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RESEARCH ARTICLE

Effect of Aquatic Exercise Training in Young Female Individuals With Chronic Ankle Instability

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Abstract

Purpose: The purpose of this research was to examine effect of aquatic exercise training in young females with chronic instability of the ankle. **Method:** The research comprised of 100 female individuals aged 20-30 years that fulfilled the inclusion and exclusion criteria. Participants were separated into two categories with equal participants, control group (n=50) and experimental group (n=50) by using SPSS software. Experimental group underwent hydrotherapy program while control group underwent land-based exercise program with frequency of twice a week for about 6 weeks. The scores were statistically analysed by using paired and unpaired t-test. **Findings:** The findings showed that the two groups improved significantly in ROM. Group B improved significantly in ankle dorsiflexion, plantarflexion, inversion, and eversion ($p < 0.0001$), while the Group A showed p values of 0.0271, 0.3758, 0.4466, and 0.0452, respectively. The experimental group exhibited more improvement in MMT than the control group. The experimental group had significant strength in dorsiflexors, plantarflexors, invertors, and evertors ($p < 0.0001$), while the control group had significant strength dorsiflexors, invertors, and evertors ($p = 0.0015$, 0.0055, and 0.0020) and plantarflexors ($p = 0.0207$), respectively. The experimental group improved SEBT significantly ($p < 0.0001$) in all directions, while the control group exhibited significant results ($p< 0.0001$,0.0068,0.0062,0.0031,0.0090, 0.0423,0.0167).**Conclusion:** It concluded that the aquatic training program had shown a significant positive response in improving ROM, muscle strength and balance among young females experiencing chronic instability of the ankle.

Keywords
Ankle instability, Ankle Sprain, Balance, Hydrotherapy, Muscle Strength

INTRODUCTION

Chronic Ankle Instability (CAI) is a condition characterized by remaining symptoms associated with ankle sprain, such as prolonged pain, recurring instances of sprain, and the sensation that the ankle feels unstable in any way (Al-Mohrej & Al-Kenani, 2016). CAI growth requires an acute ankle sprain injury (Hertel & Corbett, 2019).The twisting of the ankle joint comprises concurrent inversion and plantarflexion, which is among the most prevalent cause of damage in ankle sprain where any of the ligaments within the ankle joint are stretched or partially torn. Because the anterior talofibular ligament (ATFL) is the most weakened, it is most typically injured during an ankle sprain. Approximately 93% of individuals with minor ankle sprain do not receive appropriate treatment (Al-Mohrej & Al-Kenani, 2016; Hertel & Corbett, 2019). According to Mackenzie M. Herzog's study,

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70% of people who suffer a mild ankle sprain acquire chronic ankle instability (Herzog et al., 2019). Chronic ankle instability causes include repeated ankle sprains, ankle joint diseases, and an one-time ankle injury at young ages (Al-Mohrej & Al-Kenani, 2016; Herzog et al., 2019). Women in the middle stages of life experience a wide range of hormonal abnormalities, as this age category encompasses each of the postpartum and menopausal periods. Research on persistent instability of the ankle across a range of demographic groups and information resources showed that the incidence of chronic instability of the ankle is 2.6 times greater in women as compared to men (Herzog et al., 2019; Heitz et al., 1999). This is due to women's bodies fluctuate in the amounts of progesterone, estrogen, and testosterone, which are critical for the structure of ligament the collagen and the preservation of the integrity of the ligaments. Women, especially those in their middle years, might be even more susceptible to sprains due to increased flexibility in ligaments and tendons, a condition primarily caused by the hormone estrogen (Heitz et al., 1999).

Furthermore, two potential causes has identified by earlier research as probable causes of persistent ankle instability. The initial process involves structural harm to the connecting ligamentous tissues resulting in instability in mechanics caused by ligament flexibility and increased joint movement of the talocrural, subtalar, and inferior tibiofibular joints. Functional instability is another mechanism, wherein an individual experiences persistent sprains and an imbalance in postural stability, regardless of whether they have a sensation of ankle give-away (Nualon et al., 2013; Hertel , 2000). Problems in balance and joint positioning sensing, which primarily rely on afferent signals for intricate sensory-motor emancipation will result straight away from these. Meanwhile, resilient proprioception, defined as a capacity to incorporate sensory inputs from diverse mechanical receptors, is critical for maintaining dynamic joints and functional stability (standing, walking, and running) (Tabassum & Azim, 2024). While previous studies discovered that the ankle serves an important role in preserving balance, the medical literature reveals that nearly all of rehabilitation centers for sprains of the ankle include both strengthening and perception of position activities (Ben Moussa Zouita et al., 2013; Blackburn et al., 2000; Bernier & Perrin, 1998).

