

Interacting in Multiple Languages Contributes to Cognitive Resilience in Malaysian Older Adults (Keupayaan Berinteraksi dalam Pelbagai Bahasa Menyumbang kepada Ketahanan Kognitif dalam kalangan Warga Emas Malaysia)

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Received: 25 December 2025 / Accepted: 19 February 2026

ABSTRACT

Cognitive reserve in everyday problem-solving and decision-making abilities is influenced by both demographic and experiential factors. Cognitive reserve should ideally remain stable across one's lifespan; however, ageing is often accompanied by cognitive decline for some individuals, highlighting the need to identify factors that may help preserve cognitive reserve in later life. Malaysia's multilingual landscape provides a unique context for examining whether lifelong exposure to multiple languages contributes to cognitive resilience in older adults. Therefore, this study investigates whether or not being bilingual or plurilingual contributes to cognitive resilience among Malaysian older adults who participated in the MyAgeWell Program. 352 community-dwelling participants above 60 years old completed assessments of global cognition, everyday functional problem-solving, and decision-making tasks. Cognitive function was measured using the Montreal Cognitive Assessment (MoCA), whereas everyday cognitive processing and behavioural decision-making were assessed using the Malaysian Everyday Problems Test (MEPT). Age and Number of Languages spoken were treated as primary predictors, while Gender, Ethnicity, and Religion were included as control variables. General Linear Model (GLM) analyses were conducted to examine the associations between age, number of languages, and MoCA and MEPT scores, controlling for demographic factors. Partial eta squared (η^2p) was reported as a measure of effect size. The overall GLMs were significant for both MoCA and MEPT. After controlling for demographic variables, both Age and Number of Languages significantly predicted performance. These findings underscore the importance of age and language experience in cognitive and practical problem-solving functioning, contributing to a better understanding of cognitive ageing in Malaysia.

Keywords: Everyday Problems Test; Older adults; language performance; Cognitive performance; decision making.

ABSTRAK

Rizab kognitif dalam keupayaan menyelesaikan masalah dan membuat keputusan harian dipengaruhi oleh faktor demografi dan pengalaman. Rizab kognitif sepatutnya kekal stabil sepanjang hayat seseorang; walau bagaimanapun, proses penuaan sering disertai dengan kemerosotan kognitif bagi sesetengah individu. Hal ini menguatkan keperluan untuk mengenal pasti faktor-faktor yang mungkin membantu memelihara rizab kognitif di kemudian hari. Landskap pelbagai bahasa Malaysia menyediakan konteks yang unik untuk mengkaji sama ada pendedahan sepanjang hayat kepada pelbagai bahasa menyumbang kepada ketahanan kognitif dalam kalangan warga emas. Oleh yang demikian, kajian ini menyelidik sama ada kebolehan berinteraksi dalam pelbagai bahasa boleh menyumbang kepada daya tahan kognitif dalam kalangan warga emas Malaysia yang menyertai Program MyAgeWell. Seramai 352 orang peserta yang berumur 60 tahun ke atas telah melengkapkan penilaian kognisi global, penyelesaian masalah fungsian harian, dan

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tugasan membuat keputusan. Fungsi kognitif diukur menggunakan Montreal Cognitive Assessment (MoCA), manakala pemprosesan kognitif harian dan tingkah laku mereka ketika membuat keputusan dinilai menggunakan Malaysian Everyday Problem Test (MEPT). Umur dan Bilangan Bahasa yang dituturkan dijadikan peramal utama, manakala Jantina, Bangsa, dan Agama dikategorikan sebagai pemboleh ubah kawalan. Analisis General Linear Model (GLM) telah dijalankan untuk mengkaji hubungan antara umur, bilangan bahasa, dan skor MoCA dan MEPT, dengan mengawal faktor demografi. Eta separa kuasa dua (η^2p) dilaporkan sebagai ukuran saiz kesan. GLM keseluruhan adalah signifikan bagi kedua-dua MoCA dan MEPT. Selepas mengawal pemboleh ubah demografi, kedua-dua Umur dan Bilangan Bahasa meramalkan prestasi secara signifikan. Penemuan ini menekankan kepentingan umur dan pengalaman bahasa dalam fungsi kognitif dan penyelesaian masalah praktikal. Dapatan ini menyumbang kepada pemahaman yang lebih baik tentang penuaan kognitif di Malaysia.

Kata Kunci: Everyday Problems Test; membuat keputusan; prestasi bahasa; prestasi kognitif; warga emas

INTRODUCTION

Malaysia is a linguistically diverse nation; the majority of its adult population navigate their daily life using more than one language. This is as a result of its multi-ethnic structure: 58.1% of Malaysians are Malays, 22.4% Chinese, 6.5% Indians, and the rest (13%) are indigenous people (e.g., Orang Semai, Iban) (Department of Statistics Malaysia, 2025). This multi-ethnic structure results in the need to communicate with each other in one common language – Bahasa Melayu – the national language – (henceforth Malay) and English – the official second language of the nation. Both Malay and English are compulsory subjects in the Malaysian education system; therefore, most Malaysians are expected to be at least Malay-English bilinguals. Nevertheless, since not all Malaysians attended public schools (i.e., national schools that are run by the government), or since not all Malaysians had the opportunity to attend schools (particularly those who were born before the independence), a small minority of Malaysians may be monolinguals. There are some others, however, who are plurilinguals, as a result of them living in a multilingual society. (In this article, the term “plurilingual” (instead of “multilingual”) is used to refer to individuals who can interact in more than two languages as the term “multilingual” can also refer to a society with speakers of different languages. Therefore, the terms “multilingual”, “multilingualism” that are used by other authors to refer to individuals who can speak more than two languages are changed to “plurilingual” and “plurilingualism” respectively in this article so as to avoid confusion).

