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PDCA for Dementia Prevention Using Neuropsychological Test CKPT

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Abstract

Background: Dementia is currently a serious illness in Japan, but it is clear that in the future, countries around the world will sequentially face the same problem as Japan. The Lancet Communications proposed risk reduction guideline of cognitive decline and dementia on 2020 and 2024. Anti-Aβ antibody drugs such as Lecanemab and Donanemab has been put to practical use. Research into stimulating the brain's temperament using physical stimuli such as sound and electromagnetic waves to improve cognitive functions is also becoming active, with some reports of practical applications. They shed light on the path of the study on dementia prevention.

Objective: Although many treatments are tried for dementia prevention, the problem is that we don't have economical methods to evaluate the behavior for them. To solve it, I devised a neuropsychological test named CWPT (Color Words Pick-out Test) whose Japanese Version is CKPT (Color Kanji Pick-out Test), and had got evidences and derived the diagnostic criteria using CKPT in Japan.

Method: To achieve the economical evaluation for dementia prevention, a concept using PDCA procedure is proposed. CKPT is positioned as the key technology on Check step of the circle.

Results: A prospective cohort study started since 2022. In Check step of PDCA, not only CKPT but also a lifestyle check form which was created based on the risk factors for dementia recommended by WHO have been applied to people. And both of them are utilized in Action step of the circle.

Conclusion: As CKPT is easily translated to other language, we are looking partners who want to try it in their countries. English version of CKPT is prepared for practice.

Keywords: CWPT; CKPT; Neuropsychological test; PCSD; MCI; Demetia prevention

Introduction

Dementia is a progressive disease that is known to progress to Healthy, PCSD (Preclinical Stage of Dementia), MCI (Mild Cognitive Impairment) and Dementia) [1]. Initially, as research on Dementia,

research on diagnoses methods such as PET [2] imaging and CSF [3] as biomarkers and therapeutic agents such as Donepezil [4] were active after falling into Dementia. Recently, the stage of research on Dementia shifted to Healthy, PCSD and MCI because WHO has suggested" Risk reduction of cognitive decline and dementia" since 2019 [5] and disease-modifying therapies for Amyloidβ [6] such as Lecanemab and Donanemab have been put into practical use. The CKPT used in this study is Japanese version of a neuropsychological test CWPT (Color Words Pick-out Test) [7-11], which was devised for the purpose of detecting a slight cognitive decline in the stage of Healthy, PCSD, and MCI. It is a test for which evidence has been obtained [12] and diagnostic criteria have been established [13].

Background around Dementia

Using **Figure 1 [14].** I will explain the Background around Dementia. The total world population was about 7 billion in 2015, but is expected to exceed 10 billion in 2060. The population of people over 65 is also expected to rapidly increase from 608 million to about 1.8 billion. This clearly indicates that the number of dementia patients is rapidly increasing because the biggest risk factor is the aging. This is one of the major problems facing humanity that needs to be solved. I would like to add another comment using the population over 65. In recent years, there has not been a big difference between the populations of developed and developing Regions, but the population of developing Regions is predicted to increase dramatically towards 2060. This means that dementia issues in developing countries will become an international issue. Next, let's look at the percentage of the population over 65. As aging is the biggest risk factor for dementia, so from this perspective, we can see that even in 2060, the risk of dementia will be still higher in developed countries than in developing countries.

	1950 year	In 2015	2060 *Median projection
Total Population	2,536 Million	7,380 Million	10,152 Million
Population over 65 years old			
Total	129 Million	608 Million	1,810 Million
Developed Regions	63 Million	221 Million	357 Million
Developing Regions	66 Million	387 Million	1,453 Million
Percentage of population over 65 years old			
Total	5.1 %	8.2 %	17.8 %
Developed Regions	7.7 %	17.6 %	28.2 %
Developing Regions	3.8 %	6.3 %	16.4 %
Life Expectancy			
Male	45.49 years	68.53 years	76.29 years
Female	48.49 years	73.31 years	80.64 years
Developed regions include Europe, Northern America, Japan, Australia, and New Zealand. Developing regions include Africa, Asia (excluding Japan), Latin America, Melanesia, Micronesia and Polynesia.			

Figure 1: Background around Dementia.