Many researchers have investigated the impact of exercises for strengthening, proprioceptive activities, or a combined effort of the two on an individual's restoration to activities of daily living. Furthermore, Han et al. reported that overall and sports-specific training, injuries related to sports, and sports-induced exhaustion may all impact ankle proprioception, potentially leading to decreased balance abilities (Han et al., 2015). Additionally, ROM was assessed as an indicator of ankle sprains. Dorsiflexion range was a substantial predictor of ankle sprain. Postural sway and presumably sense of position were additionally predictive factors (de Noronha et al., 2006). However, early studies indicate that people with a restricted ankle dorsiflexion motion might be more susceptible to ankle sprains. Thus, studying dynamic equilibrium, as well as static equilibrium and range of motion, is critical for preventing ankle injury. The theoretical as well as scientific study has declared that equilibrium and sense of position is vital abilities for any the participant and must be taken into account as a component of a rehabilitation regimen (Jain et al., 2014; Thein & Brody, 1998). Additionally, research suggests that land-based activity might be more advantageous for individuals who experience injuries to the ankle by enhancing ankle stability and re-educating the muscles and ligaments around the ankle joint.

The previous research done on the impact of plyometric activities on land discovered that the human being is subjected to a significant impact loading, which causes compressions of the vertebrae and the lower limbs (Donoghue et al., 2011; Yalfani et al., 2015). Most recreational activities include jumping and cutting on the ground, therefore the force exerted on the ground is stronger than on water, resulting in a high loading effect on the joint during land-based training. Then, taking into account the physical features of water (buoyancy, viscosity, hydrostatic pressure, and temperature) might be more effective in improving balance and sense of position on an aquatic program (Abadi et al., 2017; Manjrekar et al., 2024). Underwater exercise, often referred to as aquatic exercise, has been frequently employed in rehabilitation programs, particularly when training under normal gravitational settings can be challenging and uncomfortable. Water buoyant properties minimize the amount of weight that

bones, joints, and muscles must carry. The amount of weight that is carried reduces with increasing immersion in water, as a person standing underneath the water to the depth of their xiphoid process bears around 28% to 35% of their own body weight, based on gender. With increased exercise and greater rate of movement, the percentage of bearing weight increases. The comforting temperature and vacuum of the water also minimize edema and improve circulation of blood (Thein & Brody, 1998; Donoghue et al., 2011). As a result, the water's environment promotes initial active mobilisation and dynamic strengthening. In the research conducted by Nualon et al., it was discovered that the hydrotherapy and land-based treatment groups had enhanced ankle ability to function as evidenced by single-limb jumping ability (Nualon et al., 2013). Similarly, Yalfani et al., (2015) found that aquatic exercise improved pain alleviation, performance, and dynamic along with static balance in patients with chronic sprains of the ankle, although there appeared to be no statistically noteworthy distinction when compared to land exercise (Yalfani et al., 2015).

However, there has been no focus done on managing young females with chronic ankle instability experiencing limited range of motion, strength and impaired balance to recover to get back to their daily activities soon. These females need a training program to improve all these components. The goal of the present research aimed to examine the effect of 6 weeks of rehabilitative training in both land and water media on young females with chronic instability of the ankle. By employing and executing the physical characteristics of water, rehabilitation programs for young females may be able to increase the effects of training.

MATERIALS AND METHODS

Participants

A total of 100 females ([n= 4× (SD)2 /mean ×(€)2]) were randomly selected for this experimental study, which was carried out using the computerized SPSS software. The study included females in the age range of 20 to 30 years who had a record of a minimum of one substantial ankle sprain; the first sprain must have happened a minimum of one year before to study enrollment and the most recent injury had to occur at least three months before the study enrollment. Women with medical records of history of lower limb orthopedic surgeries, past experience of lower extremity fractures or situations for which diagnostic imaging is not advised (such as pregnancy) were disqualified from the research. The study included The institutional ethical council of KVVDU, Karad provided ethical authorization (Protocol No.295/2022-2023). This experimental study was conducted at Krishna College of Physiotherapy in Karad. The participant were provided with informed consent along with the volunteer form covering study details, risks, benefits, confidentiality, and participant rights. Procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975.

