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Changes in Cognitive Function Following Combined Puzzle and Dakon (Traditional Mancala) Stimulation among Community-Dwelling Older Adults in Indonesia: A One-Group Pretest–Posttest Study

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ABSTRACT

Cognitive decline is common among older adults and threatens their independence, yet simple and culturally familiar stimulation activities have rarely been evaluated in Indonesian primary care. This study aimed to examine changes in Mini-Mental State Examination (MMSE) scores among community-dwelling older adults after cognitive stimulation combining puzzles and dakon, a traditional Indonesian mancala game. A one-group pretest–posttest design was used in the service area of the Natar Primary Health Centre, South Lampung Regency, Indonesia. A total of 180 older adults aged ≥60 years were recruited by purposive sampling and attended four facilitator-led group sessions (twice weekly for two weeks; 30–45 minutes each) consisting of a picture-puzzle task followed by paired dakon play. Global cognitive function was assessed with the Indonesian version of the MMSE before the first session and after the fourth session. Pre–post scores were compared with a paired t-test, and associations between participant characteristics and post-intervention MMSE categories were examined with the Fisher–Freeman–Halton exact test. The mean MMSE score increased from 23.22 ± 4.44 to 25.00 ± 4.11 (mean difference 1.78 points; paired t-test $p < 0.001$; Cohen's $d_{av} = 0.42$). The proportion of participants in the normal MMSE category (24–30) increased from 50.6% to 67.8%. Age and education were associated with post-intervention MMSE categories (both $p < 0.001$), whereas sex ($p = 0.768$) and history of hypertension ($p = 0.141$) were not. MMSE scores were higher after four sessions of combined puzzle and dakon activities; however, because the design lacked a control group and practice effects cannot be excluded, the change cannot be attributed to the intervention alone. Controlled trials with longer follow-up are needed before the approach is recommended for routine gerontological nursing practice.

Keywords: Cognitive stimulation; Dakon; Mini-Mental State Examination; Older adults; Puzzle; Traditional games

INTRODUCTION

Population ageing is a defining demographic change in Indonesia, and national statistics on older persons emphasise the growing need for health and social services that preserve their independence and quality of life (Badan Pusat Statistik, 2024). Globally, the number of people living with dementia is projected to rise from 57.4 million in 2019 to 152.8 million in 2050, with the largest increases expected in low- and middle-income countries (GBD 2019 Dementia Forecasting Collaborators, 2022). Before dementia develops, many older adults pass through a stage of mild cognitive impairment, whose worldwide prevalence among community dwellers is approximately 15.6% and increases with age (Bai et al., 2022). Because mild cognitive impairment carries an increased risk of progression to dementia, this stage is considered an important window for prevention (Petersen et al., 2018). Declining cognitive function also affects older adults' ability to perform daily activities, maintain independence, and participate in social life, although cognitive ageing varies considerably between individuals and not every change is pathological (Harada et al., 2013).

The problem is also evident in Indonesia. An analysis of 4,236 older adults in the Indonesian Family Life Survey showed that older age, female sex, low education, rural residence, low social capital, and depression were associated with memory impairment (Handajani et al., 2024). Among community-dwelling older adults, MMSE scores have been associated with age, marital status, educational level, and literacy (Setiyani & Iskandar, 2022). Dementia is not an inevitable consequence of ageing: nearly half of cases are estimated to be preventable or delayable by addressing 14 modifiable risk factors, including low education, hypertension, physical inactivity, and social isolation (Livingston et al., 2024), and the World Health Organization recommends risk reduction and brain-

health interventions as part of dementia prevention (World Health Organization, 2019). Given the diverse and generally low educational attainment of older Indonesians, interventions to maintain cognitive function should be simple, inexpensive, and feasible without advanced literacy.

