World Journal of Management Science
Print ISSN: 2959-9628
Online ISSN: 2959-9636
DOI: https://doi.org/10.61784/wms3134

MOVING TOGETHER, AGING BETTER: WEARABLE-MEASURED PHYSICAL ACTIVITY AND SOCIAL INTERACTION IN OLDER ADULTS' COMMUNITY DANCE SESSIONS

QianJie Zhao[1*], MengLong Xiao[2,3]
[1]*Guangdong University of Business and Technology, Zhaoqing 526060, Guangdong, China.*
[2]*Zhaoqing University, Zhaoqing 526060, Guangdong, China.*
[3]*University Pendidikan Sultan Idris, Tanjong Malim 35900, Perak, Malaysia.*
[*]*Corresponding Author: QianJie Zhao*

Abstract: Community dance is the most common structured physical activity taken up by older women in China, and at least eight controlled and cohort studies have recorded its health effects. Exposure in nearly all of this work is measured by questionnaire, however, which cannot separate ninety minutes of continuous stepping from forty minutes of stepping broken up by instruction, standing and conversation. If social interaction is the ingredient that makes communal dance different from walking, what matters is not weekly minutes but the events that occur inside the session. The protocol describes a three-clock measurement design. Hip-worn accelerometry at 60-second epochs, 15-second GPS fixes within a 60-metre session geofence, and 30-second momentary observation of the same sessions by two coders are aligned on one common time base. Session-level observations, estimated at 800 to 1,150 person-sessions, will be linked to seven-day free-living activity in 96 dancers from eight squads and 40 older adults who walk alone. Social interaction is operationalised as interaction density, the share of observed intervals containing either a verbal exchange or a group response to a leader's instruction. The planned analyses cover compositional analysis of sedentary, light and moderate-to-vigorous behaviour; isotemporal substitution of 30 minutes of sedentary time with session moderate-to-vigorous activity; mixed models with participant and squad random intercepts and within-person centring of interaction density; and bootstrap mediation of the association between session activity and loneliness through interaction density. The design aims to establish whether the health advantage of communal dance over solitary walking is carried by the social structure of the session rather than by its activity volume, and to produce a session-level metric that public health programmes can specify, audit and reproduce.
Keywords: Physical activity; Accelerometry; Ecological momentary assessment; Social interaction; Loneliness; Older adults; Community dance; Compositional data analysis

1 INTRODUCTION

Guidelines for older adults are written in weekly minutes: 150 minutes of moderate-intensity activity, muscle strengthening twice a week, and balance work three times a week [1]. This currency is convenient, but it discards detail. Two older women who each reach 150 minutes can differ in whether those minutes form one continuous block or fifteen fragments, whether they walked alone along a road or stepped in a group of twenty, and whether anyone noticed when they stopped coming. Epidemiological evidence suggests these differences matter: social isolation and loneliness carry a mortality risk comparable to established behavioural risk factors, and the health benefit of physical activity in later life appears to be partly mediated by the social context in which the activity is accrued [2-3].

Plaza dancing, the choreographed group dancing practised in Chinese public squares, offers an unusually clear natural laboratory for this question. It combines a substantial amount of moderate-intensity movement with an unusually dense social structure, and it is practised at scale by the very population public health programmes find hardest to reach. Chinese cohort and intervention studies report associations with cardiovascular risk, immune function and life satisfaction, cognitive function, sleep quality through social support and depressive symptoms, and quality of life through negative emotion and attitudes toward ageing [4-9]; square dance has also been linked to mental health in older women [10].

The measurement problem runs through all of these studies. Exposure is almost always self-reported in minutes per week, at a level of detail that cannot represent what a session contains. A ninety-minute squad session typically includes five to fifteen minutes of arrival and greeting, ten to twenty minutes of standing while the leader demonstrates a new sequence, several breaks for water and conversation, and a final stretch. If the social component is the active ingredient, averaging this into ninety minutes of moderate activity three times a week discards precisely the information needed to test the claim.

Two literatures run in parallel without meeting. Accelerometry can now resolve bout structure, intensity distribution and the compositional balance of the day with acceptable precision in older adults, provided cut-points and non-wear rules are chosen for this population rather than inherited from young adults [11-17]. Social network and loneliness research

© By the Author(s) 2026, under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0).

has well-validated instruments and clear outcome constructs [18-19]. What is missing is a design that measures both at the same time, in the same place, on a time base short enough to link them.

