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ORIGINAL ARTICLE

Effects of walking on sundown syndrome in community-dwelling people with Alzheimer's disease

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Abstract

Background: Sundown syndrome is an important care issue for people with dementia (PwD) and for family caregivers. Walking is a safe and simple physical activity for most PwD, yet no research has explored the effects of different long-term walking periods on sundown syndrome.

Objectives: This study aimed to determine the effects of walking on sundown syndrome, and to identify whether different walking time periods would show different effects on sundown syndrome in community-dwelling people with Alzheimer's disease.

Methods: A quasi-experimental designed study with repeated measurements was conducted. Sixty PwD were recruited and assigned to either the control group or the morning or afternoon walking group according to their caregiver's preference. The participants in the two walking groups completed an average of 120-min walking per week, accompanied by their caregivers. Forty-six achieved the 6-month intervention. Four measurements were taken, one at the pretest and one at weeks 8, 16 and 24. The Chinese version of the Cohen-Mansfield Agitation Inventory, community form (C-CMAI) was used to assess the severity of the sundown syndrome. The generalised estimating equation (GEE) was applied for the longitudinal data analysis.

Results: There was a significant change across the study period (p = .048) in the morning walking group, indicating that the score for sundown syndrome decreased when PwD walked in the morning. Considering group effects, compared to the control group, the C-CMAI scores significantly decreased after 16 weeks of walking in the afternoon walking group (p = .001) and after 24 weeks in both the morning and afternoon walking groups (p = .001), indicating that after PwD had walked for 16 weeks, sundown syndrome ameliorated in the afternoon group and continually decreased after 24 weeks in both the morning and afternoon groups. However, there was no significant group difference between the morning and afternoon walking groups during the 24-week walking intervention.

Conclusions: The results indicated that both morning walking and afternoon walking are beneficial for ameliorating the symptoms of sundown syndrome; however, walking in the afternoon may have a faster effect on the symptoms than walking in

the morning. Walking is a safe, simple, feasible and effective intervention to benefit individuals with sundown syndrome.

Implications for practice: Regularly walking for 30 min a day, four times a week, is beneficial to alleviate sundown syndrome among PwD living in the community. Either morning or afternoon walking is effective for decreasing sundown syndrome, and the longer the walking time, the greater the impact on sundown syndrome.

KEYWORDS

Alzheimer's disease, community, sundown syndrome, walking

1 | INTRODUCTION

Alzheimer's dementia is one of the health issues accompanying an ageing society. Based on the National Statistics, in April 2019, people over 65 years old accounted for 14.76% of the total population in Taiwan. Among older people, the dementia population is nearly 2.7 million (Taiwan Alzheimer Disease Association, 2019) with most living in the community and receiving care from family members. Behavioural and psychological symptoms of dementia (BPSD), including wandering, agitation, delusion, sleep disturbance and aggressive behaviour, occur commonly in PwD. A systematic review of BPSD found that Taiwanese patients with Alzheimer's disease (AD) reported that 42% exhibited sleep disturbances and night behaviour and 39% exhibited aggressive agitation (Fuh, Wang, & Cummings, 2005). Among these BPSD, sundown syndrome is common in PwD, and is of concern for quality of life for both patients and caregivers (Bachman & Rabins, 2006; Shankar, Hirschman, Hanlon, & Naylor, 2014). Sundown syndrome is regarded as the appearance of, or increase in, neuropsychiatric symptoms in the late afternoon, in the evening or at night, including confusion, anxiety, travel behaviour, wandering, screaming, agitation and aggressiveness (Bachman & Rabins, 2006; Khachiyants, Trinkle, Son, & Kim, 2011). An earlier study found that the prevalence of sundown syndrome is as high as 66% in community-dwelling PwD (Gallagher-Thompson, Brooks, Bliwise, Leader, & Yesavage, 1992). These symptoms present a challenge to family caregivers and require advanced care management.

Daily physical exercise benefits the human circadian pacemaker (Miyazaki, Hashimoto, Masubuchi, Honma, & Honma, 2001) and has also been widely reported to diminish BPSD and agitation (Scherder, Bogen, Eggermont, Hamers, & Swaab, 2010). Walking is the most common physical activity among older adults (Rafferty, Reeves, McGee, & Pivarnik, 2002), and over one third of older people in Taiwan engaged in a regular walking (Chao, Chiang, & Pai, 2011). More than 30 min of walking twice a week reduces neuropsychiatric symptoms in PwD, thus also reducing the caregivers' burden (Christofoletti et al., 2011; Thune-Boyle, Iliffe, Cerga-Pashoja, Lowery, & Warner, 2012). In addition, the more the continued walking over time, the lower the incidence of sundown syndrome (Shih, Pai, Huang, & Wang, 2017). Venturelli et al. (2016) reported that after walking was implemented for 3 months, 5 days/week, 1 hr before sunset, both sundowning agitation and salivary cortisol levels were significantly reduced. The results indicated that afternoon or evening walking was beneficial to ameliorating sundown syndrome by reducing the cortisol level. However, previous studies have failed to consider the effects of different walking time periods on sundown syndrome. Therefore, the aims of this study were to determine the effects of walking on sundown syndrome, and to compare differently timed walking periods (morning vs. afternoon) on sundown syndrome in community-dwelling people with Alzheimer's disease.