Cognitive stimulation is one of the non-pharmacological interventions with the most consistent supporting evidence (Woods et al., 2023). Unlike cognitive training, which targets specific domains, cognitive stimulation engages a broad range of mental activities and is usually delivered in a social, often group, context (Gómez-Soria et al., 2023a). A meta-analysis of studies in older adults reported that cognitive stimulation improved general cognitive functioning by a mean difference of 1.54 points (95% CI 0.83–2.24), together with improvements in memory, orientation, praxis, and calculation (Gómez-Soria et al., 2023a). A Cochrane review of 37 randomised trials involving 2,766 participants found a small but consistent cognitive benefit in mild-to-moderate dementia, with larger gains when group sessions were held at least twice weekly (Woods et al., 2023). Benefits have also been reported for psychosocial outcomes such as quality of life and depressive symptoms (Gómez-Soria et al., 2023b). The group format has been effective since the early trials of cognitive stimulation therapy (Spector et al., 2003), and among cognitively healthy older adults, group-based supervised programmes appear more effective than unsupervised home-based training (Kelly et al., 2014; Lampit et al., 2014).

Games are a promising medium for stimulation because they combine mental demands with recreation and social interaction (Chen et al., 2022). A meta-analysis of 38 cohort studies with more than two million participants found that cognitive leisure activities, including playing games, were associated with a lower risk of dementia (Su et al., 2022), and long-term cohort studies have linked board-game playing to less cognitive decline and a lower dementia risk (Altschul & Deary, 2020; Dartigues et al., 2013). At the intervention level, meta-analyses have shown benefits of tabletop games for global cognition and executive function (Chen et al., 2022) and improvements in MMSE and Montreal Cognitive Assessment scores after traditional board games such as Go, mahjong, and chess, although domain-specific effects vary by game (Pozzi et al., 2023). The social engagement that accompanies group play is itself associated with a lower risk of dementia (Kuiper et al., 2015).

Despite this evidence, several gaps remain. First, evidence on traditional board games comes mainly from Go, mahjong, and chess; count-and-capture (mancala) games such as dakon, which are widely known in Indonesia and require no technology, have rarely been evaluated (Pozzi et al., 2023). Second, because domain effects differ by game type, combining activities with complementary demands may offer broader stimulation, but such combinations are seldom tested (Chen et al., 2022; Pozzi et al., 2023). Puzzles mainly demand visual perception, pattern recognition, attention, and problem-solving, whereas dakon mainly demands counting, working memory, planning, and decision-making during interaction with a partner. Third, cognitive stimulation programmes vary widely in content, intensity, and duration, and evidence from brief programmes that can realistically be delivered by nurses and community health cadres in primary care is limited (Gómez-Soria et al., 2023a; Woods et al., 2023). Fourth, most evidence comes from relatively well-educated populations, whereas MMSE scores are strongly influenced by age and education (Crum et al., 1993; Jones & Gallo, 2001). The contribution of this study is therefore to describe a replicable, low-cost combined puzzle–dakon protocol, to report the magnitude and precision of the pre–post change in MMSE scores in a low-education Indonesian community sample, and to describe how post-intervention cognitive status was distributed by participant characteristics, as preliminary evidence to inform a future controlled trial.

Among community-dwelling older adults, this study aimed to quantify the change in mean MMSE scores from pretest to posttest after four sessions of combined puzzle and dakon stimulation, expressed as the mean difference and Cohen's d; to determine the change, in percentage points, in the proportions of participants classified as normal, mild impairment, and severe impairment; and to measure the associations of age, sex, education, and history of hypertension with post-intervention MMSE categories, expressed as exact p-values and Cramér's V.

METHODS

Study design and setting

This was a pre-experimental study with a one-group pretest–posttest design without a control group. Cognitive function was measured in the same participants before the intervention (pretest) and after the full intervention series (posttest). This design was chosen because the study was conducted as a pragmatic, community-based evaluation within routine Posyandu Lansia (integrated health posts for older adults) activities, where allocating eligible older adults to a no-activity control group was not considered feasible; its limitations for causal inference are acknowledged. Reporting followed the TREND statement for non-randomised evaluations (Des Jarlais et al., 2004). The study was conducted in the service area of the Natar Primary Health Centre, South Lampung Regency, Lampung Province, Indonesia. Data were collected from May to July 2026, and sessions were held in the village halls of Sidoarjo I and Purwosari II, Natar District, which were easily accessible to participants.

