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Effects of water-based Thai dance on balance, muscle strength, quality of life, and blood glucose levels in elderly women

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ABSTRACT

This study investigated the impact of a water-based Thai dance routine on balance, muscle strength and endurance, quality of life, and blood glucose levels among elderly individuals. Participants were 128 women aged 60 to 70 from the Chaiyaphum Elderly Club, divided equally into an experimental group and a control group. Assessments were conducted at three intervals: before training, after six weeks, and after twelve weeks. Both one-way and two-way ANOVAs with repeated measures were employed, and Bonferroni's method was used for mean difference comparisons. Results showed that the experimental group, who engaged in the water-based Thai dance routines, exhibited significant improvements in static and dynamic balances, enhanced muscle strength and endurance, better quality of life, and maintained normal blood glucose levels compared to the control group ($p < .01$). Notably, improvements were more significant after twelve weeks of training than after six weeks. Conversely, the control group showed a slight decline in static balance after twelve weeks, although there were no significant changes in dynamic balance, muscle strength and endurance, quality of life, or blood glucose levels at any stage of the study.

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1. Introduction

By 2031, it is predicted that more than 20% of Thailand's population will be elderly. According to the World Health Organization, elderly individuals are at the highest risk of injury or death from falls due to changes in strength and flexibility, which increase the risk of falling (Kim et al., 2020). Water exercise is a beneficial activity for older adults. Water has high density and viscosity, providing greater resistance to movement than air. This helps older adults strengthen their muscles while moving. The buoyancy of water supports the body, reduces joint pressure, and creates movement resistance without increasing joint stress.

Regular exercise improves mood, reduces stress and depression, and enhances self-esteem (Martinez-Carbonell Guillamon et al., 2019; Jackson et al., 2022). It also improves balance (Shariat et al., 2022), body composition (Bailly et al., 2022), and blood sugar levels (Suntraluck et al., 2017). Exercises enhance physical fitness, muscle endurance, balance, the ability to perform daily activities, and overall quality of life (Chanakul et al., 2022; Nuangchalerm et al., 2024). For elderly people, moderate to high-intensity exercise is recommended (Maximos et al., 2022).

Physical fitness is tested by Health-Related Physical Fitness (HRPF) tests, such as muscle strength and endurance, in which the elderly have a better physical condition, as an increase in physical fitness test values shows an improvement in physical functioning (Li et al., 2018; Duan et al., 2022). There are many forms of musical and applied exercises of cultural dance, such as Brazilian dance or Chinese Tai Chi dance. Thai dance exercise is also widely known (Kaewjoho et al., 2020). Studies have shown that Thai dance combined with music is an exercise that promotes the health of the elderly (Sooktho et al., 2022). The study found that it improves bodily function, muscle strength, and endurance (Noopud et al., 2019). Based on preliminary research from previously published papers and other relevant materials. Exercise has been shown to have an effect on one's balance. It is imperative that senior people improve their quality of life, as well as their physical strength and endurance, and take preventative measures against diabetes. There are many different fitness programs accessible nowadays. Despite this, efforts are ongoing to improve its utility and

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suitability in the future. Therefore, the use of Thai dance training in water has positive effects on stability, muscular strength and endurance, quality of life, and blood glucose levels in older adults.

This approach can help seniors improve their future quality of life, physical health, and mental well-being while also providing long-term benefits designed specifically for the elderly. This study aims to investigate the effects of water-based Thai dance routines on balance, muscle strength, endurance, quality of life, and blood glucose levels in the elderly. It also aims to compare these effects at three stages: before training, after 6 weeks of training, and after 12 weeks of training.

2. Methods

This research is an experimental research design method that has been certified for human research ethics by Thailand National Sports University at SCI 018/2022 on April 29, 2022. The population was 7,752 elderly people from the Senior Citizens' Club, Chaiyaphum District, aged between 60 and 70 years, in 2021. Because of their social, technological, and cultural backgrounds, Thai families increasingly spend most of their time on televisions and mobile phones, reducing other activities and exercising less. The drop-in activity weakens muscles and causes unstable balance, perhaps leading to falls. Furthermore, two-thirds of the population is made up of females over the age of 65, who have weaker bones and muscles than men due to hormonal decline after menopause. Thus, fear of falling has a greater impact on women than men. (Tantirat et al., 2020). Cohen's (1988) sample size was used to determine the value at the significance level of .05, the effect size of 80, and the power of the test at the level of .80. The subjects must not have previously trained in the water-based Thai dance routine. If they engaged in any physical activity, it must have been irregular and not practiced more than twice. All samples were physically examined by a doctor, and no underlying conditions that could affect the trial were found. Exclusion criteria included participants who practiced less than 80% of the water-based Thai dance routine or missed more than 8 out of 36 sessions. Subjects not voluntarily participating or those prevented by force majeure events from continuing were also excluded. The research instruments can be summarized as follows:

- Weight scale and body composition measurement (TANITA, model TBF-531A).
- Height scale (FBT brand).
- Functional Reach Test with a reliability of 0.89 (Pires et al., 2020; Duncan et al., 1990).
- Osness Mobile Balance Test with a reliability of 0.86 (Thaiprasert and Supaporn, 2019; Osness, 1990).
- World Health Organization Quality of Life Brief – Thai with a reliability of 0.84.
- A blood sampling kit contains a vacuum tube with sodium fluoride anticoagulant.
- Thai Applied Dance Training Program in Water with an Index of Objective Congruence (IOC) of 0.92, indicating high accuracy (Rovinelli and Hambleton, 1976).

Thai dance moves were arranged by instructor Jittasai Lachantra, the copyright owner of Ban Tae Girl Dance. The instructor also prepared the leader to practice the water-based Thai dance routine and follow the musical rhythm appropriately.

The water-based Thai dance practice program was evaluated by three exercise physiologists and found to be valid, with an Index of Objective Congruence (IOC) of 0.92. A pilot study involving five elderly individuals not included in the sample group was conducted to test the program. Based on the pilot study results, the program was adjusted and improved before being applied to the actual samples.

Volunteers were recruited and selected according to specific criteria. The sample group was drawn from the Senior Citizens' Club in Mueang Chaiyaphum District, Chaiyaphum Province. The researcher explained the details of the research to the participants, who then signed a letter of consent to participate. Participants also completed a general health history questionnaire and a pre-training readiness assessment form based on exercise patterns.

- Participants' balances were tested before participating in the trial. Random assignment was conducted by matching the first 64 pairs and drawing a lottery ticket each to divide them into the experimental and control groups, which would yield the same number of participants. 2 groups of 64 people each.
- 64 Participants in experimental group A participated in the water-based Thai dance routine exercise for a total of 12 weeks, 60 minutes each on Monday, Wednesday, and Friday from 3.30 p.m. to 4.30 p.m. Meanwhile, the control group of 64 people led a normal 12-week life. Examples of normal activities of the control group include housework, gardening, wearing and taking off clothes by themselves, walking up and down stairs, standing up, sitting in chairs, walking, shopping, and participating in social activities.
- Preliminary data were collected before, during, and 1 day after participating in the trial.

Before the first week of the trial, during the sixth week, and after the twelfth week, subjects were tested at the Sports Science Center, Thailand National Sports University, Chaiyaphum campus. Data on age, weight, height, balance, muscle strength, and endurance were collected. A questionnaire was used to measure the quality of life of the elderly. Blood samples for glucose analysis were taken using standard methods, packaged in airtight tubes, and sent to the pathology laboratory. The blood was centrifuged at 2,000 rpm for 10 minutes, and the plasma was analyzed for blood chemistry. The collected data were recorded with mean and

standard deviation (SD). Two-way ANOVA with repeated measures was used to analyze differences in balance, muscle strength, endurance, quality of life, and blood glucose levels between the experimental and control groups. One-way ANOVA with repeated measures was used within each group to analyze differences in these variables. Pair-by-pair comparisons were made using the Bonferroni method, with statistical significance set at 0.05 (p<.05).

