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## Weaving Activity and High Plasma Levels of Brain-Derived Neurotrophic Factor (BDNF) as a Protective Factors Against Cognitive Dysfunction in Middle-Aged Women

Ruth Sharon Yuniarni\*, I Putu Eka Widyadharma, Indira Vidiari Juhanna, I Made Winarsa Ruma, Ni Nyoman Ayu Dewi, Ni Luh Gede Yoni Komalasari

Universitas Udayana, Indonesia

Emails: [ruthsharonunud@gmail.com](mailto:ruthsharonunud@gmail.com)\*

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### Abstract

*Cognitive dysfunction is a common problem associated with ageing and affects quality of life. As a repetitive activity, weaving and brain-derived neurotrophic factor (BDNF) levels are believed to be essential in maintaining cognitive function. This study aims to prove the relationship between weaving activity, BDNF levels, and cognitive dysfunction. This study is an observational study with a case-control design. The study subjects were middle-aged women (45–59 years) divided into two groups: CD (cases) and non-CD (controls). CD status was determined using the Mini-Mental State Examination (MMSE) score. Weaving activity was assessed through a questionnaire, with the criterion for active weaving being at least 3–5 times per week (minimum 60 minutes per session), categorised as weaving (+) and non-weaving (–). Plasma BDNF levels were measured using an ELISA kit and categorised as high BDNF (+) and low BDNF (–) based on the mean value. The researchers performed statistical analysis using the Chi-Square test and logistic regression. The Chi-Square test showed a significant association between weaving activity as a protective factor against CD occurrence ( $p < 0.001$ ; OR: 0.038) and high BDNF levels as a protective factor against CD occurrence ( $p < 0.001$ ; OR: 0.013). Multivariate analysis using logistic regression indicated that weaving activity ( $p = 0.001$ ; AOR: 0.028; CI: 0.003–0.247) and high BDNF levels ( $p < 0.001$ ; AOR: 0.011; CI: 0.001–0.100) were independent protective factors against CD occurrence. This study indicates that weaving activity and high plasma BDNF levels are independent protective factors against CD.*

**Keywords:** Brain-Derived Neurotrophic Factor, BDNF, Cognitive Dysfunction, repetitive physical activity, middle-aged women

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Corresponding: Ruth Sharon Yuniarni

E-mail: [ruthsharonunud@gmail.com](mailto:ruthsharonunud@gmail.com)\*



## INTRODUCTION

Aging is a biological process that occurs in everyone as they get older, characterized by a decrease in cell count and an increased risk of degenerative diseases. The middle age group (45-59 years) begins to experience problems such as forgetfulness, which is a symptom of cognitive dysfunction (CD). This disorder is very common and can affect the quality of daily life. Research shows that repetitive physical activity can be a protective factor against cognitive dysfunction through the neuroplasticity mechanism, which also increases levels of *brain-derived neurotrophic factor* (BDNF). This protein is important for maintaining brain structure and function.

Indonesia faces the challenge of an ever-increasing elderly population, so special attention is needed to ensure that the elderly not only live long lives but also live productive

and happy lives. According to projections, the number of older adults in Indonesia is expected to continue to increase until 2035, reaching around 48.19 million (Akbar & Dainy, 2023). This emphasizes the importance of strategies to maintain health and cognitive function in old age. Impaired cognitive function, such as forgetfulness, often occurs in old age and has a negative impact on physical, mental, and social health (Laksmidewi, Ayu Putri, 2018a). This condition not only affects individuals but also families and society at large.

Strategies to overcome cognitive dysfunction include high-intensity routine exercise and repetitive activities that can increase BDNF and strengthen neuroplasticity. Activities such as weaving, which involve repetitive movements and coordination between the brain, eyes, and hands, are thought to provide beneficial stimuli for the brain and to be protective factors against cognitive dysfunction. Therefore, good physical activity and social stimulation are very important for maintaining cognitive function in old age. In addition, other factors such as a balanced diet, adequate sleep, and a supportive social environment also play an important role in slowing cognitive decline (Marzola et al., 2023).