This protocol sets out such a design. Three clocks run together: the accelerometer's epoch, the GPS fix interval and the observer's sampling interval. The alignment lets each 30-second interval of a session be classified at once by movement intensity and by social content, which yields a session-level measure of interaction and allows the question to be asked inside the session rather than across the week. The design also includes a comparison group of older adults who walk alone at comparable volume, and this group separates the social component from the movement component.

Section 2 sets out the rationale and the four hypotheses, Section 3 the methods, Section 4 the statistical analysis plan, and Sections 5 and 6 the anticipated contribution and the limits of the design.

2 BACKGROUND AND HYPOTHESES

2.1 Why the Session Is the Right Unit

Weekly minutes conflate three distinct properties of an activity: the dose of movement, the pattern in which the dose is delivered, and the social conditions under which it is delivered. Bout structure is the clearest example of the second. Current evidence in older adults suggests that accumulating activity in short bouts may carry metabolic and functional benefits closer to those of longer bouts than was once assumed, and that the distribution of intensity across the day matters independently of the total [20-22]. Communal dance is a naturally fragmented activity: a session alternates between choreographed sequences of two to five minutes, standing instruction and rest. A design that measures only weekly minutes cannot see the very structure that makes the activity distinctive.

The third property, social conditions, is the one this protocol is built around. The mediation findings in the square-dance literature are consistent on this point: social support and depressive symptoms carry a measurable share of the effect on sleep, and attitudes toward ageing carry a share of the effect on quality of life [8-9]. Mediation in cross-sectional self-report data is weak evidence, however, because mediator and outcome are reported by the same person at the same time. What is needed is a mediator measured independently of the participant's own report, at a time scale on which causal ordering is plausible.

2.2 Social Interaction as a Candidate Active Ingredient

Interaction density is treated here as the candidate active ingredient, defined as the proportion of observed 30-second intervals within a session that contain either a verbal exchange between participants or a group response to a leader's instruction. The construct is deliberately behavioural rather than affective: it counts what happened, not what the participant felt about it, and this is what allows it to serve as a mediator between an objectively measured exposure and a self-reported outcome without circularity.

The reason to expect density rather than duration to matter is that social benefit in group activity is plausibly dose-like in the number of contact events rather than in total time co-present. Two hours of dancing in silence with earpieces and one hour of dancing with instruction, correction, joking and partner changes are not the same exposure, and only the second generates the recognition on which the care networks described in the qualitative literature depend. The construct also has a practical virtue: a trained observer can code it from video or in situ with modest equipment, which makes it reproducible in programme evaluation.

2.3 Three Clocks, and Why They Must Be Aligned

Accelerometers sample at 100 Hz and are conventionally reduced to 60-second epochs for older adults, a resolution at which the boundary between a dance sequence and a standing instruction is invisible. Momentary observation samples behaviour at a fixed interval, and 30 seconds is the shortest interval at which a single observer can reliably classify activity type, posture, formation and speech in a group of twenty. GPS fixes at 15 seconds are accurate enough, with a 60-metre geofence, to establish whether a participant is inside the session area without indoor positioning.

Aligning the three clocks gives every observed interval an intensity value, an indoor or outdoor status and a social code. The alignment is imperfect, and the analysis plan treats it as such: the observation interval is the unit, accelerometer epochs are aggregated to it, and intervals in which fewer than 80 per cent of the epoch data are available are coded as missing rather than imputed from neighbouring intervals.

2.4 Hypotheses

Four hypotheses are specified in advance, and the pattern that would count against each is stated in Table 3.

H1. Moderate-to-vigorous activity within a session will accumulate mainly in bouts shorter than five minutes, and the share accumulated in bouts of five minutes or longer will be lower in communal dance than in the solitary-walking comparison group at matched weekly volume.

H2. Within the same person, sessions with higher interaction density will show a higher proportion of session time in moderate-to-vigorous activity, after adjustment for choreographic intensity, session duration and time of day.

H3. Weekly session moderate-to-vigorous activity and interaction density will each be associated with lower loneliness and a larger social network, but the association with loneliness will be carried mainly by interaction density.