3. Results

Pre-trial test results of older adults in Chaiyaphum, including average age, weight, height, static balance, and dynamic balance, indicated no difference between the experimental group and the control group before the training, a statistically insignificant difference (Table 1). The comparison results of the difference in the static balance mean showed that the experimental group had a statistically significant difference from the control group at 0.01 (p<.01). When comparing within the group, it was found that the experimental group had an increased static balance value after 12 weeks and 6 weeks of training, which was higher than before the first week of training. The control group had lower stability balance values after 12 weeks than 6 weeks of training and before 1 week of training, and less after 12 weeks than 6 weeks of training. There was a statistically significant difference (P <.01) (Fig. 1). The comparison results of the mean difference in dynamic balance showed that the water-based Thai dance routine experimental group had improved balance while moving, differing statistically significantly from the control group at the level of 0.01 (p< .01). When comparing within the group, it was found that in the experimental group, the dynamic balance value decreased less after 12th and 6th weeks of training than before a week of training and decreased less at after 12 weeks than 6 weeks of training; there was a statistically significant difference (p<.01).

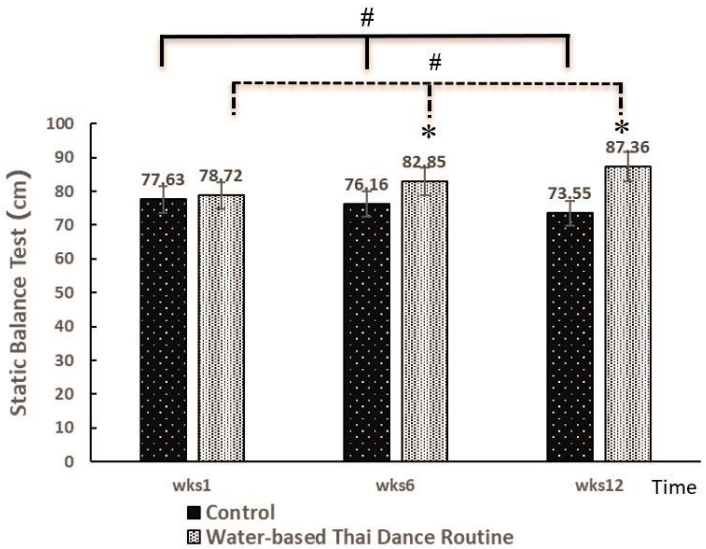
The dynamic balance value in the control group increased after 12 weeks and 6 weeks of training, as well as before the first week of training; however, these changes were not statistically significant (Fig. 2).

The comparison of mean differences in muscle strength and endurance showed that the experimental group, who practiced the water-based Thai dance routine, had statistically significant improvements in strength and endurance compared to the control group (p<0.01). Within the experimental group, muscle strength and endurance increased significantly after 6 weeks and further improved after 12 weeks of training compared to the first week. These differences were statistically significant (p<0.01).

In contrast, there were no statistically significant changes in muscle strength and endurance in the control group at any stage of the training (Fig. 3).

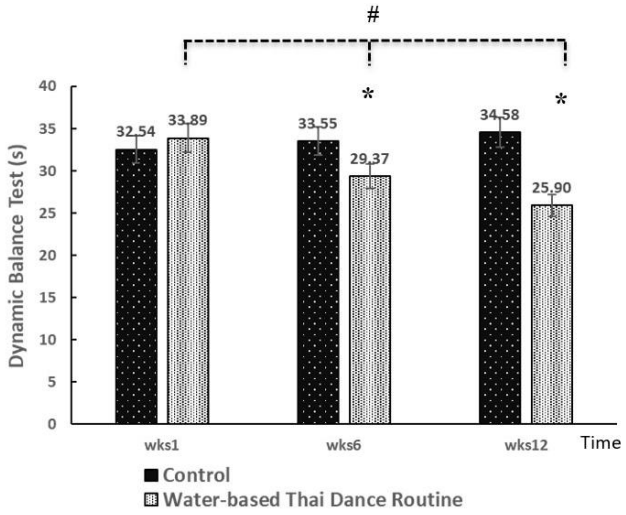
Table 1: General characteristics of the elderly and test the mean difference before training between the experimental group and the control group

Variable	Group	N	X	SD	t	p
Age (years)	Experimental	64	64.20	1.45	.364	.674
	Control	64	63.84	2.18		
Weight (kg)	Experimental	64	58.681	7.17	.863	.357
	Control	64	57.66	6.20		
Height (cm)	Experimental	64	161.63	4.79	.000	1.00
	Control	64	161.40	4.17		
Static balance test (cm)	Experimental	64	78.71	7.72	.811	.686
	Control	64	77.62	7.53		
Dynamic balance test (s)	Experimental	64	33.89	4.75	1.787	.207
	Control	64	32.54	3.68		