In the context of neuroplasticity, repetitive activities such as weaving can strengthen the relationship between presynaptic and postsynaptic neurons, thereby increasing the brain's ability to adapt and cope with change (Laksmidewi, Ayu Putri, 2018b). This shows that by utilizing traditional activities such as weaving, people can develop more effective strategies for maintaining brain health and improving the quality of life in old age. Thus, further research is needed to understand the potential of weaving activities as a protective factor against cognitive dysfunction and to increase public awareness of the importance of physical activity and mental stimulation in maintaining brain health.

## **RESEARCH METHOD**

This observational study used a case-control design and was conducted in Sukarara village, West Lombok, from July to December 2024. The sample size was calculated for unpaired categorical analytical research, resulting in a minimum of 68 participants—34 per group. Respondents were divided into two groups: cases experiencing cognitive dysfunction (CD) and controls without CD.

The inclusion criteria for both groups were women aged 45–59 years who were conscious, cooperative, willing to participate, and signed informed consent. Cases had confirmed CD, while controls did not. Exclusion criteria included a history of severe physical illness such as stroke, diabetes mellitus, brain infection, physical or mental disability, head trauma, and smoking.

Consecutive sampling was used until the sample size was met. Information about potential respondents was obtained from the village head and local weavers to ensure the sample represented the population.

The dependent variable was cognitive dysfunction, while the independent variables were weaving activities and plasma brain-derived neurotrophic factor (BDNF) levels. Confounding variables included age, BMI, education, hypertension, history of stroke, diabetes mellitus, brain infection, smoking, genetic factors, and head trauma.

The research began with coordination with the Sukarara village head to explain the study's purpose and procedures. After ethical clearance, the research team, including medical personnel from FK Udayana laboratory, prepared for the study. Brief counseling was provided to the village head and villagers.

Data collection was conducted at four stations. At the first station, subjects completed informed consent and identity forms, and their blood pressure and BMI were measured. The second station assessed cognitive function using the Mini-Mental State Examination (MMSE). At the third station, weight and height were measured, and blood was drawn for plasma BDNF analysis by ELISA in the laboratory. At the fourth station, subjects received souvenirs as a token of appreciation.

Statistical analysis was performed using SPSS version 20. Descriptive statistics described subject characteristics, with means and standard deviations for numerical data and relative frequencies for categorical data. The Chi-square test compared proportions between groups, with Odds Ratio (OR) to measure relative risk. The Fisher exact test served as an alternative if Chi-square assumptions were not met. Logistic regression analyzed associations between variables and cognitive dysfunction, using adjusted ORs. Results were considered significant at  $p < 0.05$  with a 95% confidence interval.

## RESULTS AND DISCUSSION

### Characteristics of Research Subjects

This study mentions that the cut-off for high or low BDNF levels is determined using the receiving operator curve (ROC) to achieve the highest sensitivity and specificity. The results show that the cut-off for BDNF levels is 2.2445 ng/ml with a sensitivity of 89.2% and specificity of 90%. Determining this cut-off is important for understanding the role of BDNF in cognitive function and how weaving activity affects BDNF levels and cognitive function impairment in middle-aged women.

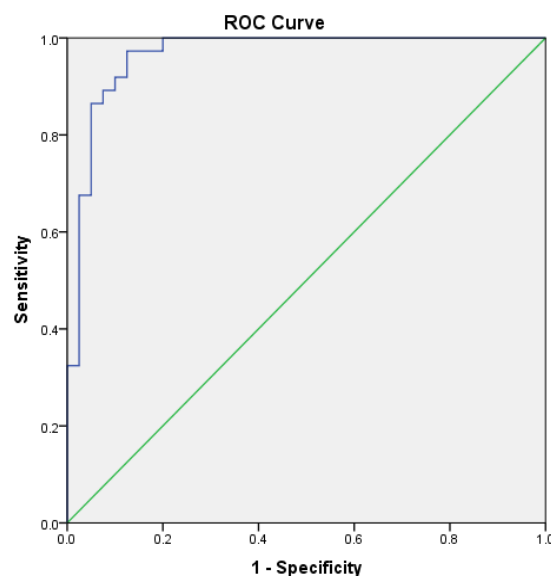


Figure 1. the receiving operator curve (ROC)

### Bivariate Analysis

Bivariate analysis was conducted to determine the relationship between two unpaired categorical variables, namely weaving activity and BDNF levels, and the occurrence of CD.