Next, let's look at **Figure 2 [14]** which show the trends in presentation of population over 65 in each country. The graph on the left shows the trends in Europe and USA, with Japan's trends shown for reference. Japan's high rate stands out. The graph on the right shows the trends in Asian countries. Notable are the rapid changes in China, Singapore, South Korea, and Thailand. South Korea in particular is predicted to overtake Japan and becomes the world's largest aging country, by 2050.

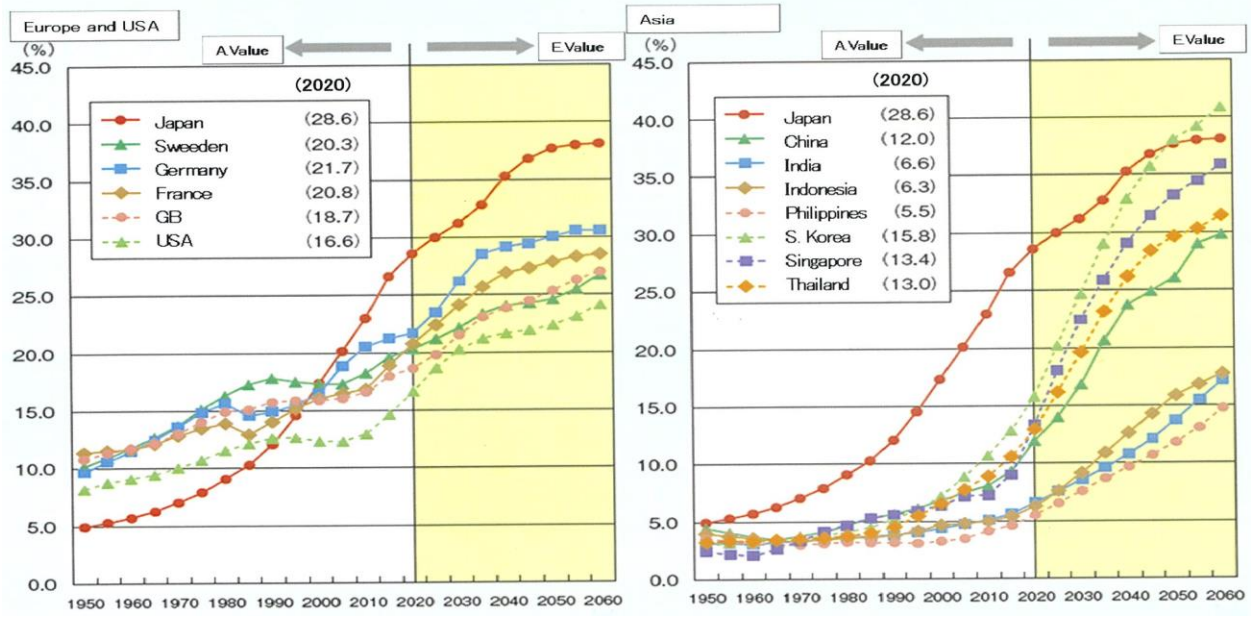

Figure 2: Changes in the world's aging rate.

Progression of Dementia and the Target of this Study

After we could detect the deposition of the causative agent of dementia in vivo using PET with tracers on Alzheimer's disease, the progression of dementia is defined clearly **(Figure 3)**. Dementia progresses from Healthy to PCSD, MCI and Dementia. At Healthy and PCSD, there are no symptoms, and symptoms only appear when the causative agents are deposited to a point of near saturation during 15-20 years. The border between MCI and Dementia is when cognitive impairment progresses to the point where it interferes with daily life and the condition is called dementia.

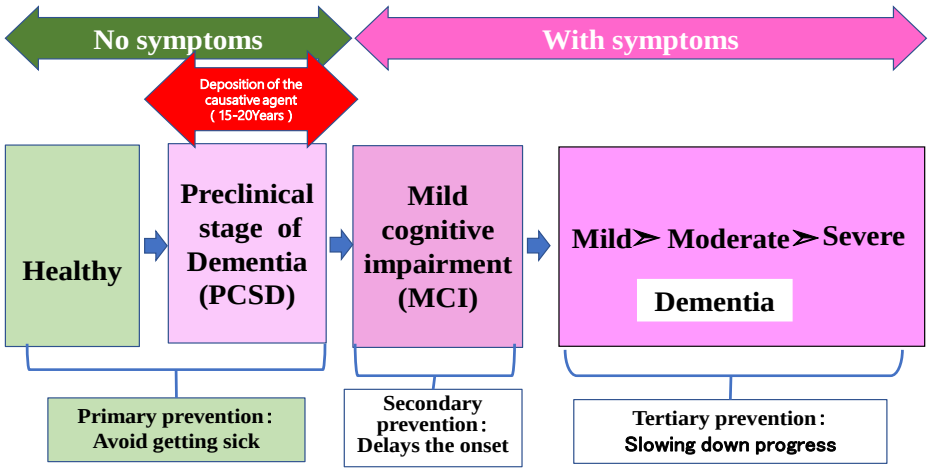

Figure 3: Progression of Dementia and Its Prevention.