H4. Substituting 30 minutes of sedentary time with 30 minutes of session activity will be associated with better lower-limb function, and the association will be stronger in dancers than in solitary walkers at comparable substitution volume.

3 METHODS

3.1 Design and Setting

The study uses a prospective observational design with a nested comparison group, conducted over twelve months across neighbourhood sites in Duanzhou District, Zhaoqing City, Guangdong Province, China. It combines seven-day free-living measurement, session-level measurement of attended sessions, and a functional and psychosocial assessment battery at baseline and at six months. The design is observational because the exposure of interest, the internal social structure of a session, is not something a trial can ethically or practically assign; the comparison group of solitary walkers supplies the contrast on social context at approximately matched volume.

3.2 Participants

96 dancers will be recruited from eight squads, 12 per squad, stratified by squad size and site type so that both plaza-based and pavement-based squads are represented. Forty older adults who walk alone at least three times a week for at least thirty minutes per session will be recruited from local neighbourhoods within Duanzhou District via community health-service registers and snowball sampling methods, and will be frequency-matched to the dancer group on age band, and weekly moderate-to-vigorous minutes estimated at screening.
Inclusion criteria: age 60 to 79; residence in the catchment for at least twelve months; able to walk unaided or with a single cane; no diagnosis of unstable cardiac disease, severe cognitive impairment or another condition precluding moderate activity, confirmed by a general practitioner where the participant reports one. Exclusion criteria: current participation in a structured exercise programme other than the study activity, planned absence of more than two weeks during the measurement month, and inability to give informed consent.

3.3 Measures

Table 1 lists the measures, the instrument or protocol used for each, the timing of collection and the part each plays in the analysis. It is included so that a reader can see, before any data exist, that every construct in the hypotheses has an independent measurement route.

Table 1 Measures, Instruments, Timing of Collection and Analytic Role

Construct	Instrument or protocol	Timing	Role
Free-living activity	ActiGraph wGT3X-BT, right hip, 100 Hz raw reduced to 60-second epochs; non-wear defined as 120 or more consecutive minutes of zero counts; valid day 10 or more wear hours, at least 4 valid days	7 consecutive days at baseline and at 6 months	Primary exposure, outer window
Location	GPS logger at 15-second fixes; 60-metre geofence around each session area	Same 7 days	Separates session from non-session time
Session behaviour	30-second momentary time sampling by two coders: activity type, posture, formation, verbal exchange, leader instruction and group response	Every attended session during the measurement month	Mediator and session-level outcome
Loneliness	UCLA Loneliness Scale version 3 [18]	Baseline and 6 months	Outcome for H3
Social network	Lubben Social Network Scale, six-item version [19]	Baseline and 6 months	Outcome for H3
Habitual activity	PASE and IPAQ short form [23-24]	Baseline	Covariate and screening match
Lower-limb function	Timed Up and Go; 30-second chair stand; four-stage balance test; grip strength	Baseline and 6 months	Outcome for H4
Affective response	Feeling Scale immediately after a session [25]	Three sessions per participant	Secondary, explanatory
Covariates	Age, education, living alone, chronic conditions, body mass index, medication count	Baseline	Adjustment

3.4 Accelerometer and Geofence Protocol

Participants wear the monitor on the right hip during waking hours for seven consecutive days, removing it only for bathing and water activity, and record removal times on a simple log. Raw acceleration is reduced to 60-second epochs, the resolution at which vertical-axis cut-points for older adults have been calibrated.
Three cut-point sets are applied, and the choice is declared in advance rather than after inspection. The primary analysis uses the adult cut-points of Freedson and colleagues as operationalised in the ActiGraph firmware: sedentary below 100 counts per minute, light 100 to 1951, moderate-to-vigorous at or above 1952 [11]. The first sensitivity analysis applies older-adult-specific vertical-axis cut-points, with moderate-to-vigorous from 579 counts per minute, and the second the higher threshold of 1013 counts per minute derived from measured walking in older adults [14, 16]. Three sets are run

rather than one because the literature on older adults reports cut-points spanning 574 to 3250 counts per minute, and the ranking of participants, not merely the absolute minutes, can change between them. A claim about relative social context should survive that choice; where it does not, that is itself a finding.