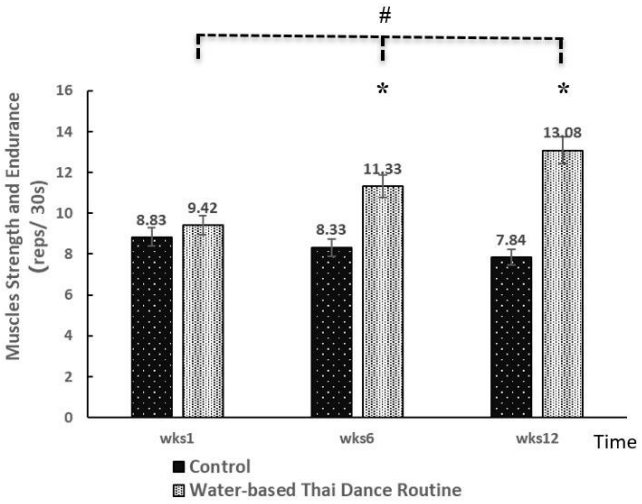
*: There was a statistically significant difference between groups (P < .01); #: There was a statistically significant intragroup difference (P < .01)

Fig. 1: Difference in static balance by testing the ability to reach forward (Functional reach test)



*: There was a statistically significant difference between groups (P < .01); #: There was a statistically significant intragroup difference (P < .01)

Fig. 2: Differences in dynamic balance by the Osness's (1990) balance



*: There was a statistically significant difference between groups (P < .01); #: There was a statistically significant intragroup difference (P < .01)

Fig. 3: Differences in muscle strength and endurance

Comparison of average quality of life differences. It was found that the water-based Thai dance routine group had a statistically significant quality of life difference from the control group at 0.01 (p< .01). When comparing within the group, it was found that the experimental group had an increase in quality of life after 12 and 6 weeks of training more than before a week of training and after 12 weeks more than 6 weeks; there was a statistically significant difference of 0.01 (P< .01). The control group had statistically insignificant differences in quality-of-life levels in all periods of training (Fig. 4).

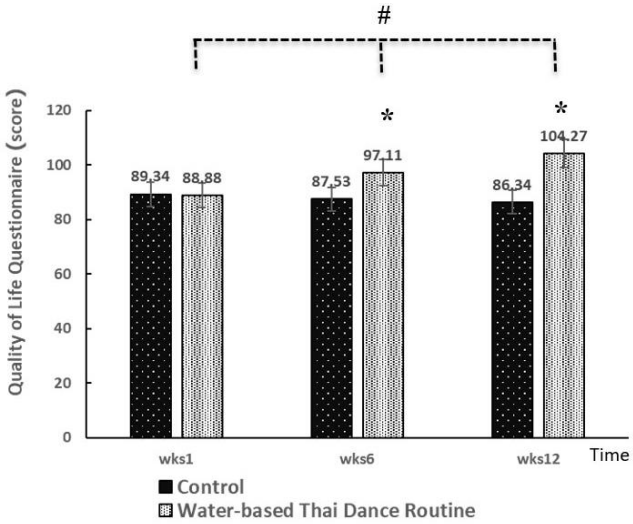
The comparison results of mean blood glucose levels showed that the water-based Thai dance routine experimental group had a statistically significant difference in blood glucose levels from the control group at 0.01 (p< .01). When comparing within the group, it was found that the experimental group had lower blood glucose levels after 12 and 6 weeks of training than before a week of training, also after 12 weeks is lower than 6 weeks of training; there was a statistically significant difference of .01 (P < .01). The control group had statistically insignificant differences in blood glucose values in all periods of training (Fig. 5).

