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Psychophysiological Effects of Dance Movement Therapy and Physical Exercise on Older Adults With Mild Dementia: A Randomized Controlled Trial

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Abstract

Objectives: Dementia interferes with older adults' functioning in cognitive, daily, psychosocial, and neuroendocrine domains. The present study examined the psychophysiological effects of dance movement therapy (DMT) and physical exercise for older adults with dementia.
Methods: This randomized controlled trial recruited 204 older adults diagnosed with mild dementia into the DMT, exercise, or waitlist control group. Both DMT and exercise interventions had similar intensity and comprised 24 hr of intervention that spanned over 12 weeks. All participants completed self-report questionnaires on psychosocial well-being, daily functioning, neurocognitive assessments, and salivary cortisol measures at baseline and 3 follow-up measurements more than 1 year.
Results: The DMT group showed significant decreases in depression, loneliness, and negative mood (d = 0.33–0.42, $p < .05$) and improved daily functioning (d = 0.40, $p < .01$) and diurnal cortisol slope (d = 0.30, $p < .01$). The effects on daily functioning and cortisol slope remained at 1-year follow-up. The exercise group of matched intensity showed no significant effects on the outcomes.
Discussion: The study findings support the potential utility of DMT as a multifaceted intervention for improving various aspects of functioning in older adults with declining cognitive abilities. The lack of beneficial effects for our exercise intervention and long-term DMT effects highlights the need to maintain persistent levels of exercise with adequate intensity and duration.

Keywords: Biomarkers, Longitudinal change, Memory, Mild cognitive impairment, Psychophysiology

Dementia is a progressive neurodegenerative disorder characterized by cognitive impairments in memory, language, and executive functioning (McKhann et al., 2011). Dementia interferes with individuals' daily functioning and psychological well-being. The deteriorating abilities in memory and communication often lead to poor self-care and behavioral and psychological symptoms (BPSD) such as agitation, irritability, and mood disturbance (Finkel, e Silva, Cohen, Miller, & Sartorius, 1997). Hong Kong has the highest life expectancy among the world with 18% of

the older adults diagnosed with very mild or mild dementia (Lam et al., 2008). Dementia is a major health issue in aging populations with massive costs of medical and informal care to the individuals and society.

Systematic reviews (McLaren, LaMantia, & Callahan, 2013) have shown limited effects for pharmacological interventions in treating dementia, with known side-effects for antipsychotics, such as worse quality of life and increased mortality. Aerobic exercise is a known nonpharmacological intervention that improves functional capacity in various populations (Pasanen, Tolvanen, Heinonen, & Kujala, 2017). Aerobic exercise has been found in a meta-analysis to positively influence cognitive function in older adults with dementia (Groot et al., 2016), though another review on exercise programs (Forbes, Forbes, Blake, Thiessen, & Forbes, 2015) reveals beneficial effects only for daily functioning but not cognition, neuropsychiatric symptoms, or depression in this population.

Dance movement therapy (DMT) is a mind-body intervention that integrates physical elements of exercise and psychosocial therapeutic components. A meta-analytic study by Koch, Kunz, Lykou, and Cruz (2014) on 23 studies demonstrates DMT effects on depression, quality of life, positive mood, and affect in various populations. DMT for dementia comprises moderate levels of physical activity in terms of hours of dance per week. DMT stimulates different brain areas associated with memory, executive function, and motor skills (Foster, 2013). For instance, dance improvisation uses frontal lobe resource, and movement relies on path integration and visual tracking. These components could activate the entorhinal and hippocampal networks associated with spatial memory, an area of profound impairment in dementia. The enhanced rhythmic movement of DMT is beneficial for mood and memory among older adults with cognitive impairment (Pearce, 2007).

Older adults with dementia experience memory loss and may become disoriented in space and time. The disorientation may provoke fear and isolation and lead to a fragmented sense of self. Group dance provides a sense of connection that may ease the challenge of the spatial disorientation. The nonverbal approach offers a medium of expression for the older adults with declining verbal abilities (Hamill, Smith, & Röhricht, 2012). Dance movement could not only evoke reminiscent emotional responses but also promote functional skills and emotional behaviors that remain useful for the older adults with dementia. A systematic review of 10 studies (Guzmán-García, Hughes, James, & Rochester, 2013) showed beneficial effects for DMT in reducing BPSD and enhancing self-expression and communication among older adults under nursing care.

Salivary cortisol is a neuroendocrine indicator of hypothalamic-pituitary-adrenal (HPA) axis activity, which is responsible for stress response and immune regulation in the body. Healthy older adults with elevated basal cortisol have shown deficits in memory tasks (Lupien et al., 1998). Heightened cortisol levels have been linked with quicker

progression of dementia (Csernansky et al., 2006) and older adults with dementia displayed flatter cortisol slopes than the cognitively normal (Kovach, Woods, Logan, & Raff, 2011). Assessment of diurnal cortisol pattern helps elucidate the interrelationship among neuroendocrine response, psychological well-being, and dementia-related decline. However, no existing studies have investigated the physiological effects of DMT and exercise on diurnal cortisol pattern in this population.

