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A Study on the Effect of Walking Stick in Lower Limb Strength and Gait of the Elderly

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Abstract

Objective: This study aims to investigate how the use of a walking stick affects lower limb muscle strength and gait performance in elderly individuals.

Participants: The research subjects were elderly residents aged 55 and above from indigenous tribes in Taitung, Taiwan.

Design: The subjects participated in a 12-week walking stick program, conducted twice per week, with each session lasting 120 minutes. Data were collected before and after the intervention, utilizing assessments of lower limb muscle strength, dynamic balance, and gait analysis.

Measurements: A sample t-test was conducted to compare pre- and post-test data.

Results: The results indicated a significant improvement trend in lower limb muscle strength, dynamic balance, and gait performance following the intervention. These findings suggest that elderly individuals can enhance lower limb strength and improve walking performance through progressive sit-to-stand exercises.

Conclusions: Increasing stride length and maintaining continuous walking may contribute to delaying the aging process.

Keywords: Gait Detection, 30-second Chair sit, Dynamic Balance

Background

Aging leads to the gradual deterioration of organ function, resulting in reduced physical ability, impaired balance, decreased vision, and muscle weakness. Physiological changes can significantly impact activities of daily life. Decline in lower limb muscle strength can cause instability and increased fall risk due to unsteady gait. Previous fall experiences often instill fear and reduce confidence in walking, leading many elderly individuals to adopt a sedentary lifestyle or rely on mobility aides to minimize fall risks. A sedentary lifestyle exacerbates physical decline, with muscle deterioration being a primary contributor to disability among the elderly [1]. Excessive sedentary behavior is associated with increased all-cause mortality and reduced life expectancy [2]. Reduced physical activity accelerates functional decline, further heightening the risk of falls. Therefore, strengthening balance and lower limb muscle training is crucial for maintaining gait stability and walking speed [3, 4].

Elderly individuals typically prioritize balance over speed during walking, resulting in slower walking speed, reduced step frequency, shorter step length, and prolonged double support phases to enhance stability and mitigate fall risk [5]. Identifying high-risk elderly individuals through gait assessments and providing fall prevention education and exercise programs are key strategies for reducing fall incidence [6]. A. Shumway-Cook et al., [7]. It is also said that elderly people with unstable gait usually have poor lower limb muscle strength and flexibility. There is a high correlation between balance and gait. From this we can see that the better the dynamic balance ability, the more stable the center of gravity transfer will be, the larger the stride or the faster the step frequency can be, and the better the gait of the elderly will be [8].

Nordic walking, which involves the use of walking poles, has gained popularity due to its ability to redistribute body weight across four points of support, thereby reducing strain on the spine, lower limb joints, and lumbar region [9, 10]. Whether standing, walking, running, etc., you need good balance [11]. Therefore, it greatly improves the sense of security and balance of the elderly and reduces the risk of falling while walking.

Compared to conventional walking aids, walking sticks promotes better posture, balance, and gait stability. Research indicates that long-term Nordic walking training improves upper and lower limb strength, endurance, cardiopulmonary function, flexibility, balance, walking distance, and gait stability [12].

While Nordic walking benefits elderly individuals with relatively intact mobility, its applicability to frail or mobility-impaired individuals remains uncertain. Because walking requires standing on both feet for a long time, it is more difficult for people with lower limb weakness and sub-healthy people. This study explores the effectiveness of a modified bamboo walking sticks program, as promoted by Dr. Guo Jian in Taiwan [13]. Unlike Nordic walking, which

may be unsuitable for frail elderly individuals, this program focuses on stationary training movements utilizing two poles to create a safe closed kinetic chain exercise pattern. This approach is particularly beneficial for elderly individuals with mobility impairments or chronic conditions. The study aims to assess the impact of a 12-week walking sticks intervention on lower limb strength, dynamic balance, and gait performance.