4. Discussion

4.1. Static and dynamic balances

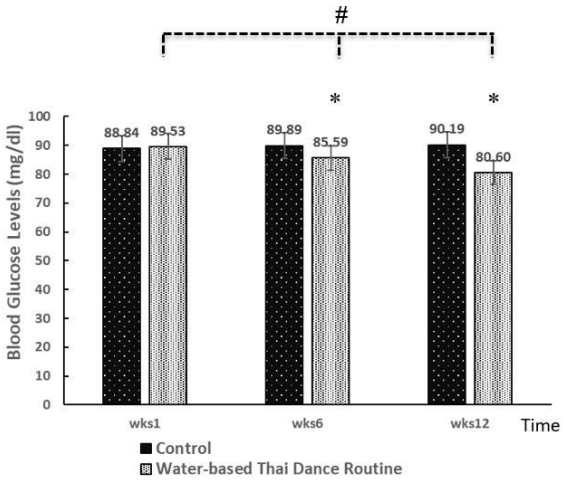
The results showed that the experimental group practicing the water-based Thai dance routine had significantly better balance, both static and dynamic, compared to the control group (p<0.01). Within the experimental group, static balance improved significantly after 6 and 12 weeks of training compared to before training, with greater improvements after 12 weeks than after 6 weeks (p<0.01). In the control group, static balance decreased after 12 weeks compared to 6 weeks and before the training started (p<0.01). There was no significant difference in dynamic balance improvement between 6 and 12 weeks and before the training in the control group. Practicing the water-based Thai dance routine helps develop balance and builds confidence in movements for the elderly. Practicing the water-based Thai dance routine for 12 weeks, three days a week, 60 minutes each time, has been shown to improve balance in the elderly. This routine is suitable for older adults, helping their bodies adapt. Besides dance, the

routine includes stretching exercises for the head, neck, torso, and back muscles. Balance is crucial for movement, involving core muscles, which include the back and abdominal muscles, to maintain stability and prevent falls. The water-based Thai dance routine includes isometric exercises, like standing on both feet, standing on tiptoes, or standing on one foot while holding the other up. It also includes isotonic exercises, such as alternating foot positions, leg steps, cross-legged steps, twisting the torso to the music, rotating shoulders and wrists, and moving wrists and fingers to the music rhythm.



*: There was a statistically significant difference between groups (P < .01); #: There was a statistically significant intragroup difference (P < .01)

Fig. 4: Differences in quality of life (WHOQOL-BREF-THAI)



*: There was a statistically significant difference between groups (P < .01); #: There was a statistically significant intragroup difference (P < .01)

Fig. 5: Differences in blood glucose levels

Thai dance training, even with ankle weights, improves walking and balance in the elderly. This improvement comes from posture exercises that challenge the body's balance by stepping in different directions and lowering the support base (Krityakiarana and Jongkamonwiwat, 2022).

Practicing Thai dance in water involves maintaining static balance by holding the position while lowering the support base. Dynamic balance is practiced by moving, such as stepping sideways, close stepping, standing on tiptoes or one toe while raising the other foot, and standing with heels raised. These movements strengthen leg and torso muscles, which help maintain balance. Practicing dynamic balance includes various postures like standing with feet together, one-legged standing, heel walking, and walking with toes and heels. These postures help improve the balance of elderly participants.

The water-based Thai dance routine promotes dynamic balance and builds confidence in the elderly's movements. This routine is suitable for the elderly and helps their bodies adapt. Regular practice of this routine stabilizes the body, especially the ankles, leg muscles, knees, hips, core muscles, and back muscles, by walking in different directions to the rhythm of the music. This strengthens leg muscles and improves coordination between the brain, ears, eyes, and the perception of joints and muscles.

Balance allows people to perform daily and other activities, like exercises and sports, through several coordinated mechanisms. Vision detects surroundings and the body's gravitational pull, while muscles, joints, arms, legs, and the spine perceive external conditions and gravity. The inner ear's balancing system senses changes in head posture. All

these functions must be coordinated in a balanced system by transmitting signals to the receiving and processing centers in two central areas.

