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CogEvo as An Early Detection Tool for Early Neurocognitive Decline in Healthy Middle-Aged and Elderly People in Japan

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Abstract. Cognitive decline in middle age and old age occurs slowly without them realizing it. Early detection to identify neurocognitive changes is needed to maintain optimal cognitive status as a person ages. This study aimed to obtain standard values of CogEvo (Total Brain Care CO., Ltd., Kobe, Japan) for healthy middle-aged and elderly people in groups below the MoCA-J reference point. Participants were 20 adults aged 42-79 years who were involved in community-based activities in 10 municipalities in Japan. They were randomly assigned (RCT) into intervention and control groups based on monthly visits. Participants were asked to use the Soso touch application every day. Neurocognitive changes were measured using the Japanese version of CogEvo and Montreal Cognitive Assessment (MoCA-J). The use of these measuring instruments had no difference in sensitivity and specificity. Measurements were carried out every month for 6 months. The results of the study showed a relationship between age and flashing light (p=<0.01) and orientation (p=0.06), and only exercise was related to flashing light (p=0.01). Neurocognitive status was consistently indicated by the CogEvo instruments (t=-3.161; p=0.005) and MoCA-J (t=-4.225; p=<,001). Age and exercise factors determine neurocognitive status. Overall, the CogEvo instrument is better at detecting early changes in neurocognitive changes compared to the MoCA-J in middle age and the elderly.

Keywords: Neurocognitive, Elderly, Sorotouch, Community, Cogevo

INTRODUCTION

The proportion of elderly people aged 65 years and over is 29.1%, with an estimate of more than 20 million in 2025[1]. The large number of elderly people has an impact on increasing medical and nursing service costs as a result of the aging process. In addition, elderly people who are aging are potentially experiencing a decline in cognitive function and this incident increases every year. It is not known when the decline in cognitive function in the elderly begins, generally the elderly realize it after there is difficulty in remembering something or even worse[2]. Detection of cognitive changes can be identified early when someone approaches the elderly age (middle-aged) or less than that age accompanied by accompanying clinical symptoms, such as forgetfulness, like being confused without cause[3]. So cognitive changes are very important to know early to prevent further problems such as dementia.

Dementia is a common cognitive impairment problem in the elderly that causes the inability to carry out daily activities independently [4]. This is because the elderly with dementia require dependence on daily care. In addition to being a burden on the family who cares for them, this problem is also a public health problem related to the cost of care and medical services[5]. In addition to being a health burden, dementia is also correlated with the mental health of the elderly, such as feelings of helplessness, uselessness, anxiety and even depression[6]. Therefore, community-based preventive and promotive efforts are needed to prevent the late adult and elderly age groups from maintaining and optimizing healthy cognitive status.

Through abacus-based cognitive training with digital applications, the elderly are encouraged to do routine exercises so that they are able to maintain their cognitive status well[7]. This cognitive status is maintained with the aim of increasing productivity, maintaining and improving the quality of life of the elderly in Japan.

The strategy for maintaining the cognitive status of the elderly based on the community is implemented by conducting regular and massive cognitive training starting from late adulthood to older elderly[8]. Cognitive strengthening through continuous training aims to train skills in certain cognitive domains with a series of standard tasks that adjust to individual abilities. Application-based cognitive training makes it easier for the elderly to carry out exercises regularly without disturbing their routine activities and is easy to operate[9]. The application of this application is mainly intended for those who have not experienced clinical cognitive disorders.

Although there are differences in studies on the effectiveness of its application at home or in primary care facilities that are implemented together, the application of applications using computers has a positive effect on the cognitive development of the elderly. A systematic study showed a positive effect on better cognitive functions such as memory, visiospatial abilities and processing speed, especially in older adults without cognitive disorders[10]. The latest study, the application of home-based applications or elderly groups produced better studies compared to the application in hospitals. Based on previous studies, to ensure its effect, the application of home-based cognitive training in public services requires an instrument that is able to identify early neurocognitive decline.