Cognitively, individuals who speak more than one language outperform monolinguals on activities that demand attentiveness to a target in the context of contradictory information (Bialystok & Craik, 2022). Past studies suggest that the ability to speak or interact in more languages may contribute to better cognitive reserve, potentially delaying cognitive decline (Perquin et al., 2013; Liu & Wu, 2021; Berkes & Bialystok, 2022; Carthery-Goulart, Privitera, & Weekes, 2023). According to Perquin et al. (2013), older adults who experience early practice on bilingualism or plurilingualism perform more efficiently in terms of cognitive reserve and brain plasticity, which help preserves their brain functions from alterations during aging. According to Liu and Wu (2021), individuals with more than one practiced language throughout their life may help the brain work more efficiently and protect thinking abilities as they age. This, therefore, delays cognitive decline which could help individuals maintain independence longer. Moreover, bilingualism or plurilingualism may help protect older adults from the effects of dementia (Berkes & Bialystok, 2022) by supporting executive functions (i.e., being in control of other cognitive components), which are more complex, high-level cognitive processes required for goal-directed behaviour (Carthery-Goulart et al., 2023).

Older adults (OA) in Malaysia have been reported to be fluent in the English language. This, in particular, is significant among those who went to school. Before Malaysia's independence in 1957, under the British colonial rule, English functioned as the primary language for administration, education, and commerce. English-medium schools were mainly located in urban areas and were associated with social prestige, economic mobility, and access to professional opportunities (Hanewald, 2016). After gaining its independence on 31st August 1957, language policy became a central component of nation-building, leading to the gradual replacement of English with Malay as the main medium of instruction at various levels of education. This transition was formalised through the Education Ordinance 1957 and was fully implemented approximately a decade later, with Malay becoming the dominant instructional language by the late 1960s (Yang, 1998). As a result of this, older adults who received their formal education prior to this policy shift were more likely to have been educated in English and therefore tend to exhibit higher English proficiency than those who attended school after the medium of instruction transitioned to Malay. This historical context is important for understanding the diverse language profiles observed among Malaysian older adults in the present study. The lifelong exposure to multiple languages, which is varied in depth, and embedded in real-world contexts (Berkes & Bialystok, 2022) makes Malaysian OA an ideal population for examining the potential cognitive effects of bilingualism or plurilingualism (Ng et al., 2022).

Worldwide research has suggested that bilingualism or plurilingualism may enhance aspects of executive functioning, attention-switching ability, and decision-making efficiency, contributing to a form of cognitive reserve (i.e., individual variability in clinical status, functional capacity, and cognitive performance) that may protect against age-related decline such as aging, injury, and neurodegenerative disease (Carthery-Goulart et al., 2023). For example, 12 out of the 16 studies (i.e., from 2007 to 2020 in six countries) reported by Mendis, Raymont, and Tabet (2021) (see Figure 1) show that bilingualism or plurilingualism have a strong association with delayed cognitive functioning and other age-related cognitive declines such as Alzheimer's disease and dementia. However, the remaining four studies suggest that bilingualism or plurilingualism may not lead to delayed and impairment of cognitive functioning. This, however, could be due to several factors, such as, 1) small monolingual population, therefore, the comparison cannot be made, 2) poorly designed study and a lot of dropped outs during the study, and 3) over 50% of bilingual or plurilingual groups were not analysed.

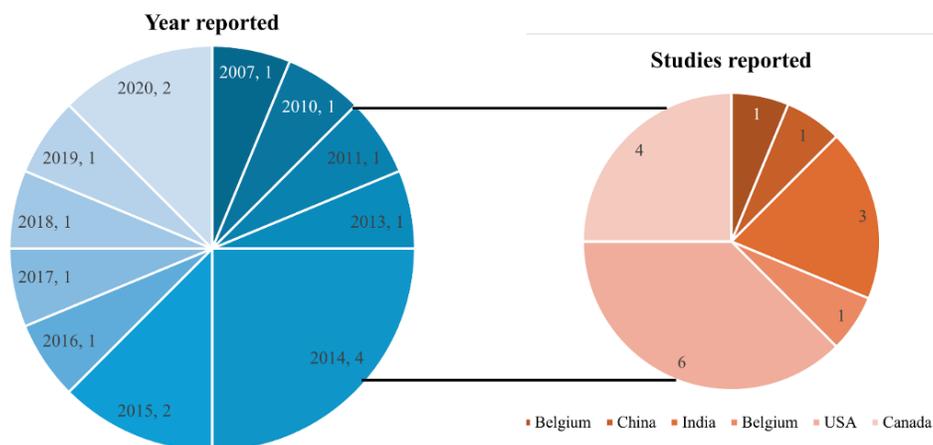


FIGURE 1. Studies reported on the effects of bilingualism or plurilingualism from 2007 to 2020

As for the more recent studies (2020 to 2025), bilingual or plurilingual OA are reported to outperform monolingual OA in all cognitive domains (e.g., India, Singapore, USA, Germany, and Switzerland). Table 1 lists the worldwide findings on the effects of bilingualism or plurilingualism on OA's cognitive functioning and cognitive reserve.