What does this research add to existing knowledge in gerontology?

- Regularly walking for 30 min a day, four times a week, can alleviate sundown syndrome among PWD living in the community.

What are the implications of this new knowledge for nursing care with older people?

- Walking, especially in the afternoon, has the most impact on the gradual decrease in the incidence of sundown syndrome.
- Sundown syndrome is also alleviated when a morning walking programme is continued.
- Either morning or afternoon walking is effective for decreasing sundown syndrome, and the more the walking is continued over time, the more the sundown syndrome is ameliorated.

How could the findings be used to influence policy or practice or research or education?

- Caregivers should be educated on advantages of walking activities for dealing with PwD's sundown syndrome.
- A walking programme, with ongoing morning or afternoon walking, should be included in a comprehensive community dementia care system to ameliorate sundown syndrome.

2 | METHODS

This study was a part of a larger project in managing sundown syndrome and sleep quality. An exploratory research drawn from a portion of data from the large project that focused on the relationships between walking and sundown syndrome and sleep quality was published (Shih et al., 2017). However, this study intended to further examine experimental effects of walking on sundown syndrome.

2.1 | Study design

A quasi-experimental study with repeated measures was designed and conducted. PwD were recruited and assigned according to caregiver's preference to either the control, the morning or afternoon walking group as part of their daily-life management during a 24-week intervention.

2.2 | Settings and sampling

PwD were referred by neurologists at dementia outpatient clinics and long-term care resource management centres in southern Taiwan. Inclusion criteria were (a) a clinical diagnosis of Alzheimer's dementia; (b) manifestation of sundown syndrome; (c) ability to walk (walker or cane allowed); and (d) no history of participating in a regular programme of physical activity and did not walk regularly. PwD were excluded if they (a) had a cardiac condition would limit exercise or had undergone major surgery within the past 3 months; (b) were prohibited from walking by a physician; (c) have not been diagnosed with depression.

Data were obtained from caregivers' observational reports who were spouses, adult relatives or employed caregivers. Caregivers with the following criteria were included: (a) had been living and caring for the of PwD for at least 3 months, and agree to implement the intervention; (b) spoke either Mandarin or Taiwanese, and would read and record their observations; (c) were stable with respect to their physical condition and any cardiovascular disease; and (d) had not been diagnosed with depression.

Calculation of the sample size was performed via G Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007), taking into account the following parameters: a medium effect size (d = 0.2); a 1:1:1 allocation rate among the three groups; repeated measurements at 4 intervals; and an α-error of .05 and a power of .80 according to Cohen (1988). Based on this calculation, a total of 15 people in each group and a 33% dropout rate, 60 subjects were required.

2.3 | Walking intervention

There were three groups: one control group (CG) and two intervention groups, a morning walking group (MWG) and an afternoon walking group (AWG). PwD in the control group maintained their usual daily activities, and caregivers were encouraged to interact with PwD for 30 min a day, four times a week, in order to provide the interactive time as the walking groups. For the intervention groups, PwD walked with their caregivers. Before implementing the walking programme, PwD and their caregivers all received information about walking precautions, safety and assistance in dealing with or overcoming obstacles when implementing the 6 months of walking intervention. Most PwD were able to walk for 30 or more minutes per day (McCurry, Gibbons, Logsdon, Vitiello, & Teri, 2005). They were encouraged to aim for 30 continuous (rest time deducted) minutes per day under caregiver supervision at a self-selected speed, in a home-based garden, atrium, the community or park throughout the 6-month period. The morning group was to walk before lunch (12 noon), and the afternoon group after lunch and before dinner (6 p.m.).

2.4 | Data collection and procedure

After the Institution Review Board (IRB) granted the required human subject protection approval, PwD and their caregivers who met the study criteria were recruited. After obtaining written consent from both PwD (or their proxy) and their caregiver, collection of demographic data and the pretest data proceeded. Data were collected between 1 October 2015 and 31 January 2017.

Four time measurements were conducted as follows: baseline measurement (pretest, T0) before the walking intervention, first post-test at the end of the 8th week (T1), second post-test at the end of the 16th week (T2), and third post-test at the end of the 24th week (T3) after the walking intervention was completed. During the 24 weeks, all caregivers were contacted via phone, the telecommunication application LINE, home visits or interviews at the OPD in order to monitor progress and collect data (walking logs and post-tests).

2.5 | Ethical considerations

Ethical approvals were obtained from the Institution Review Board (IRB) of two institutions (No. B-ER-104-99 and 15-074-B1). Written consent was obtained from each PwD (or their proxy) and caregiver before data collection. Participation was voluntary, and the anonymity and confidentiality of participants were emphasised.

