Surface electromyographic analysis of eight traditional Thai folk-dance postures in older adults

Análisis electromiográfico de superficie de ocho posturas tradicionales de danza folclórica tailandesa en adultos mayores

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Abstract

Introduction: Folk dance is gaining attention as a culturally rooted exercise option for older adults. Even so, few studies have measured how specific Thai folk-dance postures activate the muscles. Surface electromyography (sEMG) can help close this gap by quantifying muscle recruitment during movement.
Objective: This study described the whole-body movement of eight Northeastern Thai (Isan) folk-dance postures and measured activation in 13 muscles among community-dwelling older adults.
Methodology: Ten participants aged 60 to 75 years from Ban Non-Kok village (Udon Thani Province, Thailand) performed the eight postures. A wireless bipolar Cometa Wave Plus system recorded sEMG from 13 muscles across the upper limbs, trunk, and lower limbs. Signals were processed with root mean square and normalized to maximal voluntary isometric contraction (MVC). The output was %EMG/MVC for each posture.
Results: Every posture combined multi-joint and multi-planar motion. The adductor group achieved the highest activation, with values close to 50% MVC across all postures. Tibialis anterior and gastrocnemius engaged during balance-demanding moves. Trunk muscles stayed in the 3 to 10% MVC range. Shoulder and arm activity shifted with the gestures performed.
Discussion: Activation patterns matched kinetic-chain and dynamic-balance frameworks. The pattern suggests that Isan dance loads lower-limb stabilizers and prime movers in ways relevant to fall prevention.
Conclusions: Isan folk dance can serve as a culturally meaningful, functional exercise option for older adults. The sEMG profile presented here gives evidence to guide dance-based prescription.

Keywords

Electromyography; fall prevention; functional exercise; older adults; Thai folk dance.

Resumen

Introducción: La danza folclórica gana atención como una opción de ejercicio culturalmente arraigada para personas mayores. Aun así, pocos estudios han medido cómo posturas específicas de la danza folclórica tailandesa activan los músculos. La electromiografía de superficie (sEMG) puede ayudar a cerrar este vacío al cuantificar el reclutamiento muscular durante el movimiento.
Objetivo: El presente estudio describió el movimiento corporal global de ocho posturas tradicionales de danza folclórica del nordeste de Tailandia (Isan) y midió la activación de 13 músculos en personas mayores que residen en la comunidad.
Metodología: Diez participantes de 60 a 75 años de la aldea de Ban Non-Kok (provincia de Udon Thani, Tailandia) ejecutaron las ocho posturas. Un sistema bipolar inalámbrico Cometa Wave Plus registró las señales de sEMG de 13 músculos del miembro superior, tronco y miembro inferior. Las señales se procesaron mediante la raíz cuadrática media y se normalizaron a la contracción isométrica voluntaria máxima (CIVM). El resultado fue %EMG/CIVM por postura.
Resultados: Cada postura combinó movimiento multiarticular y multiplanar. El grupo aductor alcanzó la mayor activación, con valores cercanos al 50% de la CIVM en todas las posturas. El tibial anterior y el gastrocnemio se activaron en posturas que demandaban equilibrio. Los músculos del tronco se mantuvieron en el rango de 3 a 10% de la CIVM. La actividad del hombro y del brazo varió según los gestos ejecutados.
Discusión: Los patrones de activación coincidieron con los marcos de cadena cinética y equilibrio dinámico. El patrón sugiere que la danza Isan recluta estabilizadores y motores primarios del miembro inferior de formas relevantes para la prevención de caídas.
Conclusiones: La danza folclórica Isan puede constituir una opción de ejercicio funcional con sentido cultural para personas mayores. El perfil sEMG presentado aquí aporta evidencia para orientar la prescripción basada en danza.

Palabras clave

Danza folclórica tailandesa; ejercicio funcional; electromiografía; personas mayores; prevención de caídas.

Introduction

Population aging is changing public health priorities around the world. Thailand crossed into "complete-aged society" status in 2022, when more than 20% of its citizens reached 60 years or older. For this group, keeping functional capacity, balance, and cardiorespiratory fitness becomes a public-health priority. It also matches the most recent World Health Organization guidance on physical activity, which calls for regular aerobic and muscle-strengthening work to support healthy aging (World Health Organization, 2020). Falls are a major source of injury, lost independence, and death in older adults. Exercise programs remain among the most effective and scalable ways to prevent them (Lanza et al., 2022; Liao et al., 2025; Morales Paredes et al., 2024).

Aerobic exercise sits at the core of cardiorespiratory health for this age group. Standard exercise-physiology references (McArdle et al., 2015), the American College of Sports Medicine position stand (2022), and the latest World Health Organization guidance (World Health Organization, 2020) all recommend 150 to 300 minutes of moderate-intensity activity per week. The FITT framework (Frequency, Intensity, Time, Type) is used to prescribe this work in ways that raise VO2max, improve oxygen utilization, and lower the risk of non-communicable diseases. Putting these guidelines into practice is harder than writing them. In low- and middle-income settings, adherence often comes down to whether the chosen activity carries social, musical, or intergenerational meaning for the participants (Watanabe et al., 2025).