TABLE 1. Studies reported on the effects of bilingualism or plurilingualism from 2020 to 2025

Study	Country	Finding
Chan et al. (2020)	Singapore	Active bilingualism in bilingual OA has a protective effect on cognitive function and may delay or slow down cognitive decline.
de Leon et al. (2023)	United States cohort	There is no difference between bilinguals and monolinguals as bilingualism may not lead to delayed and impairment of cognitive function.
Achaa-Amankwaa et al. (2023)	Germany	Plurilingualism has a protective effect on cognitive function and may delay or slow down cognitive decline.
Venugopal et al. (2023)	India	Bilingualism has a protective effect on cognitive function and may delay or slow down cognitive decline.
Pacifico et al. (2023)	Switzerland	Plurilingualism is associated with better cognitive functioning and possible cognitive reserve which may delay cognitive decline in community-dwelling (OA who live independently at homes) but not institutionalized (OA who live at senior living facilities such as nursing homes) OA.
Menon et al. (2024)	India	Bilingualism or plurilingualism has a protective effect on cognitive function and may delay or slow down cognitive decline.
Strangmann et al. (2025)	India	Plurilingual OA are reported to outperform monolingual OA in all cognitive domains
Petrosyan et al. (2025)	India	Plurilingual OA are associated with better cognitive functioning and possible cognitive reserve which may delay cognitive decline, compared to monolingual OA.

Overall, most studies (as shown in Table 1 and Figure 1), across various countries, have reported that bilingualism or plurilingualism is associated with better cognitive functioning and a protective effect against cognitive decline in older adults. However, such findings are inconsistent across cultures and remain underexplored within the Malaysian context. Past studies in Malaysia have only focused on the reduced social interactions and limited usage of OA's second and third languages (Rajasekar et al., 2022), the prevalence of dementia and any major public health issues (Ng et al., 2021), and the optimization of aphasia rehabilitation (Hassan et al., 2023). Nevertheless, cognitive decline in decision-making and problem-solving performance remains a growing concern among older adults worldwide, including Malaysia (Khairudin et al., 2024). There is, however, limited empirical evidence examining whether the ability to interact in more than one language actually contributes to cognitive resilience in Malaysian OA. In this case, cognitive reserve refers to an individual's ability to maintain cognitive functioning despite the presence of neuropathology by efficiently and flexibly utilising neural resources (Liu & Wu, 2021; Savarimuthu & Ponniah, 2024). The capability that contributes to cognitive reserve development is influenced by life experiences in terms of individual's education, occupation, leisure and social engagement, and bilingual or plurilingual experience, rather than brain structure alone (Liu & Wu, 2021).

As human beings are susceptible to age-related cognitive decline, cognitive reserve and risk of poor-quality decision are growing public health concerns. In-depth investigation on locally relevant protective factors is therefore urgently needed. Despite Malaysia's multilingual landscape, few empirical studies have examined whether the ability to interact in multiple languages confers cognitive advantages for Malaysian older adults. To date, no known studies are reported to have used behavioral tasks such as the Everyday Problems Test (EPT), and/or the Montreal Cognitive Assessment (MoCA), to evaluate real-world functional cognition, and to measure learning and older adults' decision-making competency respectively. There is indeed an urgency in investigating and comparing bilingualism or plurilingualism with performance on tasks like EPT and MoCA among OA in Malaysia, in relation to decision-making abilities. As mentioned earlier, OA in Malaysia have diverse educational backgrounds, with Malay, or English, or Mandarin, or Tamil as the medium of instructions at national schools, private schools, national-type (Chinese) and national-type (Tamil) schools respectively. Their schooling experience may have some influences on their language proficiency and cognitive performance in one, two, or more languages. Because of this, there is a need to examine whether the ability to speak multiple languages translates into cognitive advantages within Malaysian ageing populations. Ideally, cognitive performance and cognitive reserve should remain stable across one's lifespan. However, in reality, ageing is often accompanied by declines in cognitive functioning for some individuals, highlighting the need to identify factors that may help preserve cognitive reserve in later life. Therefore, this study aims to investigate whether the ability to interact in multiple languages contributes to cognitive reserve among older adults in the Malaysian context.

CURRENT STUDY

Malaysia is expected to become an aged nation by 2030, comprising approximately 15% of OA from the population (Aziz et al., 2021). In Malaysia, policies and guidelines have been implemented to address OA's health and well-being and this includes the National Health Policy for Older Persons that was established in 1995. This policy aims to promote healthy ageing and improve the quality of life by empowering older adults, their families, and communities through supportive systems (Abdullah, Ismail, & Yusoff, 2024). This highlights the growing socioeconomic and healthcare impact of ageing population and the importance of promoting active and healthy lifestyles to support independent living. Given the circumstances, being bilinguals or plurilinguals may be a contributing factor to OA's better cognitive functioning and cognitive reserve. As suggested by Chan et al. (2020), older adults with the abilities to interact in more than one language may have better chances to maintain their specific executive control abilities and help against the natural age-related declines. Thus, bilingualism or plurilingualism may play an important role in mitigating cognitive decline in OA (Wen & Dong, 2025) and should be considered as a crucial aspect to promote healthy and independent ageing in Malaysia. Understanding how age and bilingual or plurilingual experience relate to these outcomes is important for the maintenance of OA's cognitive functioning in Malaysian context; therefore, the need to study on the relationship of bilinguals or plurilinguals and OA's cognitive functioning in Malaysia is crucial so as to help achieve Sustainable Development Goals (SDG-3), with 15% of OA with healthy lifestyle by the 2030 (Aziz et al., 2021; Abdullah et al., 2024).