One of the cognitive exercises that has taken root in Japanese society is the use of abacus in maintaining the cognitive abilities of the elderly. Abacus is a calculation tool consisting of beads moving on an axis that represents numbers. The beads are manipulated following specific rules to perform calculations, such as addition and subtraction. Some people in Japan in the middle age and elderly recognize it well during previous studies. By computerizing the abacus through the sorotoch program, more adaptively applied to the elderly based on the community, it may be effective and effective in improving cognitive function in middle-aged and older Japanese people. In Japan, an application based on the abacus, Abacus-Based Mental Calculation Education Technology ("SoroTouch"), has been developed as an educational tool for children[10]. The results of the study showed an increase in mental calculation abilities that increased in children who applied it. Based on the results of this study, this application needs to be carried out in the middle age and elderly in order to improve their cognitive mental abilities[11]. The aim of this study was to investigate the effects of home-based computerized cognitive training (CCT) utilizing SoroTouch on the cognitive function of healthy middle-aged and elderly adults and to determine the utility of the CogEvo and MoCA-J measures as early detection tools for cognitive decline.

METHODS

This study is an exploratory secondary data analysis and cross-sectional study. This study has been approved by the Ethics Committee of Showa University (Approval Number 2023-111-B). Data 1 is sourced from secondary data from 10 municipalities in Japan. This data was obtained from Total Brain Care co. Ltd. The data used as respondents have exclusion criteria: 1) age less than 40 years or more than 100 years; 2) performing CogEvo for the second time or later; and 3) performing other than the five basic tasks ("Flashing Lights," "Follow Commands," "Orientation," "Route 99," and "Same Shape"). The data are only CogEvo scores, age and sex with anonymous data. The data collected is based on tasks and it is not known which tasks the participants performed, so the total score of the five basic CogEvo tasks is unknown.

Data 2 is the baseline data from the RCT "Effectiveness of SoroTouch Software Application in Middle-Aged and Elderly People", involving participants aged 42-79 years old who were community-based organized by the Niyokatsu General Association. Both participants were not diagnosed with dementia and came to the service on their own. Neurocognitive function was measured using CogEvo with a standard score of MoCA-J $\leq$ 25, which was measured before and after the intervention using the sorotouch application. In addition, the data obtained were demographic data and clinical conditions. These two instruments were used as a comparison because they had almost similar sensitivity and specificity, namely 66.7% and 63.6%. The participants in this study numbered 20 people.

RESULTS AND DISCUSSION

The study results data are in the form of respondent characteristics data, the relationship of factors that affect neurocognitive status, data status: normality and homogeneity and differences in neurocognitive status based on CogEvo and MoCA-J measurements. The data can be seen according to the following table and image. Based on table 1, the data shows the difference between the treatment and control groups related to neurocognitive status is the habit of drinking alcohol. This is a concern when starting to measure neurocognitive status related to participant demographic data.

Table 1. Respondent Characteristics

Variable	SoroTouch n (%)	Control n (%)	*p*
Age			.639
Old adulthood	4(57.1)	3(42.9)	
Elderly	6(46.2)	7(53.8)	
Sex			1.00
Male	3(50.0)	3(50.0)	
Female	7(50.0)	7(50.0)	
Job			.288
Work	7 (43.7)	9 (56.3)	
No Work	3(75.0)	1 (25.0)	
BMI			.774
Normal	8(53.3)	7(46.7)	
Obesity low weight	0(0.0)	2(100.0)	
Low weight	2(66.7)	1(33.3)	
Education Back Ground			.571
Hight school	1(25.0)	3(75.0)	
Junior college	3(75.0)	1(25.0)	
University	4(44.4)	5(55.6)	
Vocational school	2(66.7)	1(33.3)	
Smoking			.606
Yes	2(40.0)	3 (60.0)	
No	8(53.3)	7(46.7)	
Current alcohol			*.025**
Yes	7(77.8)	2(22.2)	
No	3(27.3)	8(72.7)	
Hypertension			.531
Yes	2(66.7)	1(33.3)	
No	8(47.1)	9(53.9)	
Diabetes Melitus			.606