Practicing Thai dance in water includes standing postures, knee bending, and knee stretching in various poses. Some postures involve raising the knees to resist the force of the water, resulting in increased developmental balance. This is in line with Yee et al. (2021), where balance is associated with daily life. Standing, walking, running, getting up, sitting, training in forms of standing on one leg, double legs, and stepping feet in the direction of various training postures, such as stepping feet forward, back, left, right, and raised (Giannouli et al., 2020). There are constant changes in movement and posture. Dynamic movement is the practice of controlling the balance of the body while moving and changing the center of the body by using the mechanism of balance control from the vestibular system of consciousness and position perception of body movement. Proprioceptive senses, visual systems, and nerve impulse impulses are gathered, processed, and communicated to the body control system, allowing muscles to respond to changes and move in desired postures without losing balance. Thus, resulting in better balance, various body aches and pains decrease as muscles, ligaments, and joints are stretched and properly loosened (Dunsky, 2019). The water-based applied Thai dance practice for the elderly is different from other exercises on land. As age increases, it becomes more difficult and less fun to exercise. Even walking creates pressure on the bones and joints. Exercises with devices that help to reduce shocks on the joints, such as cycling and elliptical machines, can also be dangerous as there is a risk of falling (Harvey et al., 2018). Thus, exercising the applied Thai dance combined with the use of the physical properties of the water results in greater efficiency effects on the muscular system. The resistance of water causes muscles to work more compared to the same movements on land, which increases muscle strength. While the buoyant force of water supports the body's weight and helps older people maintain balance, it also has an impact on bone and joint systems because it reduces the pressure of the body's weight on bones and joints, which helps maintain or increase bone density. Consequently, shock-induced pain is relieved, and blood and fluid circulation in the body improves. Thus, it lowers the chance of falling (Abadi et al., 2020).

4.2. Muscle strength and endurance

The study found that in the water-based Thai dance routine experimental group, muscle strength and endurance values increased after 12 and 6 weeks of training more than before 1 week of training. Also, after 12 weeks is higher than 6 weeks of training with a statistically significant difference of 0.01 ($P < .01$). The control group, muscle strength and endurance in all three stages have no statistically significant difference. As a result, exercising in the water helps relieve stress both physically and mentally. The water's properties also help develop strong muscles, allow arms and legs to move conveniently, and reduce impact on joints. Water exercise is, therefore, a suitable choice for older adults. In line with Martínez-Rodríguez et al. (2022), it is concluded that aquatic exercise can increase muscle strength and increase body flexibility. This exercise in water has low impact and risk. According to physics calculations, the body weight pressed on the soles of the feet decreases by about 50 percent if the water is at waist level and only 30 percent if the water level reaches the chest. In line with Kim (2021), exercise in water is characterized by limb movement in water. In the depth of water at chest level, the buoyancy helps support the body weight. In addition, turbulence and viscosity allow the body to exert water throughout movements. The water exercise reduces shock. Water exercise has been shown to improve body strength, stability, and balance, as well as prevent spills (Kim et al., 2022). It also helps to improve the physical and mental health of the elderly. The different Thai dance postures practiced in water can increase muscle strength in the arms and legs or target specific muscle groups, improving functional mobility (Saxon et al., 2021). There are research studies of people who participated in a water exercise program for 12 weeks, 3 times per week, and 45 minutes each. After the program ended, it was concluded that aquatic exercise increased physical performance by strengthening the arm and leg cages (Erkkola et al., 2021). It can be concluded that water exercise is an appropriate activity for the elderly since it provides health development benefits, burns energy efficiently without high risk of injury, and also forms resistance and support forces to maintain balance.

4.3. Quality of life

The results showed that the water-based Thai dance routine experimental group had a statistically significant quality of life score different from the control group at 0.01 ($p<. 01$). When comparing within the group, it was found that the water-based Thai dance routine group had higher quality of life values after the 12th and 6^{th} weeks of training than before training, moreover after the 12^{th} week is higher than the 6^{th} week with a statistically significant difference 0.01 ($P < .01$). The control group had statistically insignificant differences in quality of life scores after all periods of training. The study's result on the quality of life of the elderly showed that after the program, the group that practiced the water-based Thai dance routine had a better score on the quality of life than the control group in terms of physical components of the quality of life. Includes the perception of a person's physical condition that affects daily life, such as perceiving the integrity of the body, recognition of the ability to deal with physical pain, awareness of the strength of daily life, and the perception of independence

without dependence on others (Weziak-Bialowolska et al., 2023).

Aquatic exercise programs affect the physical quality of life, resulting in a higher overall quality of life. Water exercise programs last approximately 60 minutes at a time, consisting of breathing exercises, warm-up sessions that stretch all muscles in the body, and exercises that involve joint arm and leg movements, moving forward and backward, side-slide and brisk walking, and ending with a cool-down period that consists of slow walking, relaxation, and stretching, which are the appropriate programs for older adults that help the elderly stay healthy (Bar-Tur, 2021). Exercise three times a week for eight weeks will be sufficient to develop physical fitness. The study showed that there was an increase in physical quality of life scores after participation in water exercises. The result of the exercise program with Thai dance applied in the water has increased balance, mobility, muscle strength and endurance, flexibility, tolerance of the circulatory system, and breathing while decreasing fear of falls and body composition fat percentage. This improved overall health and increased the elderly's abilities to perform various daily activities efficiently. This is in line with previous studies that have found that increased physical fitness from exercise affects the quality of life, especially in body composition.

