The Relationship between Nutritional Status, Mid-Upper Arm Circumference (MUAC), and Anemia on Working Memory Capacity in Adolescent Girls

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Keywords: Working Memory, Nutritional Status, Anemia.

Abstract: One of the causes of students' difficulty in remembering is due to low working memory capacity. Working memory is a cognitive process that has the main function of facilitating and increasing the capacity of encoding, storage, and search functions that are important for learning at the information processing level. This study aims to analyze the relationship between nutritional status, MUAC (Mid-Upper Arm Circumference), and anemia on working memory capacity in adolescent girls. The research design was cross-sectional, conducted on students girls of Adila College of Health Sciences in July 2024. The sample used total sampling following the inclusion and exclusion criteria provisions. The sample consisted of 35 students. Data collection on characteristics used a questionnaire that the respondents themselves filled in. Nutritional status data was collected using anthropometric measurements and determined based on BMI (Body Mass Index). MUAC (Mid-Upper Arm Circumference) data was measured to determine the risk of CED (Chronic Energy Deficiency). Anemia data was obtained through hemoglobin level measurements. Working memory data was collected using digit span test measurements. Data was analyzed using the Gamma correlation test. The results stated that there was a relationship (p<0,05) between nutritional status and anemia on working memory capacity, while MUAC had no relationship with working memory capacity. In conclusion, nutritional status and anemia are related to working memory capacity.

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1 INTRODUCTION

One of the causes of students' difficulty in remembering is due to low working memory capacity. Working memory is a cognitive process that has the main function of facilitating and increasing the capacity of coding, storage, and search functions that are important for learning at the information processing level (Kuswana, 2011). Working memory is related to various cognitive processes during school learning, from reasoning tasks for verbal comprehension to mathematical abilities (Alloway & Capello, 2013). Working memory capacity is a limited capacity system that stores and manipulates information temporarily and plays a very important role in the student learning process, such as thinking, reasoning, remembering, and solving problems in counting, language, and reading comprehension activities (Santrock, 2011; Bailey et al, 2008); following instructions, concentrating (focusing) and completing academic tasks (Cockcroft, 2015); and a complex construct in the process of storing verbal, spatial, visual information (Baddeley, 2003).

Working memory capacity is a cognitive aspect that can affect student learning achievement. One of the factors causing children's difficulties in remembering, calculating, and reading is the low capacity to remember temporary information in working memory. (Alloway, T.P., & Alloway, R.G., 2010). The size of the working memory capacity affects the ability to learn learning materials and the ability to work on questions (Alloway, T.P. & Elsworth, M., 2012).

Several studies have shown a relationship between working memory and student learning achievement. Haydar's (2013) research showed a positive relationship between working memory and student learning achievement at SDN Kleco I Surakarta (r = 0.442; p = 0.008) (Haydar, 2013). Another study by Puspitasari (2018) showed a significant positive relationship between working memory and mathematics learning achievement (p < 0.05) (Puspitasari, 2018).

Several factors that influence students' working memory include internal factors, namely interest, motivation, gender, and age, as well as external factors, namely physical activity and sports, stress, environment, and nutrition. As part of cognition, working memory is greatly influenced by nutrition (Burhaein E. 2017; Bryan, J. et al, 2004]. Several aspects that can affect working memory and want to be studied in this study are nutritional status, upper arm circumference (LLA), and anemia.

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2nd International Conference on Medical Science and Health (ICOMESH 2024), pages 66-69.

Nutritional status affects students' working memory. In Indonesia, the nutritional status of children aged 5-18 years is assessed using anthropometric standards with the BMI/U (Body Mass Index by Age) indicator (Ministry of Health of the Republic of Indonesia, 2020). The relationship between nutritional status and short-term memory (including working memory) has been studied by previous researchers, namely Winarsih (2021) where the study showed that there was a relationship between nutritional status and short-term memory with a p value of 0.004. In this study, short-term memory was measured using a digit span test which is also a measuring tool to measure working memory. Children with good nutritional status will have normal short-term memory (working memory). Conversely, poor nutritional status causes poor short-term memory or working memory (Winarsih, 2021). Nutritional status is a reflection of a person's intake balance where if a person's nutritional intake is good, the person's nutritional status will be good (Par'i, H.M, 2017). If a person's nutritional status is good, the body's cells, especially the brain, have enough energy to process metabolism and organ function properly. This affects the process of information flow in the brain, thus affecting brain performance including a person's cognitive abilities and working memory (Bogale, A, et a. 2011).

Blood hemoglobin levels have a positive relationship with working memory. The relationship between hemoglobin (Hb) levels and working memory has been studied by previous researchers, namely Nadira (2023) where there was a relationship between Hb levels and working memory in SMA Negeri 1 Samudera students with a p value of 0.000. Most students who have high and normal Hb levels will have good working memory. Conversely, if students have low Hb levels, then working memory will be lacking. Low memory ability in anemia patients can be caused by low iron levels in certain parts of the brain. Low iron levels in the brain can alter neurotransmitter function and slow down the myelination process that plays a role in cognitive, socioemotional, and motor functions. In addition, low Hb levels (anemia) cause the oxygen transported by Hb to also be reduced from normal conditions. Limited oxygen to the brain will affect students' thinking processes so that memory will decrease (Nadira, C.S et al, 2023; Astina J, 2012).