Non-wear is defined as 120 or more consecutive minutes of zero counts, the threshold recommended for older adults [13]. The commonest error in this literature is applying the 60-minute rule validated in younger samples, which classifies long sedentary periods in older adults as non-wear and inflates activity estimates. A valid day requires at least 10 hours of wear, and a valid measurement at least 4 days including one weekend day [26].

Geofencing uses a 60-metre radius around the centroid of each squad's habitual area, defined at baseline by walking the boundary with the squad leader and recording a track. Session windows are defined as the 30 minutes before the first and the 30 minutes after the last observed arrival and departure, so that the session-level dataset includes approach, dancing and dispersal rather than dancing alone.

3.5 Momentary Observation and the Interaction Density Metric

Each attended session is observed in situ by two trained coders positioned outside the group's perimeter, using 30-second momentary time sampling with a vibrating interval timer; direct observation of group activity follows the same interval-coding logic established in earlier fitness-instruction observation systems [27]. At each prompt the coder records activity type (choreographed sequence, marching in place, stretching, instruction and demonstration, rest), posture, formation grouping, whether audible speech occurred between participants, whether the leader issued an instruction, and whether the group responded to it as a body. Coders do not code audio recordings after the event, because the presence or absence of speech is the variable of interest and retrospective coding from a single microphone cannot attribute it.

Interaction density is computed as the number of intervals containing either a verbal exchange or a group response, divided by the number of valid intervals in the session. Two derived quantities are retained: exchange density, which counts only participant-to-participant speech, and instruction density, which counts only leader-initiated exchange with group response. The separation matters because the two carry different implications: exchange density is the plausible mediator for loneliness, instruction density the plausible driver of adherence and of the proportion of session time spent moving.

Inter-rater agreement is assessed on 20 per cent of sessions coded independently, with Cohen's kappa reported per dimension, and a kappa below 0.60 on any dimension triggers recoding of that dimension across the whole session rather than adjudication of individual intervals.

Table 2 defines every session-level metric, so that the reporting in Stage 2 cannot silently redefine a construct after the data have been seen.

Table 2 Session-Level Metrics and Their Definitions

Metric	Definition	Source and resolution
Session duration	First arrival to last departure, including greeting and dispersal	Observation; 1 minute
Attendance	Number of participants present, counted at each interval	Observation; 30 seconds
Session sedentary, light, MVPA	Minutes and proportions within the session window by intensity class	Accelerometry; 60-second epochs aggregated to intervals
Step count	Steps within the session window	Accelerometry
Bout structure	Number of MVPA bouts of 5 minutes or longer, and share of session MVPA accumulated in bouts under 5 minutes	Accelerometry; derived
Interaction density	Intervals with verbal exchange or group response, divided by valid intervals	Observation; 30 seconds
Exchange and instruction density	Same computation restricted to participant speech and to leader-initiated exchange	Observation; 30 seconds
Choreographic intensity	Leader-rated intensity of the sequence in force during the interval, on a three-level ordinal scale	Observation; 30 seconds
Weekly session MVPA	Sum of session MVPA minutes across attended sessions in the measurement week	Accelerometry plus attendance

3.6 Procedure

Recruitment and baseline assessment take place in month 1. Each participant completes the questionnaire battery and the functional tests in a community room, then receives the monitor and the geofence briefing. Over the following seven days the participant wears the monitor continuously and attends sessions as usual, and observers code every session the participant attends that falls within the observation schedule. Sessions are observed in a fixed rotation so that all eight squads are covered in the same week, which prevents seasonal or festival effects from concentrating in one squad. The Feeling Scale is administered after three sessions per participant. The six-month assessment repeats the battery and the seven-day wear. Exit interviews are conducted with participants who drop out, which matters because dropout is itself an outcome in this population.

4 STATISTICAL ANALYSIS PLAN

4.1 Compositional Analysis of the Activity Day

Activity data are compositional: sedentary, light and moderate-to-vigorous time are parts of a fixed 24-hour whole, and conventional regression on one part while ignoring the others produces coefficients that cannot be interpreted as substitutions. An isometric log-ratio transformation is therefore applied to the three-part composition, with the sedentary part as the reference pivot, and the resulting two coordinates are entered as covariates [20, 22]. Compositional means and dispersion are reported as geometric means of the parts, together with the percentage of total variance attributable to each part.