2.6 | Instruments

2.6.1 | Demographic data

Demographic data collected from the PwD through face-to-face interview with their caregiver include age, gender, education, marital status, severity of dementia (Clinical Dementia Rating, CDR), the use of dementia-related medication and the individual's relationship with the accompanying walker.

2.6.2 | Walking logs

Walking adherence was assessed using walking logs. Caregivers completed walking logs to record the intervention adherence. Walking logs recorded the following: (a) date and time period of walking; (b) reasons for not achieving a walking duration of 30 min; (c) use of medication and medication changes; and (d) date of attending activities or events.

2.6.3 | Chinese version of the Cohen-Mansfield Agitation Inventory, community form (C-CMAI)

The Cohen-Mansfield Agitation Inventory (CMAI) developed by Cohen-Mansfield and Billig in 1986 has been widely used to measure evening agitation, sundown syndrome (Cohen-Mansfield, Garfinkelc, & Lipson, 2000), nocturnal agitation behaviours (Rose et al., 2011) and agitation from day to night (9 a.m.–9 p.m.) (Chang, Huang, Lin, & Lin, 2010). In this study, sundown syndrome in PwD was defined as occurring between 3 p.m. and 10 p.m. measured by the C-CMAI. The Chinese version of the CMAI was translated and validated by Lai in 2000. The C-CMAI is a 23-item caregiver's rating questionnaire scale with four subscales that assesses behavioural problems, including physically non-aggressive behaviour, physically aggressive behaviour; verbally aggressive behaviour and verbally non-aggressive behaviour. Of the 23 items, 22 represent observable behavioural problems (Item 23 inquires about any behavioural problem not covered by the questionnaire). Each item is scored according to the frequency of behaviour over the previous 2 weeks, ranging from 1 (never happened) to 7 (several times in an hour). Scores range from 23 to 161, with higher scores representing more frequent or more types of behavioural problems. The C-CMAI has been shown to be valid and reliable for a Taiwanese sample with Cronbach's α 0.88 for the overall scale (Huang, Shyu, Chen, & Hsu, 2009). In this study, the internal consistency of Cronbach's α of the C-CMAI in the pretest was .804 (Wu, 1984).

2.7 | Data analyses

SPSS 17.0 statistical software package was used for analysis. Demographic data were analysed by conducting Fisher's exact test or one-way ANOVA to determine differences among the groups. The pretest (T0) of sundown syndrome was analysed by conducting the one-way ANOVA. The generalised estimating equation (GEE) with the intention-to-treat (ITT) analysis was applied to determine the differences in sundown syndrome among and within the three groups. Before applying the GEE, the regression coefficients within the groups were used to analyse the homogeneity; there was no effect of pretesting on each group at T1, T2 and T3. The interaction effects among the four time measures (T0–T3) and the groups on the scores of C-CMAI were determined, followed by simple main effects.

3 | RESULTS

3.1 | Participation rate and demographic characteristics of the subjects

Sixty PwD assessed for eligibility agreed to participate and completed the pretest (T0). The PwD were equally distributed among the three groups (n = 20, N = 60). Between the period of the pretest (T0) and T1, eight PwD withdrew from the study (1 hospitalisation, 1 caregiver changed and 6 refused to participate), and from the period of T1 to T3, one PwD in the morning walking group walked both in the morning and in the afternoon, and five PwD did not reach the average weekly walking time in the afternoon walking group. Therefore, fourteen PwD were excluded from final analysis due to failure to complete the

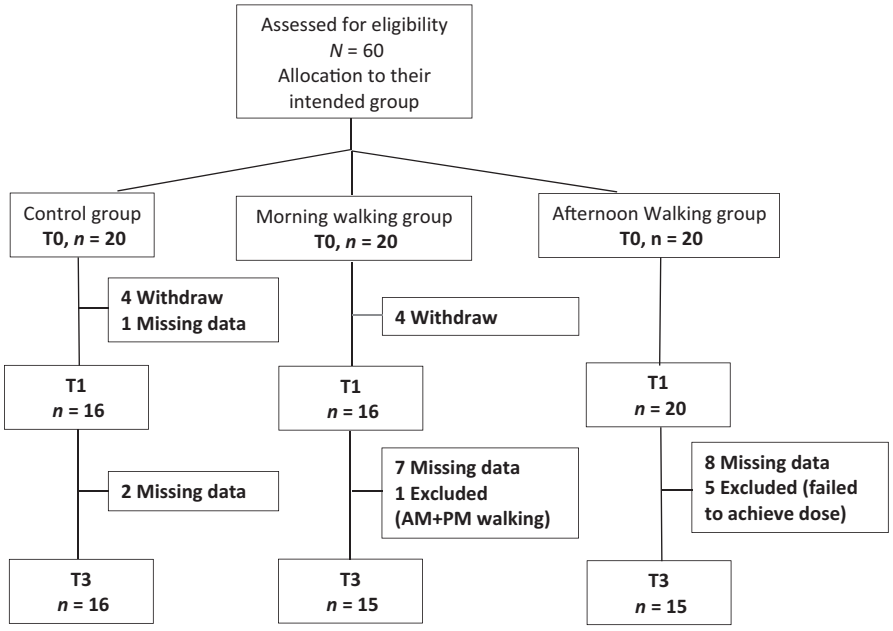

FIGURE 1 Flow chart of participant recruitment and participation through the study

walking duration (Figure 1) for a 23% attrition rate. Data of 46 PwD were included. From T1 to T3, 18 (9.8%) of the measurements were missing (Figure 1). The reasons for data missing included individuals' being too busy, medical conditions, change in caregivers, caregiver's burden, falls and hospitalisation of PwD. There was no significant difference in any of the demographic variables among the three groups (Table 1).