Despite the clinical establishment and preliminary studies of DMT, evidence from existing studies remains largely descriptive and is limited by methodological designs. Karkou and Meekums (2017) conducted a Cochrane review on randomized controlled trials of DMT for dementia. None of the 19 identified studies met the inclusion criteria and were excluded in the review, calling for methodological trials for a systematic evaluation of the intervention. In light of the research gap, the present study makes the first attempt in the field to systematically evaluate the effects of DMT and exercise interventions in multidimensional functioning of older adults with mild dementia. It was hypothesized that both the DMT and exercise interventions would show significant treatment effects in comparison to waitlist control. A secondary objective of the present study was to explore the comparative effectiveness of the two interventions. Findings of this study would provide evidence for the DMT intervention to improve the multidimensional manifestations of dementia.

Method

Research Design

The present study adopted a single-blind, three-arm randomized controlled trial (RCT) design with waitlist control. After screening and collection of baseline data, the participants were randomized into one of the three groups: DMT, exercise, or waitlist control, on a 1:1:1 basis using simple randomization with computer-generated random numbers and no blocking. All participants were assessed at four-time points over 12 months. Baseline data were collected 1 week before the start of the intervention (Time 1). Postintervention assessment (Time 2) was administered at the end of the intervention, that is, 3 months after baseline. Two follow-up assessments were conducted at 6 months (Time 3) and 12 months (Time 4) after baseline. These two follow-up measures were completed 3 months and 9 months following the end of the intervention and reflected the longer-term maintenance effect. Ethical approval was obtained from the local institutional review board of the university and hospital authority (IRB reference number = UW 14–121). This trial has been registered in the Chinese Clinical Trial Registry (ChiCTR-IOR-15006541).

Participants

Older adults with a clinical diagnosis of dementia (DSM IV) or mild neurocognitive disorder (DSM V) were recruited

from psychogeriatric outpatient departments of a local hospital and older adults community centers in Hong Kong via referrals from the treating psychiatrists or facility staff. A Clinical Dementia Rating (CDR) screening evaluation was conducted by the team's psychiatrist for each potential participant. The inclusion criteria of the study were a CDR rating of 0.5 and 1 (very mild to mild dementia), aged 65 or older, mobility of at least the upper limbs and body, sufficient visual and auditory abilities to complete assessments, and stable doses of medication for at least 30 days before screening. The exclusion criteria included clinical diagnosis of major psychiatric disorder or abuses of drug or alcohol that could cause cognitive impairment, history of stroke, or other severe illnesses that led to neurological deficits that limit participation in the interventions.

Recruitment and Study Flow

Supplementary Figure 1 depicts the flow chart of the study. Out of the 339 older adults who were assessed for eligibility, 63 of them did not meet the inclusion criteria and were excluded. Fifty-eight older adults declined to take part in the study, and another 14 were unavailable to join because of other commitments. The remaining 204 eligible older adults gave written informed consent and were randomized into the DMT, exercise, or waitlist control group after baseline assessment. They would obtain a graduation certificate upon completion of the DMT or exercise program. In total, 38 participants dropped out of the study over the year, with reasons for drop-out including refusal to join the follow-up assessments, lost to follow-up because they were hospitalized, no longer living in Hong Kong, or had passed away. The overall 1-year attrition rate (38/204 = 18.6%) was lower than the rate (35%) of a previous trial (Lam et al., 2012) and the DMT group showed a lower attrition rate of 10.1% than the exercise or control group (22.4% and 23.5%). Attrition analysis did not find any significant difference in the demographic and baseline characteristics between the dropouts (*n* = 38) and the completers (*n* = 166). The differences in attrition could be due to the greater satisfaction, and enjoyment participants in the DMT group experienced compared with participants in the exercise and control groups.

Interventions

The dance-movement intervention was led by a registered dance-movement therapist or one in training. The program was modified from an established dance/movement therapy program which had previously been applied within the Chinese population over the past decade. To enhance the effectiveness, more emphasis was placed on easy steps and rhythm, and the movements were modified so that they could also be performed in both standing and sitting positions to cater to the participants' bodily needs and to reduce tiredness. Materials, such as scarves, elastic bands,

ribbons, and small musical instruments were used more often to enhance the sense of working with objects, elasticity, strength, and coordination. The modified program was shown to be feasible and well-received in a pilot trial of ten older adults with cognitive impairment.

DMT comprised four main elements, namely, simple group dance, movement games, improvisational dance movement, and movement interactions among group members. These elements aimed to encourage the participants to remember steps and sequences, improve mood and vitality, foster imagination, creativity, and personal expression, and enhance communication and social exchange (Foster, 2013), respectively. The intervention emphasized rhythmic and contralateral movements on both sides of the body to enhance coordination and stimulation between the left and right cerebral hemispheres (Phillips-Silver & Trainor, 2007). Finally, verbal sharing was done as a group discussion following the end of each session. All participants were invited to use one or two words or a gesture or movement to express their feelings about the movement experience or to say something supportive or caring to each other, which facilitated articulation and mutual support among the participants.