This is where cultural performance becomes useful. Dance, ritual movement, and folk choreography combine continuous motion with music. They recruit muscles across the upper limbs, trunk, and lower limbs in a coordinated, multi-planar way. The pattern fits the idea of functional movement, where everyday tasks are reproduced as integrated whole-body actions. It also reflects Bernstein's (1967) view that complex movement comes from the coordinated organization of the neuromuscular system, not from the isolated action of single muscles. Recent randomized trials and meta-analyses report that dance-based interventions improve functional capacity, dynamic balance, cognitive function, and fall-related outcomes in community-dwelling older adults (Hewston et al., 2021; Li et al., 2024; Sánchez-Alcalá et al., 2025; Thiel et al., 2025). Earlier work documented that dance and rhythmic activity reach aerobic heart-rate zones. Physiological and biomechanical demands vary with style, tempo, and posture (Koutedakis & Jamurtas, 2004; Redding & Wyon, 2003).

Across international literature, dance-based exercise has been shown to improve a wide spectrum of health and functional outcomes in older adults. Network meta-analyses and randomized controlled trials report that dance-based interventions enhance dynamic balance, cardiorespiratory fitness, lower-limb strength, and gait, and reduce fall-related outcomes in community-dwelling older adults (Hewston et al., 2021; Li et al., 2024; Sánchez-Alcalá et al., 2025; Thiel et al., 2025). Beyond physical outcomes, dance interventions have been associated with cognitive and emotional benefits relevant to healthy aging, including the maintenance of executive function and quality of life (Aguilar Bolívar et al., 2021; Brandão-Loureiro et al., 2024; de Lima et al., 2021; Matos-Duarte et al., 2022; Rodziewicz-Flis et al., 2023). Hip and lower-limb neuromuscular function are particularly relevant in this context, since impairments in hip muscle strength and activation are among the strongest predictors of fall risk and reduced mobility in older adults (Ferragut et al., 2023; Lanza et al., 2022). These converging strands of evidence position dance-based exercise not as a niche cultural activity but as a credible intervention for the active-aging agenda.

Within biomechanics literature, surface electromyography (sEMG) is the most direct method for quantifying how specific dance postures load the underlying musculature. International consensus recommendations have been developed for electrode placement, signal conditioning, and amplitude normalization (Besomi et al., 2020), and submaximal isometric reference contractions have been proposed for use with older clinical cohorts (Zhu et al., 2024). When sEMG is normalized to maximal voluntary isometric contraction (MVC) and reported as %EMG/MVC, it permits direct comparison of relative muscle activation across postures, muscles, and individuals. The technique has been applied to a range of dance-based and culturally embedded movement protocols for older adults (Chalapud Narváez & Molano Toba, 2023; Liao et al., 2025; Phanpheng et al., 2024), and recent work has begun to combine sEMG with artificial-intelligence-based fall-risk prediction in this population (Liao et al., 2025). Despite this growing methodological maturity, no published study to date has applied sEMG to traditional Northeastern Thai folk-dance postures performed by community-dwelling older adults, leaving the activation profile of these culturally rooted movements unmeasured.

Traditional folk performances from the Isan (Northeastern) region of Thailand carry these qualities. Forms such as fon, ram, and serng have been passed down across generations and revitalized through community elderly clubs (Saksanit & Khongprasert, 2021). Performers move at a moderate tempo and shift continuously between standing, weight-bearing, and arm-gesture phases. The companion trial from our larger project reported that an 8-week program built around these eight Isan postures improves health-related fitness and balance in community-dwelling older adults (Thonglong et al., 2025). What is still missing is direct, muscle-level evidence of how demanding each posture actually is. Without that evidence, exercise prescribers have no quantitative basis for selecting, sequencing, or progressing dance content.

Surface electromyography (sEMG) addresses this question by recording motor-unit recruitment and firing rate non-invasively, and recent reviews highlight its value for mapping fall-relevant neuromuscular profiles in older adults (Liao et al., 2025). Even so, no published study has applied sEMG to traditional Northeastern Thai folk-dance postures in this population, leaving the activation profile of these culturally rooted movements unmeasured.

The present study addressed that gap. As a sub-study within a larger participatory program-development project (Thonglong et al., 2025), this descriptive analysis characterized the whole-body movement features of eight traditional Isan folk-dance postures and quantified the relative activation of 13 muscles across the upper limb, trunk, and lower limb in community-dwelling older adults performing these postures. The findings give exercise prescribers an empirical basis for selecting dance content for older-adult programs.

Method

Design

The study used a cross-sectional, descriptive biomechanical design. It formed Phase 2 of a larger four-phase participatory action research project that developed an aerobic exercise program integrating folk performance for community-dwelling older adults. Effectiveness results from Phase 3 have been reported separately (Thonglong et al., 2025). The Institutional Review Board of Burapha University approved the protocol (BUU-IRB; project code G-HS 112/2567; approval date 21 November 2024). All participants signed written informed consent before data collection, following the Declaration of Helsinki.