The current study then addresses these gaps by analyzing the cognitive and behavioral data gathered from OA who enrolled in MyAgeWell program, a cohort study which involves a community-based longitudinal study on OA aged 60 years and above (i.e., for this study, age range

was between 62 to 100 years old) who reside in Selangor and the Federal Territory of Kuala Lumpur (Khairudin et al., 2024; Chia et al., 2025; Lim et al., 2025). The cohort includes a multiethnic sample with balanced representation across gender and socioeconomic status, based on Malaysia's household income classification into B40 (bottom 40%) and non-B40 (middle- and high-income) groups. Participants were recruited if they (1) were generally healthy (including those receiving routine medical care), (2) had functional mobility (self-reported ability to walk at least 3 meters), and (3) were able to communicate in at least one of the following languages: English, Malay, Mandarin, or Tamil (Lim et al., 2025).

By examining the relationships between OA's language profiles and cognitive abilities in decision-making performance and problem solving, this research aims to determine whether the ability to interact in more than one language may be associated with better cognitive outcomes among Malaysian OA. The findings will contribute valuable insights for local ageing research, policy development, and cognitive health. With the in-depth investigation on OA's language profiles and cognitive performance, this study hopes to contribute to, (1) new insights on plurilingual cognitive advantages in ageing Malaysians, (2) local empirical evidence for policymaking in ageing, lifelong learning, and dementia prevention, and (3) future support for interventions based on language engagement (e.g., bilingual activities, language-learning programmes for OA).

The aim of this study is therefore to investigate if being a bilingual or a plurilingual can contribute to cognitive reserve of OA in the Malaysian context. Thus, this study examines the association between bilingual or plurilingual experience and cognitive functioning among Malaysian OA. Specifically, to achieve the aim of the study, the current study hopes to answer the following research questions:

1. Is the number of languages spoken associated with overall cognitive functioning and everyday problem-solving performance among older adults?
2. Does bilingual or plurilingual experience relate to performance on global cognitive screening (via the Montreal Cognitive Assessment (MoCA)) and functional cognitive tasks (Malaysian Everyday Problems Test (MEPT)) after controlling for demographic factors such as age, gender, ethnicity, and religion?

This study was conducted using the following tests: (1) MoCA to measure OA's overall cognitive function and (2) MEPT to measure OA's cognitive performance in terms of problem-solving and decision-making abilities.

METHODOLOGY

PARTICIPANTS AND SETTING

Data for this study were drawn from the "Successful Ageing: Evidence-Based Interventions to Delay Ageing-Related Decline" (MyAgeWell) project. MyAgeWell is an ongoing community-based initiative aimed at examining and supporting cognitive functioning among Malaysian older adults. Recruitment was conducted through public announcements, WhatsApp messages, posters, and community briefings in various venues, including senior citizen clubs, religious centres, People's Housing Programme facilities, and neighbourhood gatherings. Individuals with diagnosed neurodegenerative conditions (e.g., Alzheimer's disease, Parkinson's disease),

significant cognitive impairment (MoCA score < 13), psychiatric disorders, severe mobility limitations, or uncorrected hearing or visual impairments were excluded from the cohort. A total of 387 OA responded and completed the MoCA test. However, due to some limitations, 35 participants withdrew after the MEPT test. Altogether, 352 participants completed both MoCA and MEPT tests and they were all included in this study. All participants signed the informed consent form prior to the study. A more detailed participants' profile is shown in Table 2.

TABLE 2. General Linear Model Results (GLM) predicting MoCA scores

Participants' Profile	N (%)
Age	
60 – 69 (the youngest participant is 62 years old)	204 (57.9 %)
70 – 79	132 (37.5 %)
80 – 89	15 (4.3 %)
> 90 (the oldest participant is 100 years old)	1 (0.3 %)
Gender	
Male	171 (49%)
Female	181 (51%)
Ethnicity	
Malay	133 (37.8%)
Chinese	139 (39.5%)
Indian	73 (20.7%)
Others	7 (2%)
Religion	
Islam	140 (39.8%)
Buddhism	82 (23.3%)
Christianity	66 (18.8%)
Hinduism	48 (13.6%)
Others	16 (4.5%)
Number of language(s) spoken	
One language (monolingual)	75 (21.3%)
Two languages (bilingual)	136 (38.6%)
Three or more languages (plurilingual)	141 (40.1%)

During the recruitment process, potential participants who met the inclusion criteria were briefed about the study using the participant information sheet (PIS). Once they agreed to participate, MoCA screening test was conducted. Those who scored more than 13 out of 30 in the MoCA were then scheduled to participate in the baseline assessment, which includes the surveys (i.e., (1) baseline general questionnaire which consists of 135 questions on participants' demographic details, socioeconomic status, self-disclosed health conditions, and the short form of the International Physical Activity Questionnaire (IPAQ), and (2) MEPT) (Chia et al., 2025). Those who scored 13 or below were automatically be excluded from MyAgeWell study.