The goal of the study was explained to the participants, and they were informed about the procedure. Participants will receive a quick assessment prior to the evaluation. These 100 females were randomly assigned to one of two groups. Group A as well as Group B by the using the envelope technique. Before the treatment starts, two envelopes bearing the group names A and B were created, and subjects were instructed to select one. The Star Excursion Balance Test (SEBT), manual muscle testing (MMT), and range of motion (ROM) were used as pre-test measures of outcome. They gave the individual the intervention that was assigned to them in the envelope. Aquatic training were given to group A , whereas, traditional land-based training were given to group B participants. For approximately six weeks, each group engaged in the activities. The investigation was conducted for about six months.

Group A (Aquatic Training)

Every participant was requested to participate in an aquatic treatment session at Krishna Vishwa Vidyapeeth's Hydrotherapy Pool, which is part of Krishna College of Physiotherapy. A 50-minute training schedule was devised, interspersed with a 10-minute recovery time. Ten minutes of warm-up, thirty minutes of active exercise, and ten minutes of cooling down comprised the workout routine. For around six weeks, the 50-minute workout regimen was followed two times a week. A physiotherapist and an aquatic exercise instructor oversaw this program. The pool's temperature was kept between 33°C and 34°C. The workouts were progressively raised in both intensity and frequency for a period of 6 weeks. We paid greater attention to the participant's safety and security during every

training session than we did to precision. Therefore, in order to prevent injuries, we gave the patient instructions to complete the exercise with slightly altered movement. The exercise program is mentioned in Table 1.

Group B (Land Based Training)

The six-week land-based training course took place in a therapy room next to the hydrotherapy pool. Same exercises were given to this group as that for aquatic training group.

Data Collection Tools

Range of Motion (ROM)

Active dorsiflexion, plantarflexion, inversion, and eversion ROM were measured with a universal goniometer. The participant was directed to actively and maximally move their ankle in four directions. Three measurements were taken in each direction, from which a mean degree was determined. To avoid movement of the hips and knee movement, the same assistance stabilized the fibula and tibia. The Goniometer's ICC coefficients ranged from 0.81 to 0.94 (Cox et al., 2018; Norkin & White, 2016).

Table1. Exercise protocol for group A aquatic exercise program (Ragab, 2020; Singh et al., 2022; Kadav et al., 2023).

Program	Exercise	Intensity (Week 1--> Week 6)	Frequency (sets of repetition) (Week 1--> Week 6)
Warm up (10 minutes)	Static walk	-	-
	Jog in a place	-	-
	Combination stretching	-	-
Strength Training (10 minutes)	Double-leg squat	10 repetitions	3 ----> 6
	Single leg squat	10 repetitions	3 ----> 6
	Hip flexion-extension using theraband	10 repetitions	3 ----> 6
	Hip abduction-adduction using theraband	10 repetitions	3 ----> 6
Balance training and Range of Motion (ROM) exercise (20 minutes)	Walking forward and backward (meter)	20 meter	20×4 ---->20×8 (Progress to eyes closed)
	Tandem walking (meter)	20meter	20×4 ---->20×8 (Progress to eyes closed)
	Toe raises (steps)	10--->15	1-----> 6
	Heel raises (steps)	10--->15	1-----> 6
	Step up and step down	10 steps	1-----> 6
	Side stepping-Right and left side	10--->15 steps	1-----> 6
	Forward lunges	10 steps	2-----> 6
	Side lunges	10 steps	2-----> 6
	Standing knee lift- Right & Left (marching)	10 steps	3 ----> 6
	Hip kickers- Right & Left	10 steps	3 ----> 6
	Deep water bicycle	1 minute	3 ----> 6
	One leg balance-right &left (Eyes open to eyes closed)	Front (hold 3 counts),& Side to side (hold 3 counts)	3 ----> 6
	Single limb stance and catching and throwing the ball (Eyes open to eyes closed)	Hold the position:30 seconds-60seconds	3 ----> 6
	Wall pushups	10	3 ----> 6
Cool Down (10 minutes)	Combination Stretching	-	-
	Joint relaxation	-	-
	Deep breathing	-	-