**Table 1 – Chi-square test Weaving with CD**

Activity Weave	CD		No CD		OR	P	IK95%
	N	%	N	%			
Yes	16	20,8	35	45,5	0,038	<0,01*	0.008-
No	24	31,2	2	2,6			

Description: CD = impaired cognitive function; OR = *odds ratio*; p = significance, p = significance; IK= Trust Index

The Chi-square test results indicate a significant relationship between weaving activity and the occurrence of cognitive dysfunction. Of the total respondents, the proportion of individuals who weave and experience cognitive dysfunction is lower than that of those who do not weave. A p-value of <0,01 and the odds ratio of 0.038 indicate that weaving activity significantly reduces the risk of cognitive dysfunction.

**Table 2 – Chi-square test of BDNF levels with CD**

Categorical BDNF	CD		No CD		OR	P	IK95%
	N	%	N	%			
High	4	5,2	35	42,9	0,013	<0,001*	0.003-
Low	36	46,8	4	5,2			

Keterangan: CD = gangguan fungsi kognitif; OR = *odds ratio*; p = signifkansi, p = signifkansi; ; IK= Indeks Kepercayaan

Chi-square analysis shows that high BDNF levels are significantly associated with a reduced risk of cognitive dysfunction. Most individuals with high BDNF levels did not experience cognitive dysfunction, while the group with low BDNF levels had a higher incidence of the disorder. The p-value of <0,01 and the odds ratio of 0,013 confirm the protective role of high BDNF levels against cognitive dysfunction.

**Table 3 – Chi-Square Test**

	Value	df	Asymptomatic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	20.966 <sup>a</sup>	1	.000		
Continuity Correction <sup>b</sup>	18.816	1	.000		
Likelihood Ratio	23.107	1	.000		
Fisher's Exact Test				.000	.000

Linear-by-Linear Association	20.694	1	.000
N of Valid Cases	77		

<sup>a</sup> 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.49

<sup>b</sup> Computed only for a 2x2 table

Table 3 presents the Chi-square test results to examine the relationship between two variables in a 2x2 table. The Pearson Chi-square value of 20.966 with a degree of freedom (df) of 1 indicates two-tailed asymptotic significance (p) of 0.000, which means the relationship between the variables is highly statistically significant. The continuity correction test yielded a value of 18.816 with p = 0.000, further confirming the significance of the results. Additionally, the likelihood ratio was 23.107 with p = 0.000. Fisher's Exact Test provided significance values 0.000 for two-sided and one-sided tests, confirming that the association found was not due to chance. The Linear-by-Linear Association test also showed a significant value with p = 0.000, indicating a strong linear relationship between the variables. No cells in the table had an expected count less than 5, thus fulfilling the assumptions of the Chi-square test. These results indicate a highly significant relationship between the two variables tested.

### **Multivariate Analysis**

Multivariate logistic regression analysis revealed that weaving activities had a regression coefficient (B) of -3.593 with a significance value (p) of 0.001. The Exp(B) value or odds ratio (OR) of 0.028 (95% CI: 0.003–0.247) indicates that participants who engage in weaving activities have a 97.2% lower risk of experiencing cognitive dysfunction compared to those who do not weave, after controlling for other variables.