Purpose

This study examines the effects of a 12-week walking sticks exercise program on lower limb strength, dynamic balance, and gait performance in elderly individuals aged 55 and above from two indigenous tribes in Taitung, Taiwan. Participants attended one 120-minute session per week throughout the study period.

Methods

Participants

The subjects of this study are the elders from Taitung aboriginal tribes who have been registered at the Cultural Health Center. According to regulations, the senior citizen of a tribe is 55 years old or above. Selected 2 tribes for course intervention, totaling 42 people. Following the 12-week intervention, 31 participants (21females and 10males) completed both Paired Samples T-Test. The mean age was 75.87 ± 8.89 years, with the following age distribution: 55-59 years (n=2), 60-64 years (n=1), 65-69 years (n=4), 70-74 years (n=6), 75-79 years (n=7), and 80+ years (n=11). (Table.1)

Variables	category	quantity	percentage (%)
percentage	male	10	32.3
	female	21	67.7
Age	55~59age	2	6.5
	60~64age	1	3.2
	65~69age	4	12.9
	70~74age	6	19.4
	75~79age	7	22.6
	Over 80age	11	35.5

Table.1 Add basic information of research subjects

Research Instruments

1. Lower Limb Assessment: 30-second sit-to-stand test (lower limb muscle strength) 2.44-meter timed up-and-go test (dynamic balance).

2. Gait analysis: Based on the gait phase definitions outlined by A. Khard et al., [14]. Four gait parameters were recorded: walking speed, stride length, stride frequency, and step length.

Results

1. Effects on Lower Limb Muscle Strength

Post-test results showed significant improvements in both the 30-second sit-to-stand test and the 2.44-meter timed up-and-go test ($p < .05$)(Table.2), indicating enhanced lower limb muscle strength following the 12-week intervention. These findings align with previous studies [15-17]. Confirming the effectiveness of walking sticks in strengthening lower limbs.

The results of this study confirmed that lower limb training, whether continuous walking or partial lower limb training on a chair, Although most current studies use Nordic walking as an example, most elderly people in Taiwan are in sub-health conditions, so using a cane is a good training method in the early stages.

Test items Test items	Per-test M (SD)	Post-test M(SD)	T value	P
30-second chair sit	12.29(4.18)	13.97(3.92)	-2.33	0.26*
dynamic balance (2.44m Chair Around Object)	12.11 (7.10)	10.32(4.26)	-1.33	0.14*

Table.2 Lower limb muscle strength before and after test results

Note: M (average value): SD(Standard Deviation); *p<.05 **p<.01

2. Effects on Gait Performance

Post-test results demonstrated significant improvements in walking speed, stride length, and step length ($p < .05$)(Table.3), Only the stride frequency is not significant. These findings are partially consistent with previous studies [8, 18-21].

After 12 weeks of brisk walking training, there was a significant improvement in stride length and walking speed. Although stride frequency remained stable, participants exhibited improved walking speed and stride length, indicating enhanced mobility without an increase in step frequency. Although there was no significant difference in stride frequency, the elderly showed better walking speed and stride length at the same stride frequency. It has been shown that elderly people who have used walking sticks for 12 weeks have better mobility.

Test items Test items	Per-test M(SD)	Post-test M(SD)	T value	P
walking speed	0.76(0.28)	0.87(0.3)	-3.07	.004*
stride length	0.87(0.25)	0.98(0.25)	-3.85	.001*
stride frequency	1.7(0.25)	1.74(0.22)	-0.99	.329
step length	0.45(0.15)	0.5(0.13)	-2.53	.017*

Table.3 Gait test results before and after

Note: M (average value): SD(Standard Deviation); *p<.05 **p<.01

Conclusion

1. The walking sticks Intervention with walking sticks can significantly improve the lower limb muscle strength and dynamic balance ability of the elderly.

2. The intervention of walking sticks exercise improved the walking speed, stride length and step length of the elderly; There was no improvement in stride frequency.