3.2 | The effectiveness of walking on sundown syndrome

The mean scores of the C-CMAI for sundown syndrome among the control, morning walking and afternoon walking groups were 51.88 (*SD* = 13.15) with a range from 30 to 79; 44.73 (*SD* = 13.41) with a range from 26 to 76; and 45.2 (*SD* = 21.02) with a range from 26 to 94 in the pretest, respectively. The independent one-way ANOVA showed no difference in the pretest of the C-CMAI score among the three groups, indicating that these three groups were homogeneous ($F_{2,43}$ = 0.951, p = .394).

3.2.1 | Time effects of walking on sundown syndrome in each of the three groups

There were significant interactions between time and group (Wald X^2 = 16.4, p = .012), indicating that the effects of walking differed among the groups over 24 weeks (Table 2).

A GEE model of simple time effect (controlling for the severity of dementia) was conducted to determine the significant changes across the study period in sundown syndrome for the 3 groups. There was a significant change across the study period (Wald

TABLE 1 Comparison of PwD demographic characteristics among the three groups (*n* = 46)

Variables	Groups									
	Control group (*n* = 16)		Morning walking group (*n* = 15)		Afternoon walking group (*n* = 15)		All (*n* = 46)		*F*	*p* value
Age (mean ± *SD*)	78.1 (±7.3)		75.1 (±8.3)		79.9 (±8.3)		77.7 (±8.0)		1.430	.250
Gender[a] (*n*, %)										
Male	6	37.5	4	26.7	9	60	19	41.3	3.458	.188
Female	10	62.5	11	73.3	6	40	27	58.7		
Marital status (*n*, %)										
Married	16	100	15	100	15	100	46	100	–	–
Education[a] (*n*, %)										
Elementary or below	11	68.8	10	66.7	8	53.3	29	63	3.148	.578
High school	4	25	4	26.7	3	20	11	24		
College or above	1	6.2	1	6.6	4	26.7	6	13		
Severity of dementia[a] (*n*, %)										
CDR = 1	6	37.5	12	80	7	46.7	25	54.3	6.83	.119
CDR = 2	8	50	2	13.3	7	46.7	17	37		
CDR = 3	2	12.5	1	6.7	1	6.6	4	8.7		
Dementia-related medication (yes)[a] (*n*, %)										
Medication for dementia treatment	12	75	13	86.7	13	86.7	38	82.6	0.975	.700
Antipsychotics	5	31.3	2	13.3	2	13.3	9	19.6	1.923	.456
Hypnotics	10	62.5	4	26.7	4	26.7	18	39.2	5.316	.072
Accompanying caregiver[a] (*n*, %)										
Spouse	–	–	7	46.7	5	33.3	12	40	0.892	.745
Adult children or relatives	–	–	3	20	5	33.3	8	26.7		
Employee or care attendants	–	–	5	33.3	5	33.3	10	33.3		
Gender of accompanying caregiver[a] (*n*, %)										
Male	–	–	6	40	2	13.3	7	23.3	–	.215
Female	–	–	9	60	13	86.7	23	76.7		

Abbreviation: CDR, Clinical Dementia Rating.

[a]Fisher's exact test with Monte Carlo simulation.

X^2 = 7.91, p = .048) in the morning walking group, indicating that the score for sundown syndrome decreased in this group of PwD. There was no significant change in the afternoon walking group or the control group (Wald X^2 = 4.47, p = .215; Wald X^2 = 4.15, p = .246). Interestingly, the sundown syndrome in the control group gradually increased compared to baseline (T0).

3.2.2 | Group effects of walking on sundown syndrome in each time point

A GEE model of the simple group effect (controlling for the baseline C-CMAI score (T0) and severity of dementia) was applied to determine group differences in sundown syndrome across the 24 weeks. There were significant differences among the three groups at T2 (Wald X^2 = 14.64, p = .001) and T3 (Wald X^2 = 15.08, p = .001). At T2, the post hoc test showed that the C-CMAI score in the afternoon walking group was lower than in the control group (mean difference = 13.4, p = .000). At T3, the post hoc test showed that there were significant differences between the morning walking group and the control group (mean difference = 10.72, p = .008), and between the afternoon walking group and the control group (mean difference = 16.4, p = .000). However, there was no significant difference between the morning and the afternoon walking group (mean difference = 5.7, p = .201), although the afternoon walking group was trended lower than that in the morning walking group.