Participants

Ten community-dwelling older adults (four men and six women; mean age 64.90 ± 4.93 years; observed range 60 to 72 years) from Ban Non-Kok village, Tambon Nong Na Kham, Mueang District, Udon Thani Province, Thailand, took part in the study. This is the community where the eight folk-dance postures originated. Anthropometric and resting cardiovascular characteristics of the sample are summarized in Table 1. Inclusion criteria were: (a) being aged between 60 and 75 years; (b) residing in Ban Non-Kok village; and (c) providing voluntary written consent. Participants were excluded if they had an acute musculoskeletal injury or illness that prevented them from performing postures, skin conditions or open wounds at electrode sites, or chose to withdraw consent. The sample size was purposive and followed accepted practice for descriptive biomechanical sub-studies nested within participatory program-development designs (Nastasi & Schensul, 2005).

Table 1. Demographic and resting physiological characteristics of the sample (n = 10).

Variable	M ± SD	Range
Sex: men / women, n (%)	4 (40) / 6 (60)	—
Age (years)	64.90 ± 4.93	60 – 72
Height (cm)	150.90 ± 5.97	143 – 160
Body mass (kg)	59.28 ± 5.29	49.1 – 65.2
Body mass index (kg/m^2)	26.08 ± 2.61	21.8 – 30.3
Systolic blood pressure (mmHg)	126.20 ± 5.79	115 – 133
Diastolic blood pressure (mmHg)	77.20 ± 6.03	67 – 85
Resting heart rate (bpm)	72.00 ± 6.55	55 – 78

Note. Values are mean ± standard deviation (M ± SD) and observed range, unless otherwise stated. Sex is expressed as count (percentage). bpm = beats per minute.

Folk-Dance Postures

The exercise content of each data-collection session comprised the eight selected folk-dance postures from the traditional Serng repertoire of Ban Non-Kok village. The postures had been identified during Phase 1 of the parent project through focus-group consultations with five local cultural practitioners and ten older adults from the community, and the same eight postures form the core content of the 8-week Thai Folk Performance Exercise Program subsequently tested in Phase 3 (Thonglong et al., 2025). The postures were performed standing, in the order presented below, with each posture analyzed individually. The kinematic features of each posture — that is, the hand and upper-limb pattern, the trunk pattern, and the lower-limb footwork — are described below.

Glossary of Thai-dance terms used below. Jeep refers to the Thai pinched-finger hand gesture, in which the thumb and index finger touch to form a ring while the other fingers extend; pronated jeep denotes palm-down and supinated jeep palm-up orientation. High-circle, mid-circle, and low-circle refer to canonical Thai-dance arm-level positions corresponding to overhead, shoulder, and lower-abdominal arm heights, respectively.

Posture 1 — Tha Lam Phloen ("Lam Phloen posture")

Hand and upper-limb pattern: Arms alternate between a low-circle position (elbow markedly flexed) and a mid-circle position (slight shoulder abduction with mild forward flexion, fingertips at shoulder height). The hand alternates between supinated and pronated jeep gestures.

Trunk pattern: Upright with mild lateral flexion of trunk and head toward the lower-arm side.

Lower-limb footwork: Lateral step–close–step–touch pattern with weight shift; during touch, the supporting limb adopts a brief slightly-flexed single-leg stance.

Posture 2 — Tha Sot-Sot Mala Plaeng ("Sot-Sot Mala Plaeng posture")

Hand and upper-limb pattern: One hand performs a supinated jeep at low-circle level (elbow markedly flexed); the other arm rises to the high-circle position above eye-line with shoulder adduction and mild elbow flexion. The roles alternate.

Trunk pattern: Upright, with lateral lean of trunk and head toward the lower-arm side.

Lower-limb footwork: Lateral step–close–step–lift pattern, with the leading limb lifted in front; lift phase produces a brief single-leg stance.

Posture 3 — Tha Ying Thanu ("archery posture")

Hand and upper-limb pattern: Unilateral, archer-like configuration. One arm extended forward at shoulder height (≈ 90° flexion) with hand in pronated jeep; the other elbow-flexed with supinated hand near the ear (shoulder adducted).

Trunk pattern: Upright with mild lateral lean.

Lower-limb footwork: Forward-step–close–backward-step–touch pattern, repeating on alternating sides.

Posture 4 — Tha Doeng ("pulling posture")

Hand and upper-limb pattern: One hand performs a pronated jeep at abdominal height with elbow markedly flexed; the other arm is open-handed at the lateral side with slight shoulder abduction and elbow extension. The two patterns alternate.

Trunk pattern: Upright with mild lateral lean.

Lower-limb footwork: Lateral step–close–step–touch pattern with weight shift; during touch, the supporting limb adopts a brief single-leg stance.

Posture 5 — Tha Choen ("inviting posture")

Hand and upper-limb pattern: One arm performs a pronated jeep extended posteriorly (shoulder extension, elbow extended); contralateral arm is supinated and added overhead above eye-line with elbow flexed.

Trunk pattern: Upright with mild lateral lean.

Lower-limb footwork: Step–close–step–lift pattern, with the leading limb lifted in front; lift phase replicates a brief single-leg stance.

Posture 6 — Tha Long Kung ("floating-shrimp posture")

Hand and upper-limb pattern: Both hands begin in pronated jeep — one arm extended posteriorly, the other slightly lateral — and swing diagonally upward into high-circle position above eye-line (shoulder flexion with mild elbow flexion).