Dunsky (2019) reported that balance, falling, and quality of life in older adults improve with regular exercise. The study found that those who exercised three times per week had significantly better balance than those who did not exercise. Supaporn (2018) concluded that people of all ages, including the elderly, need to socialize. While younger people regularly meet others at school or work, retired individuals often stay home and have fewer social interactions. Physical activities with others provide opportunities for seniors to meet, share experiences, and reduce stress. Exercise helps the elderly make friends, be social, and relieve stress. It also improves concentration and stimulates memory, increasing confidence in daily life. Smith and Merwin (2021) found that exercise improves the mental health of older adults. Programs that combine exercise with folk music showed improved mental health and reduced depression after training. Factors influencing quality of life include physical, psychological, relational, and environmental aspects. Social interaction is crucial. While exercising at home is convenient and beneficial, lack of interaction can lead to depression and loneliness, negatively affecting overall well-being. Participating in group Thai dance exercises in water not only improves static balance, dynamic balance, muscular endurance, and quality of life but also provides social interaction with peers. This reduces loneliness and depression (Zimmer et al., 2021).

4.4. Blood glucose levels

The results showed that the experimental group practicing water-based Thai dance had significantly different blood glucose levels compared to the control group ($p<0.01$). Within the experimental group, blood glucose levels were significantly lower after 12 weeks of training compared to 6 weeks before training ($p<0.01$). There was no significant change in blood glucose levels in the control group at any stage of the training.

The training was conducted continuously for one hour, three days per week, for twelve weeks, which led to the body using energy from glucose breakdown (Soori et al., 2017). Moderate-intensity exercise for at least 150 minutes per week increases glucose metabolism, resulting in lower blood sugar levels. This helps suppress the appetite control center in the hypothalamus, reducing cravings for excess food and helping with weight control (Behary et al., 2019).

Exercise also causes the body to sweat regularly, and burning 500 calories per week increases energy consumption, improving physical fitness. It enhances the endurance of the cardiovascular system at rest, lowers blood pressure, makes blood vessels more elastic, increases lung capacity, and improves strength, endurance, flexibility, and body composition (Mileva and Zaidell, 2022).

Moreover, aquatic exercise helps lower blood glucose levels because exercise in water moves the core muscles, causing the metabolic system to work. Glucose energy is consumed in the muscles by increasing Glucose transporter-4 (GLUT-4). This reduces insulin resistance, increases the number of receptor insulin, and increases tissue sensitivity in response to insulin. As a result, blood glucose levels decrease when glucose is insufficient.

The body has an increase in the breakdown of fat accumulated in different parts of the body, resulting in body composition and body mass index decreases. Proper or healthy physical activity can be measured according to the level of fitness that has changed. While exercising, the hormone insulin introduces sugar into working muscle cells, and moderate-intensity exercise reduces sugar by 50% (Ceylan et al., 2020; Mamrack, 2020; Väistö, 2021). Therefore, continuous exercise with Thai dance in water for 12 weeks, 3 days a week, 60 minutes each session, is suitable for the elderly and results in lower blood sugar levels.

4.5. Qualitative data from the water-based applied Thai dance study

From observing and interviewing the elderly who participated in the water-based applied Thai dance exercise, they were satisfied with their increased ability to perform daily activities; they were confident in walking and getting around by themselves; they had fewer aches and pains in their arms, legs, and knees; they had more freedom to do or move as they wished since they had enough muscle strength to do more daily tasks; they could concentrate more on work; loneliness and depression were reduced; and they could wear or remove clothes in a more confident position; they

can move through crowds, overcome barriers, walking on rocky ground, sloping terrain, and in low-light conditions; they also feel more energized, since their fear of falling has decreased.