INSTRUMENTS

MONTREAL COGNITIVE ASSESSMENT (MoCA)

The Montreal Cognitive Assessment (MoCA) is a brief cognitive screening tool which was developed and copyrighted by Z. Nasreddine M.D. (2005) to detect mild cognitive impairment (MCI). It is administered in approximately 10 minutes, scored out of 30, and assesses multiple cognitive domains including attention, executive function, memory, language, visuospatial skills, and orientation (Nasreddine et al., 2005). MoCA was designed based on clinical observations of cognitive domains commonly affected in MCI and has been refined through several years of

clinical use. The final version (MoCA version 7.1) assesses eight core cognitive domains using brief, sensitive, and easy-to-administer tasks. The instrument was validated in clinical memory clinic settings with English- and French-speaking participants, including cognitively healthy controls, individuals with MCI, and patients with mild Alzheimer's disease. Validation studies demonstrated that the MoCA has superior sensitivity for detecting MCI and mild Alzheimer's disease compared to the Mini-Mental State Examination (MMSE) (Julayanont et al., 2013).

The original cutoff score for MoCA is 26 (Julayanont et al., 2013). However, in MyAgeWell study, the cutoff score for MoCA (administered in Malay, English, and Mandarin) was redefined and decided at 13 based on three reasons (Marzuki et al., 2024):

- (1) The original cut-off of 26 for MOCA is criticised to be too high, even in samples of highly-educated older adults;
- (2) the MOCA is highly sensitive to one's education level across various cultures, and many of our participants living in poverty reported having little to no education. Using the original cut-off, or even the cut-off of 18 as recommended in a study reporting results in a Malay-speaking sample, would have led to the exclusion of a significant proportion of low-income participants;
- (3) several papers recommend a cut-off of 13-to-14 in less-educated or ethnic minority groups for ruling out potential Alzheimer's disease (p. 11).

MALAYSIAN EVERYDAY PROBLEMS TEST (MEPT)

In the current study, the Malaysian version of the Everyday Problems Test, known as the Malaysian Everyday Problems Test (MEPT) developed by Khairudin et al. (2024), was used. The MEPT is a culturally adapted based on performance-based assessment derived from the original Everyday Problems Test (EPT) developed by Willis and Marsiske (1993), which assesses everyday cognitive and problem-solving abilities in older adults. The MEPT consists of 14 items designed to measure reasoning and problem-solving performance in everyday contexts relevant to OA (Khairudin et al., 2024). The test items are based on the same seven functional domains as the original EPT: health and medication management, meal preparation and nutrition, telephone use, consumer activities (shopping), financial management, household management, and transportation. However, the MEPT was adapted to reflect materials and situations commonly encountered by Malaysian OA in their daily lives. Items are presented in realistic formats such as bills, product labels, application forms, directions, and charts, and require participants to interpret and use the information provided to answer the questions. The measure was administered in three languages, namely, 1) English, 2) Malay, and 3) Mandarin, considering these are the most practiced languages among the participants. All translated versions underwent Brislin's back-translation procedure to ensure conceptual and semantic equivalence across languages (Brislin, 1970 as cited in Khairudin et al., 2024).

PROCEDURE

Information on participants' language profile was obtained from the general questionnaire; this includes the number of languages spoken, self-reported proficiency, frequency of language use, the medium of instruction during schooling, and the language used during testing. Cognitive functioning was assessed using the Montreal Cognitive Assessment (MoCA) for participants screening, which provided domain-specific scores. Decision-making and learning under uncertainty were measured using the Malaysian Everyday Problems Test (MEPT), including

indices such as advantageous and disadvantageous selections, reaction times, and final bank balance. Everyday functional cognitive performance was captured using MEPT scores, reaction times, accuracy rates, and error patterns. Figure 2 illustrates how the current study was conducted.