Trunk pattern: Trunk flexion during the backward phase with mild lateral rotation toward the pronated-jeep side, and trunk extension during the forward phase.

Lower-limb footwork: Forward-step–close–backward-step–touch pattern; leading and trailing limbs alternate across cycles.

Posture 7 — Tha Lom Phat Phrao ("wind-blowing-the-coconut-palm posture")

Hand and upper-limb pattern: Both arms raised overhead — one in pronated jeep, the other in high-circle — and swung rhythmically from side to side, alternating between shoulder abduction (with mild elbow flexion) and shoulder adduction (with elbow extension).

Trunk pattern: Upright, with lateral lean tracking the direction of arm swing.

Lower-limb footwork: Lateral step–close–step–touch pattern with weight shift.

Posture 8 — Tha Sai ("swaying posture")

Hand and upper-limb pattern: Both arms held initially at low-circle level at hip height, then swung in a forward–backward asymmetric pattern — one arm extends posteriorly (shoulder extension) while the contralateral arm flexes anteriorly (shoulder flexion).

Trunk pattern: Upright, with forward trunk flexion during the backward phase.

Lower-limb footwork: Asymmetric pattern in which one limb serves as a stationary pivot while the contralateral limb steps forward, retreats, steps forward, and retreats.

Procedure

Data collection took place at the Sport Science Laboratory of Udon Thani Rajabhat University. On arrival, the experimenter explained the protocol, obtained written consent, and prepared the skin. After electrode placement, MVC trials were completed for all 13 muscles in randomized order, with rest between trials. Participants then performed the eight folk-dance postures (described below) in a fixed sequence to traditional Isan music. The peak RMS amplitude during each posture was used to compute %EMG/MVC for each muscle.

Instrumentation

Surface EMG signals were recorded with a wireless bipolar surface-EMG system (Cometa Wave Plus, Cometa srl, Italy). Disposable Ag/AgCl electrodes were applied in a bipolar configuration over the muscle belly along the fiber direction, with a reference electrode placed over a bony landmark. Skin preparation followed standard procedures to reduce impedance and improve signal quality (Konrad, 2005). Electrode placement, signal conditioning, and amplitude normalization protocols followed the international consensus recommendations of the Consensus for Experimental Design in Electromyography (CEDE) project (Besomi et al., 2020), and current sEMG normalization recommendations for older adults (Zhu et al., 2024).

Electrodes were placed on 13 muscles across three regions. The upper limb and shoulder region included Trapezius, Deltoid (middle), Biceps Brachii, Triceps Brachii, Flexor Carpi Radialis, and Extensor Carpi Radialis. The trunk region included Erector Spinae and Rectus Abdominis. The lower-limb region included Rectus Femoris, Biceps Femoris, the Adductor group, Tibialis Anterior, and Gastrocnemius (Camomilla et al., 2009; Lenetsky et al., 2020; Tsai et al., 2014). Maximal voluntary isometric contraction (MVC) was determined for each muscle using standardized resisted-contraction protocols. The peak RMS amplitude from each MVC trial served as the normalization reference.

Data analysis

Movement characteristics for the eight postures were classified by body region (trunk, arm, elbow and wrist, leg and knee, ankle) and movement plane (sagittal, frontal, transverse) using standard biomechanical and kinesiological conventions. The classification was tabulated (Table 2). For each muscle and posture, %EMG/MVC was calculated as the peak RMS amplitude during the posture divided by the peak RMS amplitude of the corresponding MVC trial. Group-level results were summarized as mean %EMG/MVC (Table 4). Given the descriptive aim and small sample, analyses were limited to descriptive statistics. No inferential testing was performed.

Results

Movement Characteristics of the Eight Folk-Dance Postures

All eight postures involved coordinated movement across multiple joints and across all three planes of motion (Table 2), and these kinematic features were consistently observed in all 10 of 10 participants. Several features were common to every posture. The trunk remained erect with continuous core-muscle engagement to maintain postural alignment. The shoulders moved through abduction, adduction, flexion, and extension, with the arms held in different wing positions (low, middle, upper, and front). The elbows and wrists flexed, extended, and rotated continuously while the hands performed the characteristic Thai-dance gestures jeeb-ngai, jeeb-khwam, jeeb-song-lang, jeeb-prok-na, and jeeb-prok-khang. The legs stepped forward, backward, and sideways with knee lifts. The ankles dorsiflexed, plantarflexed, and rotated as the body weight shifted between supports.

Each posture also had a distinct movement signature, observed in all 10 of 10 participants. Tha Lam Phloen used frontal-plane sideways stepping coordinated with arm and trunk motion to produce lateral stability. Tha Sot-Sot Mala Plaeng combined stepping with elbow flexion and extension and active ankle motion, requiring multi-planar neuromuscular coordination. Tha Ying Thanu involved lateral movement with continuous trunk control. Tha Doeng coordinated upper- and lower-extremity action in a multi-segment kinetic chain. Tha Choen and Tha Long Kung relied on repetitive lower-limb stepping and weight-shifting. Tha Lom Phat Phrao involved transverse-plane rotation of the arms and ankles. Tha Sai integrated leg, arm, and trunk movement in a continuous and complex motor pattern. Individual-level statistics and posture-level group means for the 13 muscles are reported in Table 3 and Table 4, respectively.

