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DEVELOPING THE INNOVATIVE BODY SUPPORT DEVICES FOR THE ELDERLY WITH FAMILY PARTICIPATION

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Abstract

This research was a research and development. The objectives were to study 1) the problems and needs of innovations to assist mobility of the elderly in Chachoengsao Province, 2) develop innovations to assist mobility of the elderly in Chachoengsao Province, 3) trial the innovations to assist mobility of the elderly in Chachoengsao Province, and 4) evaluate the use of innovations to assist mobility of the elderly in Chachoengsao Province. The sample group consisted ofed13 elderly people in Nong Naen Subdistrict, Chachoengsao Province. The tools used were questionnaires, assessment forms, and equipment to help lift and support the elderly. The experiment was trial. Data were analyzed using frequency, percentage, mean, and standard deviation. The results of the study revealed that 100 percent of the elderly were female, had a higher-than-normal weight and height, were married, and most had completed primary school. They had chronic back pain in their last health check-up within the past year and were not related to working with vibrating machinery. Overall, environmental factors affecting pain and stiffness were at a high-risk level. Most body movements needed to be urgently improved. Therefore, a lifting device was developed using ergonomic principles. The data were obtained from interviews and from studying principles and concepts that were consistent with the problems and needs of the elderly. It was tested with the elderly and further developed according to the recommendations. After testing the innovative lifting device for the elderly, participants were very satisfied and suggested an innovative lifting device assisting the elderly stand up and support themselves better. In using this innovation, elderly people who need to use lifting devices in their daily lives should be selected and the device should be used continuously for at least one week to see clear changes. It is hoped that this will be a guideline for developing new knowledge and extending it to improve the quality of life of the elderly with effective lifting devices.

Keywords: Innovation, Body Support Devices, Elderly, Participation, Family.

INTRODUCTION

Demographic changes are affecting every country in the world. In 2020, the world's population was aging rapidly. The global population was 7.795 billion, with 1.05 billion "senior citizens" aged 60 and over, or 14 percent of the total population. In Thailand, there were 12 million older people out of a total population of 66.5 million, accounting for 18 percent of the total population. Thai society has become a "complete aging society" since the beginning of 2022, with the proportion of the population aged 60 and over increasing by 20 percent, or approximately 14 million people out of a population of approximately 66 million. In 2033, or 12 years from now, Thailand will become a "super aging society", with the proportion of the population aged 60 and over increasing to 28 percent and the

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population aged 65 and over increasing to 20 percent, while the population born between 1963 and 1983 would be about to become elderly. The phenomenon or "declining birth rates and people living longer lives" is happening all over the world and is having a widespread impact (Foundation for Research and Development of the Thai Gerontology Institute (TRGI), 2021, pages 5 - 6). It is well known that entering the aging society would be a major problem for the development of the country in the future because the government had to take care of the elderly. At the same time, the country's competitiveness might decrease when the working-age population decreases. In addition, the issue of the elderly is not just an economic figure, but also a matter of spiritual society, because everyone's parents and grandparents are included in this group and may be the next us in the future. The problem is how to make Thai society ready to support the approaching aging society, so that society can live together harmoniously, have a good quality of life, have new skills for employment, have technological devices to help with daily activities, have a good attitude towards each other, strengthen each other and create value among each other. Innovation will help both the elderly directly and those who are not yet elderly to be able to live together in social changes and the current world, a world of innovation that will help create opportunities for the elderly to access facilities, the elderly can live independently and help themselves, have a good quality of life, and that is the transition from retirement age to a stable and happy power of the land according to age.