Participants and sampling

The population comprised older adults aged ≥60 years registered in the Natar Primary Health Centre service area. Participants were selected by purposive sampling: potential participants were identified with the primary health centre officer responsible for older-adult services and Posyandu Lansia cadres, then screened against the eligibility criteria. Inclusion criteria were age ≥60 years,

ability to communicate verbally in Indonesian, adequate vision and hand function to assemble puzzle pieces and move dakon seeds, and willingness to attend all sessions. Exclusion criteria were a medical diagnosis of severe dementia, severe uncorrected visual or hearing impairment, and acute illness or conditions requiring bed rest during the study period. Only participants who completed all four sessions and both MMSE assessments were included in the analysis (n = 180). The sample size was determined by the number of eligible older adults who could be reached in the two villages during the study period rather than by an a priori calculation. A sensitivity analysis showed that 180 paired observations provide 80% power at a two-sided α of 0.05 to detect a standardised paired change of $d_z = 0.21$, a small effect (Faul et al., 2007).

Intervention

The intervention is described according to the TIDieR checklist (Hoffmann et al., 2014). It consisted of four group sessions delivered over two weeks (twice weekly), each lasting 30–45 minutes. Sessions were delivered by the researcher together with three trained Posyandu Lansia cadres and three nursing students acting as facilitators; participants were organised into groups of 15, so that each facilitator assisted a small sub-group. Before the intervention, facilitators were trained by the researcher using a written session guide covering the session sequence, game rules, standard instructions, and the level of assistance permitted.

Every session followed the same sequence. (1) Opening (approximately 5 minutes): greeting, orientation to day, date and place, and explanation of the activities. (2) Puzzle activity (approximately 10–15 minutes): each participant assembled a 20-piece picture puzzle of familiar images, exercising attention, visual perception, pattern recognition, visuomotor coordination, and problem-solving; for participants who had difficulty, the number of pieces was reduced progressively. (3) Dakon activity (approximately 15–20 minutes): participants played in pairs on a standard wooden dakon board with seven small holes on each side and one large store hole for each player, using the common local rules of sowing seeds around the board and capturing seeds; the game exercises counting, remembering rules and move sequences, planning, decision-making, and social interaction. (4) Closing (approximately 5 minutes): a short discussion of the playing experience and positive feedback.

Instructions were given orally in simple language, followed by a direct demonstration by the facilitator, practice, and assistance. Instructions were repeated when needed, and facilitators provided verbal prompts but did not complete the puzzle or make dakon moves for participants. All participants received the same materials, session structure, and duration (standardised intervention); only the number of puzzle pieces was adapted to individual ability. Fidelity was supported by the written session guide and a checklist of session components completed by the researcher, and attendance and participation were recorded at every session.

Outcome measure

Cognitive function was assessed using the Indonesian version of the Mini-Mental State Examination (MMSE) (Folstein et al., 1975; Rambe & Fitri, 2017). The MMSE comprises 11 items assessing orientation, registration, attention and calculation, recall, language, the ability to follow commands, and copying a figure, with a total score of 0–30 (Tombaugh & McIntyre, 1992). Scores were analysed as continuous data and classified, following commonly used cut-offs adapted from Tombaugh and McIntyre (1992), as normal (24–30), mild impairment (17–23), and severe impairment (<17). Because MMSE scores are influenced by age, education, and literacy, these categories were treated as screening categories rather than clinical diagnoses (Crum et al., 1993; Jones & Gallo, 2001).

All MMSE items were administered orally in Indonesian in a face-to-face structured interview, with standard wording and scoring for all participants. For participants with no formal education or limited literacy, the reading, writing, and serial subtraction items were presented in the standard way and scored as administered; no education-adjusted cut-offs were applied, which we acknowledge as a potential source of educational bias. The pretest and the posttest were administered by the same assessor, who had been trained in MMSE administration and scoring; because the same research team delivered the intervention, the assessor was not blinded to the intervention.

Participant characteristics comprised age, sex, educational level, and history of hypertension. Age was grouped as 60–70, 71–80, and ≥81 years. Educational level was categorised as higher (college/university), secondary (junior/senior high school), primary (elementary school or equivalent), and no formal education. History of hypertension (yes/no) was obtained by interview and verified against primary health centre medical records.

