

# Influencing Factors on Less Self-Conscious Exercise Movement among the Elderly in Using Recumbent Exercise Bike

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## ABSTRACT

Exercise is good and strongly recommended for elders. However, it is widely recognized that continuous exercise is the most difficult issue for their exercise. An interdisciplinary team, consisting of physiologists, sport scientists, engineers, and product designers, has addressed the issue of how to keep elders exercising. Six subjects were selected for observation and in-depth interview. All physical activities that occurred before, during, and after exercise were observed and analyzed. More than two hours of in-depth interviews helped the team to understand the cause of each subject's unsuccessful exercise while processes of ideation and prototype were daily developed to get needed data. Collected information showed that the exercise equipment functionality was not the only consideration when designing exercise equipment, but also the enjoyment and the exercise benefits they must get. Through many cycles of "data collection - prototype test", the study presented four significant points for good exercise equipment design: 1) The right purpose: The performance of exercise using an equipment should strengthen lower body parts of elders to prevent falling and promote physical abilities. 2) Continuous exercise: The design should keep elders doing exercise with less conscious correct movement with the "non-perfect smooth movement". 3) Enjoyment: While exercising with less conscious movement, elders can do sub-activities e.g. watching television or talking with others with their upper body parts. 4) Right control: The "non-perfect smooth movement" allows elders to use exercise equipment with very less consciousness for controlling the quality and continuity of movement. When the exercise quality is decreasing, a sense in non-perfect smooth movement will give a small reflection directly to the working body parts to bring the exercise movement back to the earlier point, less consciously. By noting these points as well as the basic requirements of friendly design e.g. simple instruction, simple movement, and friendly usage, elders could enjoy their exercise and gain its right benefits.

**KEYWORDS:** Exercise for Elders, Less Conscious Movement, Enjoyment, Elders Behaviors,

## 1. INTRODUCTION

### *Background*

It is recognized that exercise is broadly is very important for elders. Generally, The Thai Health Promotion Foundation (THPF) strongly recommends that elders should exercise more than 30 minutes

continuously per day and they should exercise three days per week (Chomnapas, 2017). In 2018 Japan's Ministry of Health, Labor and Welfare has recommended that people should exercise more than 30 minutes, more than twice a week and maintain this exercise habit for more than a year. Good exercise for elders should be cardiorespiratory fitness, such as jogging, walking, dancing, or biking, and encourage large muscle movement as much as possible to enhance flexibility of body movement in daily life.

However, it is noticed that elders get difficulty to follow this above suggestion. At the early state, elders might be encouraged and perform well. However, as time passed, elders might lack motivation and then felt bored to exercise. They mostly started reducing the exercise time and the number of exercise per week. Vilai (2018) also mentioned that exercising elders take at least 6-10 weeks to recognize positive changes of their body and mind. The benefits of exercise are slowly recognized. Henk and others (1997) mentioned that after trying the behavior and learning about exercise consequences and/or its difficulty, the person may decide to quit the action. For elders who do not exercise so often, it is very difficult to maintain exercise in terms of both exercise duration per time and number of exercise per week. It is much better for them to start with increasing time or distance of some daily activities such as walking, gardening, or biking until they feel comfortable (Noawarat & Others, 2014).

Elders have to spend more than 30 minutes continuously to exercise at least three times per week. It is very important to classify the kind of exercise which is suitable for elders' body condition and the benefit to their daily life and behavior. Literature also mentioned that body parts and muscles which are able to help elders to avoid or prevent failing are significantly important. They need to be trained in terms of both strength and flexibility.

### *Home Activities*

Focusing on home exercise, elders who exercise at home normally do it alone. They are easily bored and are despondent. Motivation and encouragement from family members are very important to push the elders to exercise. However, the primary observation showed that elders generally spend time at home mostly for chit-chatting, watching television, interacting with smartphone or tablet, and doing hobbies. Subjects reflected that these kinds of activities deliver enjoyment. Typically, most elders can enjoy these

activities as natural behavior. Oppositely, the enjoyment of exercise happens just only at the early stage of exercise. When the time passes, elders cannot maintain the enjoyment during exercise as they feel when they do other activities. While focusing on home-based exercise, it would be better to have a meeting once a week at a club with friends to reinforce the program (Melinda et al., 2001) and also encouragement.