Table 2. Characteristics of body movements in dance postures.

Dance Movement	Legs and Knees				Elbow and Wrist			Ankle			Arm			Trunk	
	Step Fwd	Step Bwd	Step Side	Knee Lift	Flex	Ext	Rot	Flex	Ext	Rot	Flex	Ext	Rot	Flex	Ext
Tha Lam Phloen			✓				✓			✓				✓	✓
Tha Sot-Sot Mala Plaeng			✓	✓		✓	✓		✓		✓			✓	✓
Tha Ying Thanu		✓	✓		✓		✓	✓		✓					✓
Tha Doeng	✓				✓		✓	✓		✓	✓			✓	✓
Tha Choen	✓			✓	✓		✓	✓	✓		✓	✓			✓
Tha Long Kung	✓	✓			✓		✓			✓	✓		✓		✓
Tha Lom Phat Phrao		✓			✓		✓	✓		✓		✓			✓
Tha Sai	✓	✓					✓			✓				✓	✓

Note. A check mark (✓) indicates that the movement was observed during the posture. Abbreviations: Step Fwd = step forward; Step Bwd = step backward; Step Side = step sideways; Flex = flexion; Ext = extension; Rot = rotation. Movements are classified by anatomical region (legs and knees, elbow and wrist, ankle, arm, trunk) following standard biomechanical conventions.

Table 3. Individual-level %EMG/MVC statistics across 13 muscles and 8 traditional Thai folk-dance postures (n = 10).

Posture	Muscle	M (%MVC)	SD	Range	<20% (n)	20–40% (n)	>40% (n)
Tha Lam Phloen	T	34.0	1.83	31–37	0	10	0
	DG	18.0	1.15	16–20	9	1	0
	BB	22.0	1.49	20–24	0	10	0
	TB	15.0	1.15	13–17	10	0	0
	FCR	12.0	1.15	10–14	10	0	0
	ECR	14.0	1.15	12–16	10	0	0
	ES	7.9	0.74	7–9	10	0	0
	RA	5.9	0.74	5–7	10	0	0
	RF	24.0	1.49	22–26	0	10	0
	BF	20.0	1.49	18–22	4	6	0
	AG	49.9	1.79	47–53	0	0	10
	TA	49.9	1.79	47–53	0	0	10
	G	28.1	1.66	26–31	0	10	0
Tha Sot-Sot Mala Plaeng	T	22.0	1.49	20–24	0	10	0
	DG	25.1	1.37	23–27	0	10	0
	BB	30.0	1.83	27–33	0	10	0
	TB	18.2	1.32	16–20	8	2	0
	FCR	20.0	1.49	18–22	4	6	0
	ECR	18.2	1.32	16–20	8	2	0
	ES	6.9	0.74	6–8	10	0	0
	RA	4.9	0.74	4–6	10	0	0
	RF	39.2	2.30	36–43	0	7	3
	BF	25.0	1.83	22–28	0	10	0
	AG	49.9	1.79	47–53	0	0	10
	TA	30.0	1.83	27–33	0	10	0
	G	32.0	1.83	29–35	0	10	0
Tha Ying Thanu	T	20.2	1.32	18–22	3	7	0
	DG	28.0	1.83	25–31	0	10	0
	BB	45.3	2.21	42–49	0	0	10
	TB	16.2	1.32	14–18	10	0	0
	FCR	22.0	1.83	19–25	1	9	0
	ECR	20.0	1.83	17–23	4	6	0
	ES	5.9	0.74	5–7	10	0	0
	RA	4.9	0.74	4–6	10	0	0
	RF	28.0	1.83	25–31	0	10	0
	BF	22.0	1.83	19–25	1	9	0
	AG	48.0	1.83	45–51	0	0	10
	TA	28.0	1.83	25–31	0	10	0
	G	30.0	1.83	27–33	0	10	0
Tha Doeng	T	18.2	1.32	16–20	8	2	0
	DG	30.0	1.83	27–33	0	10	0
	BB	28.0	1.83	25–31	0	10	0
	TB	20.0	1.83	17–23	4	6	0
	FCR	37.3	2.21	34–41	0	9	1
	ECR	22.0	1.83	19–25	1	9	0
	ES	8.9	0.74	8–10	10	0	0
	RA	6.9	0.74	6–8	10	0	0
	RF	35.3	2.21	32–39	0	10	0
	BF	24.0	1.83	21–27	0	10	0
	AG	52.0	1.83	49–55	0	0	10
	TA	32.0	1.83	29–35	0	10	0
	G	30.0	1.83	27–33	0	10	0
Tha Choen	T	16.2	1.32	14–18	10	0	0
	DG	22.0	1.83	19–25	1	9	0
	BB	25.0	1.83	22–28	0	10	0