The exercise group contained a mild to moderate exercise program of comparable length and intensity as the DMT group and was conducted by trained and qualified fitness instructors. Each exercise session consisted of a warm up (15 min), stretching and joint movements (15 min), exercising with towels (15 min) and a cool down (15 min). Heart rates of the participants were monitored throughout the entire intervention sessions using portable heart rate monitors to maintain a similar level of exercise exertion in both groups (40%–60% of the VO_2 max value). For both DMT and exercise arms, interventions spanned 12 weeks, with 1-hr sessions held twice a week in groups of about 10–12 participants each. Participants in both groups received in total 24 hr of intervention. The waitlist control group received regular medication and routine care during the study and was offered DMT or exercise intervention upon study completion.

Measures

Participants completed a battery of self-rated scales on psychosocial and daily functioning under guidance and received neurocognitive assessments on cognitive functioning by the research coordinators. The assessments were conducted by research coordinators who were blinded to the randomization and had received training in using the instruments. Participants collected five salivary cortisol samples at each assessment as stress biomarkers.

Screening Instrument

The Clinical Dementia Rating Scale (Hughes, Berg, Danziger, Coben, & Martin, 1982) characterizes six dimensions of

cognitive and functional performance: memory, orientation, judgment and problem solving, community affairs, hobbies and habits, and personal care. At baseline, the raters conducted semi-structure interviews with the participants and their caregivers to determine the impairment on each dimension. An overall CDR score was computed based on the degree of impairment in the six dimensions. A CDR rating of 0.5 and 1 denoted the case of very mild dementia and mild dementia, respectively.

Psychosocial and Daily Functioning

The de Jong Fierveld Loneliness Scale (G. T. Leung, de Jong Gierveld, & Lam, 2008) is a 6-item, 3-point self-reported scale that inquires the feelings of being alone. Depressive symptoms were measured as the sum of four dichotomous items of the Geriatric Depression Scale (Cheng & Chan, 2005). The 8-item, 11-point Visual Analogue Mood Scale (Folstein & Luria, 1973) assessed the positive mood (feeling relaxed, energetic, and delighted) and negative mood (feeling worried, nervous, angry, tired, and anxious) over the past week. The instrumental activities of daily living (IADL) scale (Tong & Man, 2002) was used to assess daily functioning skills such as cooking, doing housework, and taking medications. Participants' ability to accomplish these tasks was evaluated via self-report responses and information from their caregivers.

Behavioral and psychological symptoms of dementia (BPSD) of the respondents were assessed by the 12-item Neuropsychiatric Inventory (V. P. Leung, Lam, Chiu, Cummings, & Chen, 2001). The severity of the symptoms such as apathy, hallucination, and agitation were recorded from the personal caregivers of the participants on 4-point scale (0 = *none*, 3 = *severe*). The total score on loneliness, depression, positive mood, negative mood, IADL, and BPSD range from 0 to 6, 0 to 4, 0 to 10, 0 to 10, 0 to 18, and 0 to 36, respectively, with higher scores for positive mood and IADL suggesting better functioning and otherwise. The five measurement scales displayed acceptable to good reliability for loneliness ($\alpha = 0.71$), depression ($\alpha = 0.61$), positive mood ($\alpha = 0.78$), negative mood ($\alpha = 0.81$), IADL ($\alpha = 0.90$), and BPSD ($\alpha = 0.84$) at baseline.

Cognitive Functioning

The Fuld Object Memory Evaluation (Ho, Fong, Hon, et al., 2018) evaluates episodic retrieval of the participants. The respondents were instructed to identify ten unrelated daily items from an opaque bag by touch and vision and verbally repeat its name thereafter. This was followed by a 1-min rapid semantic retrieval task that served as distraction to prevent rehearsal. Then the respondents would try to recall the 10 items within 60 s, and any unrecalled items were reminded by the raters. Such retrieval-reminding-distraction process repeated another four times with 30-s rapid semantic retrievals in between for five recall trials,

with a delayed recall trial conducted after 20 min. Total retrieval refers to the total number of items that were correctly recalled over the five recall trials (range = 0–50). Delayed recall refers to the number of items (out of the 10) that the respondent correctly identified in the delayed recall trial. Both total retrieval and delayed recall represent the long-term episodic memory. Verbal fluency is defined as the sum of the total number of objects named in the five semantic retrieval tasks (Chiu et al., 1997) and denotes the respondents' verbal memory.