4 | DISCUSSIONS

4.1 | Time effects of walking on sundown syndrome within each group

The findings of this study showed that sundown syndrome significantly decreased after eight weeks of walking compared to the baseline in the morning walking group. This result was similar to that of a review study of the effect of walking on decreasing neuropsychiatric symptoms (Thune-Boyle et al., 2012) and the effect of short-term physical exercise on agitation (Aman & Thomas, 2009). However, after morning walking for 16 weeks, the effects of sundown syndrome increased compared to the effect of eight weeks of walking nearly returning to baseline levels. The possible reasons for the exacerbation of sundown syndrome may be attributed to some subjects' physical discomfort and short-term daily schedule changes. Pain (Cohen-Mansfield, Thein, & Marx, 2014), physiological factors (Cipriani, Lucetti, Carlesi, Danti, & Nuti, 2015) and wandering (Ray, Taylor, Lichtenstein, & Meador, 1992) are reported to be negatively related to evening agitation. Although there was no significant effect after 16 and 24 weeks of morning walking, sundown syndrome scores trended downwards compared to baseline (T0).

Within the afternoon walking group, study findings did not show any effect of a six-month walking intervention on sundown syndrome.

TABLE 2 Effect of sundown syndrome among the three groups of PwD at each time point (n = 46)

Time/C-CMAI score	T0 (Baseline)		T1 (8 weeks)		T2 (16 weeks)		T3 (24 weeks)		Wald $X^{2,b}$	p value	Post hoc test
	M	*SE*	M	*SE*	M	*SE*	M	*SE*			
Sundown syndrome											
CG	52.0	9.35	55.7	9.71	55.6	9.41	57.7	9.97	4.15	.246	
MWG	44.4	3.77	39.6	4.59	43.2	4.34	40.6	3.96	7.91*	.048*	T1 < T0
AWG	44.1	9.74	45.0	9.54	39.8	9.75	39.0	9.45	4.47	.215	
Wald $X^{2,a}$		3.57	14.64**	15.08**							
p value		.168	.001**	.001**							
Post hoc test			AWG < CG	MWG, AWG < CG							

Note: Sundown syndrome was measured by the C-CMAI.

Abbreviations: AWG, afternoon walking group; CG, control group; MWG, morning walking group; T0, pretest, T1, 1st post-test, T2, 2nd post-test, T3, 3rd post-test.

[a]GEE of simple group effect (controlling the pretest and severity of dementia).

[b]GEE of simple time effect (controlling the severity of dementia).

*p < .05;

**p < .01;

***p < .001.

Caregivers reported discontinuing medication for dementia, physical unwellness, and wandering and getting lost across the study period in the afternoon walking group. These conditions increase the severity of sundown syndrome (Cipriani et al., 2015; Cohen-Mansfield et al., 2014; Ray et al., 1992). Although not significant, sundown syndrome trended downwards after afternoon walking for 16 weeks and continually after walking for 24 weeks compared to the pretest result. This indicated that 120 min of weekly afternoon walking for 16 to 24 weeks was potentially beneficial to PwD for alleviating sundown syndrome.

Unlike the improvement in the morning and afternoon groups, sundown syndrome in the control group worsened over the 6-month intervention time. This result was consistent with the findings of previous studies that showed that a low level or lack of physical activity is detrimental to circadian rhythms (Barger, Wright, Hughes, & Czeisler, 2004; Escames et al., 2012; Miyazaki et al., 2001; Van Someren, Lijzenga, Mirmiran, & Swaab, 1997), resulting in sundown syndrome.

4.2 | Group effect of walking on sundown syndrome among the three groups

The eight-week short-term effect of walking did not significantly reduce sundown syndrome in the two walking groups. This finding is consistent with Eggermont, Blankevoort and Scherder's study (2010) that demonstrated that walking for six weeks, 150 min per week, did not result in decreased night-time restlessness. In the current study, the limited effect of eight weeks of walking on sundown syndrome may be related to other conditions in PwD in the afternoon walking group, such as afternoon fatigue. According to Bachman and Rabins (2006), afternoon fatigue may increase sundown syndrome in the first eight weeks due to individuals not yet having adapted to the regular walking schedule. Other conditions noted during the first eight weeks were physical unwellness, discontinuation of medication for dementia, and wandering and getting lost as reported by caregivers in the afternoon walking group; no events were reported in the control and morning walking groups. Of note, the current study started baseline data collection in late autumn and moved towards winter. Researchers have reported a higher incidence of sundown syndrome in the winter due to the decrease in sunlight (Volicer, Harper, Manning, Goldstein, & Satlin, 2001). The seasonal change may have influenced outcome measurements across the three groups.