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Appendix A

Investigator-Developed Survey

Neurological Vision Knowledge and Confidence Pre-and-Post Survey

Please complete this survey for the neurological vision post-stroke training module effect study.

1. I believe I have the knowledge to implement occupational therapy assessments with patients that have neurological vision impairments.

2. I feel confident in my ability to select appropriate occupational therapy assessments to complete without seeking help from others.

3. I believe I have the knowledge to implement occupational therapy interventions with patients that have neurological vision impairments.

4. I feel confident in my ability to select appropriate occupational therapy interventions to complete without seeking help from others.

5. I believe I have the appropriate knowledge to provide therapeutic interventions to patients with neurological vision impairments.

6. I feel confident in my ability to provide therapeutic interventions to patients with neurological vision impairments.

Appendix B

Investigator-Created Qualitative Post-Survey

Neurological Vision Exit Questionnaire

1. What are your thoughts about participating in the education modules?
2. Describe your experience while participating in the education modules. (i.e. flow of information, presentation of information, thoughts about provided information)
3. Do you feel that the completion of the educational modules will help with future interventions? If yes, please explain how. If not, please explain why not.
4. Are there any areas of improvement for the modules?
5. Please share any other comments or suggestions.

Appendix C

WINSTON-SALEM STATE UNIVERSITY INFORMED CONSENT FORM

(Approved by WSSU IRB dated 08/11/2021)

Occupational Therapists' Experience Following Post-Stroke Visual Rehabilitation Educational Modules

You are being asked to participate in a research study. Participation in this study is completely voluntary. Please read the information below and ask questions about anything that you do not understand before deciding if you want to participate. An investigator listed below will be available to answer your questions.

Research Team

Principal Investigator:

XXXX

Student Investigators:

XXXX

PURPOSE OF STUDY

The purpose of this study is to assess the effectiveness of the neurological vision educational modules which are expected to enhance occupational therapists' knowledge for stroke interventions.

SUBJECTS

Inclusion Requirements

You are eligible to participate in this study if you

(1) full-time or part-time/PRN employment at the inpatient facility

(2) licensed occupational therapy practitioner

Exclusion Requirements

You are ineligible to participate in this study if you

(1) work on other units outside of the targeted site

(2) do not read or speak English

Number of Participants and Time Commitment

This study will include approximately 7-10 subjects and will involve approximately 2-3 hours of your time.

PROCEDURES

The following procedures will occur:

1. After your consent to participate in the study you will receive an email with a link containing one 2-hour education module with embedded questionnaires.
2. Once you have finished the education modules, you will complete the embedded questionnaires.
3. Once you have completed the embedded questionnaire your participation in the study will conclude.

RISKS AND DISCOMFORTS

This study has no potential for harm or discomfort beyond those connected to normal daily life. There is no more than minimal risk when participating in this study.

BENEFITS

Subject Benefits

The possible benefits you may experience from the procedures described in the study include knowledge and confidence related to visual impairment intervention.

Benefits to Others or Society

Knowledge gained through this study may help the scientific community improve rehabilitation outcomes for stroke patients.

ALTERNATIVES TO PARTICIPATION

The only alternative to participation in this study is not to participate.

COMPENSATION, COSTS AND REIMBURSEMENT

Compensation for Participation

You will not be paid for your participation in this research study.

Costs

There is no cost to you for participation in this study.

WITHDRAWAL OR TERMINATION FROM THE STUDY AND CONSEQUENCES

You are free to withdraw from this study at any time. The research team may also end your participation in this study if you do not follow instructions, miss scheduled visits, or if your safety and welfare are at risk.

CONFIDENTIALITY

Subject Identifiable Data

All identifiable information that will be collected about you will be removed at the end of data collection.

Data Storage

All research data will be maintained in a secure location at WSSU. Only authorized individuals will have access to it. All research data will be stored electronically on a secure computer with password protection.