The Digit Span Test of the Wechsler Adult Intelligence Scale (Yao, Chen, Jiang, & Tam, 2007) was used to measure short-term and working memory of the respondents. The respondents listened to sequences of numbers with increasing length from two to nine digits. They were instructed to memorize the sequences and repeat the digits in the original (forward) or reverse (backward) order. Two attempts were allowed to solve each set length, and the test ended when the respondent failed both attempts on the same length. Forward digit span assesses the short-term memory on maintenance of information and backward digit span evaluates working memory on the processing of information. The trail making test (Lu & Bigler, 2002) measures the time (in min) the participant needs to finish two tasks (Parts A and B) in drawing lines between alternate numbers. This test requires visuospatial construction abilities such as visual search, attention, and mental flexibility. The trail making test scores reflect cognitive abilities in complex attention and executive function. Both completion times were restricted to a maximum of 5 min. The Fuld object memory evaluation, digit span test, and trail making test were administered by four trained raters, and acceptable inter-rater reliability (intraclass correlation coefficients > .70) was found for these assessments.

Biomarkers

In all assessment waves, participants collected saliva samples using cotton salivette tubes at home at five occasions on a normal weekday: wake-up (Sample 1), one hour after wake-up (Sample 2), noon before lunch (Sample 3), late afternoon (Sample 4), and evening before bedtime (Sample 5). A previous study (Ho, Fong, Chan, & Chan, 2013) has demonstrated acceptable intra-individual stability for consecutive days of cortisol measures with no significant day-to-day difference among Chinese cancer patients and healthy older adults. Written instructions, verbal explanations, and reminder notes were provided to help the participants collect the saliva. They were instructed to collect the first sample immediately upon awakening, mark the collection time of each sample on a daily log, and avoid food consumption and strenuous exercise 30 min before sample collection. Instruction sheets and briefing sessions were provided to their caregivers to improve adherence of saliva sampling times. The collected salivette tubes were kept frozen at the stress laboratory of the university, and

the cortisol levels were determined after thawing and centrifugation at 3000 rpm for 15 min using the ELISA kit (Salimetrics, PA). The intra-assay and inter-assay variation was less than 8%.

Preliminary screening of cortisol values winsorized outliers that deviated substantially (>3 *SD*) from the means. A total of 17, 13, 21, and 11 cortisol outliers were winsorized among the 853, 821, 761, and 678 samples at Time 1, Time 2, Time 3, and Time 4, respectively. The diurnal cortisol pattern was summarized by the diurnal cortisol slope and mean cortisol. The former denoted the hourly change in cortisol levels by regressing the five cortisol values on the collection time while the latter represented the average cortisol level by dividing the area under the curve by the elapsed time between the first and last cortisol measures. Smaller (more negative) diurnal slopes showed more rapid declines in cortisol and vice versa.

Data Analysis

Chi-square independence tests and analysis of variance compared the demographic characteristics and baseline variables across the three groups, with characteristics that differed significantly across groups entered as covariates in subsequent analyses. Multigroup latent growth modeling was used to evaluate the effectiveness of DMT and exercise via piecewise estimation of the growth trajectories and between-person variation in the outcomes. The piecewise growth models had one latent intercept and two latent slopes factors. The intercept denoted the baseline status at Time 1, the first slope depicted the change during the 3-month intervention period (Time 1–Time 2), and the second slope modeled the subsequent change during the 9-month maintenance period (Time 2–Time 4). Overall Wald tests were carried out for each outcome variable to examine whether the two latent slopes differed significantly across groups. The latent slopes of the three groups were contrasted in a pairwise manner by computing the mean slope difference between groups.

Mplus 8 (Muthén & Muthén, 1998–2017) was used with the robust maximum likelihood estimator for the skewed cortisol data. Missing data were handled via full information maximum likelihood under the missing-at-random assumption, which allowed us to analyze all of the available data under the standard intent-to-treat clinical approach. Model fit was assessed using the following criteria (Hu & Bentler, 1999): nonsignificant χ^2 (*p* > .05), comparative fit index (CFI) and Tucker–Lewis index (TLI) ≥0.95, and root mean square error of approximation (RMSEA) ≤0.06. Cohen *d* reflects the standardized intergroup difference in the slopes, with values of 0.2, 0.5, and 0.8 denoting small, medium, and large effect sizes, respectively (Cohen, 1988). Using Monte Carlo simulation, the present sample size (*n* = 204) showed a statistical power of 77% to detect statistical significance for a medium intervention effect (*d* = 0.5) under 5% Type I error.

Results

Participant Characteristics

The mean age of the participants was 79.0 years (*SD* = 8.0). The majority of them were female (81.9%), single/widowed (62.7%), received at most 6 years of education (67.5%), and performed the regular exercise (78.4%). The average time of exercise for the sample was 3.7 hr per week (*SD* = 3.7, range = 0–14). Around two-third (68.6%) of them were diagnosed with very mild dementia with CDR of 0.5 and the remaining (31.4%) having a CDR of 1. No significant difference (*p* > .05) was found among the three groups in the demographic characteristics including the baseline physical activity (Table 1). At Time 1, mean cortisol levels (in nmol/L) of the sample were 7.65 (*SD* = 6.39), 9.39 (*SD* = 7.96), 4.98 (*SD* = 5.10), 3.89 (*SD* = 4.47), and 2.96 (*SD* = 3.21) across the five saliva samples, with mean collection time at 0609 hr (*SD* = 67 min), 0714 hr (*SD* = 81 min), 1,156 hr (*SD* = 43 min), 1,655 hr (*SD* = 43 min) and 2,058 hr (*SD* = 35 min), respectively. Neither the baseline cortisol levels nor sample collection time differed significantly across groups (*p* > .05). Supplementary Table 1 shows the descriptive statistics of the outcome variables on psychosocial functioning, cognitive functioning, daily functioning, and diurnal cortisol pattern at the four-time points by group. The descriptive statistics of the three groups did not differ significantly (*p* > .05) in the outcome variables at Time 1.