There were significant changes in sundown syndrome among the three groups after walking for 16 weeks and 24 weeks. After 16 weeks' intervention, sundown syndrome occurred less frequently among PwD walking in the afternoon than in PwD who did not walk. After 24 weeks' intervention, sundown syndrome was less frequent among PwD in both the morning and afternoon walking groups compared to PwD who did not walk. Research findings have provided evidence that physical exercise has advantages to regulate sleep–wake rhythm (King, Oman, Brassington, Bliwise, & Haskell, 1997) and body temperature (Waterhouse et al., 2005), is beneficial to circadian rhythm and has a positive effect on sundown syndrome. Therefore, the current study results are supported by previous reports.

Walking regularly in the afternoon for 16 to 24 weeks decreased the severity of sundown syndrome. Venturelli, Scarsini, Muti, Salvagno, and Schena (2013) found a correlation between the hypothalamic–pituitary–adrenal (HPA) axis dysregulation and sundown syndrome in PwD that likely contribute to neuropsychiatric symptoms in the afternoon to evening period. Tortosa-Martinez et al. (2015) found that a longer exercise programme (3 months) could result in lower levels of diurnal cortisol. Furthermore, Venturelli et al. (2016) illustrated that sundown syndrome decreased when PwD walked in the afternoon or evening for three months, also related to the downregulation of cortisol. Walking might not show a significant short-term effect on sundown syndrome; however, continuous, long-term afternoon walking could be beneficial in decreasing the severity of sundown syndrome. The current findings were consistent with those of Venturelli and colleagues in 2016.

The incidence of sundown syndrome decreased after 24 weeks of morning walking. A majority of studies have found the effect of walking on behaviour disturbances during daytime exercise, but without a specific walking period. It may be speculated that the mechanism underlying the association observed in this study between a longer period of morning walking and improved sundown syndrome is due to the regulation of the cortisol and circadian rhythm. Due to a consideration for participant safety, the walking intensity in this study was deliberately not required to be aerobic, but the duration was required to be 120 min per week. The 120-min level and duration of physical activity can be completed by PwD and can contribute to ameliorating sundown syndrome.

5 | CONCLUSIONS

For PwD, walking, especially in the afternoon, has the most beneficial effects of gradually alleviating the incidence of sundown syndrome. In addition, sundown syndrome also gradually improved after a longer walking time in the morning group. Either morning or afternoon walking was effective in improving sundown syndrome, and the longer the duration of the walking time, the more the sundown syndrome can be decreased.

5.1 | Limitations and recommendations for future study

There were four major limitations in this study. First, PwD were recruited at a time of seasonal change, which may affect the incidence of sundown syndrome. Recruiting subjects at the same time period in order to control potential confounding factors is needed. Second, social interaction was not measured in this study and might be a potential confounding factor although caregivers in the control group were encouraged to interact with PwD and keep the same interaction duration as the two walking groups. However, social interaction might be one of the factors to enhance PwD participation or effects (Hoffmann et al., 2016). Using actigraphy or a step counter might

provide more objective data on the effect of walking duration on sundown syndrome. Finally, selection bias due to caregivers' decision to be in the control, morning or afternoon walking group according to their preferences may affect the generalisability of the findings. Although less respective to the dyads' daily schedule, a randomised control trial could be considered in the future.

6 | IMPLICATIONS FOR PRACTICE

- Walking, especially in the afternoon, has the most impact on the gradual decrease in the incidence of sundown syndrome.
- Sundown syndrome is also alleviated when a morning walking programme is continued.
- Either morning or afternoon walking is effective for decreasing sundown syndrome, and the more the walking is continued over time, the more the sundown syndrome is ameliorated.

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CONFLICT OF INTEREST

No conflicts of interest exist to study participants and institutions where the authors are affiliated.

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REFERENCES

Aman, E., & Thomas, D. R. (2009). Supervised exercise to reduce agitation in severely cognitively impaired persons. *Journal of the American Medical Directors Association*, *10*(4), 271–276. https://doi.org/10.1016/j.jamda.2008.12.053

Bachman, D., & Rabins, P. (2006). "Sundowning" and other temporary associated agitation states in dementia patients. *Annual Review of Medicine*, *57*, 499–511. https://doi.org/10.1146/annurev.med.57.071604.141451

Barger, L. K., Wright, K. P., Hughes, R. J., & Czeisler, C. A. (2004). Daily exercise facilitates phase delays of circadian melatonin rhythm in very dim light. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *286*(1), R1077–R1084. https://doi.org/10.1152/ajpregu.00397.2003

Chang, F. Y., Huang, H. C., Lin, K. C., & Lin, L. C. (2010). The effect of a music programme during lunchtime on the problem behaviour of the older residents with dementia at an institution in Taiwan. *Journal of Clinical Nursing*, *19*(7–8), 939–948. https://doi.org/10.1111/j.1365-2702.2009.02801.x

Chao, M. L., Chiang, T. L., & Pai, F. M. (2011). The patterns and correlates of leisure-time physical activity among elderly adults in Taiwan. *Journal of Tourism and Health Science*, *10*(1), 81–95.