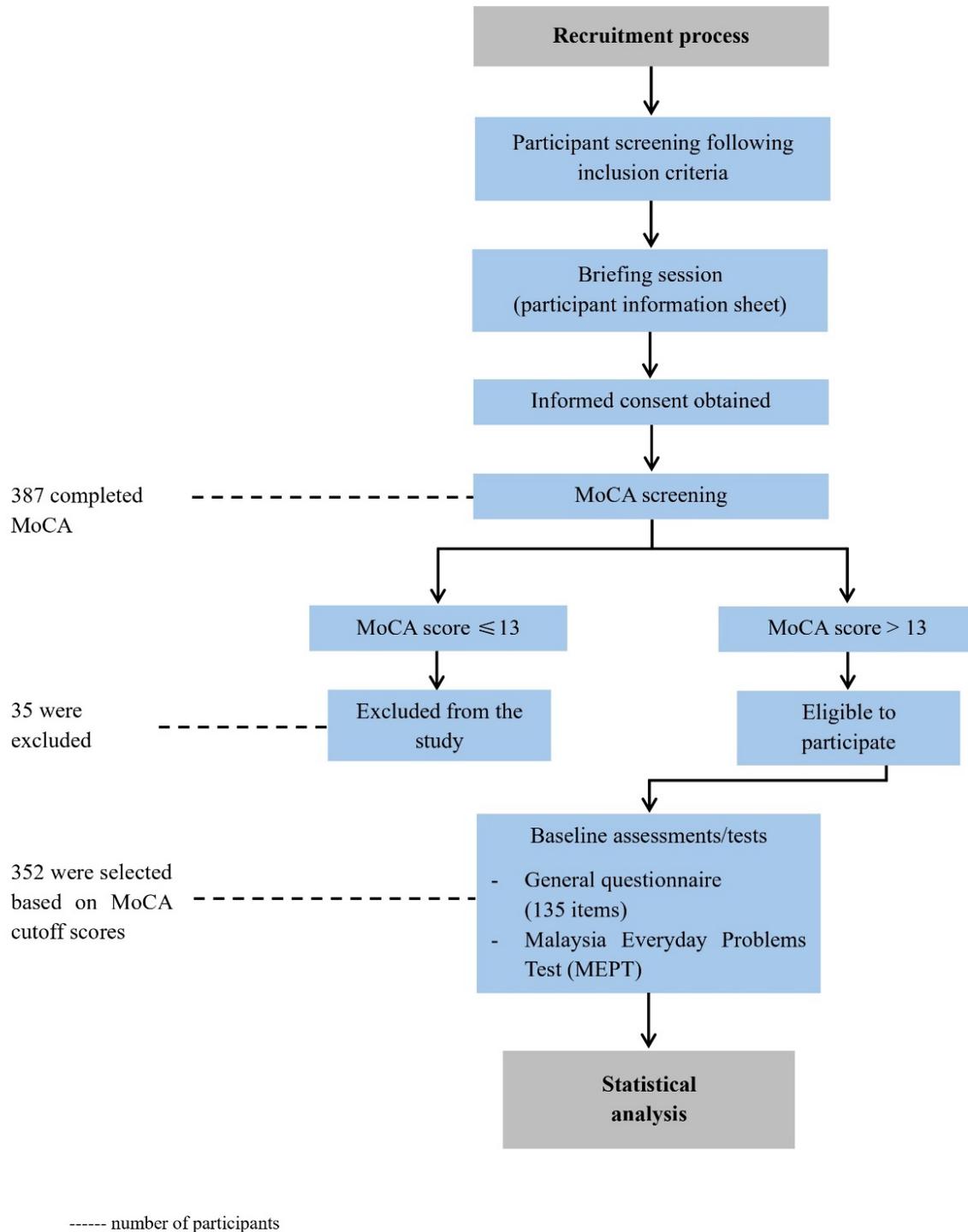


FIGURE 2. Study procedures

STATISTICAL ANALYSIS

To examine the effects of Age and Number of Languages on cognitive performance, measured by MoCA and MEPT, General Linear Model (GLM) analyses were conducted using SPSS (version 25). Gender, Ethnicity, and Religion were included as control variables. Age and Number of Languages were treated as covariates, whereas Gender, Ethnicity, and Religion were treated as fixed factors. For each dependent variable (MoCA and MEPT), the main effects of Age and Number of Languages were tested while controlling for the effects of categorical variables and their interactions. Interaction terms among the categorical variables (Gender \times Ethnicity, Gender \times Religion, Ethnicity \times Religion, Gender \times Ethnicity \times Religion) were included to account for potential combined effects. Partial eta squared was reported as a measure of effect size. Residuals were examined for normality and homoscedasticity using histograms and scatterplots of standardized residuals against predicted values.

ETHICAL CONSIDERATIONS

Ethics approval was obtained from the Sunway University Research Ethics Committee (SUREC2020/039). Prior to recruitment, all participants were briefed about the study and they later provided their informed consent.

RESULTS

MONTREAL COGNITIVE ASSESSMENT (MoCA)

The overall findings of General Linear Model (GLM) to predict Montreal Cognitive Assessment (MoCA) was significant (Corrected Model: $F(29, 322) = 3.678, p < .001, \eta^2p = 0.249$, Adjusted $R^2 = 0.181$). This indicates that approximately 19.1% of the variance in global cognitive performance was explained by the combined effects of age, number of languages spoken, and the included control variables. Therefore, this depicts that the model explained a substantial portion of variance in MoCA scores among OA. After controlling for Gender, Ethnicity, and Religion, both Number of Languages ($F = 13.655, p < .001, \eta^2p = 0.041$) and Age ($F = 13.598, p < .001, \eta^2p = 0.041$) show significant associations with MoCA scores. These results suggest that participants with a higher number of languages and younger age performed better on MoCA. The effect sizes for both number of languages and age are small to moderate, however, they are comparable in magnitude. Thus, this suggests that bilingual or plurilingual experience and age contributed independently.

Among the control variables, Religion showed a significant main effect ($F = 3.425, p = .005, \eta^2p = 0.050$), which indicates differences in cognitive performance across religious groups among OA. In contrast, Gender and Ethnicity were not significant ($p > .05$). Some interactions among the categorical variables were significant (Gender \times Ethnicity: $F = 3.438, p = .017$; Gender \times Religion: $F = 4.084, p = .001$; Gender \times Ethnicity \times Religion: $F = 4.162, p = .016$), though these were included primarily to control for potential confounding effects rather than for interpretation of the main hypotheses. Importantly, the significant effects of number of languages and age remain robust after accounting for these interactions. Hence, the MoCA findings indicate that both younger age and greater bilingual or plurilingual experience are associated with better global cognitive functioning among Malaysian OA which is the independent of demographic factors. Table 3 shows the overall results of General Linear Model (GLM) to predict MoCA in all variables.