Data Access

The research team, authorized WSSU personnel, the study sponsor (if applicable), and regulatory entities such as the Food and Drug Administration (FDA) and the Office of Human Research Protections (OHRP), may have access to your study records to protect your safety and welfare. Any information derived from this research project that personally identifies you will not be voluntarily released or disclosed by these entities without your separate consent, except as specifically required by law. Research records provided to authorized, non-WSSU entities will not contain identifiable information about you. Publications and/or presentations that result from this study will not include identifiable information about you.

Data Retention

The investigators intend to keep the research data until the research is published and/or presented.

IF YOU HAVE QUESTIONS

If you have any comments, concerns, or questions regarding the conduct of this research please contact the research team listed at the top of this form.

If you are unable to reach a member of the research team listed at the top of the form and have general questions, or you have concerns or complaints about the research study, research team, or questions about your rights as a research subject, please contact XXXX

CONSENT STATEMENT

You should not sign this form unless you have read and understand the attached Informed Consent Form. Participation in this study is voluntary. You may refuse to answer any question or discontinue your involvement at any time without penalty or loss of benefits to which you might otherwise be entitled. Your decision will not affect your future relationship with Winston-Salem State University. Your signature below indicates that you have read the information in thisconsentform and have had a chance to ask any questions that you have about the study.

I agree to participate in the study.

_____ _____

Subject Signature* **Date**

_____

Printed Name of Subject *

_____ _____

Legally Authorized Representative/Guardian Signature **Date**

_____

Printed Name of Legally Authorized Representative/Guardian's

_____ _____ **Legally Authorized**

Representative/Guardian Signature **Date**

_____

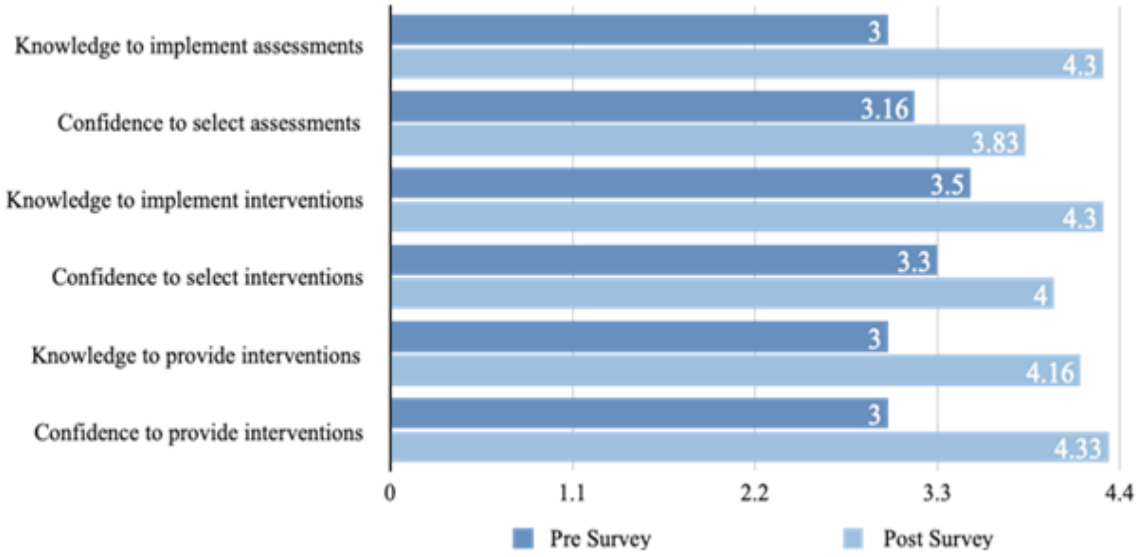
Printed Name of Legally Authorized Representative/Guardian's

_____ _____

Investigator Signature* **Date**

Printed Name of Investigator*

Appendix D: Pre and Post Neuro-Vision Knowledge and Confidence Survey



Appendix E

Qualitative Results Word Cloud