xy}) Chi – square และ Alpha Coefficient ของครอนบาค และตรวจสอบการพยากรณ์ด้วย Regression Analysis

ผลการวิจัยพบว่า มาตรวัดการรับรู้ความเหนื่อย OMNI ที่สร้างขึ้น สามารถใช้ในการวัดการรับรู้ความเหนื่อยได้อย่างเที่ยงตรงและเชื่อมั่น ดังนี้

1. ผลการตอบรับทางร่างกาย ผู้สูงอายุไทย ที่ออกกำลังกายด้วยการเดิน การก้าวขึ้น-ลงบันได และตารางเก้าช่อง มีปริมาณแลกเตทในเลือด อัตราการเต้นของหัวใจ คะแนนการรับรู้ความเหนื่อยตามมาตรวัดของ BORG และคะแนนการรับรู้ความเหนื่อยตามมาตรวัด OMNI เพิ่มขึ้นในทิศทางเดียวกันสำหรับการออกกำลังกายแอโรบิกทั้งสามรูปแบบ

2. ผลการวัดการรับรู้ความเหนื่อยด้วย OMNI มีผลการวัดสัมพันธ์กับการวัดด้วยมาตรวัดการรับรู้ความเหนื่อย BORG ทุกช่วงเวลาและโดยรวมอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05 และ 0.01 ผลการเปรียบเทียบความแตกต่างจากการใช้มาตรวัดโดยเครื่องมือสองชนิดโดยรวมไม่แตกต่างกัน มาตรวัดการรับรู้ความเหนื่อย OMNI ที่สร้างขึ้นมีค่าความเชื่อมั่น (Cronbach's Alpha Coefficient ($\propto$)) ระหว่าง 0.708 – 0.749

3. ผลการวิเคราะห์ความสัมพันธ์และความสามารถในการพยากรณ์พบว่า อัตราการเต้นของหัวใจ (HR) จากการออกกำลังกายแอโรบิกทั้งสามรูปแบบ สามารถระบุและพยากรณ์มาตรวัดการรับรู้ความเหนื่อยของ BORG และ OMNI ได้อย่างมีนัยสำคัญทางสถิติที่ระดับ 0.01

TITLE Development of OMNI Perceived Exertion Scale for Aerobic Exercises in Thai Elderly

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ABSTRACT

This study's aims to: 1) Develop an instrument of OMNI Perceived Exertion Scale for Aerobic Exercise in Thai Elderly, and 2) Evaluate and test of the newly development Thai OMNI Perceived Exertion Scale instrument for Thai Elderly in terms of validity and reliability in three mode of aerobic exercises, which each during walking exercise , bench stepping exercise and nine-square stepping exercise. The samples used in this study were selected from voluntary participants 60 subjects, the subjects had been three mode of aerobic exercise walking exercise, bench-stepping exercise and nine-square stepping exercise. The instruments will be use in this study include: Heart rate monitoring, Blood lactate analyzer, and Rating perceived exertion scales - Borg's perceived exertion scale (6-20 scale) and Thai OMNI perceived exertion scale for elderly that will be development by the researcher. Statistical analysis used mean, standard deviation, Pearson ' s Correlation Coefficient (r_{xy}) Chi – square and Regression analysis.

The research found OMNI perceived exertion scale for aerobic exercises in Thai Elderly that can be measure fatigued with validity and reliability as follow:

1. Physiology responses of Thai elderly with walking exercise, bench-stepping exercise and nine-square stepping exercise had the blood lactate concentration (BLC) hearth rate (HR), the Borg (6-20) scale REP (BO) and the OMNI scale RPE (OM) increase respectively in the same directions.

2. Results of OMNI scale RPE was relationship with Borg (6-20) scale RPE ($P < 0.05, 0.01$), compared the results by chi – square found not different and OMNI scale RPE have Alpha coefficient (α) during 0.708 – 0.749.

3. The results of correlation and prediction found the heart rate (HR) measuring from three mode aerobic exercise can be assign and predict the BORG (6-20) scale REP (BO) and the OMNI scale RPE (OM) ($p < 0.01$).

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Janejira Wongkoomngoen