Yes	3(60.0)	2(40.0)	
No	7(46.7)	8(53.3)	
Depression			1.00
Yes	1(50.0)	1(50.0)	
No	9(50.0)	9(50.0)	
Hearing impairment			.305
Yes	0(0.0)	1(100.0)	
No	10(52.6)	9(47.4)	
Head injury			.305
Yes	1(60.0)	0(40.0)	
No	9(47.4)	10(52.6)	
Exercise			.329
Yes	8(57.1)	6(42.9)	
No	4(66.7)	2(23.3)	
Social contact			.305
Yes	9(47.4)	10(52.6)	
No	1(100.0)	0(0.0)	

*) Sig α<0.05; significance

Table 2. Differences in mean scores before and after intervention and differences in changes between the two groups in MoCA-J and Evo-Cog scores

Variable	Sub variable	Soro touch (mean±SD)	Control (mean±SD)	*Sig α*
CogEvo	Same shape	354.20±106.01	345.70±110.81	.431
	Orientation	371.20±39.21	314.60±68.81	.018*)
	Flashing light	306.00±201.56	291.00±123.05	.422
	Route99	228.30±57.24	256.40±55.66	.140
	Follow the order	243.40±33.09	236.00±43.89	.338
MoCa-J	Visuospatial abilities	4.60±.516	4.60±.516	1.000
	Naming	3.00±.000[a]	3.00±.000[a]	.035*)
	Attention	4.50±1.434	5.60±.516	1.000
	Language	2.10±.738	2.10±.568	.065
	Abstraction on	1.70±.483	2.00±.000	.472
	Delayed recall	3.30±1.636	2.80±1.398	.151
	Orientation	6.00±.000	5.80±.422	.628
	Alternatint trail making	.80±.422	.70±.483	.151
	Visuocontruction skills: cube	.80±.422	1.00±.000	.331
	Visuocontruction skills: clock	3.00±.000	2.90±.316	.556
	Digit span	1.80±.422	1.90±.316	.033
	Seral sevens	1.80±1.135	2.70±.483	.556
	Verbal fluency	.90±.316	.80±.422	.764
	Sentence repetition	1.20±.789	1.30±.675	1.000

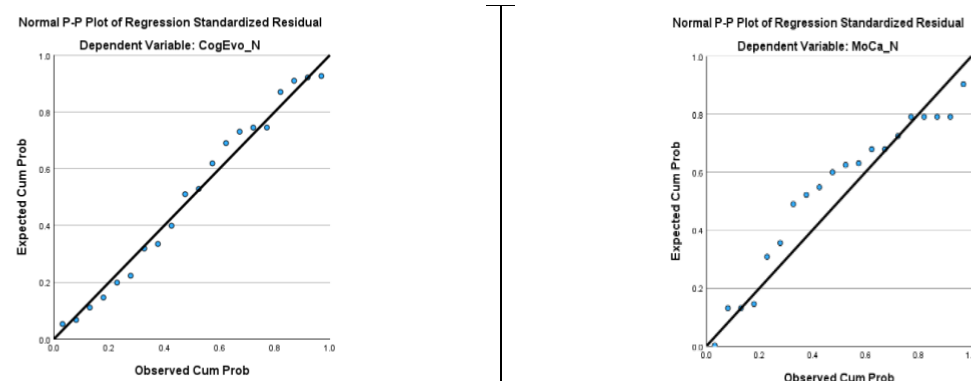
*)Sig α<0.05; significance

The difference in mean and standard deviation of neurocognitive values in healthy middle-aged and elderly before intervention using MoCA-J and EvoCog instruments, shows that each sub-variable has similarities in terms of the aspects measured. These data indicate that the aspects measured before the intervention describe the similarities in each variable in the treatment and control groups. Except for the orientation aspect in the CogEvo measurement and naming in the MoCA-J. This may be related to differences in age and activity.