There are three types of prevention, primary prevention to avoid getting sick, secondary prevention to delay the onset, Tertiary prevention to slow down progress, in dementia care, and the target of this paper is healthy people and those in PCSD, which is strictly speaking called primary prevention, but when we talk about prevention in this paper, we are referring to primary prevention.

Methods

PDCA for Dementia prevention

We propose basic steps for preventing dementia using the Deming Circle [15] method (Plan, Do, Check and Action: PDCA) which is showed in **Figure 4**. As for the initial, participants who would like to avoid falling in dementia will undergo a check to understand the state of their cognitive function and then learning how to prevent dementia. After that, they will be asked to live a dementia prevention lifestyle in accordance with this Deming Circle once a year.

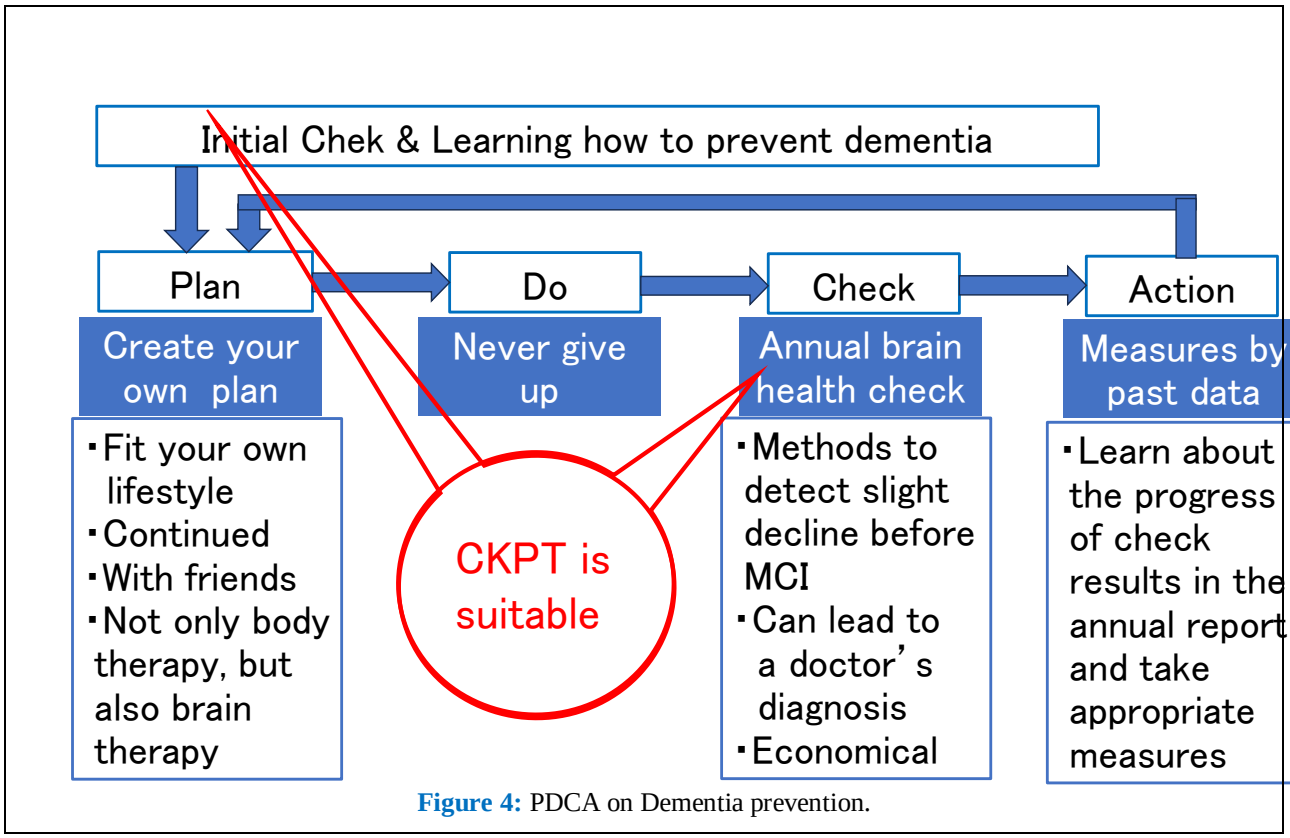

Figure 4: PDCA on Dementia prevention.