To support and encourage elders to keep exercising in the right way, the study aims to 1) understand the factors driving enjoyment of elders during exercise; and 2) propose a conceptual framework to make the elderly maintain performance of exercise during enjoyment. The framework explains the possibility to develop an exercise equipment that elders can exercise with it with less conscious movement while they enjoy other activities such as chatting, watching television, etc.

### **Focuses**

An interdisciplinary team, consisting of physiologists, sport scientists, engineers, and product designers, has addressed the issue of how to keep elders exercising as a habit. The primary interview and observation show that exercise enjoyment is not easily manifested for beginner. There should be multiple factors, such as experience, preference, and environment, to create exercise enjoyment. However, the elderly exercise equipment design will be more beneficial if it does not only concern enjoyment from exercise but also allows other activities during exercise and extends the exercise time as well.

### **Objectives**

The main purpose of this study is to identify the factors driving enjoyment of elders during their exercise and to conceptualize a solution to maintain the quality of exercise movement during their enjoyment.

## **2. METHODOLOGY**

### **2.1 Exercise Behavior of Elders**

To understand the root problem of exercise behavior of elders, observation and interview of elders were conducted to clearly understand 1) the insight of elders who exercise regularly, 2) the relationship of insight and drive of starting exercise and keeping exercise, 3) change mechanism of exercise behavior, and 4) functional and emotional drive for keeping regular exercise.

Data were collected from observation and interview at the subjects' residence. Subjects were requested to perform exercise with their exercise equipment in the real situation and to demonstrate problems and needs of their exercise. The subjects in this data collection could be divided into two groups: 1) elders who always exercise either inside the residence or outside the residence, and 2) elders who

are assigned to exercise but they have not done exercise regularly.

Subjects were systematically selected by screening questions. Six subjects were interviewed and observed at their residences. In each case, the visit took more than two hours for interviews and observations. All physical activities that occurred before, during, and after exercise were observed, recorded, and analyzed. Around two hours of in-depth interviews helped the team to understand the cause of each subject's unsuccessful exercise while processes of ideation and prototype were daily developed to get needed data. Collected information showed that performance of exercise was not the only concern when designing exercise equipment but also the enjoyment of elderly users as well as their exercise benefits.

Three subjects were requested to exercise together while doing other activities that make them enjoy such as watching television, chatting, and interacting with their smart phone. However, it was observed that while they enjoy and pay attention to those activities, the performance of their exercise such as the speed of movement significantly dropped. However, the observation showed that non-regularly exercising elders can extend their exercise time longer than when they did only exercise.

### **2.2 Usability Design Test**

Through many cycles of "data collection - ideation", the study of exercise behavior of elders grounded the hypothesis of exercise as a sub-activity of main enjoyment activity. Some elders were able to regularly keep exercising more than 30 minutes if they were doing other enjoyable activities such as watching television, chatting, or interacting with smart phone. This situation could be explained that elders basically pay attention for enjoyable activities, and pay less consciousness for exercise. The problem of this concept is how to maintain the performance or quality of exercise movement for them to enjoy the main benefits of exercise.

Feedback system from exercise equipment delivered directly to moving body parts was mentioned as a concept to design mechanic to control the quality of exercise movement during satisfying enjoyable activities. Recumbent Exercise Bike (REB) was considered by the interdisciplinary team to be a case study of exercise equipment for elders because elders are familiar with this kind of exercise equipment in which they are able to perform motor movement. Exercising with recumbent exercise equipment is also able to enhance particular muscles which benefit balance ability and fall prevention. The report from the Department of Physical Education (2014) mentioned that 50% of elders who are more than 65 years old have falling incidents at least once a year.

The objective of the test considered the performance of controlling the quality of motor movement to be in moderate zone while subjects pay consciousness to enjoyable activities.