Table 3. Determinants detecting early neurocognitive decline in healthy middle-aged and elderly in Japan

Variable	EcoCog (*rho;sig α<0.05)*				
	Same shape	Orientation	Flashing light	Route 99	Follow on the order
Age (years)	-.322 (.166)	-.588 (.006)*	-.689 (<,001)**	-.386(.092)	-.230 (.330)
Sex	-.230 (.329)	-.004(.987)	-.370(.108)	-.313(.179)	-.099(.677)
BMI	-.082(.730)	.494(.027)*	.175.460	-.155(.515)	.168(.478)
Education background	-.282(.229)	-.118(.621)	-.146(.538)	-.372(.107)	-.103(.667)
Exercise	.205(.385)	.417(.068)	.662(.001)**	.322(.166)	.343(.139)
Smoking	-.098(.682)	.119(.617)	.139(.559)	.157(.508)	-.171(.472)
Current alcohol	-.381(.098)	.109(.647)	-.175(.461)	.135(.570)	-.078(.745)
Hypertention	-.432(.057)	.173(.466)	.201(.394)	-.005(.985)	-.128(.591)
Diabetic mellitus	.107(.653)	.105(.659)	.283(.227)	.222(.347)	.321(.168)
Hearing injuries	-.177(.455)	.151(.524)	-.165(.488)	-.035(.883)	-.091(.704)
Depression	-.128(.591)	-.104(.663)	-.170(.474)	.336(.147)	.199(.401)
Social contact	-.163(.492)	.051(.830)	.179(.451)	-.133(.577)	-.186(.432)

The results of the CogEvo assignment showed that orientation was related to the age and nutritional status (BMI) of the participants, while flashing light was related to age and exercise. The ability of participants to carry out the assignment in CogEvo showed the identification of potential neurocognitive decline. Attention is needed, especially on age, nutritional status and exercise, to be targeted as a basis for maintaining optimal neurocognitive status.



Kormogorov-Smirnov test: .121; *Sig α*=.200*)	Kormogorov-Smirnov test: .139; *Sig α*=.200*)

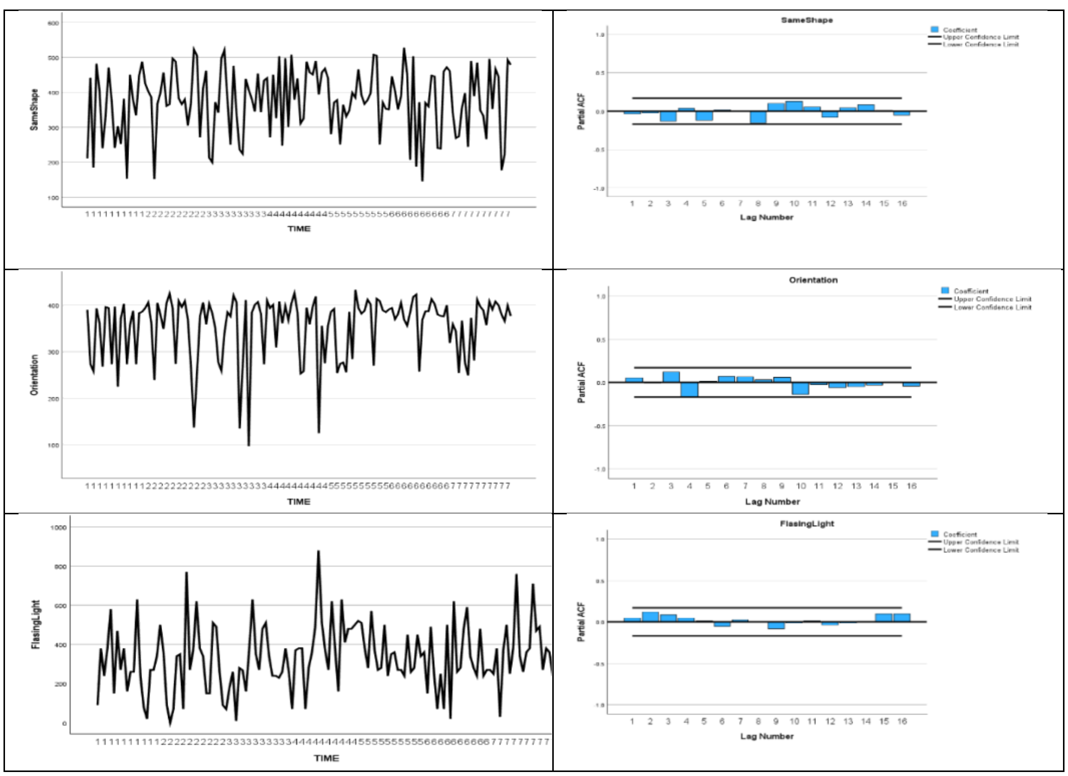
Figure 1. Data Normality

Data status needs to be determined before conducting the analysis. The author conducted a normality test and a homogeneity test on the characteristics of the two groups. The results of the analysis showed that the data had a normal distribution (table 3) and were homogeneous (table 4).