Chachoengsao Province is one of the provinces in the Eastern Economic Corridors (EEC) which the government has designated as a green area or will develop into a quality residential area which is livable and worth living in. Since 2019, the province has been divided into administrative areas including 11 districts, 93 sub-districts, and 851 villages. In 2019, Chachoengsao Province had a total population of 711,035 people, with a population structure that is in the middle of the pond, with the age group of 40 - 44 years having the largest population at 56,393 people (7.9 percent of the total population). If the population structure was classified by age group, there were 123,002 children (aged 0-14 years), accounting for 17.3 percent, 466,715 working-age people (aged 15-59 years), accounting for 65.6 percent, and 121,318 elderly people (aged 60 years and over), accounting for 17.3 percent of the total population (Chachoengsao Provincial Statistical Office, 2020).That is, at present, “Chachoengsao Province has fully entered the Aged Society” and is stepping into becoming a “Complete Aged Society”. In the past 5 years, the working-age population has tended to decrease while the elderly population has tended to increase continuously.

The population structure of the province will affect the economic situation and potential in the future because the economy of the province depends on the working-age population, in which the children and elderly population must rely on the working-age population. That is, the ratio of the child population to the elderly population to the working-age population, or the so-called "dependency ratio", is an indicator that will be used to analyze and determine various policies in the future because in economics, the working-age population is seen as the income earners to take care of the child and elderly population

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(Chachoengsao Provincial Office, 2020, pages 75 - 76). It can be seen that overall, Chachoengsao Province has a dependency rate of 51.78 percent, meaning that working-age people who earn 100 baht must spend 52 baht to support the elderly and children, which is more than taking care of themselves. This shows that it is a burden that must be borne in large numbers and will lead to stress for family members, individuals, and working-aged people, resulting in low work efficiency and slow and low development of society and the country.

In particular, if the health of the elderly, which is as much as 17 percent of the total population, can be improved, it will help reduce the burden and dependency on the family. The elderly naturally have a deteriorating body and may have diseases as a result of behaviors in childhood and adolescence, including improper behaviors in the present, which put them at risk of disease and illness. Therefore, they must bear the cost of health care, such as medicine costs, equipment costs, and caregivers (Caregiver), and others. In addition, it is found that most elderly people have problems with physical movement due to the deterioration of various organs with age, which causes problems such as difficulty in standing up and sitting, knee pain, muscle pain when walking a lot, etc. In addition, with science and technology changing rapidly, the development and promotion of the quality of life of the elderly must find innovations that are appropriate for the health and physical condition of each elderly person and the environment in the home. The family should also agree because the family is the one who takes care of the elderly all the time. Therefore, they will know the problems and needs very well to improve the quality of life of the elderly and solve problems at the source, including local leaders, community leaders, directors of health promotion hospitals, village health volunteers, and related persons to provide joint opinions which will help support innovations or promote innovations for appropriate use and further development in community businesses.

The research team saw the importance of innovations in lifting and supporting devices for the elderly. It will help solve health problems and help the elderly perform their daily activities more easily, without having to rely on others all the time, and reduce complications from certain chronic diseases that make daily life uncomfortable and unhappy, such as back pain, leg pain, difficulty in standing up and sitting down, and may stagger, leading to falls and broken arms and legs, which are common in the elderly. In addition, the research team is a group of instructors in Rajabhat Rajanagarindra University; the university, for local development and serving society, is the only university in Chachoengsao Province, which is most aware of the problems and needs of the people. Furthermore, there has never been a study on the development of innovations on equipment to help lift and support the elderly which are suitable in Chachoengsao Province before. Therefore, the researchers are interested in studying the development of innovations on helping the elderly move their bodies appropriately with community participation and ergonomic principles in Chachoengsao Province, Thailand. The results of this research will provide guidelines for developing innovations in equipment for lifting and supporting the elderly which are appropriate for Chachoengsao Province and will be

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a good model for developing innovations in helping the elderly move their bodies, which will help improve the health and quality of life of the elderly in other provinces.

Research Objectives

1) To study the problems and needs of innovations to assist mobility of the elderly in Chachoengsao Province.
2) To develop innovations to assist mobility for the elderly in Chachoengsao Province
3) To test the use of innovations to assist the mobility of the elderly in Chachoengsao Province.
4) To evaluate the use of mobility assistance innovations for the elderly in Chachoengsao Province

Conceptual framework for research

This study is a research and development study; which ergonomic principles are applied in this conceptual research framework as showed in the figure 1.