2 METHOD

The research design was cross-sectional, conducted on students girls of Adila College of Health Sciences in July 2024. The sample used total sampling. The sample consisted of 35 students. Nutritional status was collected by using anthropometric measurements and determined based on BMI (Body Mass Index). MUAC (Mid-Upper Arm Circumference) was measured to determine the risk of CED (Chronic Energy Deficiency). Anemia was obtained through hemoglobin level measurements. Working memory capacity was collected by using digit span test measurements. Data was analyzed using the Gamma correlation test.

3 RESULT

Distribution of Nutritional Status, MUAC, Anemia Status, and Working Memory Capacity

Tabel 1: Research Variables

Variables	n	%
Nutritional Status		
Thinness	8	22,9
Normal	25	71,4
Overweight	2	5,7
MUAC (Mid-Upper Arm Circumference)		
Risk of Chronic Energy Deficiency (CED)	6	17,1
No Risk of Chronic Energy Deficiency (CED	29	82,9
Anemia Status		
Anemia	7	20,0
Normal	28	80,0
Working Memory Capacity		
Very Less	0	0
Less	0	0
Average	29	82,9
Good	6	17,1
Very Good	0	0

Most respondents' nutritional status were normal, but there were respondents who had thinness body (8 persons) and overweight (2 persons). Most of respondents had no risk of CED (Chronic Energy Deficiency), but there were 6 persons of respondents who had risk of CED. There were 7 persons of respondents who had anemia. Working memory capacity were dominated by the average score. There were only 6 respondents who had good score.

Relationship of Nutritional Status, MUAC, and Anemia Status to Working Memory Capacity

Table 2: Relationship of Nutritional Status, MUAC, and Anemia to Working Memory Capacity

Variables	Working Memory				*r*	*p value*
	Average		Good			
	n	%	n	%		
Nutritional Status						
Thinness	8	22,8	0	0		
Normal	20	57,1	5	14,3	0,863	0,037
Overweight	1	2,8	1	2,8		
MUAC						
Risk of CED	4	11,4	2	5,7	-0,515	0,354
Normal	25	71,4	4	11,4		
Anemia Status						
Anemia	7	20,0	0	0	1,000	0,024

The results stated that there was a relationship (p value <0,05) between nutritional status and anemia on working memory capacity, while Mid Upper Arm Curcumference (MUAC) had no relationship with working memory capacity. From the study, nutritional status and anemia had very strong relationship on working memory capacity (r value in the range of 0.8 - 1.0).

4 DISCUSSIONS

Relationship between Nuritional Status and Working Memory Capacity

This study shows that there is a significant relationship between nutritional status and working memory capacity as indicated by a p value of 0.037 (<0.05). The strength of the relationship between the two variables is very strong, indicated by an r value of 0.863 (r value> 0.8). The form of a positive relationship where the better the nutritional status, the better the working memory capacity.

The cognitive function is very important for regulating student's academic achievement. Nutritional status is a reflection of a person's nutrition intake balance. If a person's nutritional intake is good then nutritional status will be good too. If a person's nutritional status is good, body cells, especially the brain, have enough energy to process metabolism and organ function properly. This affects the broadcasting of information processes in the brain, thus affecting brain performance including a person's cognitive abilities and working memory. The finding of this study support the assumption that nutritional status effects on the working memory capacity.

Relationship between Anemia Status and Working Memory Capacity

This study shows that there is a significant relationship between anemia and working memory capacity as indicated by a p value of 0.024 (<0.05). The strength of the relationship between the two variables is very strong, indicated by an r value of 1,000 (r value> 0.8). The form of a positive relationship where the more normal hemoglobin levels (not anemia), the better the nutritional status.

Students who have high or normal hemoglobin (Hb) levels will have good working memory capacity. Conversely, if student's hemoglobin levels is low or anemia, working memory will not be maximum. Low memory capacity in anemia students can be caused by low iron levels in certain parts of the brain. Low iron levels in the brain can change the function of neurotransmitters and slow down the myelination process which plays a role in cognitive, socioemotional, and motor functions. In addition, low Hb levels (anemia) can cause the oxygen that transported by Hb will be reduced from normal conditions. Limited oxygen to the brain will affect students' thinking processes so that memory will decrease. The finding of this study support the assumption that anemia status can effect on the working memory capacity of students.

5 CONCLUSIONS

Based on the results of this study, it can be concluded that there is a relationship between nutritional status and anemia with working memory capacity and there is no relationship between upper arm circumference (ALL) with working memory capacity. Having normal nutritional status and good hemoglobin levels will make memory capacity better than having a thin body and anemia.

6 ACKNOWLEDGEMENTS

The author expresses her thanks to all parties who contributed during the implementation of the research.

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