Data collection procedures

After permission had been obtained from the Natar Primary Health Centre, eligible older adults received an explanation of the study objectives, procedures, benefits, risks, and their rights, and then provided written informed consent. Demographic data and the baseline MMSE were collected before the first session. The posttest MMSE was administered on the day of the fourth session, after the session had ended, by the same assessor using the same procedure; the interval between the pretest and posttest was approximately two weeks.

Statistical analysis

Categorical data were presented as frequencies and percentages, and numerical data as means, standard deviations, and minimum–maximum values. The normality of the paired differences (posttest minus pretest) was assessed with the Kolmogorov–Smirnov test and inspection of the histogram and Q–Q plot. Because no marked departure from normality was observed and, with 180 pairs, the sampling distribution of the mean difference is approximately normal, the paired t-test was used. The

effect size was calculated as Cohen's d_{av}, the mean difference divided by the average of the pretest and posttest standard deviations (Lakens, 2013). Changes in the distribution of MMSE categories were described in percentage points.

Associations between participant characteristics and post-intervention MMSE categories were examined using cross-tabulation. Because more than 20% of the cells in every table had expected frequencies below five (minimum expected frequency 0.64–1.09), the Fisher–Freeman–Halton exact test was used instead of Pearson's chi-square test, and the strength of association was expressed as Cramér's V. The higher-education category had no participants and was therefore excluded from the analysis. The significance level was set at $\alpha = 0.05$, and analyses were performed using IBM SPSS Statistics version 23.

RESULTS AND DISCUSSION

Participant characteristics

All 180 participants analysed completed the four sessions and both MMSE assessments (Table 1). Most participants were aged 60–70 years (63.3%) and female (74.4%). Educational attainment was low: 83.9% had only primary education or no formal education, and none had higher education. Nearly three in four participants (72.8%) had a history of hypertension.

Table 1. Characteristics of the participants (n = 180)

Characteristic	n	%
Age (years)		
60–70	114	63.3
71–80	36	20.0
≥81	30	16.7
Sex		
Female	134	74.4
Male	46	25.6
Education		
Higher (college/university)	0	0.0
Secondary (junior/senior high school)	29	16.1
Primary (elementary school or equivalent)	112	62.2
No formal education	39	21.7
History of hypertension		
Yes	131	72.8
No	49	27.2

Note: Percentages are calculated with n = 180 as the denominator for every characteristic.

Changes in MMSE scores before and after the intervention

After four sessions, the mean MMSE score increased by 1.78 points, from 23.22 ± 4.44 to 25.00 ± 4.11 (paired t-test, $p < 0.001$), corresponding to a small-to-moderate standardised change ($d_{av} = 0.42$) (Table 2). The minimum score was 10 at pretest and 14 at posttest, and the maximum score was 30 at both assessments.

At the group level, the distribution of MMSE categories also shifted. The proportion of participants in the normal category increased by 17.2 percentage points (from 50.6% to 67.8%; a net increase of 31 participants), whereas the proportions in the mild impairment and severe impairment categories decreased from 44.4% to 30.0% and from 5.0% to 2.2%, respectively (Table 2). Because these are marginal (group-level) distributions, they do not show how individual participants moved between categories.

Table 2. MMSE scores and categories before and after the intervention (n = 180)

Variable	Pretest	Posttest	Change
MMSE score			
Mean ± SD	23.22 ± 4.44	25.00 ± 4.11	+1.78
Minimum–maximum	10–30	14–30	–
MMSE category, n (%)			
Normal (24–30)	91 (50.6)	122 (67.8)	+17.2 pp
Mild impairment (17–23)	80 (44.4)	54 (30.0)	−14.4 pp
Severe impairment (<17)	9 (5.0)	4 (2.2)	−2.8 pp
Paired comparison: mean difference 1.78 points; paired t-test $p < 0.001$; $d_{av} = 0.42$			

Note: MMSE, Mini-Mental State Examination; SD, standard deviation; pp, percentage points; d_{av}, Cohen's d based on the average of the pretest and posttest SDs. Paired t-test. Category changes are net (marginal) changes and do not represent individual transitions.

