VR exercise game to keep the shoulder self-exercise going

N. Takahashi, K. Ishihara

Purpose Stretching improves the range of motion of joints, inhibits muscle atrophy, promotes blood circulation, prevents disorders, and relieves muscle fatigue, and should be actively practiced on a daily basis to maintain good health. One way is to participate in gymnastics classes held by the government, but since these are not held every day, one must train on one's own. Elderly people, in particular, are prone to loss of flexibility in their shoulder joints as well as muscle strength due to decreased activity, leading to a decline in their ability to perform activities of daily living (ADLs). In order for them to maintain their ability to live independently, they will need to incorporate self-exercise into their daily routines. However, self-exercise at home tends to reduce motivation to continue exercising due to problems such as the exercise menu being perceived as monotonous repetitive training, difficulty in seeing the results of exercise, and boredom due to the lack of change in the surrounding scenery (Plante et al., 2003). To solve these problems, I created a VR exercise game in Unity that uses an MetaQuest2 (Lohse et al., 2013, Tao et al., 2021). **Method** The game aims to motivate users to continue exercising, and consists of earning in-game rewards through exercise and using them to grow plants. The player operates a controller held in both hands to perform shoulder flexion/extension and adduction/abduction exercises through movements such as climbing ladders (Figure 1), rowing a boat (Figure 2), and wiping a wall in the field. Since the exercise is performed indoors and in a seated position, there is no risk of fractures or other injuries due to falls. In addition, a minimum amount of exercise per day will be set as a daily quest, and users will be rewarded for completing the quest. Rewards earned through daily quests and exercise can be used to cultivate original flower beds, and this is intended to motivate users to continue with the program as a rewarding element. After the complete software was developed, we tested the effects of the exercises performed in the game. The participant was a man in his 50s who had developed right arm pain and a cervical hernia due to nerve compression in his shoulder three years earlier. He measured the time required to ascend and descend a ladder twice a day for three days, for a total of six times. The evaluation of this experiment will consist of a questionnaire survey on the measured angle of movement of the upper arm using a perpendicular line passing through the acromion point as the basic axis to determine effectiveness, and on the degree of difficulty and whether the game can be continued every day as a sense of use. **Results and Discussion** The time required in the first trial was 40 seconds, which was reduced to 32 seconds in the sixth measurement. These results suggest that the shoulder flexion exercise by the ladder ascend and descend quest is effective in improving the range of motion of the joint and the progress of the exercise. In addition, the range of motion of the shoulder joint improved from grasping the ladder rungs one at a time in the first trial to being able to grasp the rungs alternately with the left and right hand in the sixth trial. By using a head-mounted display, the user can exercise comfortably in an open game field while indoors. The main appeal of using games for exercise is that they change the perception of exercise from an imposed quota to a self-imposed goal. This creates a positive emotional attachment to continued exercise.

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Address: Faculty of Rehabilitation, Hiroshima International University, JP
Email: st18012@ms.hirokoku-u.ac.jp

Figure 1. The large game field has towers with ladders and reward coins.

Figure 2. Rowing the boat by grabbing the paddle with the controller operation.