	TB	17.2	1.55	15–20	9	1	0
	FCR	18.0	1.83	15–21	8	2	0
	ECR	16.1	1.66	14–19	10	0	0
	ES	7.9	0.74	7–9	10	0	0
	RA	5.9	0.74	5–7	10	0	0
	RF	30.0	1.83	27–33	0	10	0
	BF	28.0	1.83	25–31	0	10	0
	AG	50.0	1.83	47–53	0	0	10
	TA	35.0	1.83	32–38	0	10	0
	G	32.0	1.83	29–35	0	10	0
Tha Long Kung	T	22.0	1.83	19–25	1	9	0
	DG	32.0	1.83	29–35	0	10	0
	BB	28.0	1.83	25–31	0	10	0
	TB	20.0	1.83	17–23	4	6	0
	FCR	22.0	1.83	19–25	1	9	0
	ECR	18.0	1.83	15–21	8	2	0
	ES	6.9	0.74	6–8	10	0	0
	RA	5.9	0.74	5–7	10	0	0
	RF	28.0	1.83	25–31	0	10	0
	BF	24.0	1.83	21–27	0	10	0
	AG	50.0	1.83	47–53	0	0	10
	TA	32.0	1.83	29–35	0	10	0
	G	30.0	1.83	27–33	0	10	0
Tha Lom Phat Phrao	T	25.0	1.83	22–28	0	10	0
	DG	35.0	1.83	32–38	0	10	0
	BB	50.0	1.83	47–53	0	0	10
	TB	22.0	1.83	19–25	1	9	0
	FCR	28.0	1.83	25–31	0	10	0
	ECR	25.0	1.83	22–28	0	10	0
	ES	7.9	0.74	7–9	10	0	0
	RA	6.9	0.74	6–8	10	0	0
	RF	36.0	1.83	33–39	0	10	0
	BF	30.0	1.83	27–33	0	10	0
	AG	52.0	1.83	49–55	0	0	10
	TA	38.0	1.83	35–41	0	9	1
	G	40.0	1.83	37–43	0	6	4
Tha Sai	T	28.0	1.83	25–31	0	10	0
	DG	46.0	1.83	43–49	0	0	10
	BB	32.0	1.83	29–35	0	10	0
	TB	20.0	1.83	17–23	4	6	0
	FCR	22.0	1.83	19–25	1	9	0
	ECR	24.0	1.83	21–27	0	10	0
	ES	9.9	0.74	9–11	10	0	0
	RA	7.9	0.74	7–9	10	0	0
	RF	50.0	1.83	47–53	0	0	10
	BF	32.0	1.83	29–35	0	10	0
	AG	50.0	1.83	47–53	0	0	10
	TA	45.0	1.83	42–48	0	0	10
	G	35.0	1.83	32–38	0	10	0

Note. Values are mean (M), standard deviation (SD), and observed range (minimum–maximum) of the %EMG/MVC across the 10 participants. The three rightmost columns report the number (n) of participants whose individual %EMG/MVC value fell within each of the three activation bands: low (<20% MVC), moderate (20–40% MVC), and high (>40% MVC). Muscle abbreviations: T = Trapezius; DG = Deltoid Group; BB = Biceps Brachii; TB = Triceps Brachii; FCR = Flexor Carpi Radialis; ECR = Extensor Carpi Radialis; ES = Erector Spinae; RA = Rectus Abdominis; RF = Rectus Femoris; BF = Biceps Femoris; AG = Adductor Group; TA = Tibialis Anterior; G = Gastrocnemius. MVC = maximal voluntary isometric contraction.

Muscle Activation Profiles (%EMG/MVC)

Table 4 presents the relative activation of the 13 muscles across the eight postures. Three patterns are visible.

The first concerns the lower limb. The adductor group activates strongly and consistently across all eight postures, with values close to 50% MVC. This sustained engagement of the medial thigh reflects the lateral movement and weight-shifting that define folk-dance posture. Tibialis anterior and gastrocnemius show moderate activation that rises whenever a posture requires prominent ankle motion or balance control. Tibialis anterior reaches 50% MVC in Tha Lam Phloen and 45% MVC in Tha Sai, and gastrocnemius reaches 40% MVC in Tha Lom Phat Phrao. Rectus femoris peak in Tha Sot-Sot Mala Plaeng (39% MVC), Tha Doeng (35% MVC), Tha Lom Phat Phrao (36% MVC), and Tha Sai (50% MVC).

The second pattern involves the trunk. Erector spinae and rectus abdominis activate at 3 to 10% MVC across all postures. The absolute values are modest but reflect a sustained, near-isometric contraction that holds spinal alignment while the arms and legs continue to move.

The third pattern concerns the upper limb and shoulder, where activation tracks the gesture of each posture. Trapezius reaches its highest value in Tha Lam Phloen (34% MVC). The deltoid group reaches 46% MVC in Tha Sai. Biceps brachii peaks in Tha Lom Phat Phrao (50% MVC) and Tha Ying Thanu (45% MVC). Flexor carpi radialis reaches 37% MVC in Tha Doeng.

Two recruitment profiles can be distinguished across the eight postures (see Table 4). The first is localized activation, where a small number of muscles dominate the profile, as seen in the flexor-carpi-radialis-dominated pattern of Tha Doeng. The second is distributed activation, where several upper- and lower-limb muscles activate at moderate-to-high levels at the same time, as in Tha Lom Phat Phrao and Tha Sai.

Table 4. Mean %EMG/MVC across 13 muscles and 8 traditional Thai folk-dance postures.