4.2 Isotemporal Substitution

The substitution model estimates the association of replacing 30 minutes of one behaviour with 30 minutes of another while holding total time constant. Coefficients are obtained from the compositional model by reallocating the pivot and re-evaluating the fitted values, rather than by fitting a separate model for each replacement, which is the approach that preserves the constraint. The primary substitution replaces 30 minutes of sedentary time with 30 minutes of session moderate-to-vigorous activity and is tested against lower-limb function at six months; the same substitution is estimated separately in dancers and in solitary walkers, with the difference tested by an interaction term rather than by comparing coefficients across models.

4.3 Mixed Models for Session-Level Data

Session-level outcomes are analysed with linear mixed models containing a random intercept for participant and a random intercept for squad, which handles the two levels of clustering the design creates: intervals within a person, and persons within a squad. The exposure of interest, interaction density, is decomposed into a within-person component, obtained by centring each person's session values on that person's mean, and a between-person component, entered as the person mean. The separation is necessary because the hypothesis concerns what happens when the same person has a more interactive session, whereas a model with the raw variable alone would answer a between-person question.
Every model adjusts for choreographic intensity, session duration, attendance, time of day, squad size and season. The proportion of session time in moderate-to-vigorous activity is modelled with a logit link, since it is bounded, and reported on the percentage scale. Intraclass correlation coefficients are reported for both random effects, because the squad-level ICC is itself a substantive result: it quantifies how much of the variation in session activity is attributable to the squad rather than to the individual, which is what a programme would need to know if it wanted to change behaviour by changing squads rather than people.

4.4 Mediation

The mediation model tests whether interaction density carries the association between weekly session activity and loneliness at six months. Mediation is estimated by bootstrap with 5,000 resamples, reporting the indirect effect with a bias-corrected 95 per cent confidence interval, and with baseline loneliness, age,, living alone and social network entered as covariates. Sessions attended is included as a covariate so that the mediator is density rather than dose. The same model is estimated with social network as the outcome, and the two indirect effects are compared. Because the design is observational and longitudinal but not experimental, the mediation analysis is framed as an estimate of an association consistent with a mechanism, not as a demonstration of one.

4.5 Power, Missing Data and Multiplicity

With 96 dancers contributing an assumed eight to twelve sessions each, the session-level dataset will contain roughly 800 to 1,150 person-sessions, which gives more than 80 per cent power to detect a within-person association of interaction density with the moderate-to-vigorous proportion at an effect size of 0.15 standard deviations, the smallest effect that would be policy-relevant at the session level. Power for the six-month outcomes is more limited: with 96 and 40 participants, the design can detect differences of about 0.5 standard deviations between groups on the functional measures, and the analyses of loneliness and network are therefore framed as estimates with confidence intervals rather than as tests.
Missing accelerometer data are handled by multiple imputation at the day level with 20 imputations, using wear time, season and observed session attendance as auxiliary variables; sessions with fewer than 80 per cent valid intervals are excluded rather than imputed. Four hypotheses and one mediation model are declared, no adjustment for multiplicity is applied to them, and all secondary analyses are labelled exploratory in the Stage 2 report.
Table 3 states, for each hypothesis, the analysis that will test it and the pattern that would count as disconfirmation, so that a reader can check afterwards whether the reported analysis is the one that was planned.

Table 3 Hypotheses, Planned Analyses and the Patterns That Would Disconfirm Them

Hypothesis	Planned analysis	Pattern that would disconfirm it
H1	Bout-length distribution of session MVPA; comparison of the share accumulated in bouts under 5 minutes between dancers and walkers	Dancers accumulate the majority of MVPA in bouts of 5 minutes or longer, at a rate equal to or above walkers
H2	Mixed model of MVPA proportion on within-person interaction density, adjusted for choreographic intensity and duration	Within-person coefficient indistinguishable from zero, or negative

Hypothesis	Planned analysis	Pattern that would disconfirm it
H3	Separate models of loneliness and network on weekly session MVPA and interaction density	Loneliness associated with MVPA but not with density, or with neither
H4	Isotemporal substitution of 30 minutes sedentary to session MVPA, with group interaction	Substitution coefficient null in both groups, or positive in walkers and null in dancers