Manual Muscle Testing (MMT)

The following MMT methods and grading method will be used while performing MMT on the gluteus medius, gluteus maximus, quadriceps, tibialis anterior, tibialis posterior, peroneus longus/brevis (group), and gastocnemius. The examinations will be stopped if the subject experiences pain or is unable to maintain the test

position at a particular level of resistance. To identify weakness in the muscles, these assessments continue to have sufficient validity and intra-rater consistency (Kendall et al., 2005).

Star Excursion Balance Test (SEBT)

A diagnostic test for dynamic balance is the SBET. Participants will take a unilateral stance in the middle of a grid that has 45-degree intervals marked around it. Participants will perform three repetitions of the single-limb squat reach after completing a training trial that consists of six repetitions in one of the eight test directions. There will be a pair of trials conducted: one in which the participant has to stand on both the afflicted as well as unaffected limbs. Anterior, lateral, anterolateral, posterolateral, posterior, medial, anteromedial, and posteromedial are among the test directions. After three repetitions in every direction, the observing therapist will note the distance covered between the reaching extremity's heel and stance toe. In between each trial, there will be a fifteen-second break. If the participant does not (1) sustain bearing weight throughout the test, (2) elevates the stance foot, (3) lose balance, or (4) fails to maintain or start positions for one second, they won't be allowed to repeat. The reliability of the test at hand is satisfactory (ICC =.67-.97) (Gribble et al., 2007; Hertel , 2000; Kinzey & Armstrong, 1998).

RESULTS

100 female participants in the research were allocated into two distinct categories, group A and group B, consisting of 50 individuals each, using a simple method of random sampling. Group B underwent a land-based exercise regimen two times for every week for about six weeks, whereas Group A received an aquatic exercise regimen. When comparing to a land-based training program, the impact of an aquatic training regimen was considerably more successful for treating chronic instability of the ankle in young females, in accordance with the statistical evaluation.

Table 2. Demographic variables

Variables	Number of participants (%)	
	Group A (n=50)	Group B (n=50)
Age (Mean)	24.28±4.43	25.06±5.20
BMI (kg/m^2) (mean)	23±3.295	23.34±3.088
Injured Leg		
Right	33 (66%)	36(72%)
Left	17(34%)	14(28%)

Interpretation

Table 2 show the mean age of the 100 participants in Group A was 24.28±4.43 and in Group B was 25.06±5.20. The mean BMI in Group A was 23±3.295, while in Group B it was 23.34±3.088. However, the wounded leg was also taken into account. In Group A, 66% of 100 participants had right side ankle sprains and 34% of females had left side ankle sprains, but in Group B, 72% had right side ankle sprains and only 28% had left side ankle sprains.

Interpretation

Table 3 shows a significant difference ($p < 0.0001$) in mean values of ROM value for individuals with chronic instability of the ankle in Group A for ankle dorsiflexion, plantarflexion, inversion, and eversion, while Group B had p values of 0.0271, 0.3758, 0.4466, and 0.0452. The post-test mean values for ankle dorsiflexion and plantarflexion between the ROM groups were determined to be significant ($p = 0.0410$ and $p = 0.0457$). There was a substantial difference in ankle inversion and eversion ($p=0.0484$) respectively.

Interpretation

Table 4 shows the findings of the comparison of the mean values of MMT scores within the groups of individuals with persistent ankle instability. It was discovered that the ankle dorsiflexors, plantarflexors, invertors, and evertors of Group A were extremely significant ($p < 0.0001$), and that the ankle dorsiflexors, invertors, and evertors of Group B were very significant ($p = 0.0015$, 0.0055, and 0.0020) and for plantarflexors it was substantially significant ($p = 0.0207$). The findings of the post-test mean variations between two groups of ROM for ankle dorsiflexors, plantarflexors, and evertors were determined to be extremely significant ($p = 0.0002$, 0.0003, and <0.0001), whereas ankle evertors were shown to be very significant ($p = 0.0010$).