Intervention Effects on Psychosocial Functioning

The multigroup piecewise growth models showed an adequate model fit for all of the outcome variables with nonsignificant chi-squares (*p* = .16–.85), CFI and TLI ≥0.96, and RMSEA ≤0.06. Table 2 shows the estimates of DMT and exercise effects on the outcomes from Time 1 to Time 2. The Wald test showed significant chi-squares (χ^2 = 6.80–14.26, *p* < .05) for depression, loneliness, and negative mood, but not for positive mood and BPSD (χ^2 = 0.60–3.77, *p* = .15–.74). From Time 1 to Time 2, the DMT group showed significantly lower scores in depression (*B* = −0.51, *SE* = 0.19, *p* < .01, *d* = 0.33), loneliness (*B* = −0.96, *SE* = 0.28, *p* < .01, *d* = 0.42), and negative mood (*B* = −0.74, *SE* = 0.30, *p* < .05, *d* = 0.30) than the control group. The exercise group showed negative but statistically nonsignificant effects on these variables (*B* = −0.03 to −0.60, *SE* = 0.20–0.31, *p* = .05–0.91, *d* = 0.01–0.23). Figure 1 shows the 1-year growth trajectories of the psychosocial functioning variables for the three groups. The levels of depression, loneliness, and negative mood decreased during the first three months for the DMT group and increased slightly in the control group. From Time 2 to Time 4, however, the DMT group showed considerable rebounds in depression, negative mood, and loneliness. At Time 4, the DMT and control group no longer differed significantly in these three variables (*d* = 0.10–0.21, *p* = .08–.42).

Table 1. Profile of Demographic Characteristics and Baseline Cortisol Values of the Participants

Variables	DMT	Exercise	Control	χ^2	df	p
	N (%)	N (%)	N (%)			
Gender—*Female*	56 (81)	56 (84)	55 (81)	0.20	2	.91
Education level				0.30	2	.86
Primary (≤6 years)	48 (70)	43 (65)	46 (68)			
Secondary (≥7 years)	21 (30)	23 (35)	22 (32)			
Marital status				5.15	2	.08
Single/widowed	38 (56)	49 (74)	41 (61)			
Married	30 (44)	17 (26)	26 (39)			
Care setting—Community	40 (58)	38 (57)	46 (68)	2.04	2	.36
Clinical dementia rating				0.80	2	.67
0.5	48 (70)	48 (72)	44 (65)			
1	21 (30)	19 (28)	24 (35)			
	Mean (SD)	Mean (SD)	Mean (SD)	F	df	p
Age (years)	79.4 (7.6)	79.3 (8.1)	78.3 (8.4)	0.42	2, 196	.66
Wake-up time (hr)	6.1 (0.9)	6.3 (1.3)	6.1 (1.1)	0.98	2, 201	.38
Sample 1 cortisol (nmol/L)	8.0 (7.0)	6.6 (5.2)	8.2 (6.6)	0.99	2, 157	.38
Sample 2 cortisol	8.5 (6.1)	8.8 (7.9)	10.8 (9.6)	1.39	2, 168	.25
Sample 3 cortisol	4.8 (5.2)	4.8 (5.1)	5.1 (5.0)	0.05	2, 176	.95
Sample 4 cortisol	3.6 (3.9)	4.0 (5.3)	3.9 (4.2)	0.09	2, 178	.92
Sample 5 cortisol	3.4 (3.4)	2.3 (2.7)	2.9 (3.4)	1.54	2, 159	.22
Exercise time (hr/week)	3.8 (4.1)	3.6 (3.7)	3.7 (3.4)	0.06	2, 167	.94

Table 2. Effects of DMT and Exercise Interventions on the Outcomes from Time 1 to Time 2