Associations between participant characteristics and post-intervention MMSE categories

Age and education were significantly associated with post-intervention MMSE categories (both $p < 0.001$, Cramér's $V = 0.25$), indicating a moderate strength of association (Table 3). The proportion in the normal category decreased with age, from 78.1% among participants aged 60–70 years to 33.3% among those aged ≥81 years, in whom most (60.0%) were in the mild impairment category. Similarly, the proportion in the normal category was 82.8% among participants with secondary education but 38.5% among those without formal education. Sex (67.2% vs. 69.6% normal; $p = 0.768$) and history of hypertension (64.9% vs. 75.5% normal; $p = 0.141$) were not significantly associated with post-intervention MMSE categories.

Table 3. Association between participant characteristics and MMSE categories after the intervention (n = 180)

Characteristic	Normal (24–30) n (%)	Mild (17–23) n (%)	Severe (<17) n (%)	p[a] (V)
Age (years)				<0.001 (0.25)
60–70 (n = 114)	89 (78.1)	24 (21.1)	1 (0.9)	
71–80 (n = 36)	23 (63.9)	12 (33.3)	1 (2.8)	
≥81 (n = 30)	10 (33.3)	18 (60.0)	2 (6.7)	
Education[b]				<0.001 (0.25)
Secondary (n = 29)	24 (82.8)	5 (17.2)	0 (0.0)	
Primary (n = 112)	83 (74.1)	26 (23.2)	3 (2.7)	
None (n = 39)	15 (38.5)	23 (59.0)	1 (2.6)	
Sex				0.768 (0.09)
Female (n = 134)	90 (67.2)	40 (29.9)	4 (3.0)	
Male (n = 46)	32 (69.6)	14 (30.4)	0 (0.0)	
History of hypertension				0.141 (0.14)
Yes (n = 131)	85 (64.9)	44 (33.6)	2 (1.5)	
No (n = 49)	37 (75.5)	10 (20.4)	2 (4.1)	
Total (n = 180)	**122 (67.8)**	**54 (30.0)**	**4 (2.2)**	

Note: MMSE categories: normal 24–30, mild impairment 17–23, severe impairment <17. Percentages are row percentages. V, Cramér's V. [a]Fisher–Freeman–Halton exact test (more than 20% of cells had expected frequencies <5 in every table). [b]The higher-education category (n = 0) was excluded from the analysis.

Discussion

The main finding of this study is that MMSE scores were higher after a brief programme of combined puzzle and dakon activities, with a mean increase of 1.78 points and a small-to-moderate standardised change. The direction of change is consistent with meta-analyses of cognitive stimulation in older adults (Gómez-Soria et al., 2023a; Woods et al., 2023). However, the magnitude cannot be compared directly. The 1.54-point pooled effect reported by Gómez-Soria et al. (2023a) is a between-group difference, that is, the change in the intervention group after subtracting the change in control groups, and it was achieved with programmes that were generally longer and more intensive than ours; most trials in the Cochrane review lasted around ten weeks with about 20 sessions (Woods et al., 2023). Our 1.78-point change is an uncontrolled within-group change after only four sessions, and it therefore includes any practice effect, regression to the mean, and time-related influences in addition to any intervention effect. The true intervention effect is therefore likely to be smaller than the observed change.

Statistical significance does not establish clinical significance. A change of about 1.4 MMSE points has been proposed as the minimum clinically important difference in trials of people with Alzheimer's disease (Howard et al., 2011), whereas reliable change indices indicate that an individual change of at least 2–4 points is needed to exceed measurement error and practice effects in older adults (Hensel et al., 2007). Thus, the observed mean change lies close to the threshold proposed for group-level clinical relevance in dementia, but it is smaller than the change required to be confident of real improvement in an individual. Furthermore, the net increase of 31 participants in the normal category should not be interpreted as individual clinical recovery: many participants had baseline scores close to the 23/24 cut-off, so a change of one or two points could move them across categories without clinically meaningful change, and individual-level transition data and clinical assessment would be required to support such a conclusion (Crum et al., 1993; Petersen et al., 2018).