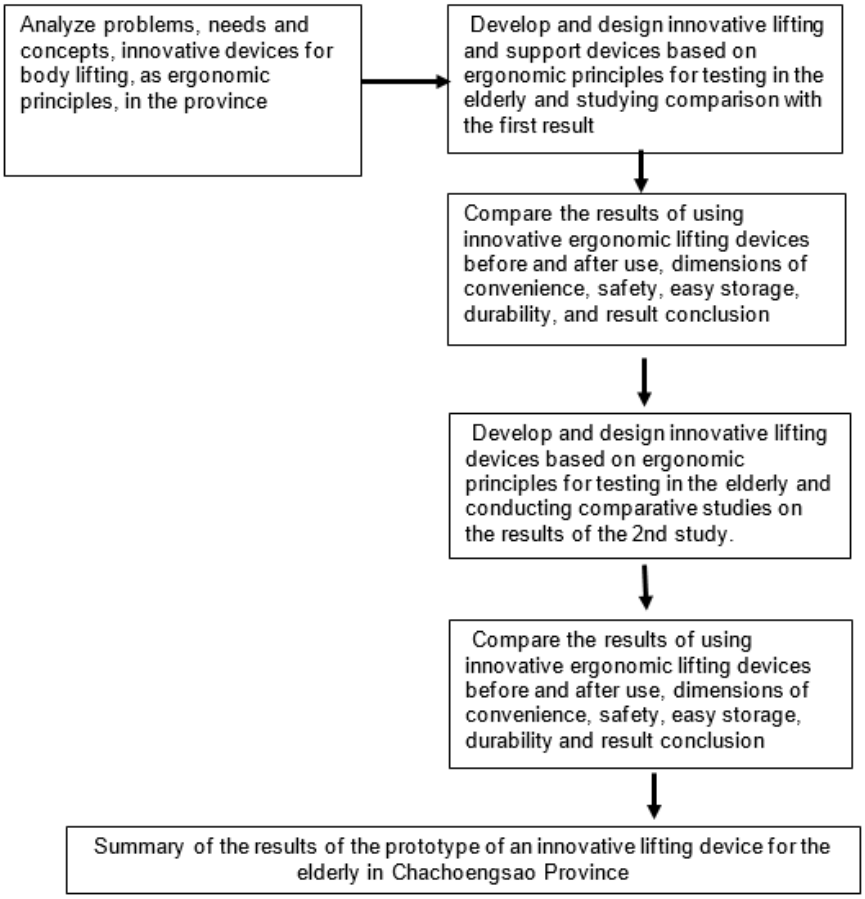

Figure 1: Conceptual Research Framework

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METHODOLOGY

This study is a research and development study consisting of the following research steps:

Step 1: Analysis to explore the clear problems by surveying data, including studying theories, concepts related to the problems and needs for lifting and supporting devices for the elderly and the lifting and supporting devices for the elderly's needs to be developed to solve the problems (R1: Research 1).

Step 2: Prototype development is the design of the innovation development workpiece for lifting and supporting devices for the elderly by developing the model for creating and using the device to support the movement of the elderly (D1: Development 1).

Step 3: Test the prototype of the developed lifting and support device in a small group of three elderly people with lifting and support problems in Nong Na Subdistrict.

Step 4: Evaluate and develop the prototype to be suitable and complete (D2) and suitable for use in Step 5 by designing and improving it according to the suggestions of the sample group.

Step 5: The complete prototype was applied to a larger sample group, 13 elderly people with lifting problems in Nong Naen Subdistrict (R2). The evaluation and development of the prototype was conducted continuously until the researchers were confident that the complete prototype could be applied to the target group and solved the problems completely.