The variable of education  $\geq 9$  years was also statistically significant (B = -4.547; p = 0.002) with an OR of 0.011 (95% CI: 0.001–0.176), indicating that longer education contributes as a protective factor against cognitive dysfunction. Meanwhile, the variable “no hypertension (No HT)” was not statistically significant (p = 0.095), although it showed a protective trend (OR = 0.289). The model constant of 57.991 reflects the baseline odds when all independent variables were set to zero.

**Table 4 – Multivariate Analysis of Logistic Regression of Weaving Variables, BDNF Levels, and 9 Years of Education**

Variable	B	P	Exp(B)	95% CI
Weave	-3.593	.001	.028	.003 - .247
9 Years Education	-4.547	.002	.011	.001 - .176
No HT	-1.242	.095	.289	.067 - 1.240
Constant			57.991	

Description: BDNF = brain-derived neurotrophic factor; CI = confidence interval; OR = odds ratio; p = significance; B = regression coefficient; Exp (B) = exponent of B; IK = confidence index

High BDNF level variables showed a regression coefficient (B) of -4.481 with a significance level of  $p < 0.001$ , and an OR of 0.011 (95% CI: 0.001–0.100), indicating that individuals with high BDNF levels have a very low risk, approximately 98.9% lower, of experiencing cognitive dysfunction compared to individuals with low BDNF levels. The variable of 9 years or more of education also plays a significant role with a B value of -3.977,  $p = 0.011$ , and an odds ratio of 0.019 (95% CI: 0.001–0.401), indicating that higher education levels significantly contribute to reducing the risk of cognitive dysfunction. Meanwhile, the non-hypertension variable showed a negative coefficient (B = -2.134) with a p-value of 0.065, approaching significance, and an odds ratio of 0.118 (95% CI: 0.012–1.138), indicating a protective trend against cognitive dysfunction in individuals without hypertension, although this result has not yet reached conventional statistical significance.

**Table 5 – Multivariate Logistic Regression Analysis of BDNF Levels, 9 Years of Education, and No Hypertension**

Variable	B	P	Exp(B)	95% CI
High BDNF	-4.481	<.001	.011	.001 - .100
9 Years Education	-3.977	.011	.019	.001 - .401
No HT	-2.134	.065	.118	.012 - 1.138
Constant			42.304	

Explanation: BDNF = brain-derived neurotrophic factor; CI = confidence interval; OR = odds ratio; p = significance; B = regression coefficient; Exp (B) = exponential of B; IK = confidence index.

### Relationship between Weaving Activity and CD

This study shows a significant association between weaving activity and a decrease in the incidence of cognitive dysfunction (CD) in middle-aged women (45-59 years). Bivariate analysis with the Chi-square test revealed that women who actively weave had a lower risk of experiencing CD than those who did not do the activity, in line with evidence that repetitive activities play an essential role in maintaining healthy cognitive function and protecting against neurodegenerative processes (Sukma, 2019; Fernandes et al., 2020). Repetitive activities such as weaving provide repetitive stimuli that promote neuroplasticity mechanisms, increase the representation of motor work in the brain, and strengthen biochemical pathways that support neuroplastic changes, including increased neurotrophic factors and gene expression, thus providing a protective effect on cognitive function (Pickersgill et al., 2022; Noor & Merijanti, 2020; Amaya, 2007). In addition, repetitive activities are also effective in preventing forgetfulness by strengthening memory through repetition (Wowor et al., 2022). Multivariate analysis showed a direct effect of weaving activity on CD, although it is important to consider confounding factors such as education level and BDNF levels, which also play a protective role (Runesi et al., 2024; Mudjihartini, 2021). Biologically, prolonged weaving activities stimulate

synaptic neuroplasticity through a cascade of molecular events that prevent cognitive dysfunction (Gulyaeva, 2017), while psychosocially, these activities provide satisfaction and a social environment that favours the release of brain neurotransmitters, amplifying the protective effect (Marzola et al., 2023). These findings are consistent with studies showing that repetitive activities involving physical and brain movements can improve cognitive function at the age of 50-60 years (Puspitosari et al., 2025). Therefore, weaving activity can be considered an independent protective factor against impaired cognitive function, with important implications for clinical practice and the development of local culture as a CD prevention effort.