A possible explanation for the observed change is the multidomain character of the two games. Puzzles involve visuospatial processing, attention, and problem-solving, whereas count-and-capture board games involve calculation, working memory, and planning, so the two activities target different but complementary demands (Chen et al., 2022; Pozzi et al., 2023). The cognitive enrichment hypothesis proposes that engagement in mentally challenging activities can maintain or enhance functional capacity in later life (Hertzog et al., 2008), and the scaffolding theory of ageing suggests that the older brain retains plasticity that can be mobilised by structured cognitive engagement (Park & Bischof, 2013). Playing dakon in pairs also adds social interaction, which is independently associated with a lower risk of dementia (Kuiper et al., 2015). These mechanisms are the authors' interpretation based on previous literature; domain-specific outcomes and mechanisms were not measured in this study, and the observed change cannot be attributed to any particular cognitive process.

The increase in the minimum score from 10 to 14 suggests that participants with low baseline scores were able to take part in the activities, consistent with reports that cognitive stimulation is suitable for people with cognitive impairment (Woods et al., 2023). However, improvement among participants with the lowest baseline scores may partly reflect regression to the mean (Barnett et al., 2005), whereas the ceiling of the MMSE limits the detection of change among those who already scored near 30 (Tombaugh & McIntyre, 1992). The small reduction in standard deviation (from 4.44 to 4.11) is therefore not interpreted as evidence of a more homogeneous or safer cognitive profile.

The age gradient in post-intervention cognitive status is consistent with evidence that ageing is associated with changes in processing speed, memory, and executive function (Harada et al., 2013) and that the prevalence of mild cognitive impairment increases with age (Bai et al., 2022). In Indonesia, older age is also consistently associated with memory impairment and lower MMSE scores (Handajani et al., 2024; Setiyani & Iskandar, 2022), and population norms show lower median MMSE scores in older age groups (Crum et al., 1993). Importantly, this analysis examined the association between age and cognitive status after the intervention, not the magnitude of change by age group. It therefore does not show that age modifies the effectiveness of the intervention or that the oldest participants were less responsive; answering that question would require comparing individual change scores across age groups or testing an age-by-time interaction (Lakens, 2013).

The association between education and post-intervention cognitive status is consistent with the cognitive reserve hypothesis (Stern, 2012) and with meta-analytic evidence that low education is associated with a higher risk of dementia (Meng & D'Arcy, 2012). At the same time, several MMSE items depend on reading, writing, and arithmetic, so the instrument contains an educational bias that can lower the scores of older adults with no formal education without reflecting a true neurological deficit (Jones & Gallo, 2001), and the influence of literacy on MMSE scores has been reported among community-dwelling older Indonesians (Setiyani & Iskandar, 2022). The lower proportion of normal scores among participants without formal education may therefore reflect measurement bias as much as differences in cognitive function. As with age, these data do not indicate that participants with more education responded better to the intervention, because change scores were not compared between educational groups. Practically, programmes for older adults with little schooling should rely on oral instructions, demonstration, repetition, and adjustable difficulty, and evaluations should use education-adjusted norms or less literacy-dependent instruments (Crum et al., 1993).

The absence of a significant association between sex and post-intervention cognitive status should not be interpreted as evidence that sex is unrelated to cognitive function or that the intervention was equally effective in women and men. A national analysis identified female sex as a risk factor for memory impairment (Handajani et al., 2024), sex differences in MMSE item performance have been described (Jones & Gallo, 2002), and a large cohort showed that women had higher baseline cognition but faster decline (Levine et al., 2021). The small number of men in this sample (n = 46) limits the precision of the comparison. Similarly, hypertension is known to damage cerebral vessels and is associated with cognitive decline (Iadecola et al., 2016), and intensive blood-pressure control reduced the risk of mild cognitive impairment in a randomised trial (Williamson et al., 2019). The non-significant result in this study is likely influenced by the binary measurement of hypertension history, which did not capture its duration, severity, blood-pressure control, or treatment, and by other unmeasured confounders. A similar lack of association between blood pressure and MMSE scores was reported among community-dwelling older Indonesians (Setiyani & Iskandar, 2022).