On Plan step, the most important points to pay attention is to create their own plan, where the plan is required to fit their own lifestyle, be continued plans, be done with friends, include not only body therapy, but also brain therapy. On Do step, you never give up to practice the therapy. On Check step, annual brain health check is appropriate, where a method to detect slight decline before MCI is required. The method can lead to a doctor's diagnosis and also should be an economical one. CKPT is quite suitable for these conditions. On Action step, measures using past data is the important operation, where they should learn about the progress of check results in the annual report and take appropriate measures.

Key Technology on PDCA

Many trials are challenged for dementia prevention on the therapy stage in the world. However, it is difficult to confirm their effects scientifically and economically, because expensive instruments such as PET and MRI or inversive methods such as CFS can be available now. Using **Figure 5a,b and 6**. Outline of a neuropsychological test CKPT is introduced below.

Natsuko grabbed her small pink bag and went to the sea to swim. Beyond the brown hills ,there was a long, gray sandy beach, where red, blue, and green parasols were lined up like flowers.

Figure 5a: CKPT example (Story).

Enclose the answer that you think is correct in circles.

(1) What color was Natsuko‘s back?

(red, pink, green, forgot)

(2) What did Natsuko go to do?

(Shopping, swimming, sightseeing, forgot)

Actual problem: Number of color characters is 25 and Number of questions is 12
INDEX1 (Score): Number of correct answers in Story
× Percentage of correct answers in Questions
Test time (in Story): 2 minutes

Figure 5b: CKPT example (Questions).

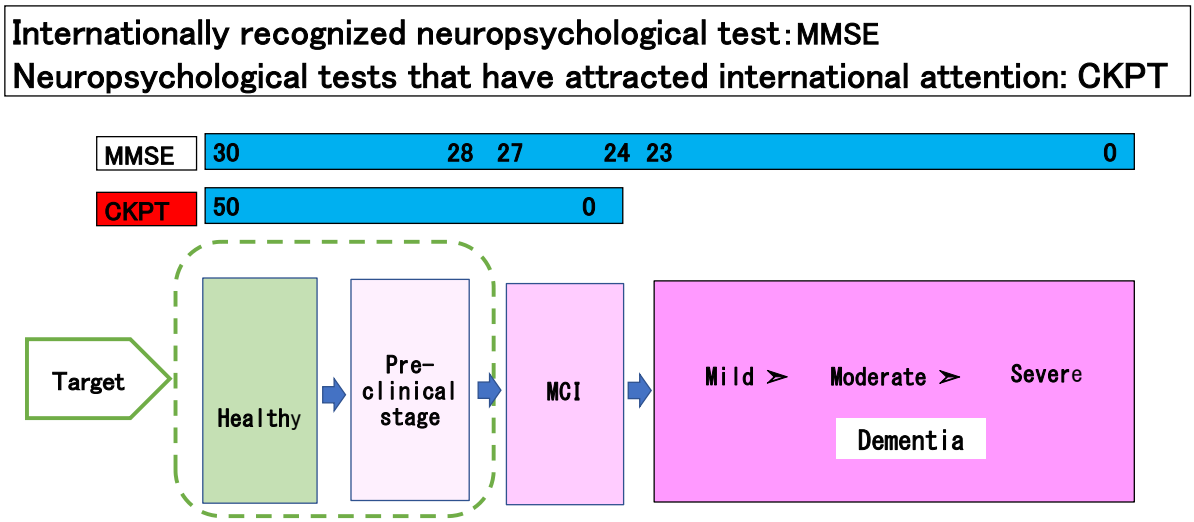

Figure 6: Neuropsychological tests used in brain examinations.