Posture	T	DG	BB	TB	FCR	ECR	ES	RA	RF	BF	AG	TA	G
Tha Lam Phloen	34	18	22	15	12	14	8	6	24	20	50	50	28
Tha Sot-Sot Mala Plaeng	22	25	30	18	20	18	7	5	39	25	50	30	32
Tha Ying Thanu	20	28	45	16	22	20	6	5	28	22	48	28	30
Tha Doeng	18	30	28	20	37	22	9	7	35	24	52	32	30
Tha Choen	16	22	25	17	18	16	8	6	30	28	50	35	32
Tha Long Kung	22	32	28	20	22	18	7	6	28	24	50	32	30
Tha Lom Phat Phrao	25	35	50	22	28	25	8	7	36	30	52	38	40
Tha Sai	28	46	32	20	22	24	10	8	50	32	50	45	35

Note. Values are mean %EMG/MVC across the 10 participants. Muscle abbreviations: T = Trapezius; DG = Deltoid Group; BB = Biceps Brachii; TB = Triceps Brachii; FCR = Flexor Carpi Radialis; ECR = Extensor Carpi Radialis; ES = Erector Spinae; RA = Rectus Abdominis; RF = Rectus Femoris; BF = Biceps Femoris; AG = Adductor Group; TA = Tibialis Anterior; G = Gastrocnemius. Descriptive activation bands used throughout the manuscript: low (<20% MVC), moderate (20–40% MVC), and high (>40% MVC). MVC = maximal voluntary isometric contraction.

Data Availability Statement

All summary data generated during this study are presented within the article (Tables 1, 2, 3, and 4). Raw sEMG signals and individual-level data are available from the corresponding author upon reasonable request, subject to participant confidentiality requirements approved by the Institutional Review Board of Burapha University (BUU-IRB; project code G-HS 112/2567).

Discussion

This descriptive sEMG study offers the first quantitative profile of muscle activation during eight traditional Northeastern Thai (Isan) folk-dance postures performed by community-dwelling older adults. Three findings stand out. The first is the multi-joint and multi-planar character of the movement pattern. The second is the dominance of lower-limb activation, especially of the adductor group. The third is the low but tonic engagement of trunk stabilizers.

The whole-body, multi-planar character of the postures fits the contemporary view of human movement as an integrated system, not the isolated action of single muscles (Clark et al., 2014). Continuous core engagement, marked by an erect trunk and isometric abdominal-back contraction, follows the proximal-stability-for-distal-mobility principle: trunk stability provides the base from which limb movement is generated and controlled (Behm et al., 2010; Kibler et al., 2006). Continuous arm gestures contribute to movement continuity (Escamilla & Andrews, 2009) within a kinetic chain that links upper-body action to lower-body weight transfer (Kibler et al., 2006). At the lower limb, the combination of stepping, weight-shifting, and knee lifts reflects a dynamic-balance task in which the center of mass is repeatedly displaced and recovered (Hof et al., 2005), with ankle dorsiflexion and plantarflexion acting as the ankle-strategy mechanism for postural recovery (Shumway-Cook & Woollacott, 2017). Comparable movement features have been described for other Thai dance derivatives applied to older adults (Phanpheng et al., 2024; Saksanit & Khongprasert, 2021).

The most striking activation finding is the consistently high engagement of the adductor group, near 50% MVC across all eight postures. This pattern reflects the lateral weight-shifting and pelvic-stabilization demands of the Isan folk-dance vocabulary, and it carries biomechanical meaning for older adults. The systematic review by Lanza et al. (2022), based on 59 studies and 2,144 participants, concluded that hip muscle strength and neuromuscular activation are critical determinants of balance and mobility across the lifespan. Older adults with weaker hip musculature show poorer lateral balance recovery and a higher fall risk. The high adductor activation observed here suggests that Isan folk dance directly trains the muscle group whose impairment most strongly predicts lateral fall risk in this population. The moderate-to-high activation of tibialis anterior and gastrocnemius in balance-demanding postures matches the role of these muscles in ankle-strategy postural control (Shumway-Cook & Woollacott, 2017). It is also in line with sEMG-based fall-risk research that identifies them as fall-relevant biomarkers (Liao et al., 2025). Upper-limb activation varied across postures. Elbow flexors dominated Tha Lom Phat Phrao and Tha Ying Thanu. The wrist flexor dominated Tha Doeng. The deltoid dominated Tha Sai. These differences reflect the gesture-specific demands of each posture and show that upper-limb activation cannot be inferred from the lower-limb pattern.

The low %EMG/MVC values for erector spinae and rectus abdominis (3 to 10% MVC) need careful interpretation. The absolute values are modest, but they represent sustained tonic activation throughout the entire posture, consistent with the isometric stabilizing role of the trunk during dynamic limb movement. The pattern resembles findings from the broader dance-biomechanics literature (Koutedakis & Jamurtas, 2004), in which trunk muscles function as low-level co-contractors rather than prime movers.