These findings suggest potential applications for gerontological nursing in primary care that require further evaluation. Traditional games that are familiar, inexpensive, and technology-free are consistent with the WHO recommendation to develop widely accessible risk-reduction interventions (World Health Organization, 2019). The combined puzzle–dakon activity could be tested as a component of Posyandu Lansia activities within a multidomain approach, such as that shown to maintain cognitive function in at-risk older adults in the FINGER trial (Ngandu et al., 2015), alongside the management of vascular risk factors such as hypertension (Livingston et al., 2024). Such programmes should be adapted to participants' age, education, and abilities.

This study has several limitations. First, the absence of a control group means that the change cannot be separated from history, maturation, the attention received during the study, and other time-related influences (Des Jarlais et al., 2004). Second, repeated administration of the same MMSE after a short interval of about two weeks may have produced practice effects (Galasko et al., 1993); practice effects can appear after a single repetition (Calamia et al., 2012) and are also seen in older adults with mild cognitive impairment (Duff et al., 2008). This limitation is central to the interpretation of the primary finding. Third, regression to the mean may have contributed to the improvement among participants with low baseline scores (Barnett et al., 2005). Fourth, the assessor was not blinded, the posttest was administered immediately after the fourth session, when fatigue or activation may have affected performance, and the MMSE has ceiling effects and educational bias and is insensitive to domain-specific change (Jones & Gallo, 2001; Tombaugh & McIntyre, 1992). Fifth, purposive sampling and the analysis of completers only limit generalisability, and no follow-up assessment was performed, so the sustainability of any change is unknown. Sixth, participants' previous familiarity with puzzles or dakon was not recorded and may have influenced engagement and performance, and potential confounders such as depression, physical activity, and other chronic diseases were not measured. Future studies should use randomised designs with an active control group, longer and more intensive programmes, alternate test forms or additional domain-specific instruments, blinded assessors, analysis of individual change scores by age and education, and follow-up assessments several months after the intervention (Lampit et al., 2014; Woods et al., 2023).

CONCLUSION

MMSE scores among community-dwelling older adults were higher after four sessions of combined puzzle and dakon activities, with a mean increase of 1.78 points

and an increase in the proportion of participants in the normal MMSE category from 50.6% to 67.8%. Age and education were associated with post-intervention MMSE categories, whereas sex and history of hypertension were not. Because the study had no control group, the change may partly reflect practice effects and other influences and cannot be attributed to the intervention alone, and its long-term benefit is unknown. The combined puzzle–dakon activity is a simple, low-cost, and culturally familiar option that may be considered for Posyandu Lansia programmes, but it requires evaluation in randomised controlled trials with longer follow-up and clinically meaningful outcomes before it is recommended for routine practice.

DECLARATIONS

Ethics Approval and Consent to Participate. This study received ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Tanjungkarang (Certificate of Ethical Approval No. 239/KEPK-TJK/IV/2026, valid from 14 April 2026 to 14 April 2027). Written informed consent was obtained from all participants before participation. For participants with limited literacy or substantial cognitive difficulties, the information sheet was read aloud in simple Indonesian, understanding was checked by asking participants to restate the main points, participants signed the consent form, and a family member was present as a witness. Participants could rest at any time during the sessions or assessments, were monitored by facilitators for signs of fatigue or distress, and could withdraw at any time without any consequence for the health services they received. All procedures adhered to the principles of confidentiality, privacy, beneficence, and risk minimisation.

Availability of Data and Materials. The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest. The authors declare that they have no conflict of interest.

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Author Contributions. DA: conceptualisation, methodology, intervention delivery, data collection, formal analysis, and writing – original draft; P: methodology, supervision, and writing – review and editing. All authors read and approved the final manuscript.

Artificial Intelligence (AI) Usage Statement. During the preparation of this manuscript, the authors used an AI-assisted tool solely to improve language and readability. No AI tool was used to generate data, perform statistical analyses, or interpret the findings. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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