Step 6: Evaluate and develop improvements to the prototype after using the innovative device to lift and support the elderly to be suitable and complete (D2). This process focused on the group discussions with experts for consideration and take the prototype from the prototype development process above into the phase 2 testing process by testing the prototype in phase 2 for a period of 30 days and evaluating satisfaction with the lifting and support device before concluding and using it as a prototype in the broader picture.

Population and Sample of Study

Population

The population in the study was 1,131 older people in Nong Naen Subdistrict, Chachoengsao Province.

Sample Group

The sample group consisted of 13 older people from Nong Naen Subdistrict, Chachoengsao Province, who were specifically selected based on the following qualifications: 1) being elderly; 2) having difficulty moving around, standing up or sitting

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down; 3) being willing and needing a lifting device; 4) being able to communicate with understanding; and 5) being willing to cooperate with the family.

The experts in the focus group included five experts in industrial technology and design, a nurse representative in the elderly care sector, and an academic representative.

Tools used for data collection

1) The questionnaire is divided into two parts:

Part 1: General information of the respondents, including general information about gender, weight – height, marital status, education level, whether you have ever had health problems or symptoms, when was your last health check-up, and whether you have ever worked with machinery that generates vibrations while working.

Part 2: The questionnaire on environmental factors affecting pain symptoms was in the form of a rating scale using Likert's method (Likert, 1967, pp. 90-95). The risk level of pain symptoms at work was divided into 5 levels.

2) The satisfaction assessment form is a questionnaire in the form of a rating scale with 5 levels: the opinion matches the question the most, much, moderately, a little, and least.

Verifying the quality of tools

Content validity was examined by presenting the questionnaire to five experts to consider its completeness, accuracy, and consistency and to calculate the consistency index. The content validity was 0.90 using the selection criteria: questions with an IOC value of 0.5-1.0 were selected for use, and questions with an IOC value lower than 0.5 were considered for improvement or discarded.

3) Lifting aids for the elderly

The researchers had studied, analyzed, synthesized documents and related research using the RULA (Rapid Upper Limp Assessment) (McAtamney & Corlett, 1993) assessment form as a tool for evaluating the working postures of the elderly to use as information for analyzing the causes of pain in the elderly. The method was developed by Lynn McAtamney and Nigel Corlett in 1993.It was participating in the development of innovation and design of lifting and support equipment that uses ergonomic design theory in designing lifting and support equipment under the study of the quality of lifting and support equipment from three elderly people, then improving and modifying it, and then testing it on 13 people. The research process began with studying preliminary data from the elderly and their standing up behavior to evaluate with an ergonomic assessment form. Then, the data were analyzed using statistics to design a lifting device appropriate for the body size and proportions of the user. Therefore, this research had to collect data from the elderly group with data on injuries from standing up, data on body size and proportions of the elderly group, and data on standing postures, along with an

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assessment of the risk of standing up postures using an ergonomic assessment form to analyze using statistics to lead to a prototype lifting device.

Data Collection

The researchers collected data by themselves, classifying the sample groups according to the nature of the work and exposure to similar factors. Data were collected among the sample group by using a set of questionnaires eliciting personal information and a set of work environment questionnaire, work posture, and the RULA (Rapid Upper Limp Assessment) ergonomics assessment form to assess the causes of muscle and bone pain among those who had try-out the lifting device and record the results to improve the lifting device.

Data Analysis

Data analysis was content and descriptive analyses.

Statistics used in data analysis: It included frequency, percentage, mean and standard deviation.

RESEARCH RESULTS

1. Study the problems and needs of innovations to assist mobility of the elderly in Chachoengsao Province

A survey of problems in getting up and sitting in the elderly included a survey of injuries and getting up and sitting postures in 13 elderly people. All were female, most had a weight and height above normal, were married, and most had completed primary school. They had chronic back pain at their most recent health check-up no more than one year ago and were not involved in work involving vibrating machinery.