The story in **Figure 5** is the example and is a translation of the Japanese story. As the subjects read the story, when they come across a color word that describes a color, they must judge whether the meaning of the color word matches the printed color or not, marking it with a circle if it matches, or a cross if it does not match. This judging method is an application of Stroop Effect **[16]**. After judging color words, subjects must answer the questions without seeing the story. The questions in **Figure 5b** is also the example. "pink" and "swimming" are correct answers in this case. Actual story has 25 color words and questions are 12. The score is called INDEX1 and is calculated by multiplying the number of correct answers in Story and the rate at which subjects answered the questions correctly.

In **Figure 6**, comparison between MMSE **[17]** which is the most well-known neuropsychological test internationally and CKPT is showed. MMSE is a test that can be applied to everyone from healthy to severe dementia and the scores are from 30 point to zero point. As there are only three points (30, 29, and 28) in healthy and preclinical stages, it is not suitable for making a slight classification of cognitive function. In contrast, the CKPT can theoretically classify subjects into 50 point categories between normal and MCI, making it possible to observe more detailed changes.

Figure 7 explains the difference between MMSE and CKPT in more detail. Here are histograms of the two tests when applied to healthy and preclinical subjects. MMSE's distribution shown on the right is biased towards high scores, makes classification difficult, but CKPT's one shows a normal distribution, so classification is easy using the mean and standard deviation. **Table1** shows distribution parameters of CKPT obtained by 1367 subjects and diagnoses is down using these criteria.

Table 1: Distribution parameter of CKPT using 1367 subjects.

Male	Average - 1.5SD	Average - SD	Average	Average + SD	Average + 1.5SD
Sixties	5.1	7.3	11.7	16.1	18.3
Seventies	5.1	7	10.7	14.4	16.2
Eighties	3	4.9	8.6	12.3	14.2
Female	Average - 1.5SD	Average - SD	Average	Average + SD	Average + 1.5SD
Sixties	5.9	7.9	11.9	15.9	17.9
Seventies	4.6	6.6	10.6	14.6	16.5
Eighties	2.3	4.5	8.8	13.1	15.3

Average-1.5SD or less: 0.067, Average-SD or less: 0.159

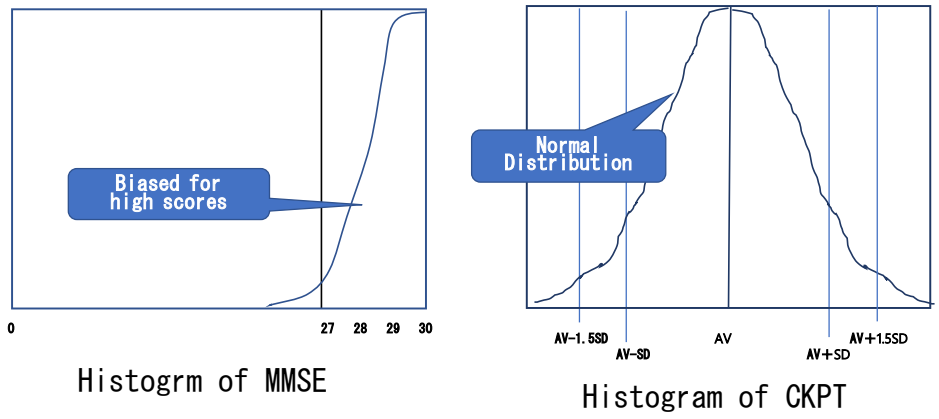

Figure 7: Histogram comparison of MMSE and CKPT applied to healthy and preclinical subjects.

Results

Ideal dementia prevention circle

Initiation of a prospective cohort study started since 2022. **Figure 8** shows an ideal dementia prevention circle, where the outer dark blue circle represents brain function therapy and the inner circle represents physical therapy. We believe that by implementing both of these circles, we can achieve ideal dementia prevention, but in reality, people who need physical therapy are different from people who want brain therapy. Therefore, brain therapy and physical therapy are achieved independently. In the future, the ideal circle will become common when the social

education about dementia prevention methods completed among people.