Slope	Wald test		DMT vs control				Exercise vs control			
	χ^2	p	B	SE	p	d	B	SE	p	d
Depression	**7.05**	**.03***	**−0.51**	**0.19**	**<.01****	**0.33**	−0.30	0.20	.13	0.18
Loneliness	**14.26**	**<.01****	**−0.96**	**0.28**	**<.01****	**0.42**	−0.03	0.28	.91	0.01
Positive mood	0.60	.74	0.22	0.33	.50	0.08	−0.00	0.32	.99	0.00
Negative mood	**6.80**	**.03***	**−0.74**	**0.30**	**.02***	**0.30**	−0.60	0.31	.05	0.23
BPSD	3.77	.15	0.01	0.65	.98	0.00	1.04	0.63	.10	0.20
Forward digitspan	1.76	.41	−0.26	0.20	.20	0.16	−0.19	0.21	.37	0.11
Backward digitspan	4.78	.09	0.29	0.22	.19	0.16	−0.18	0.23	.44	0.09
Total retrieval	0.18	.92	0.39	0.94	.68	0.05	0.09	0.90	.92	0.01
Delayed recall	2.55	.28	−0.31	0.25	.21	0.15	−0.33	0.24	.16	0.17
Verbal fluency	2.65	.27	1.46	1.10	.18	0.16	−0.16	1.22	.90	0.02
Trail making test A	1.00	.61	0.15	0.16	.35	0.11	0.02	0.15	.87	0.02
Trail making test B	4.38	.11	0.06	0.18	.73	0.04	0.35	0.19	.06	0.22
Instrumental ADL	**11.07**	**<.01****	**1.92**	**0.58**	**<.01****	**0.40**	0.74	0.59	.21	0.15
Mean cortisol	2.74	.25	0.25	0.17	.14	0.18	0.25	0.17	.14	0.18
Cortisol slope	**9.10**	**.01***	**−0.10**	**0.04**	**<.01****	**0.30**	−0.07	0.03	**.03***	0.28

Note. B = unstandardized coefficient; *SE* = standard error; *d* = Cohen *d*.
The significance of the bold values: **p < .01; *p < .05.

Intervention Effects on Cognitive Functioning

For the seven outcome variables on cognitive functioning, the Wald test did not find any significant chi-squares (χ^2 = 0.18–4.78, df = 2, p = .09–.92). Figure 2 shows the 1-year growth trajectories of the cognitive functioning variables for the three groups. From Time 1 to Time 2, neither DMT nor exercise interventions showed significant effects on cognitive functioning (d = 0.01–0.22, p = .06–.92) compared with control. From Time 2 to Time 3, the DMT group displayed significant improvements in total retrieval (B = 1.81, SE = 0.89, p < .05, d = 0.25) and delayed recall (B = 0.80, SE = 0.40, p < .05, d = 0.24) over the control

group. However, their growth trajectories converged at Time 4 with no differences between the two groups. Figure 2 showed overlapping growth trajectories of digit span and trail making tests where all three groups showed trivial changes.

Intervention Effects on Daily and Neuroendocrine Functioning

The Wald test revealed significant chi-squares (χ^2 = 9.10–11.07, df = 2, p < .01) for IADL and diurnal cortisol slope but not for mean cortisol (χ^2 = 2.74, df = 2, p = .25). From Time 1 to Time 2, both the DMT and exercise groups significantly decreased the diurnal cortisol slope (B = −0.07 to −0.10, SE = 0.03–0.04, p = .025–.009, d = 0.28–0.30) and only the DMT group showed a significant and positive effect on IADL (B = 1.92, SE = 0.58, p < .01, d = 0.40)

Figure 1. One-year growth trajectories of psychosocial functioning variables for the three groups.
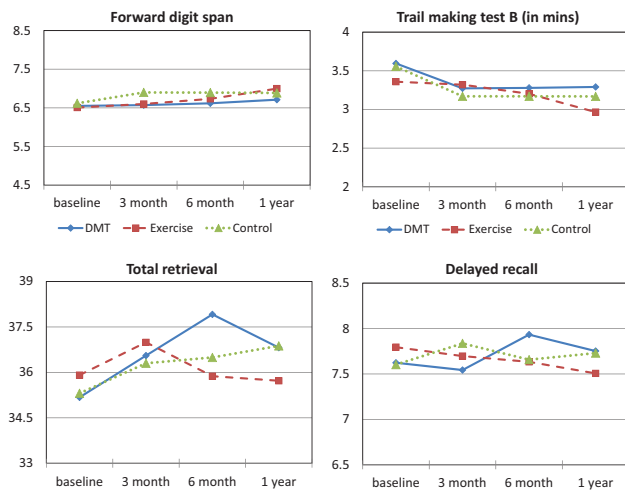
Figure 2. One-year growth trajectories of cognitive functioning for the three groups.

compared with control. Figure 3 shows the growth trajectories of IADL and diurnal cortisol pattern for the three groups. From Time 2 to Time 4, the three groups showed similar decreasing trends in both mean cortisol and IADL. The postintervention difference in IADL between the DMT and the control group was maintained till Time 4. For the diurnal cortisol slope, the DMT group showed a continuous decline compared with control with a significant and more negative diurnal cortisol slope (B = −0.25, SE = 0.11, p = .02, d = 0.28) at Time 4. The exercise group showed a more negative cortisol slope than the control group at Time 4 but the difference was not statistically significant (B = −0.11, SE = 0.10, p = .26, d = 0.14).