As for environmental factors affecting pain, overall, the risk was at a high level. The average risk, from highest to lowest, was working with repetitive postures, followed by incorrect lifting postures, sitting on the floor for long periods of time, regularly lifting heavy objects, and the average risk with the least risk was machinery/tools which were used to cause pain.

The elderly were at risk of mobility and gave reasons such as back pain, arm pain, or leg pain. Therefore, the researchers analyzed the initial standing posture data by choosing to use the RULA assessment form because it was the analysis method which could assess the working posture of the workers most comprehensively. And from the RULA evaluation results for arms, head, body, legs and feet, it was found that most body movement postures needed to be improved urgently, accounting for 38.46 percent, followed by those who needed to be corrected immediately and improved equally, accounting for 23.08 percent, and those who were acceptable, accounting for 15.38 percent.

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2. Develop and test innovations to assist mobility of the elderly in Chachoengsao Province.

The results of the study found that after learning about the problems, needs and ergonomic risks of the sample group integrated with the concept and theory of innovation for the elderly, a device to help lift and support the movement of the elderly was created. The development of innovation to help lift and support the movement of the elderly had the following steps in innovation development:

1) Preparation of research/document review (e.g. literature review, preparation of tools and equipment). Data were prepared by studying and reviewing relevant literature and finding information by reviewing the literature on body size and human body proportions, especially the proportions of Asian people and Thai people in each age range in order to estimate the size of lifting equipment to be able to completely support the body of the sample group. After studying the data and reviewing the literature, the design of the standing and sitting postures was carried out to be consistent with the physiology reviewed in the literature, including the evaluation of the possible usage of the sample group to be consistent with the daily lifestyle to obtain a tool that was consistent with daily life and can be used effectively.

2) Conduct research (e.g. data collection, experimental results, results of creating tools, equipment or inventions, etc.)

   Step 1: The problems were clearly analyzed by surveying both quantitative and qualitative data, including studying theories and concepts related to the problems and needs of mobility aids for the elderly and lifting aids for the elderly who needed to be developed to solve the problems.

   Step 2: Develop a prototype to develop a model for creating the use of mobility aids for the elderly, as shown in the picture.