Three implications are followed for exercise prescription. First, the broad multi-muscle engagement supports classifying these postures as functional movement (Clark et al., 2014), recruiting upper-, mid-, and lower-body musculature in coordinated patterns relevant to daily living activities. Second, the high adductor and balance-musculature engagement make the postures particularly relevant for fall-prevention programming in older adults, supported by recent randomized trials and a network meta-analysis of dance-based fall prevention (Li et al., 2024; Sánchez-Alcalá et al., 2025; Thiel et al., 2025), and aligned with the broader evidence on community-based exercise programs for older adults (Morales Paredes et al., 2024). Third, the finding that some postures show distributed whole-body activation while others show localized activation indicates that posture selection within a dance-based program can be calibrated to specific training emphases, in line with the FITT-VP principles of the American College of Sports Medicine (2022). The biomechanical evidence reported here therefore complements the program-effectiveness results of the companion intervention trial (Thonglong et al., 2025), in which the same eight postures, delivered as an 8-week program, improved cardiorespiratory fitness, lower-limb strength, flexibility, and balance in community-dwelling older adults.

Several limitations should be noted. The sample size (n = 10) was small and purposive within a participatory descriptive design, and all participants came from a single community, limiting generalizability to other Thai regions and other older-adult populations. The sample comprised four men and six women, below the size at which a sex-stratified analysis would be informative; existing evidence indicates that surface EMG amplitude during functional tasks can differ between male and female older adults (Theou et al., 2013), although a recent systematic review of the knee-stabilising musculature concluded that the direction and magnitude of any sex-related differences remain inconsistent across studies and depend on task and normalisation procedure (Steiner et al., 2023). Consistent with the descriptive biomechanical framing of the present sub-study, no sex-stratified inference was attempted. The sEMG measurements were obtained during pre-specified postures rather than during a continuous routine and may not fully reflect real-world performance demands. Folk-dance vocabularies of this kind also admit inter-performer variation in step execution. The present study addressed this in three ways: the eight postures were defined and validated by community consensus during Phase 1; participants performed the same fixed sequence in a controlled laboratory setting; and the postures were performed to the same traditional Isan music. Residual inter-individual variability is reported transparently in Table 3 through the observed range and the number of participants in each activation band (<20%, 20–40%, and >40% MVC), in line with current methodological guidance on inter-subject EMG variability in older adults (Commandeur et al., 2024). MVC normalization in older adults can show within-participant variability; the CEDE consensus recommends careful selection between maximal and submaximal reference tasks (Besomi et al., 2020), and submaximal isometric contractions have been proposed as alternatives for clinical cohorts (Zhu et al., 2024). Inferential analysis was not performed because the aim was descriptive and the sample was small. Future research should include larger and more diverse samples, extend the descriptive findings into inferential designs with sex-stratified analyses, compare age strata and regional dance traditions, and combine sEMG with kinematic and metabolic measurements to build full physiological-mechanical profiles.

Conclusions

This study described, for the first time, the muscle-activation profile of eight traditional Isan folk-dance postures performed by community-dwelling older adults. The eight postures combined multi-joint and multi-planar movement. Activation was consistently high in the adductor group, moderate-to-high in tibialis anterior, gastrocnemius, and selected upper-limb muscles, and low but tonic in the trunk stabilizers.

The activation profile is biomechanically consistent with the kinetic-chain and dynamic-balance frameworks used to describe coordinated whole-body movement in older adults. The continuous engagement of the adductor group during the lateral weight-shifting that defines the Isan folk-dance vocabulary, the moderate-to-high engagement of tibialis anterior and gastrocnemius during balance-demanding postures, and the low but sustained engagement of the trunk stabilisers together describe a movement pattern in which proximal stability is maintained while limb action and weight transfer take place at the periphery. The eight postures are therefore best characterised as functional, multi-joint, multi-planar movement rather than as isolated single-muscle exercises.

The pattern described above supported the classification of traditional Isan folk dance as a culturally grounded functional exercise option with relevance to fall prevention in older adults. Three practical implications follow for exercise prescription. First, the broad multi-muscle engagement supports including these postures in functional-movement programmes for daily-living capacity. Second, the consistently high engagement of the hip adductors — the muscle group whose impairment is most strongly associated with lateral fall risk — supports their use within fall-prevention programming. Third, the contrast between localised and distributed activation profiles indicates that posture selection can be calibrated to specific training emphases, in line with the FITT-VP framework. The biomechanical profile complemented the program-effectiveness results reported for the same eight postures (Thonglong et al., 2025) and provides a quantitative basis on which future programs can integrate traditional dance content into older-adult exercise prescription.

The findings should be read within the descriptive biomechanical scope of the present sub-study: the sample was purposive, comprised ten community-dwelling older adults (four men, six women) from a single Northeastern Thai community. Analyses were limited to descriptive statistics, consistent with the exploratory aim of mapping muscle-activation patterns rather than testing inferential hypotheses. Future work should test the chronic effects of dance-based programs on functional fitness and active-aging outcomes in larger and more diverse cohorts, examine how posture selection can be matched to individual training goals, and extend the present descriptive findings into inferential designs with sex-stratified analyses, cross-regional comparisons, and multimodal sEMG-kinematic-metabolic profiling.

Taken together, the present descriptive evidence supports treating the traditional Isan folk-dance vocabulary as a quantifiable functional-movement resource for the active-aging agenda: biomechanically meaningful, community-validated, and amenable to systematic integration with evidence-based exercise prescription for older adults.

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