Discussion

Effects of DMT Intervention

This randomized controlled trial provides a first evaluation of the holistic effects of DMT among older adults with mild dementia over the 1-year course. The present study demonstrates short-term multifaceted effects for DMT in better psychosocial functioning (decreased depression, loneliness, and negative mood), improved IADL and neuroendocrine functioning compared with waitlist control. These results are consistent with recent findings (Ho, Fong, Cheung, Yip, & Luk, 2016; Ho, Fong, & Yip, 2018) on the DMT effects on perceived stress, pain, and diurnal
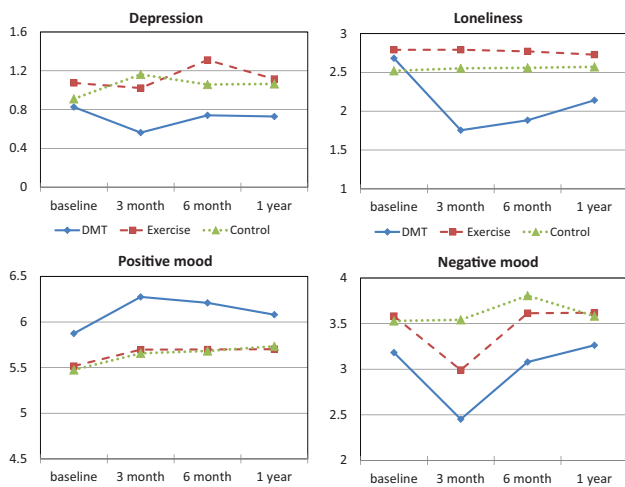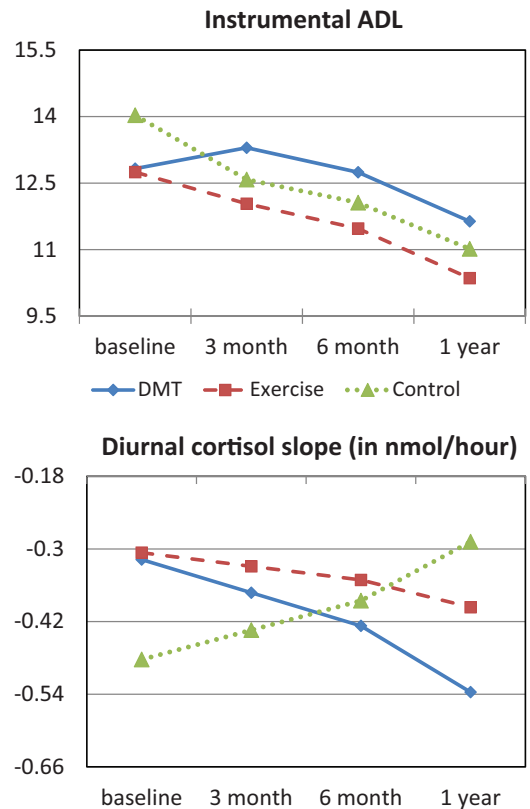

Figure 3. One-year growth trajectories of daily functioning and diurnal cortisol pattern for the three groups.

cortisol slopes in breast cancer patients. DMT is an integrative mind-body therapy that provides structure and support to the older adults with cognitive impairment without any adverse effects. DMT is applicable to this population for the following three reasons: first, it could promote the participants' body awareness and functional skills; second, it could foster greater acceptance of the illness and sharing of personal feelings; third, motor learning is relatively well-preserved in dementia.

The DMT group showed delayed improvements in total retrieval and delayed recall compared with the control group at 3 months after the end of intervention. Given that the improvements appeared after several months but not immediately after the intervention, the time lag appears to imply the potential existence of mediating factors for this delayed effect. Neuroendocrine factors (HPA axis functioning) and psychological factors (depressed mood and emotional distress) could temporally mediate the treatment effect on cognition. Future longitudinal studies should take into account factors from multidimensional (neuroendocrine, molecular, psychological, or behavioral) domains to elucidate the underlying mechanisms of DMT on cognitive improvements.

At 1-year follow up, only the DMT effects on daily and neuroendocrine functioning remained with fewer declines in daily functioning and steeper diurnal cortisol slopes than the control group. The DMT effects on psychosocial and cognitive functioning diminished gradually and dissipated by the end of the study at 1-year follow-up. The lack of long-term DMT effects in the psychosocial and cognitive aspects suggests that its current levels of frequency and duration may not be sufficient to yield a long-lasting effect. Further studies should elucidate the dose–response relationship for DMT and investigate whether a 6-month DMT intervention could produce sustainable effects at long-term follow-up.

Effects of Exercise Intervention

Our findings did not indicate any beneficial effects for exercise in the psychosocial, cognitive, and daily functioning domains compared with waitlist control. This appears to be inconsistent with the findings of existing studies (Barnes et al., 2015; Heyn, Abreu, & Ottenbacher, 2004) on the favorable effects of exercise on physical fitness, functional performance, behavior, and quality of life. There are two plausible explanations. First, reviews on aerobic exercise (Erickson & Kramer, 2009; Littbrand, Stenvall, & Rosendahl, 2011) suggest that the exercise activity should last at least 6 months and have sufficient intensity to challenge the individual's physical capacity and produce cognitive improvement. Although aerobic physical exercise has demonstrated positive effects on the prevention of the occurrence and worsening of dementia, stretching has not shown such an effect (Erickson et al., 2011). In the present study, since warm up and cool down occupied half

(30 min) of the total time of the exercise intervention, this group did not actually perform a lot of aerobic movement. The lack of exercise effect might be attributed to the insufficient levels of aerobic movement.