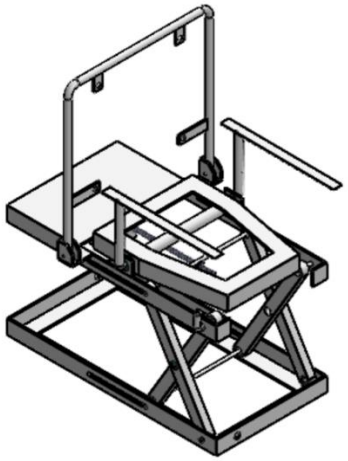

Figure 2: Mobility aids for the elderly

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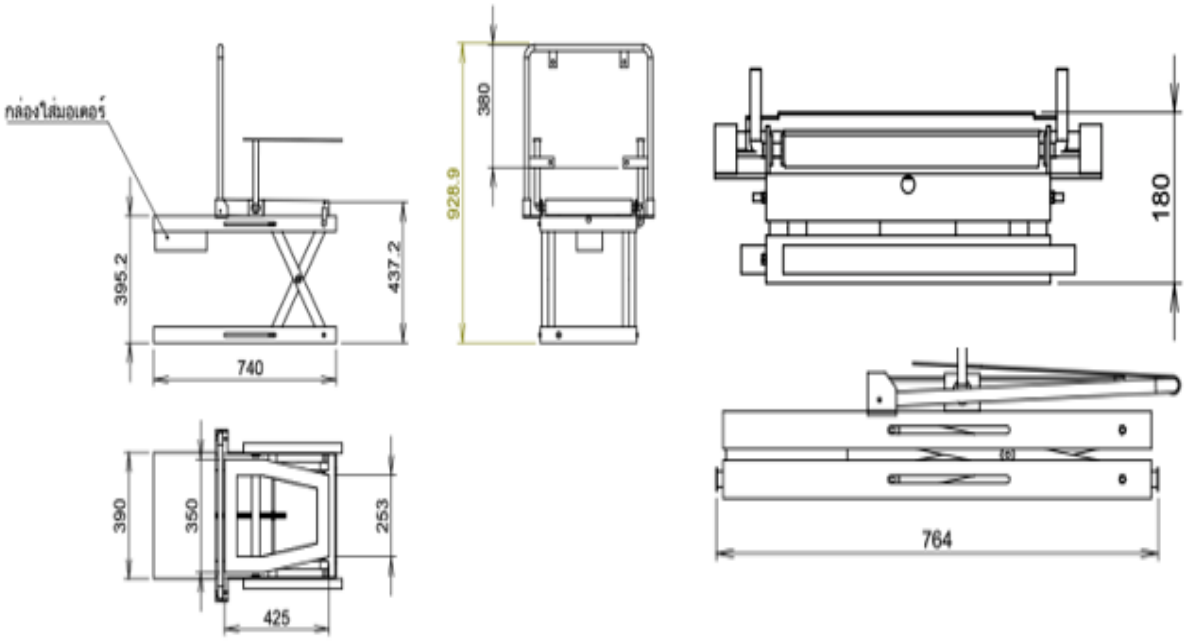

Figure 3: Blueprint design of mobility aids for the elderly

Then, it was tested on a sample group of three people, which resulted in problems with the equipment being too heavy and inconvenient to move. The equipment protruded and might hurt the user. The seat pressed down, causing the user to lean forward head first, resulting in injury.

The control system was changed to an up and down push button switch. The armrests wanted to be able to be adjusted to spread out to the side. Because the locking position made it impossible for the big body people to sit in it, the motor storage area should be moved or stored under the seat to make the chair compact.

The seat cushion was difficult to use and required a lot of force to pull it to the lock to fold it. It needed to add wheels for movement, could be locked in a way that did not require the elderly to bend down to lock it, and any parts that were important structures should be strong, but any parts that could be made lighter should be made lighter.

The researchers improved the body-lifting device for the elderly to be complete and suitable for use by designing and improving it according to the suggestions of the sample group. The complete body-lifting device was used with a larger sample group of 10 elderly people with body-lifting problems in Nong Naen Subdistrict.

The results were evaluated, and the prototype was continuously developed until the researchers were confident that the complete body-lifting device for the elderly could solve the problems completely and could be used effectively.

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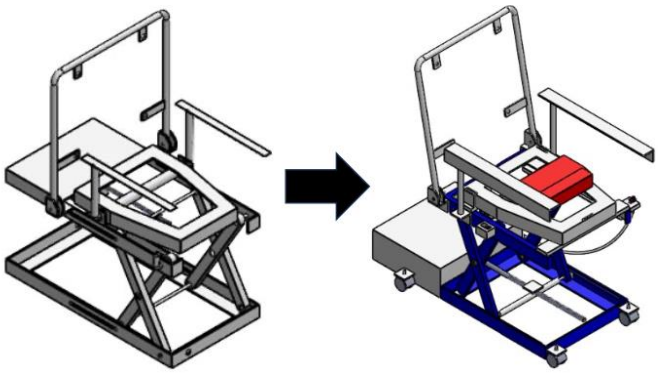

Figure 4: Mobility aids for the elderly after improvement based on suggestions from the sample group