Compared to enjoyable activities such as watching television, chatting, interacting with smart phone or tablet which can draw attention from users, easy math question was used to pull consciousness from the subjects. This concept of math question was brought from Takao Laboratory, Tokai University. Math question is one digit number + one digit number = two digit number, such as  $7+5=12$ ,  $4+9=13$ ,  $8+7=15$  but subjects had to answer just the number of last digit of calculated number such as

Question:  $7+5=12$       Answer: 2  
 Question:  $4+9=13$       Answer: 3  
 Question:  $8+7=15$       Answer: 5.

By these questions and conditions to answer, subjects needed consciousness to consider the answer. However, as this was simple math for the subjects, they were able to reply the right answer in a few seconds if they just consciously considered it. During the cycling and answering math questions, average heart rates (HR) were recorded. When HR was significantly reduced, the resistance of recumbent exercise bike was suddenly released for a short while. The change of exercise movement was critically recorded.

Subjects' profile should be both male and female who are 40-65 years old doing cardio exercise either at gym or home. The criteria and number of subjects are presented in Table 1.

Table 1. Sample Qualifications for Testing

Criteria	Qualification	Quantity
Genders	Male	3
	Female	4
Age	Forty to sixty years	5
	More than sixty years	2
Math Skill	Pass the Test	7
Exercise Background	Subjects use exercise equipment regularly	3
	Subjects used to try using exercise equipment but they could not keep doing it	4

Test procedure and evaluation methodology were systematically designed by the interdisciplinary team. The test was started with introduction and preparation as following.

1. Introduction to test procedure
2. Introduction to test instruction and equipment
3. Device installation and test and preparation
4. Equipment set up and posture adjustment
5. Vision and audio test
6. Camera set up



Fig 1. Usability Testing Environment

After preparation, subjects using the REB received the signal to start the test following the instructions below.

1. Signal receiving
2. Starting cycling at the preferred resistance level until target HR, 50-55 % of  $220 - \text{age}$  (Noawarat and Others, 2014) is maintained
3. Maintaining cycling at this level for one minute
4. Answering the math questions shown on the monitor (question was changed to next after getting the right answer only)
5. Monitoring average of HR
6. Releasing the resistance as conditions in Table 2.

Table 2. Condition of Resistance Release

HR and RPM monitoring	Math question running
If HR reduced to be lower than average HR more than ten units for ten seconds	Question was changed when getting the right answer only
<b>Then resistance was released for two seconds</b>	

7. Continuing the test for 20 minutes
8. Rechecking collected data

### Hypothesis of Test

Comparing the answering math to enjoy other activities, subjects might pay attention to answering math more than cycling using REB. In this case, subjects might perform cycling as motor movement while more consciously calculating math while the quality of exercise was determined by HR. If HR of the subject is maintained, it could be assumed that subjects still perform exercise in the right way.

However, when HR dropped from average zone for more than 10 units, the resistance of exercise equipment was totally released for three seconds. However, when subjects slightly delayed answering math question, HR significantly dropped for a short while. Hypothesis of the test is that when math question accidentally pulls more consciousness from subjects, then subjects less-consciously performed cycling. In this case, quality of cycling might be dropped.

While releasing resistance, acts as feedback from equipment, the moving legs were supposed to directly get this feedback and assumed to automatically react by harder cycling. By this assumption, once subjects push harder cycling, HR should be significantly increased from dropped one. However, during this reaction, subjects were also expected that the math answering is not significantly delayed.

### 3. RESULT AND CONCEPTUAL DEVELOPMENT

#### Test Result

From seven subjects test, there were 43 times for HR change and resistance release. The observation of HR increase show significant data.

HR was increased to be the average zone	66%
HR was decreased	16%
HR was not significantly increased	18%

Although the test was not focused on smoothness of answering math, the observation also showed non-smooth answering to math question. There are three patterns of non-smooth answering: 1) smooth, 2) delay, and 3) repeat.

#### Conceptual Development

Test result gave the possibility to develop the idea of physical feedback directly to the moving part of the body. The less conscious reaction allowed the subject to continue answering math. This idea could be developed to be a framework of the conceptual design of feedback system of exercise equipment to encourage quality control of exercise.