Second, a randomized controlled trial by Baker and colleagues (2010) found significant benefits on cognition, insulin and cortisol levels for aerobic exercise in older adults with mild cognitive impairment. Their intervention comprised 96 hr of high-intensity aerobic exercise over 6 months. Since the present exercise intervention only comprised 24 one-hr sessions of moderate-intensity exercise held twice a week for 3 months, our results could be attributed to the lower levels of intensity, frequency, and duration of the intervention. The current null findings appear to imply that adequate levels of frequency and intensity are needed for the protective effects of aerobic exercise on dementia to take place.

Comparative Treatment Effects

Compared with the null results for exercise intervention, the present findings appear to suggest additional benefits for DMT over exercise in the psychosocial, daily, and neuroendocrine domains. Direct contrast of the two interventions showed positive changes favoring DMT over exercise in terms of reduced depression, loneliness, and BPSD, and improved mood, backward digit span, verbal fluency, and IADL. However, most of these between-treatment differences did not reach statistical significance except for loneliness ($p < .01$), backward digit span ($p = .03$), and marginally for IADL ($p = .067$). Given the same levels of frequency and duration for both interventions, it is plausible that DMT targets both the physical and mental well-being of the participants and can more likely satisfy their multidimensional needs. In line with the direction of evidence-based medicine, future comparative effectiveness research is needed to determine which of the two interventions works better in other samples of older adults with different contexts.

Study Limitations and Strengths

Several study limitations should be noted. First, vigorous exercise programs have shown improvements in cognition and reduced risk of dementia. Our current exercise intervention may not have comparable levels of intensity, frequency, or duration as in previous studies, which could lead to a lack of significant effects for exercise on the outcome variables. The present study could not make definitive conclusions about the effectiveness of exercise on older adults with dementia. Future studies on dose–response relationship are needed to evaluate whether physical exercise of higher intensity and dosage can benefit the psychosocial and cognitive functioning of the older adults. Second, over three-fourth of the present sample reported having regular exercise, which seems unusually high contrary to decreasing rates of exercise with advancing age in the general

population. Given the cognitive impairment of the participants, they may have misremembered their exercise habits and overreported their exercise frequency and duration. The higher level of physical exercise in this sample may also reflect sampling response bias towards the physically active older adults who were more interested in joining the interventions. Caution should be warranted before generalizing the present findings to the population of Chinese older adults who are likely not as physically active.

Third, the present study did not distinguish between different types of dementia since the CDR screening could only determine the dementia severity but not its subtype. Given the differences in symptoms and management among patients with Alzhimer's disease, frontotemporal dementia or dementia with Lewy bodies (Robinson, Tang, & Taylor, 2015), the DMT effect could plausibly vary over the unmeasured dementia subtype. Future studies should assess the dementia subtype and examine its potential moderating role on the treatment effectiveness in a larger sample. Fourth, the diurnal cortisol pattern at each assessment was measured on a single day which did not account for potential day-to-day fluctuations. The self-reported time of awakening and saliva collection was subject to recall bias given the cognitive impairment. Future studies should obtain multiple days of saliva samples and utilize objective methods such as actigraphy to verify the sampling adherence. Two strengths of the present study are the systematic randomized design with a larger sample size and longitudinal follow-ups. The present study incorporates multiple sources of data such as subjective self-report questionnaires on psychosocial and daily functioning, professional ratings from clinical interviews with caregivers, physiological biomarkers on salivary cortisol, and objective neurocognitive assessment tasks.

Conclusion

The substantial individual difference in the rate of cognitive decline in older adults implies that deterioration in brain areas and cognitive functioning are common but not inevitable characteristics of human aging. This is the first study that examines the effects of DMT or creative arts-based intervention in the psychophysiological functioning of older adults. The present study demonstrates short-term multifaceted therapeutic effects for DMT but not exercise intervention in the psychosocial, daily, and neuroendocrine functioning of the older adults with cognitive impairment. The lack of long-term DMT effects except for daily and neuroendocrine functioning highlights the importance for the older adults to maintain persistent levels of dance movement. Dance movement could be incorporated in a structural rehabilitation program to provide early psychosocial support among the older adults in need. Further studies are recommended to elucidate the buffering effect of DMT against decline in daily functioning and neuroendocrine functioning by exploring potential mechanisms such as insulin metabolism and inflammation mechanisms. It would be of interest to investigate whether DMT intervention could show improvements in other biomarkers such as cholinergic transmission and synapse plasticity.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

Conflict of Interest

All of the authors have no financial or other conflicts of interests to disclose.

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