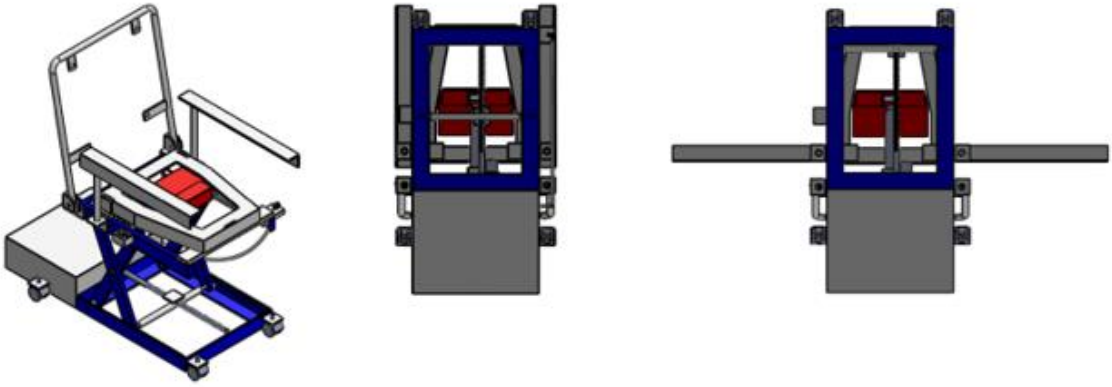

Figure 5: Blueprint design of mobility aids for the elderly after improvement based on feedback from the sample group

3. Evaluation of the use of innovations to assist mobility of the elderly in Chachoengsao Province

The results of the study found that the equipment to help lift and support the elderly in moving, which has been improved and developed, has been confirmed by five experts as a device which could help the elderly lift and support themselves appropriately to the user's body, including safety and convenience for efficient use. It could be expanded to other agencies or the elderly. After that, the researchers expanded the results by taking the equipment from the improvement and development process to the testing process by testing with the original sample group of 13 people for 30 days. After 30 days of use, no problems were found in the steps and processes of use. The researchers conducted an evaluation of the satisfaction of the users and found that overall satisfaction with the use of the device to lift and support the elderly was at a high level. When considering each item, it was found that the item with the highest average value was that the device could help lift and support the elderly when moving well. The next highest average value was that when using the device, it took up little space and the materials used were durable

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and strong. The item with the lowest average value was that it is lightweight and convenient to move.

DISCUSSION

The results of the study on the design and development of innovative lifting and support devices for the elderly with mobility problems have met the needs of ergonomic problems in terms of risks and postures of the elderly's body movements of the arms, head, body, legs, and feet, including various work postures having a significant impact on the need to urgently improve those related to lifting and supporting. Therefore, the innovation was developed with a focus on supporting the elderly to live their daily lives and selecting strong and durable materials. It was designed for users to use according to their abilities to help lift, support, stand up, and move the elderly well. When using the device, it needed little space.

The materials used are durable, strong, lightweight, and easy to move. It affects the body's movement to create comfort in life, affecting the quality of life of the elderly, and is in accordance with the principles of movement to support the body and stand up. And from the results of testing the prototype device, it was found that the device to help lift and support the body movement of the elderly could lift and support the body according to the patient's weight as designed and could help the patient to move and support with the device to help lift and support the body more conveniently for the elderly. As a result, the elderly were satisfied with using the device to help lift and support the body of the elderly, overall, at a high level.

This might be due to environmental risk factors of the elderly who had worked for more than 50 years and had repetitive work all the time, causing muscle pain, especially in the arms, head, torso, legs, and feet. It might be due to physical decline, which was partly because the elderly were using some parts of their body inappropriately, which might cause them to be more likely to be injured than normal. From the continuous monitoring and measurement of ergonomic evaluation results, an innovative lifting device was invented to help the elderly with knee, knee joint, and standing problems to help the elderly had a better quality of life than before in their daily lives in society happily. The device is especially suitable for the body of the elderly in Thailand.

The findings are consistent with Songsak Rakpuang and Phuchong Senanuch (2019, p. 205) who stated that the importance of social innovation for the elderly. It would help improve the quality of life, respond to the needs of the elderly in various aspects effectively, as well as help reduce social inequality more to prepare for entering the aging society in Thailand. In this regard, the application of innovation must consider and consider the needs and potential of each elderly person.