Table 3. Range of motion (ROM)

ROM	Pretest	Posttest	p value	t value
Dorsiflexion				
Group A	8.98±2.14	11.06±3.07	<0.0001	4.240
Group B	8.64±2.43	9.8±3.010	0.0271	2.279
Interference	0.4599		0.0410	
Plantarflexion				
Group A	39.02±5.06	41.82±7.10	<0.0001	5.276
Group B	38.88±5.41	39.24±5.55	0.3758	0.8937
Interference	0.8941		0.0457	
Inversion				
Group A	29.44±3.726	31.92±4.711	<0.0001	5.720
Group B	29.96±3.95	30.26±3.504	0.4466	0.7673
Interference	0.5001		0.0484	
Eversion				
Group A	9.16±3.38	11.02±4.58	<0.0001	8.475
Group B	9.18±3.46	9.56±2.37	0.0452	2.055
Interference	0.9768		0.0484	

Table 4. Manual muscle testing (MMT)

MMT	Pretest	Posttest	p value	t value
Dorsiflexion				
Group A	3.14±0.75	4±0.75	<0.0001	6.143
Group B	3±0.90	3.42±0.75	0.0015	3.364
Interference	0.4028		0.0002	
Plantar flexion				
Group A	3.08±0.69	4.14±0.88	<0.0001	6.419
Group B	3.1±0.54	3.46±0.95	0.0207	2.391
Interference	0.8730		0.0003	
Inversion				
Group A	3.16±0.79	4.04±0.69	<0.0001	5.755
Group B	3.06±0.61	3.5±0.88	0.0055	2.902
Interference	0.4836		0.0010	
Eversion				
Group A	3.02±0.82	4.1±0.50	<0.0001	8.088
Group B	3.12±0.59	3.4±0.57	0.0020	3.259
Interference	0.4867		<0.0001	

Interpretation

Table 5 illustrates the findings of comparison of the mean values of SEBT scores within the groups of individuals with persistent ankle instability. For Group A, the findings revealed that the anterior, anterolateral, posterolateral, posterior, medial, anteromedial, and posteromedial scores were extremely significant ($p<0.0001$), while for Group B, the findings revealed that the medial and anteromedial scores were extremely significant ($p<0.0001$), while the lateral, anterolateral, posterolateral, and posteromedial scores were found to be very significant (p=0.0068,0.0062,0.0031,0.0090) and anterior and posterior were significant (p=0.0423,0.0167) respectively. The post-test mean values between the ROM groups for the medial direction were found to be highly significant ($p = 0.0041$);whereas, the anterior, lateral, anterolateral, posterolateral, posterior, anteromedial, and posteromedial directions were found to be highly significant (p=0.0343, 0.0344, 0.0362, 0.0227, 0.0135, 0.0497, and 0.0475).

Table 5. Star excursion balance test (SEBT)

SEBT	Pretest	Posttest	p value	t value
Anterior				
Group A	70.68±6.60	74.62±5.64	<0.0001	5.927
Group B	71.78±6.33	72.16±5.81	0.0423	2.086
Interference	0.7002		0.0343	
Lateral				
Group A	82.7±5.73	85.4±5.70	0.0006	3.692
Group B	82.1±6.93	82.8±6.40	0.0068	2.824
Interference	0.6382		0.0344	
Anterolateral				
Group A	79.98±4.83	83.1±6.30	<0.0001	7.254
Group B	80.18±5.07	80.58±5.533	0.0062	2.858
Interference	0.8406		0.0362	
Posterolateral				
Group A	81.48±6.652	85.02±6.33	<0.0001	5.287
Group B	81.02±6.554	81.94±6.96	0.0031	3.115
Interference	0.7284		0.0227	
Posterior				
Group A	69.72±6.77	74.08±5.20	<0.0001	7.632
Group B	70.16±6.12	71.12±6.49	0.0167	2.477
Interference	0.7341		0.0135	
Medial				
Group A	59±4.14	62.7±4.33	<0.0001	12.278
Group B	59.54±4.39	60.26±3.96	<0.0001	4.938
Interference	0.5286		0.0041	
Anteromedial				
Group A	61.26±5.62	64.16±5.38	<0.0001	9.667
Group B	61.06±5.55	62±5.48	<0.0001	6.950
Interference	0.8583		0.0497	
Posteromedial				
Group A	62.12±4.85	65.08±5.73	<0.0001	6.353
Group B	62.4±5.02	62.94±4.89	0.0090	2.722
Interference	0.7774		0.0475	