5 ANTICIPATED CONTRIBUTION

5.1 What the Three-Clock Design Adds

If the design works as specified, it produces a measurement object that does not currently exist: a session-level dataset in which movement, place and social content are recorded on a common time base. Three uses follow. It separates dose from structure, since the square-dance literature has established that the activity is associated with health outcomes but not which property of the activity carries the association, because the instruments used could not see structure. It makes the social component countable, because interaction density is a behavioural count rather than a self-report, and can therefore serve as a mediator without the circularity that afflicts cross-sectional mediation in this literature. And it produces a metric a programme can specify, since a health service commissioning a community dance programme can write "at least 20 per cent of intervals containing participant exchange" into a contract in a way that it cannot write "social support".

5.2 What the Comparison Group Adds

The solitary-walking group is frequency-matched on volume, so the contrast between groups is a contrast in social context holding movement roughly constant. That is the comparison the field has been missing: studies compare dancers with sedentary controls, which establishes that activity is better than inactivity and says nothing about whether dancing together is better than walking alone. If H4 holds, the interpretation is that the association between activity and function is conditional on how the activity is socially organised, a substantive claim about the design of programmes rather than about the merits of exercise.

5.3 Practical Implications

Three implications follow for programme design, and they are stated here as conditional on the findings. Squad-based delivery should be preferred to class-based delivery for this population, because the squad is the unit that retains members, notices absence and produces the interaction that the mediator measures. Leader training should cover the maintenance of interaction and not only choreography, since instruction density and group response are the components most directly under a leader's control. And programme evaluation should report session-level structure alongside weekly minutes, because two programmes with identical weekly volume can differ in bout structure and social density by an order of magnitude.

For measurement practice the design carries a warning. The choice of non-wear rule and cut-point materially changes estimates in older adults, and the field's reliance on rules validated in younger samples has produced activity estimates that are too high and sedentary estimates that are too low [13-14, 16]. A study that reports differences between social contexts without declaring its processing choices is reporting a result that may not survive a change of cut-point, which is why Section 3.4 declares three sets and Section 4 states which is primary.

6 LIMITATIONS AND CONCLUSIONS

Five limits are accepted in advance. The design is observational, so the mediation analysis estimates an association consistent with a mechanism and cannot exclude selection: women who are less lonely may be more likely to join a squad and to stay in one. Matching on volume reduces but does not remove confounding by health status and neighbourhood. Momentary observation requires observers to be present, which changes the behaviour being observed, and the direction of that change is unknown; the four-week observation rotation is intended to let participants habituate, and the first observed session of each squad is excluded from analysis. Interaction density counts the occurrence of exchange, not its quality or valence, so a session full of argument scores as highly interactive. And the sample is recruited from community dance squads located in Duanzhou District, Zhaoqing City, and only includes groups willing to participate in field observation, which biases towards stable, well-organised squads and away from the fragile ones that the qualitative literature suggests are most at risk.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] World Health Organization. WHO guidelines on physical activity and sedentary behaviour. WHO Press, 2020.
[2] Holt-Lunstad J, Smith T B, Layton J B. Social relationships and mortality risk: A meta-analytic review. PLoS Medicine, 2010, 7(7): e1000316.
[3] Wong M Y C, Ou K L, Chung P K, et al. The relationship between physical activity, physical health, and mental health among older Chinese adults: A scoping review. Frontiers in Public Health, 2022, 10: 914548.