However, the feedback on resistance release did not significantly disturb the enjoyment of other activities and also did not critically obstruct the continuity of cycling. In this case, the feedback created “non-perfect smooth movement” for exercise movement. This kind of movement should highly benefit to recall the correct movement back when performance drops. However, the “non-perfect smooth movement” should work with only exercise movement which is considered as motor movement. The idea of “non-perfect smooth movement” would be able to allow users to enjoy other activities such as watching television, chatting, and interacting with smart phone during quality exercise.

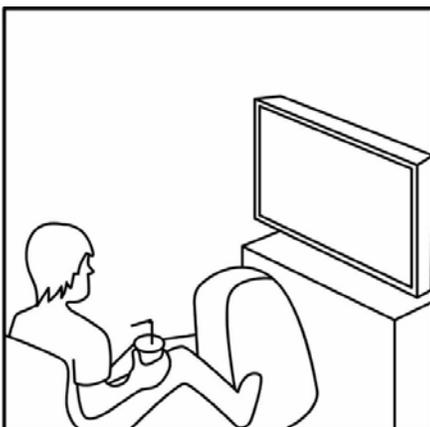


Fig 2. The Conceptual Idea of Being Able to Enjoy Other Activities During Quality Exercise

### 4. DISCUSSION

Suprani (2014) recommends to consider FITTE in the exercise of the elderly: F for Frequency of exercise, I for Intensity of exercise, T for Time of exercise, T for Type of exercise, E for Enjoyment. While frequency, intensity, time, and type are clear to study and follow, enjoyment might be difficult to measure because it is the most subjective. Interviews and observations showed evidence that elders who have not exercised before need time to feel enjoyment with exercise. The Ministry of Health, Labor and Welfare, Japan (as cited in Mikie et al., 2017) mentioned that exercise habit can be counted after people continue exercising for more than 30 minutes, more than twice a week, maintained for more than 1 year. However, the literature critically recommended that enjoyment is one of the key success factors to draw elders to perform exercise regularly.

Previous literature suggested that elders should cardio exercise because it does not only benefit their body but also their heart. However, many elders have health problems and fall prevention is very important for them. Therefore, at least, elders might start to exercise for strengthening their lower body parts to prevent falls and promote physical abilities.

Exercise is important for elders and elders have been informed about this information from many kinds of sources such as doctors, family members, and the mass media, yet not many elders have exercise habit. To encourage elders to stay longer with exercise equipment, it should provide the mechanics to keep elders doing exercise with less conscious correct movement with the “non-perfect smooth movement”. The result showed that using the recumbent exercise bike convinced elders to enjoy exercising and encouraged them to do exercise while enjoying other enjoyable activities. While exercising with less conscious movement, elders can do sub-activities such as watching television or talking with others with their upper body parts being exercised. This result is related to Henk et al.’s (1997) suggestion that it might be more potential for elders to exercise when exercise is established, especially incorporating in their existing lifestyle such as walking or cycling. In this case, moderate activities such as watching television or chatting might turn to support positive health consequences.

The test result presented critical opportunity to design the feedback from exercise equipment which can support elders to less self-consciously control their quality movement while they enjoy other activities such as watching television, chatting, or interacting with smart phone. The test presented the idea of “non-perfect smooth movement” as feedback concept design. The “non-perfect smooth movement” allows elders to use very less conscious control of the quality and continuity of their movement. When the exercise quality is decreasing, a sense in “non-perfect smooth movement” will give a small reflection directly to the working body parts and joint to bring the exercise

movement back to the earlier point with less consciousness. This reflection or feedback could be considered as proprioceptive signal sent from exercise equipment to users and benefit elders who exercise. Isabella et al. (2016) suggested that elders tend to down-regulate their proprioceptive cues when opening their eyes less than young people do. By noting these points as well as the basic requirements of friendly design such as simple instruction, simple movement, and friendly usage, elders could enjoy their exercise and gain right benefits. If the exercise experience can satisfy users, these experiences may initially bolster one's attitudes or feelings of behavioral control and one may learn that the previously proposed goal can be accomplished (Henk et al., 1997). For example, one of the elderly participants mentioned that, "When I am on the phone and walking, I can walk until I end the call, even though it is 30 minutes or hours. However, I have never done exercise by walking more than 20 minutes".

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