### **Relationship between BDNF levels and CD**

This study shows that higher Brain-Derived Neurotrophic Factor (BDNF) levels protect against cognitive dysfunction (CD) in middle-aged women. Bivariate analysis with chi-square and multivariate logistic regression analysis confirmed the association, in line with the growing evidence that BDNF is a key regulator of cognitive function and protection against neurodegenerative processes (Juhaina, 2019; Wlodarczyk et al., 2021). Glia cells in the central nervous system produce BDNF and play an important role in maintaining aspects of cognitive function, including memory formation and synaptic plasticity, as well as protecting neurons from oxidative damage associated with Alzheimer's disease and other neurodegenerative disorders (Molinari et al., 2020; Mudjihartini, 2021). Clinical studies show that low BDNF levels correlate with decreased functional and cognitive status, such as in post-stroke patients, where physical rehabilitation can increase BDNF levels and improve the condition (Wlodarczyk et al., 2021). BDNF-mediated neuroplasticity mechanisms, including the induction of long-term potentiation (LTP), are the functional basis of its protective influence on cognition. However, this relationship is complex and influenced by factors such as education level, nutritional status, comorbidities, and medications that may modulate BDNF expression (Juhaina, 2019; Mudjihartini, 2021). The clinical implication of these findings is the importance of identifying individuals with low BDNF levels for targeted interventions, both through pharmacological and lifestyle changes that can increase BDNF levels and lower the risk of impaired cognitive function, as well as encourage repetitive activities that involve cognitive function as a preventive effort in the community (Runesi et al., 2024; Marzola et al., 2023).

### **Relationship of Confounding Variables with CD**

This study found that 9 years of education had a significant effect as a protective factor against the incidence of cognitive dysfunction (CD) in middle-aged women. Chi-square analysis showed that subjects with 9 years of education had a lower risk of developing CD, and logistic regression analysis confirmed education as an independent protective factor. This finding aligns with previous research showing that higher education levels correlate with better cognitive function, while the elderly without formal education tend to experience cognitive dysfunction (Sukma, 2019). Other studies also indicate that an environment with complex

stimuli, including adequate education, improves brain ability, as in rats that received higher stimulation, which had better acetylcholine levels (Ar & Hasan, 2020).

Meanwhile, the variables of not being obese and not being hypertensive in this study did not significantly affect the incidence of CD. Although obesity is known to reduce cognitive function through disturbances in the blood-brain barrier and white matter atrophy (Widyaningrum, 2024), this effect may be more dominant at a young age, while in the elderly, other factors such as lack of stimulation, comorbidities, and drugs play a role. The obesity sample in this study was relatively small (<20%), so further studies with larger samples are needed to explore this relationship. Similarly, normotension showed no significant association with CD, possibly due to the multifactorial nature of cognitive dysfunction and the more dominant influence of other variables such as weaving activity, BDNF levels, and education (Pandean & Surachmanto, 2016). These findings remind us that normotensive factors are considered one of the many factors that influence cognitive function without over-interpreting them in clinical practice and public health.

## CONCLUSION

Based on the findings of this study, it can be concluded that weaving activity serves as a significant protective factor against cognitive dysfunction in middle-aged women, primarily through its positive association with elevated brain-derived neurotrophic factor (BDNF) levels. The results demonstrate that women who engage in repetitive activities such as weaving not only have a markedly lower risk of cognitive impairment but also exhibit higher BDNF levels, which are independently associated with reduced odds of cognitive dysfunction. Additionally, higher educational attainment further contributes to this protective effect. These findings highlight the importance of promoting culturally relevant physical and mental activities, such as weaving, alongside education and other lifestyle modifications, as part of comprehensive strategies to maintain cognitive health and quality of life in aging populations. Further research is warranted to explore the broader applicability of these interventions and to strengthen public health initiatives aimed at preventing cognitive decline in older adults.

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