Table 4. Data Homogeneity

Variable	Group	Mean±SD	F	Sigα
CogEvo				
Pre	Intervention	1459.50±298.49	.688	.418**)
	Control	1487.30±347.29		
Post	Intervention	1700.60±269.13	1.190	.290**)
	Control	1583.90±345.01		

The data from this analysis shows that the variants in both groups are similar (homogeneous), so that both groups have never been intervened and have not been measured using both instruments. Based on the characteristics of the existing data, it can be continued to conduct parametric analysis. Furthermore, it can be analyzed using a difference test. To ensure that the intervention carried out follows the standard of change, the researcher tested with a time series to ensure that the intervention carried out has consistency during the measurement period.



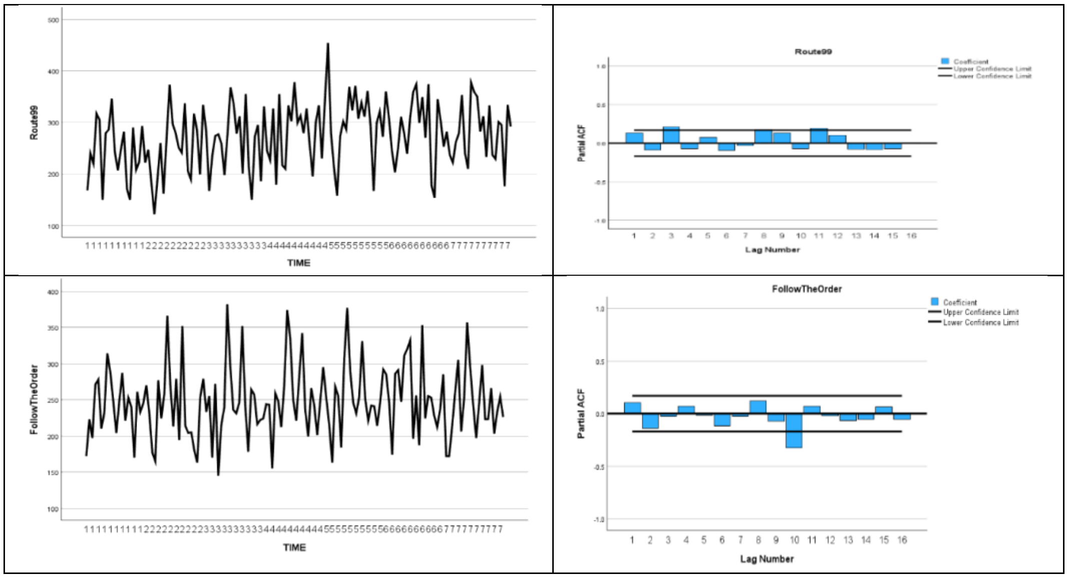


Figure 2. EvoCog Neurocognitive Consistency before and after Intervention in Treatment and Control Groups

The interventions implemented 7 times for 6 months showed that the interventions had undeniable accuracy. The developments assessed from the CogEvo sub-variables showed consistency in each intervention that had been implemented. Thus, the standard quality of the intervention in each stage can be estimated according to the provisions and requirements that have been set. The results of the study can be seen in Figure 2.

Table 5. Differences Early Neurocognitive before and after SoroTouch Intervention Decline in Healthy Middle-aged and Elderly People in Japan

Variablel	Mean±SD	T	Sigα	95% Confidence Interval	
				Lower	Upper
Pre-Post CogEvo	-168.850 ± 238.881	-3.161	.005*)	-280.650	-57.050
Pre-Post MoCA-J	-1.950 ± 2.064	-4.225	<,001	-2.916	-.984

There are neurocognitive changes in the CogEvo instrument before and after intervention using the soro touch application. Neurocognitive results of measurements using CogEvo are more visible than those of MoCA-J. Thus, the use of CogEvo is better for early detection of neurocognitive decline in healthy middle-aged and elderly people in Japan.