Christofoletti, G., Oliani, M., Bucken-Gobbi, L., Gobbi, S., Beinotti, F., & Stella, F. (2011). Physical activity attenuates neuropsychiatric disturbances and caregiver burden in patients with dementia. *Clinics*, *66*(4), 613–618. https://doi.org/10.1590/s1807-59322011000400015

Cipriani, G., Lucetti, C., Carlesi, C., Danti, S., & Nuti, A. (2015). Sundown syndrome and dementia. *European Geriatric Medicine*, *6*(4), 375–380. https://doi.org/10.1016/j.eurger.2015.03.006

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*, 2nd ed. Hillsdale, MI: Lawrence Erlbaum Associates.

Cohen-Mansfield, J., & Billig, N. (1986). Agitated behaviors in the elderly: I. A conceptual review. *Journal of American Geriatric Society*, *34*(10), 711–721. https://doi.org/10.1111/j.1532-5415.1986.tb04302.x

Cohen-Mansfield, J., Thein, K., & Marx, M. S. (2014). Predictors of the impact of nonpharmacologic interventions for agitation in nursing home residents with advanced dementia. *The Journal of Clinical Psychiatry*, *75*(7), e666–e671. https://doi.org/10.4088/JCP.13m08649

Cohen-Mansfielda, J., Garfinkelc, D., & Lipson, S. (2000). Melatonin for treatment of sundowning in elderly persons with dementia - A preliminary study. *Archives of Gerontology and Geriatrics*, *31*(1), 65–76. https://doi.org/10.1016/S0167-4943(00)00068-6

Eggermont, L., Blankevoort, C., & Scherder, E. (2010). Walking and nighttime restlessness in mild-to-moderate dementia: A randomized controlled trial. *Age and Ageing*, *39*(6), 746–749. https://doi.org/10.1093/ageing/afq115

Escames, G., Ozturk, G., Baño-Otálora, B., Pozo, M. J., Madrid, J. A., Reiter, R. J., … Acuña-Castroviejo, D. (2012). Exercise and melatonin in humans: Reciprocal benefits. *Journal of Pineal Research*, *52*(1), 1–11. https://doi.org/10.1111/j.1600-079X.2011.00924.x

Faul, F., Erdfelder, E., Lang, A., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Fuh, J. L., Wang, S. J., & Cummings, J. L. (2005). Neuropsychiatric profiles in patients with Alzheimer's disease and vascular dementia. *Journal of Neurology, Neurosurgery and Psychiatry*, *76*(10), 1337–1341. https://doi.org/10.1136/jnnp.2004.056408

Gallagher-Thompson, D., Brooks, J. O., Bliwise, D., Leader, J., & Yesavage, J. A. (1992). The relations among caregiver stress, "sundowning" symptoms, and cognitive decline in Alzheimer's disease. *Journal of the American Geriatrics Society*, *40*(8), 807–810. https://doi.org/10.1111/j.1532-5415.1992.tb01853.x

Hoffmann, K., Sobol, N. A., Frederiksen, K. S., Beyer, N., Vogel, A., Vestergaard, K., … Hasselbalch, S. G. (2016). Moderate-to-high intensity physical exercise in patients with Alzheimer's disease: A randomized controlled trial. *Journal of Alzheimer's Disease*, *50*(2), 443–453. https://doi.org/10.3233/JAD-150817

Huang, H. L., Shyu, Y. I., Chen, S. T., & Hsu, W. C. (2009). Caregiver self-efficacy for managing behavioural problems of older people with dementia in Taiwan correlates with care receivers' behavioural problems. *Journal of Clinical Nursing*, *18*(18), 2588–2595. https://doi.org/10.1111/j.1365-2702.2008.02547.x

Khachiyants, N., Trinkle, D., Son, S. J., & Kim, K. Y. (2011). Sundown syndrome in persons with dementia: An update. *Psychiatry Investigation*, *8*(4), 275–287. https://doi.org/10.4306/pi.2011.8.4.275

King, A. C., Oman, R. F., Brassington, G. S., Bliwise, D. L., & Haskell, W. L. (1997). Moderate-intensity exercise and self-rated quality of sleep in older adults: A randomized controlled trial. *Journal of American Medical Association*, *277*(1), 32–37. https://doi.org/10.1001/jama.1997.03540250040029

Lai, C. K. Y. (2000). The use of the Cohen-Mansfield Agitation Inventory in the assessment of agitation in people with dementia: Applicability in Hong Kong. *The Hong Kong Journal of Gerontology*, *14*(1 & 2), 66–69.