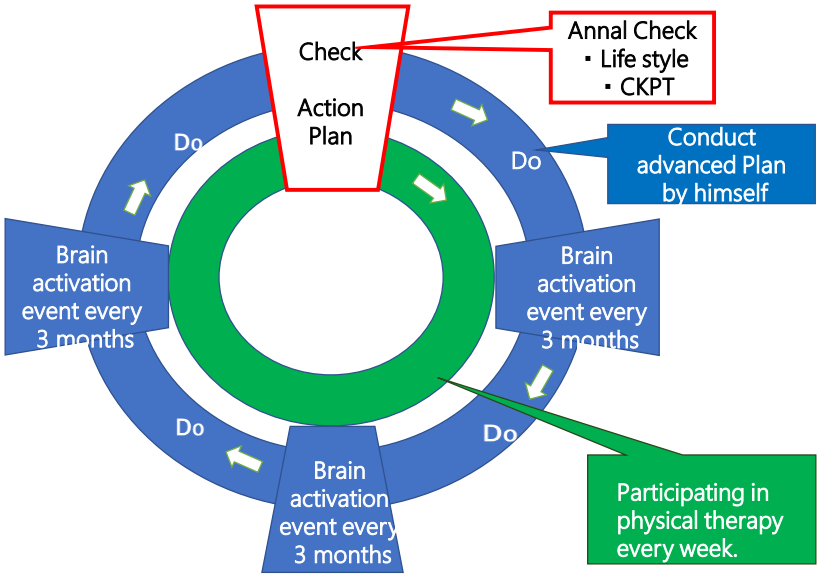

Figure 8: Ideal dementia prevention circle.

PDCA for brain therapy

We have started a PDCA cycle for dementia prevention using CKPT and lifestyle checks which is shown as a dark blue circle in **Figure 8** from 2022. Lifestyle check form was created based on the risk factors for dementia recommended by the WHO. After Check results are feed backed to the subject through an annual report **(Figure 9)**, it is hoped that he will take the ACTION to reflect on his past lifestyle, create a new lifestyle PLAN for the next year, and then execute the DO to step into the next year.

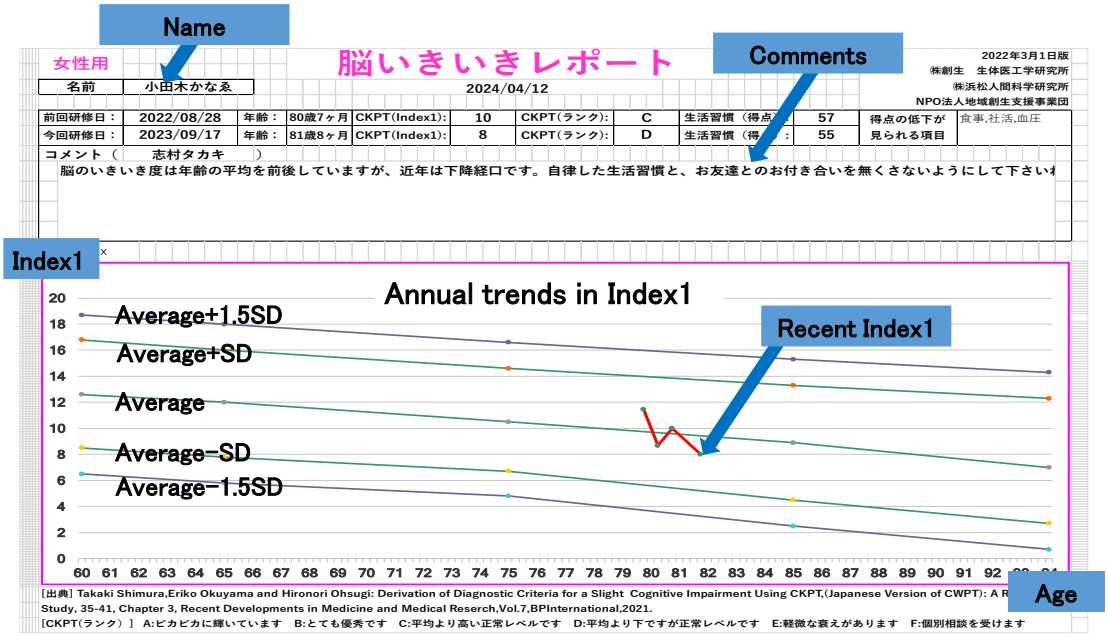

Figure 9: Sample of annual report for dementia prevention.

Summery

The neuropsychological test CKPT, which can detect slight cognitive decline before the onset of dementia, has been completed, and this paper proposed a PDCA to achieve dementia prevention using it. Furthermore, the contents of an actual prospective cohort study that was initiated based on this were introduced. The universal name of CKPT has been designated as CWPT (Color Words Pick-out Test), and an English version has also been created18). Since the English version can be easily translated into the languages of various countries, we would be happy to provide it to researchers who wish to use it for research purposes.

Acknowledgments

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