The results of the study showed that exercise was able to differentiate the flasing light examination. This examination, spurs the elderly to concentrate in following the movement of the lights shown in the application. Elderly without cognitive disorders who often do physical activities help improve cardiorespiratory fitness which helps improve cognitive performance and provides thickness in the cerebral cortex area[12]. In addition to improving cardiorespiratory, regular physical activity can also improve memory performance and executive brain function as desired by strengthening regular physical activity[13]; [14]. In addition, physical exercise, especially cognitive-based, especially time-based and verbal response will improve the neurocognitive function of the elderly with cognitive disorders. Thus, physical and cognitive exercise can improve the neurocognitive abilities of the elderly, especially in activities that require concentration[15].

The results of the study also showed a relationship between age and orientation and flasing light abilities. Increasing age will affect memory, attention and speed of information processing and executive function[16]. Cognitive exercise helps them maintain a healthy and optimal neurocognitive status according to age[17]. Trained cognition improves neurocognition in preventing dementia and encouraging good social interactions that can build mood[18]. Healthy cognition will build good communication in maintaining social interactions[19]. Resilience in social interactions improves cognitive abilities in older adults[20].

Elderly age affects cognitive function, this is related to increasing age decreasing cognitive function such as concentration and attention[21]. Increasing age, cognitive ability decreases according to the increasing age of the elderly[22]. This is an important concern in considering the results of the intervention. Cognitive training with peers in the community encourages communication and interaction with peers[23].

This study provides strong support for efforts to improve cognitive ability in achieving mental health levels, especially in managing emotions and cognitive function[24]. The duration of cognitive needs to be considered, because the length of intervention will help improve neurocognitive especially in the elderly with mild dementia[25] and prevent the risk of depression and the combination of cognitive stimulation with acetylcholinesterase inhibitors is more effective in reducing depressed mood in people with dementia without severe depression than some antidepressants[26]; [27].

Cognitive stimulation by utilizing daily activities to make it easier for healthy elderly to maintain mental health[28]. Cognitive stimulation helps the elderly to increase self-efficacy in building optimism in maintaining mental status. The growing efficacy of cognitive stimulation in dementia patients, fosters effective communication with peers[29] and encourages mutual understanding with caregivers[30]. Thus, cognitive stimulation also maintains executive function.

The results of the study showed that stimulation using the SoroTouch application had significant neurocognitive differences in middle age and elderly. Both neurocognitive difference values were measured using CogEvo and MoCA-J which showed differences in measurement results. The measurement results using CogEvo were better than MoCA-J, because CogEvo was more sensitive to detecting early neurocognitive decline[31]. This can be explained that CogEvo is a series of easy and potentially useful computer-assisted tests that can be used to evaluate age-related or pathological cognitive decline since middle age and the early assessment stage of cognitive decline[32].

Cognitive stimulation through SoroTouch home-based computerized cognitive training has the potential to improve working memory, attention, and planning in healthy middle-aged and elderly adults[33]. In addition, cognitive intervention will improve cognitive function especially in older elderly[34]. Meanwhile, cognitive training is effective for elderly people without cognitive impairment[35], while for elderly people who have experienced mild cognitive impairment it will be significant for the dementia group[34]; [35].

This application can be implemented in the community by considering the ease of elderly access, easy training and affordable costs. In addition, the continuity of the long-term program and the benefits obtained are considerations for implementing this application[36]. The sustainability of this intervention in maintaining neurocognitive will reduce the risk of dementia early on and can prevent it from getting worse with expensive care costs[37]. Community health care can utilize this application to detect early neurocognitive decline in elderly people who utilize primary services.

CONCLUSIONS

This study can be concluded that age and exercise factors are early predictors of changes in neurocognitive status. CogEvo is the best choice for detecting neurocognitive changes in middle age and old age.

DATA AVAILABILITY

The data set generated and analyzed in this study are available from the Data Dryad repository [34]. Data ini menggunakan lisensi Public Domain CC. *Dryad.* https://doi.org/10.5061/dryad.1ns1rn8zx

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