The innovation used must be consistent with the context of the area and environment. In addition, it must emphasize the integrated work of the multidisciplinary team, focusing on the participation of all sectors in order to meet the needs of providing services for the

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elderly to be able to access various technologies and innovations appropriately and comprehensively, which would result in the elderly being able to rely on themselves, which would ultimately make these elderly people become elderly people with quality and potential, ready to accept changes in society in all dimensions. It is also consistent with Worat Sitthileothaworn (2016, p. 110 - 114) who stated that the design of a walking training frame with a partial weight support system for people with walking movement problems found that the design and development of a walking device with partial weight support for people with walking movement problems, such as stroke patients, muscle weakness patients, and the elderly, to solve the problem of walking training after patients have trained to walk or used robotic walking training technology until they had a better walking ability to a certain extent.

Patients who could help themselves or step on their own should practice walking as often as possible using a walking training frame (Walker), which would make the muscles strong. But, the problem of falling is caused by that they did not have the device for weight-support system, and because patients with mobility problems had residual disabilities, it affected their body movement and walking patterns, increasing the risk of falling by 2-3 times. The device has been designed to be comfortable and correct according to the principles of walking training. From the results of testing the prototype device, it was found that the device could support the patient's weight as designed and could help patients to practice walking with walking training devices more easily. It also was in line with Athit Lamunplang (2019) who said that the increasing number of elderly people reflected the evolution of more modern medicine, along with the care for the health of the elderly.

However, to allow the elderly who are physically weak to live happily in an aging society, innovation should be another aid in taking care of their health and bodies that are not conducive to movement. In the future, it may be the main option that the aging society needs to use more of these innovations, which will help fulfill the lives of the elderly to be happier, have a better quality of life, and see their own value more in the context of Thai society which is entering a complete aging society.

Because the design considers the physique of Thai people, which is different from the standards developed from abroad, using strong, lightweight materials that are suitable for Thai living spaces, such as small houses or limited space, including designs that comply with the principles of proper support and movement, helping to reduce the burden on caregivers in the family.

The results of this innovation development were also consistent with the concept of Songsak Rakpuang and Phuchong Senanuch (**2019)** who stated that social innovation for the elderly could reduce inequality and improve the quality of life to suit the context of the area. It also supported the concept of Worat Sitthileothaworn (**2016)** who pointed out the importance of designing devices that support weight and are appropriate for the user's abilities.

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SUGGESTIONS

1. Suggestions arisen from this research

1) The results of this study should be further studied and monitored continuously. For example, chairs should be provided and suitably arranged for the elderly to reduce pain in some areas. New innovations might need to be designed to be suitable for the elderly, back support devices, and more rest periods between work.
2) After improvement, follow-up should be conducted using the RULA assessment form and the results recorded for continuous comparison and problem solving.
3) Reducing steps that cause repetitive work postures to increase work efficiency and reduce employee fatigue.
4) From the study results, the lifting devices were able to use for benefitting the elderly in facilitating their daily lives or activities more conveniently. It could help promote walking, standing, or activities that require walking or standing for a long time. It has easy-to-use steps, is not complicated, and can be used continuously. It helps patients have positive support in using innovations and prevents the possibility of falling. This results in the development of a better quality of life in terms of physical, mental, and social health.
5) From the study, it is possible to use the lifting device to benefit the family, which is more comfortable and allows them to work to their full potential without having to worry about the elderly in their daily lives, and also creates happiness within the family.
6) From the study, it could be used to benefit the elderly in society, or even meeting friends or joining social activities for the elderly could be easier when using this lifting device, making the elderly have a strong mind and live happily in society.

2. Suggestions for further study

1) Quasi-experimental research should be conducted to study the behaviors that affect the health while working of the elderly.
2) A mixed-methods study of factors affecting the development of innovative lifting devices for the elderly which are suitable for the elderly.

Note

This research presents the development of a designed and improved lifting device to increase efficiency and comfort in use. It has been protected by Thailand patent number 2402003372.

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