DISCUSSION

The current study "Effect of aquatic exercise training in young female individuals with chronic ankle instability" was undertaken to examine the effect of aquatic training on Chronic Ankle Instability among the young females and to compare the effect of aquatic training and traditional land-based exercise training on Chronic Ankle Instability in young females. This research was conducted at Krishna College of Physiotherapy in Karad, with 100 individuals who met the inclusion criteria. This research enrolled only females aged 20 and 30 who had experienced at least one severe ankle sprain, with the primary sprain occurring a minimum of one year before the registration in research and the common recent injury had to have happened at least three months prior to enrollment in the study. Following protocol and ethical board approval, individuals were enrolled in the research after informed permission was obtained. 100 female individuals were assigned at random into two distinct groups using the sealed envelope method, and each group received an exercise regimen for six weeks: Group A received an aquatic training regimen, while Group B received a land-based training program. In order to assess the response of balance and ankle joint muscular strength, the studies employed ROM, MMT, and SEBT as outcome measures. In this research, young females with persistent instability of the ankle were evaluated to investigate whether

an aquatic training program affected their ROM, MMT, and balance. The purpose of the present research was to examine the effect of an aquatic exercise program on ROM, MMT and balance among young females with chronic ankle instability.

Previous research has shown people that with both acute and repeated ankle sprains often exhibit decreased postural control. Similarly, individuals with persistent ankle instability are frequently found to have functional abnormalities in postural control. It is quite probable that a combination of compromised proprioception and neuromuscular control is the cause of these postural abnormalities (Docherty et al., 2006; Wikstrom et al., 2007; Ross & Guskiewicz, 2006). Several researches have examined the impact of proprioceptive exercises, strengthening exercises, or the combination of the two on a patient's return to activities of daily living (Ben Moussa Zouita et al., 2013). Nevertheless, no previous study has yet been conducted on the efficacy of aquatic training in managing young female individuals who have chronic ankle instability, which is why this investigation was carried out. At the completion of the sixth week, Group A exhibited much better strength, ROM and balance compared to Group B.

In 2020, Ragab conducted a study to evaluate the effects of a combined program consisting of hydrotherapy and land-based exercises versus land-based exercises alone in patients suffering from chronic lateral ankle sprains. Results showed that while there was no significant difference ($p > 0.05$) between the groups, patients in the hydrotherapy group and the combined group had improved in terms of discomfort, ankle functional ability, range of motion, and satisfaction. In the present research , the control group exhibited substantial improvement with p values of 0.0271, 0.3758, 0.4466, and 0.0452, while the interventional group showed larger improvement in ankle dorsiflexion, plantarflexion, inversion and eversion ROM with a p value of <0.0001.

Singh et al.'s research from 2022 aims to establish the superiority of water versus land as a training medium for balancing exercises associated with the functional ankle instability. Based on the study's findings, both groups trained balance for mechanical instability of the ankle just as well (Singh et al., 2022). The findings of this research found that the aquatic training group outperformed other groups. Group B showed significantly better improvement for both medial and anteromedial ($p<0.0001$), while another group found significant improvement for anterior and posterior ($p=0.0423$, 0.0167) and very significant improvement for lateral, anterolateral, posterolateral, and posteromedial ($p=0.0068$, 0.0062, 0.0031, 0.0090).

In 2022, Arulekar and Shinde did a study with the objective of reviewing the state-of-the-art physiotherapy procedures and techniques in CAI and its difficulties and future directions. Overall, this study discovered that the reviewed literature indicated the difficulties associated with CAI, which primarily focus on a single area of treatment. It also proposed prospects for CAI studies and the setting up of a patient-centered, structured protocol for both the short- and long-term effects of the intervention. According to research by Yelfani et al. (2015), women with chronic ankle sprains in between the ages of 20 and 30 could experience better pain alleviation, performance, and static and dynamic stability when engaging in land- and water-based workouts (Abadi et al., 2018).