TABLE 3. General Linear Model Results (GLM) predicting MoCA scores

Predictor / Effect	F	p-value	Partial η^2
Corrected Model	3.678	< .001	0.249
Age	13.598	< .001	0.041
Number of Languages	13.655	< .001	0.041
Gender	ns	> .05	—
Ethnicity	ns	> .05	—
Religion	3.425	.005	0.050
Gender × Ethnicity	3.438	.017	—
Gender × Religion	4.084	.001	—
Gender × Ethnicity × Religion	4.162	.016	—

Model fit: Adjusted $R^2 = 0.181$

Note. Age and Number of Languages were entered as covariates. Gender, Ethnicity, and Religion were included as control variables. Interaction terms were included to control for potential confounding effects. ns = non-significant.

MALAYSIAN EVERYDAY PROBLEMS TEST (MEPT)

A parallel General Linear Model (GLM) analysis was conducted to examine predictors of performance on the Malay version of the Everyday Problems Test (MEPT). The overall GLM was statistically significant (Corrected Model: $F(29, 322) = 3.100, p < .001, \eta^2p = 0.218$, Adjusted $R^2 = 0.148$). This result indicates that approximately 14.8% of the variance in everyday problem-solving performance was explained by the predictors included in the model, representing substantial portion of variance in MEPT scores.

As for controlling for Gender, Ethnicity, and Religion, both Number of Languages ($F = 8.452, p = .004, \eta^2p = 0.026$) and Age ($F = 10.623, p = .001, \eta^2p = 0.032$) showed significant associations with MEPT scores. This suggests that participants with a higher number of languages (i.e., more languages spoken) and younger age performed better on MEPT. Even though the effect sizes for these predictors are smaller than those observed for MoCA, these predictors indicate reliable and independent contributions of age and bilingualism or plurilingualism to functional cognitive performance.

On the other hand, among the control variables of MEPT, none of Gender, Ethnicity, or Religion showed significant main effects (all $p > .05$). Furthermore, none of the interactions among the categorical variables reached significance (all $p > .05$). This result shows that the effects of Age and Number of Languages were robust across demographic groups. Table 4 shows the overall results of General Linear Model (GLM) to predict MoCA in all variables.

TABLE 4. General Linear Model (GLM) Results predicting MEPT scores

Predictor / Effect	F	p-value	Partial η^2
Corrected Model	3.100	< .001	0.218
Age	10.623	.001	0.032
Number of Languages	8.452	.004	0.026
Gender	ns	> .05	—
Ethnicity	ns	> .05	—
Religion	ns	> .05	—
All interaction terms	ns	> .05	—

Model fit: Adjusted $R^2 = 0.148$

Note. Age and Number of Languages were entered as covariates. Gender, Ethnicity, and Religion were included as control variables. No interaction effects reached statistical significance. ns = non-significant.

Overall, the MEPT findings show that bilingual or plurilingual experience and age are significant factors in cognitive performance of OA. These results complement the MoCA findings by showing that the influence of ability to interact in multiple languages extends beyond global cognitive screening measures to OA's everyday problem-solving abilities. Therefore, the results of GLM in MoCA and MEPT suggest that being bilinguals or plurilinguals may help support brain health and everyday functioning in later life. Regular use of multiple languages may act as a kind of cognitive exercise that helps older adults stay mentally sharp, even as they age.

DISCUSSION

The present study investigates the relationship between the ability to interact in multiple languages and cognitive performance (i.e., problem-solving abilities) among Malaysian older adults who participated in MyAgeWell Program. By conducting General Linear Model (GLM) analyses, the findings show that younger age and higher number of languages spoken are associated with better performance on cognitive performance and problem-solving abilities. As mentioned by Carthery-Goulart et al. (2023), OA with higher number of languages spoken show better monitoring performance on cognitive-related tasks. Maintaining more than one language throughout lifespan directs ongoing demands on executive processes such as attention control, monitoring, and switching between languages (Chan et al., 2020). These abilities closely correspond to the cognitive domains evaluated by the MoCA which includes executive functioning, attention, and memory (Julayanont et al., 2013). Therefore, sustained bilingual or plurilingual experience may help preserve the efficiency of these cognitive systems that results in better overall performance on cognitive measures in OA's later life.

Additionally, bilingualism or plurilingualism do not only benefit OA's cognitive functioning but also help OA in improving their abilities to live independently, in terms of their cognitive flexibility (e.g., to enable the process of shifting from one sentence to another while reading the text in order to learn concepts) and adaptive problem-solving which are crucial to navigate their everyday life (Savarimuthu & Ponniah, 2024). For example, studies by Liu and Wu (2021) and Berkes and Bialystok (2022) have suggested that bilingualism or plurilingualism may mitigate age-related cognitive decline such as Alzheimer's disease and other causes of dementia. However, although this does not wholly prevent cognitive decline altogether, it does help OA to maintain higher levels of cognitive functioning. Mendis et al. (2021) highlight that bilinguals or plurilinguals develop clinical symptoms of Alzheimer's disease about four years later and receive diagnoses approximately two years later than monolinguals. Moreover, in another study (Carthery-Goulart et al., 2023), it is also stated that although age and language experience are distinct factors, younger older adults in their study tend to report higher bilingual or plurilingual engagement, suggesting better cognitive functioning and cognitive reserve. Although it is clear that age does not directly cause bilingualism, younger participants were more likely to have maintained active language use, which relates to cognitive benefits. In this study, it is proven that younger OA ($p = 0.004$) with a higher number of languages spoken ($p = 0.001$) performed better on MEPT that was designed to investigate OA's ability and capacity in problem-solving and decision making (Khairudin et al., 2024). Meanwhile, the findings on MoCA of this current study similarly demonstrate an association between younger age and number of languages spoken as the participants who performed well in the MoCA screening (with > 13 cutoff score) are proven to be

less sensitive to early signs of cognitive ageing as well as mild cognitive impairment (MCI) and are more physically active (Chia et al., 2025).