4.6. Results after practicing the water-based Thai dance for 12 weeks

Improved balance decreases the fear of falling. Water-based Thai dance exercises have been shown to strengthen leg muscles, leading to better balance (Gebeyehu Ahemed, 2020). This is consistent with observations and interviews with participants. They described the dance as involving movements forward, backward, left, and right, standing on one foot, and stomping their feet back and forth. For the arms, they spread them left and right, lifted them up and down, and wiggled their wrists to the rhythm of the music. These movements trained the muscles on both sides of the body, as well as the arms and legs. Walking requires the body to lean in the direction of movement and the arms to swing for balance. As a result, their balance improved, and their fear of falling decreased. They could move left and right as needed, felt confident in their steps due to frequent practice, had stable steps, which reduced the chance of accidents, and could walk on uneven surfaces without staggering.

The body is becoming stronger. The water-based applied Thai dance practice strengthened the elderly's bodies. The constant 60-minute aerobic workout increased body strength and endurance. After training, participants relaxed and stretched their muscles, resulting in the experimental group developing a stronger body than before (Noopud et al., 2019), which was consistent with observations and interviews. One of the participants stated that their legs have become stronger. "In the past, when going upstairs, I could barely climb them, felt tired quickly, and my knees rustled. However, doing Thai dance in the water has improved my walking ability. I felt like I could walk for longer periods of time, had greater strength to walk further, raise my legs higher, and walk upstairs without stopping".

Improving agility. Moving fast requires strength and muscular endurance, as well as the ability to change the direction of movement (Sooktho et al., 2022). Consistent with observational and interview data, the participants said the water-based applied Thai dance practice involved walking in different directions. It requires coordination of the torso, arms, and legs, as well as quick command of the brain, which affects overall health in terms of increased speed, stability, and endurance in walking, feeling energized, and improved agility.

Having fun and good mental health by socializing with friends. Enjoying exercise or physical activity is important for people of all ages. Individuals tend to participate more frequently in activities that they find enjoyable. Where the fun could come from doing favorite activities, playing with good friends, or having an excellent ability to do activities, including fun or energized songs that cause an addiction to exercise or exercise more frequently. It has positive effects on health, as happiness and fun while doing exercise cause a cheerful mood and good mental health (Nuangchalerm et al., 2024). Compatible with data from observations and interviews. According to the participants, after practicing Thai dance in the water, they felt happy and in a good mood because of the fun background music, which encouraged them to exercise continuously and didn't want to stop; they were not tired or bored, their brains were refreshed, they had a cheerful mind, and they were happy with life rather than sad. Socializing with friends helped them relieve stress; they met new friends, and there was discussion and consultation; they exchanged experiences and confided in each other about various issues. Exercise is, therefore, one of the activities that allows the elderly to maintain relationships and a social life while also relieving stress.

5. Conclusion

The findings of this study demonstrate that water-based Thai dance routines significantly improve static and dynamic balance, muscle strength and endurance, quality of life, and blood glucose levels in elderly women. Participants who engaged in these exercises exhibited substantial enhancements in their physical and mental well-being compared to the control group, who did not show significant changes.

Given the positive outcomes, it is recommended that health promotion departments, sports science centers, health personnel, community leaders, clubs, and village health volunteers consider incorporating water-based Thai dance into regular exercise programs for the elderly. This exercise regimen is particularly suitable for older adults due to its low impact on joints while providing substantial health benefits.

Future studies should explore additional variables, such as changes in blood chemicals, including lactic acid levels, lipid levels, enzymes, and free radicals that indicate muscle damage. Additionally, comparative studies should be conducted to evaluate the efficacy of water-based Thai dance routines against other forms of exercise, such as walking, cycling, or land-based exercises. These investigations will further our understanding of the benefits and potential applications of water-based Thai dance for elderly health promotion.

By integrating these recommendations and suggestions into ongoing research and community health initiatives, we can better support the health and quality of life of the aging population.

Compliance with ethical standards

Ethical Considerations

This study was conducted in accordance with the ethical standards outlined by the Thailand National

Sports University. The research protocol was approved by the university's ethics committee (Approval Number: SCI 018/2022, April 29, 2022). All participants provided informed consent before their inclusion in the study. The consent process included detailed information about the study's purpose, procedures, potential risks, and benefits. Participants were assured of their right to withdraw from the study at any time without any negative consequences. Confidentiality and anonymity of the participants were strictly maintained throughout the research process. All data were stored securely and were accessible only to the research team.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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