Evidently the water's buoyancy and non-weight bearing characteristics minimize the dynamic balance that affects the direction and pace of motions during training. As a result, even while buoyancy operates against gravity, it makes joints, muscles, and tendons feel lighter in water than they would on land (Nualon et al., 2013; Thein & Brody, 1998; Donoghue et al., 2011; Abadi et al., 2017).Additionally, water's viscosity, resistance, and speed of response all come to an end (Prentice et al., 2004). Because of arm swing into the water, there may be decreased joint flexibility, increased drag, and greater difficulty maintaining stability when standing erect (Donoghue et al., 2011).Consequently, compared to the land-based group, the aquatic group would experience fewer repeats. The only aspect of underwater running that is comparable to on-land running or walking is the upright posture; nevertheless, the hydrotherapy group's participants benefit from the non-weight bearing training in the hot water since it helps reduce discomfort and swelling (Hoogenboom & Lomax, 2004).

Studies have indicated that aquatic exercise is more beneficial for improving flexibility and ROM in patients, older adults, and those with health issues (Pöyhönen et al., 2002; Wang et al., 2007; Takeshima et al., 2002). Similar findings were made in this study, which showed that ROM significantly improves in individuals with chronic

instability of the ankle. As a result, the current study showed that among females with chronic ankle instability, a water training program had a therapeutically beneficial impact on strength, range of motion, and balance. These findings highlight the potential for a holistic approach in the treatment of ankle instability, Therefore, the alternative hypothesis—that an aquatic exercise program has a significant impact on young girls with chronic ankle instability—is accepted by this study.

There are numerous limitations on the study. The findings may not be as broadly applicable to the general population due to a possible small sample size. Additionally, the results are not as applicable to males or older persons with CAI due to the unique focus on young females. A long-term evaluation of the advantages and sustainability of water exercise may also be impossible due to the study's brief duration. Middle-aged women might be selected in future attempts, and larger samples should be used in future studies to improve generalizability, as young females were enlisted for this project.

Clinical Implications

A promising approach to rehabilitation is aquatic training, which enhances strength, ROM, balance, and functional results. They offer a low-impact setting that lessens the strain on the ankle joints and makes efficient strengthening and conditioning possible. For individuals with chronic ankle instability (CAI), this could mean less pain and an enhanced standard of life. The accessibility and tolerability of aquatic workouts make them an ideal choice for individuals who find traditional land-based activities difficult. Including aquatic exercise in rehabilitation regimens can enhance long-term results and lower the chance of recurrence. Additionally, it makes it possible for them to recognize and address any musculoskeletal system abnormalities or defects. Aquatic exercise also promotes general well-being by lowering stress, elevating mood, and addressing psychological obstacles to physical engagement.

Suggestions

Comprehensive studies can be conducted to create aquatic training regimens that address deficiencies such as reduced proprioception linked to CAI. Depending on the patient's disability and functional objectives, the intensity, time span, and advancement should be tailored to them specifically. More studies needs to investigate the impact of aquatic exercise on the motivation, mood, and perceived exertion of young females.

Conclusion

The study concluded that aquatic treatment performs efficiently for enhancing strength, range of motion, and balance. After treatment, the patient has also experienced a calming and relaxing impact from aquatic therapy because the amount of fatigue and strain on their muscles is decreased. Furthermore, these young ladies may work out in a water-based environment safely and successfully because of the physical characteristics of water. It was determined that the aquatic training program had improved strength, balance and ROM in a considerably positive way. In contrast, the control group's post-test results for strength, ROM and balance showed very little change. The findings revealed that a 6-week aquatic exercise program helped young females with persistent ankle instability improve their range of motion, muscle strength, and balance.

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Conflict of İnterest

There are no conflicting relationships or activities.

Ethics Statement

This research followed ethical standards and received approval from the Institutional Ethical Committee of Krishna Vishwa Vidyapeeth, KIMSDU dated 17/01/2023 and numbered 295/2022-2023.

Author Contributions

Design of the Study: SS, IK and SS; Data Gathering: PJ, AS; Statistical Evaluation: SS; Data interpreting: PJ and SS; Writing of the Manuscript: PJ and SS; Search of the Literature: PJ and SS. Each author has reviewed the final draft of the manuscript and given their approval.

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