[4] Mu X, Yu K, Long P, et al. Leisure-time physical activity and risk of incident cardiovascular disease in Chinese retired adults. Scientific Reports, 2021, 11: 24202.
[5] Su Z, Zhao J. Comparative study of the effects of Tai Chi and square dance on immune function, physical health, and life satisfaction in urban empty-nest older adults. Frontiers in Physiology, 2021, 12: 721758.
[6] Li X, Peng A, Li L, et al. Association between walking and square dancing-oriented leisure-time physical activity and cognitive function among middle-aged and elderly people in Southwest China. BMC Geriatrics, 2023, 23: 28.
[7] Wang H, Pei Z, Liu Y. Effects of square dance exercise on cognitive function in elderly individuals with mild cognitive impairment: The mediating role of balance ability and executive function. BMC Geriatrics, 2024, 24: 156.
[8] Wu J, Yu Y, Qin K, et al. Mechanisms connecting square dance to sleep quality among middle-aged and older Chinese females: Serial mediation roles of social support and depressive symptoms. Frontiers in Public Health, 2023, 11: 1307596.
[9] Ouyang T, Qu Y, Du X, et al. The relationship between square dance exercise and quality of life in middle-aged and older adults: Chain mediated effects of negative emotions and attitudes toward aging. Frontiers in Public Health, 2024, 12: 1470624.
[10] Chang J, Chen Y, Liu C, et al. Effect of square dance exercise on older women with mild mental disorders. Frontiers in Psychiatry, 2021, 12: 699778.
[11] Freedson P S, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc. accelerometer. Medicine & Science in Sports & Exercise, 1998, 30(5): 777-781.
[12] Troiano R P, Berrigan D, Dodd K W, et al. Physical activity in the United States measured by accelerometer. Medicine & Science in Sports & Exercise, 2008, 40(1): 181-188.
[13] Hutto B, Howard V J, Blair S N, et al. Identifying accelerometer nonwear and wear time in older adults. International Journal of Behavioral Nutrition and Physical Activity, 2013, 10: 120.
[14] Barnett A, Van Den Hoek D, Barnett D W, et al. Measuring moderate-intensity walking in older adults using the ActiGraph accelerometer. BMC Geriatrics, 2016, 16: 211.
[15] Migueles J H, Cadenas-Sanchez C, Ekelund U, et al. Accelerometer data collection and processing criteria to assess physical activity and other outcomes: A systematic review and practical considerations. Sports Medicine, 2017, 47(9): 1821-1845.
[16] Evenson K R, Wen F, Moore C C, et al. Calibrating physical activity and sedentary behavior for hip-worn accelerometry in older women with two epoch lengths: The Women's Health Initiative Objective Physical Activity and Cardiovascular Health Calibration Study. Journal for the Measurement of Physical Behaviour, 2023, 6(2): 156-161.
[17] Gorman E, Hanson H M, Yang P H, et al. Accelerometry analysis of physical activity and sedentary behavior in older adults: A systematic review and data analysis. European Review of Aging and Physical Activity, 2014, 11: 35.
[18] Russell D W. UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. Journal of Personality Assessment, 1996, 66(1): 20-40.
[19] Lubben J, Blozik E, Gillmann G, et al. Performance of an abbreviated version of the Lubben Social Network Scale among three European community-dwelling older adult populations. The Gerontologist, 2006, 46(4): 503-513.
[20] Chastin S F M, Palarea-Albaladejo J, Dontje M L, et al. Combined effects of time spent in physical activity, sedentary behaviors and sleep on obesity and cardio-metabolic health markers: A novel compositional data analysis approach. PLoS ONE, 2015, 10(10): e0139984.
[21] Gennuso K P, Gangnon R E, Matthews C E, et al. Sedentary behavior, physical activity, and markers of health in older adults. Medicine & Science in Sports & Exercise, 2013, 45(8): 1493-1500.
[22] Dumuid D, Stanford T E, Martin-Fernández J A, et al. Compositional data analysis for physical activity, sedentary time and sleep research. Statistical Methods in Medical Research, 2018, 27(12): 3726-3738.
[23] Washburn R A, Smith K W, Jette A M, et al. The Physical Activity Scale for the Elderly (PASE): Development and evaluation. Journal of Clinical Epidemiology, 1993, 46(2): 153-162.
[24] Craig C L, Marshall A L, Sjöström M, et al. International Physical Activity Questionnaire: 12-country reliability and validity. Medicine & Science in Sports & Exercise, 2003, 35(8): 1381-1395.
[25] Hardy C J, Rejeski W J. Not what, but how one feels: The measurement of affect during exercise. Journal of Sport and Exercise Psychology, 1989, 11(3): 304-317.
[26] Hart T L, Swartz A M, Cashin S E, et al. How many days of monitoring predict physical activity and sedentary behaviour in older adults? International Journal of Behavioral Nutrition and Physical Activity, 2011, 8: 62.
[27] McKenzie T L, Sallis J F, Nader P R. SOFIT: System for observing fitness instruction time. Journal of Teaching in Physical Education, 1991, 11(2): 195-205.