McCurry, S. M., Gibbons, L. E., Logsdon, R. G., Vitiello, M. V., & Teri, L. (2005). Nighttime insomnia treatment and education for Alzheimer's disease: A randomized, controlled trial. *Journal of the American Geriatrics Society*, *53*(5), 793–802. https://doi.org/10.1111/j.1532-5415.2005.53252.x

Miyazaki, T., Hashimoto, S., Masubuchi, S., Honma, S., & Honma, K. (2001). Phase-advance shifts of human circadian pacemaker are accelerated by daytime physical exercise. *American Journal of Physiology - Regulatory, Integrative and Comparative Physiology*, *28*(1), R197–R205. https://doi.org/10.1152/ajpregu.2001.281.1.R197

National Statistics, R.O.C. (Taiwan) (2019). *Resident population by 5-Year, 10-Year Age Group* [Web message]. Retrieved from https://www.stat.gov.tw/ct.asp?xItem=15408&CtNode=3623&mp=4

Rafferty, A. P., Reeves, M. J., McGee, H. B., & Pivarnik, J. M. (2002). Physical activity patterns among walkers and compliance with public health recommendations. *Medicine & Science in Sports & Exercise*, *34*(8), 1255–1261. https://doi.org/10.1097/00005768-200208000-00005

Ray, W. A., Taylor, J. A., Lichtenstein, M. J., & Meador, K. G. (1992). The nursing home behavior problem scale. *The Journal of Gerontology*, *47*(1), M9–M16. https://doi.org/10.1093/geronj/47.1.M9

Rose, K. M., Beck, C., Tsai, P. F., Liem, P. H., Davila, D. G., Kleban, M., … Richards, K. C. (2011). Sleep disturbances and nocturnal agitation behaviors in older adults with dementia. *Sleep*, *34*(6), 779–786. https://doi.org/10.5665/SLEEP.1048

Scherder, E. J., Bogen, T., Eggermont, L. H., Hamers, J. P., & Swaab, D. F. (2010). The more physical inactivity, the more agitation in dementia. *International Psychogeriatrics*, *22*(8), 1203–1208. https://doi.org/10.1017/S1041610210001493

Shankar, K. N., Hirschman, K. B., Hanlon, A. L., & Naylor, M. D. (2014). Burden in caregivers of cognitively impaired elderly adults at time of hospitalization: A cross-sectional analysis. *Journal of the American Geriatrics Society*, *62*(2), 276–284. https://doi.org/10.1111/jgs.12657

Shih, Y. H., Pai, M. C., Huang, Y. C., & Wang, J. J. (2017). Sundown syndrome, sleep quality, and walking among community-dwelling people with Alzheimer disease. *Journal of the American Medical Directors Association*, *18*(5), 396–401. https://doi.org/10.1016/j.jamda.2016.10.016

Taiwan Alzheimer Disease Association (2019). *Prevalence and population of dementia in Taiwan* [Web message]. Retrieved from http://www.tada2002.org.tw/About/IsntDementia

Thune-Boyle, I. C., Iliffe, S., Cerga-Pashoja, A., Lowery, D., & Warner, J. (2012). The effect of exercise on behavioral and psychological symptoms of dementia: Towards a research agenda. *International Psychogeriatrics*, *24*(7), 1046–1057. https://doi.org/10.1017/S1041610211002365

Tortosa-Martinez, J., Clow, A., Caus-Pertegaz, N., Gonzalez-Caballero, G., Abellan-Miralles, I., & Saenz, M. J. (2015). Exercise Increases the dynamics of diurnal cortisol secretion and executive function in people with amnestic mild cognitive impairment. *Journal of Aging and Physical Activity*, *23*(4), 550–558. https://doi.org/10.1123/japa.2014-0006

Van Someren, E. J., Lijzenga, C., Mirmiran, M., & Swaab, D. F. (1997). Longterm fitness training improves the circadian rest-activity rhythm in healthy elderly males. *Journal of Biological Rhythms*, *12*(2), 146–156. https://doi.org/10.1177/074873049701200206

Venturelli, M., Scarsini, R., Muti, E., Salvagno, G. L., & Schena, F. (2013). Sundowning syndrome and hypothalamic-pituitary- adrenal axis dysregulation in individuals with Alzheimer's disease: Is there an association? *Journal of the American Geriatrics Society*, *61*(11), 2055–2056. https://doi.org/10.1111/jgs.12491

Venturelli, M., Sollima, A., Cè, E., Limonta, E., Bisconti, A. V., Brasioli, A., … Esposito, F. (2016). Effectiveness of exercise- and cognitive-based treatments on salivary cortisol levels and sundowning syndrome symptoms in patients with Alzheimer's disease. *Journal of Alzheimer's Disease*, *53*(4), 1631–1640. https://doi.org/10.3233/JAD-160392

Volicer, L., Harper, D. G., Manning, B. C., Goldstein, R., & Satlin, A. (2001). Sundowning and circadian rhythms in Alzheimer's disease. *American Journal of Psychiatry*, *158*(5), 704–711. https://doi.org/10.1176/appi.ajp.158.5.704

Waterhouse, J., Drust, B., Weinert, D., Edwards, B., Gregson, W., Atkinson, G., … Reilly, T. (2005). The Circadian rhythm of core temperature: Origin and some implications for exercise performance. *Chronobiology International*, *22*(2), 207–225. https://doi.org/10.1081/cbi-200053477

Wu, T. X. (1984). *Telephone survey: Theories and methods*. Taipei, ROC: Linking Publishing. (in Chinese).

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