Notably, the benefits of bilingualism or plurilingualism are seen in both general cognitive tests (MoCA) and everyday problem-solving tasks (MEPT); results show that the ability to use more than one language may support different aspects of OA's cognitive performance in later life. Although the effects may not be really major, they are consistent as reported in studies on OA's cognitive functioning and cognitive reserve globally (Chan et al., 2020; de Leon et al., 2023; Achaa-Amankwaa et al., 2023; Venugopal et al., 2023; Pacifico et al., 2023; Menon et al., 2024; Strangmann et al., 2025; Petrosyan et al., 2025). Thus, the findings of the current study support previous studies that bilingual or plurilingual experience plays a meaningful role in helping OA to maintain their cognitive abilities. Nevertheless, cognitive health is influenced by many factors across a person's life, such as education, type of work, physical activity, and social involvement (Achaa-Amankwaa et al., 2023). Therefore, bilingualism or plurilingualism should be viewed as one important factor among several that contribute to cognitive resilience.

Findings of this study are unique to the Malaysian OA as their different language backgrounds are due to the history of the nation's education systems, the nation's language policies after independence, and ethnic diversity. Being in a multilingual society, many participants were exposed to more than one language such as English, Malay, Mandarin, or Tamil (specifically, 136 of them (38.6%) were bilinguals and 141 (40.1%) were plurilinguals) at different stages of their lives and used these languages regularly in daily communication. This long-term and real-life use of multiple languages may be particularly helpful for maintaining cognitive health as being bilinguals or plurilinguals can help protect OA from dementia and mild cognitive impairment (MCI). (Like the study by Venugopal et al., (2023), the study also shows that bilinguals or plurilinguals have higher baseline cognitive performance compared to monolinguals). This may explain why the number of languages spoken can be an important predictor of cognitive performance, even though participants differed in education and income levels.

Even though religion and ethnicity are also linked to performance on the MoCA cognitive screening test, they are not related to everyday problem-solving ability measured by the MEPT. This suggests that some social or cultural factors may affect performance on structured cognitive tests but may not strongly influence daily functional thinking skills (Pacifico et al. 2023; Petrosyan et al., 2025). In addition, gender and ethnicity do not show any effects which indicates that the cognitive benefits of bilingualism or plurilingualism are generally similar across different demographic groups in this study. Taken together, these findings support the idea that using multiple languages throughout their life and during later life can act as a form of ongoing mental activity that helps OA maintain both cognitive performance and everyday functioning. In Malaysia, where the ageing population is increasing rapidly and independence among older adults is an important public health concern, encouraging bilingual or plurilingual practice throughout one's life may be a practical and culturally appropriate way to support healthy cognitive ageing.

CONCLUSION

This current study explores the relationship between the number of languages spoken by Malaysian older adults (OA) aged 60 to 100 years old and their cognitive functioning and cognitive reserve in terms of their everyday problem-solving and decision-making abilities. The current study features one of the first Malaysian investigations to integrate behavioural tasks such as global screening via MoCA and problem-solving and decision making via MEPT with language profile data which offers valuable insight into how bilingualism or plurilingualism experience may support OA's healthy cognitive ageing. Based on the findings, bilingual or plurilingual OA show advantages in global cognition and executive functioning which help reserve their cognitive functioning and cognitive reserve. OA with a higher number of languages spoken may also have better cognitive performance which can delay cognitive decline and help them prepare for later life. However, several limitations should be considered: 1) the study was limited to urban older adults in a single location, which may limit applicability to rural populations with different educational and language contexts, 2) certain categorical predictors suffered from estimation instability due to sparse data, and 3) language preferences were examined only within specific research settings and may vary across other aspects of daily life.

Despite these limitations, the findings have potential implications for public health strategies, ageing policies, and the design of cognitive enrichment programmes. Encouraging practice in more languages or promoting bilingual or plurilingual engagement activities among OA may serve as accessible and culturally relevant interventions for maintaining cognitive health. As Malaysia moves toward an increasingly ageing society, understanding the role that bilingualism or plurilingualism plays in cognitive resilience becomes essential. Understanding the relationship between age and bilingual or plurilingual experience and cognitive outcomes in Malaysian OA is crucial to maintain cognitive health and to help support in achieving SDG-3, which aims for healthy ageing among 15% of the older population by 2030. Future research should expand on these findings using longitudinal designs, more detailed language-use measurements, and neurocognitive assessments to fully capture the complex relationship between bilingualism or plurilingualism and cognitive ageing.

ACKNOWLEDGEMENT

This study is funded by the Ministry of Higher Education (MOHE), Malaysia through the Long-Term Research Grant Scheme (LRGS) research project LRGS/1/2019/SYUC/02/1/3 (registered as LRGS/1/2019/SYUC-UKM/1/3 in SMPU v3 UKM), under LRGS Program, LRGS/1/2019/SYUC/02/1 - Clinical Trial Number: NCT06376656). We also thank Sunway University for their support. We are grateful to all post-doctoral research fellows, graduate research assistants, research assistants, and interns involved in this project. Acknowledgement is also given to all 352 participants who took part in the study. Our special gratitude goes to Sharifah Nadhira Syed Annuar and Yin Hanmo for assisting us in various ways throughout this study.

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