Correlation between Hemoglobin Level, Attention and Working Memory Scores

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Abstract

Background: Attention and working memory functions have important roles in daily activities. Normal level of hemoglobin is required for optimum attention and working memory functions. This study aims to analyze the correlation between hemoglobin level, attention, and working memory scores in medical students who attended Atlas Medical Pioneer (AMP) Basic Program XXI.

Methods: The total population sample for this cross-sectional study included 27 males and 19 females. The hemoglobin level was meassured by using cyanmethemoglobin method. Digit Symbol Test, Digit Span Forward and Backward Test, Trail Making Test A and B, and Stroop Test were used to assess attention and working memory scores. The study was conducted from September to November 2012 in Jatinangor campus of the Faculty of Medicine, Universitas Padjadjaran and Clinical Pathology Laboratory of Dr. Hasan Sadikin General Hospital. The correlation analysis was performed using computer.

Results: The correlation between hemoglobin level in males and attention on Trail Making Test A score was (r=0.144) (p=0.474). While the correlations with theTrail-Making Test B and Stroop Test scores were (r=0.332) (0.091), and (r=-0.320) (p=-0.103), respectively. For females, the correlations with the Trail Making Test A, Trail Making Test B, and Stroop Test scores were (r=0.121) (p=0.622), (r=-0.232) (p=0.338), and (r=0.137) (p=0.576), respectively. Meanwhile, the correlation between hemoglobin level and the working memory on Digit Symbol Test, Digit Span Forward Test, and Digit Span Backward Test scores for-males were (r=0.256) (p=0.197), (r=0.419) (p=0.029), and (r=0.113) (p=0.576), respectively. For-females, the same correlations were (r=0.412) (p=0.080), (r=-0.299) (p=0.213), and (r=-0.028) (p=0.909), respectively. The only test that showed statistically significant result was Digit Span Forward Test in males.

Conclusions: There is evident of weak correlation between hemoglobin level, attention, and working memory scores in medical students who attended AMP Basic Program XXI. This may be due to the confounding factors affecting attention and working memory as well as a small sample size. [**AMJ**.2014;1(1):1–5]

Keywords: attention score, hemoglobin level, working memory score

Korelasi antara Kadar Hemoglobin, Pencapaian Skor Atensi, dan Skor Memori Kerja

Abstrak

Latar Belakang: Fungsi atensi dan memori kerja memiliki peranan penting dalam aktivitas sehari-hari. Kadar hemoglobin yang normal dibutuhkan untuk mencapai fungsi atensi dan memori kerja yang optimal. Penelitian bertujuan untuk menganalisis korelasi antara kadar hemoglobin, skor atensi, dan memori kerja pada mahasiswa kedokteran yang mengikuti Pendidikan Dasar XXI *Atlas Medical Pioneer* (AMP).

Metode: Studi potong lintang dengan jumlah sampel 46 orang, terdiri atas 27 orang laki-laki dan 19 orang perempuan. Perhitungan kadar hemoglobin menggunakan metode *cyanmethemoglobin*. *Digit Symbol Test*, *Digit Span Forward* dan *Backward Test*, *Trail Making Test* A dan B, dan *Stroop Test* digunakan untuk menilai skor atensi dan memori kerja. Penelitian dilaksanakan dari bulan September–November 2012 di Kampus Fakultas Kedokteran Universitas Padjadjaran Jatinangor dan Laboratorium Patologi Klinik Rumah Sakit Dr. Hasan Sadikin. Analisis korelasi menggunakan komputer.

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Hasil: Korelasi antara kadar hemoglobin laki-laki dengan skor atensi pada *Trail Making Test* A (r=0,144) (*p*=0,474), *Trail Making Test* B (r=0,332) (0,091), dan *Stroop Test* (r=-0,320) (p=-0,103). Pada perempuan hasil *Trail Making Test* A (r=0,121) (p=0,622), *Trail Making Test* B (r=-0,232) (p=0,338), dan *Stroop Test* (r=0,137) (p=0,576). Hasil korelasi antara kadar hemoglobin laki-laki dengan skor memori kerja pada *Digit Symbol Test* (r=0,256) (p=0,197), *Digit Span Forward Test* (r=0,419) (p=0,029), dan-*Digit Span Backward Test* (r=0,113) (p=0,576). Pada perempuan hasil *Digit Symbol Test* (r=0,412) (p=0,080), *Digit Span Forward Test* (r=-0,299) (p=0,213), dan *Digit Span Backward Test* (r=-0,028) (p=0,909). Tes yang memiliki nilai signifikan hanya *Digit Span Forward Test* pada laki-laki.

Simpulan: Terdapat korelasi lemah antara kadar hemoglobin, atensi, dan memori kerja pada mahasiswa yang mengikuti Pendidikan Dasar XXI AMP. Hal ini dapat terjadi karena *confounding factor* yang dapat memengaruhi atensi dan memori kerja seseorang serta jumlah sampel penelitian yang sedikit.

Kata kunci: kadar hemoglobin, skor atensi, skor memori kerja

Introduction

In daily life, human gets a wide range of information from the environment. This information will be processed by the human brain system to determine decisions. This process is called cognitive function.[1] Cognitive function is included into the mental activity that is conducted consciously.[2] There are some examples of cognitive function e.g. attention, memory, executive control, emotion, and language.[3]

Some of the most important cognitive functions are attention and memory. Attention is the human ability to concentrate or focus on a stimulus. The attention can be used to determine planning and decision making. Meanwhile, memory is often described as a storage of information and recall of informations. Memory is divided into declarative memory and non-declarative memory. Working memory as a part of declarative memory takes the form of human executive functions to create plans and make decisions. Non-declarative memory is formed unconsciously because human has a storage of memory on previous actions.[3,4]

Attention and working memory actually work together despite the fact that the position of working memory is higher than attention because working memory is capable to divide or split the focus of attention to some stimulus.[5] Working memory can divide attention from one action to another action without loss of interrelated information.[6]

The factors that affect a person's attention and working memory in normal environmental conditions are crowded environment and individual conditions e.g. condition of the cardiovascular system, hemoglobin characteristics, nutrition, history of disease, motivational factors, and physical activity.[4,7-8]

The attention and working memory are processed by the system of the human brain, specifically in the frontal and prefrontal parts. There are some factors which may affect the information processing e.g. neurons, blood circulation, and nutrients in brain circulation.[1,3,9] The blood circulation contains glucose and oxygen which are bound to hemoglobin.[10] The hemoglobin then releases oxygen which is used by the neurons for metabolism. Besides oxygen, neurons use glucose as a source of metabolism.[9] The results of metabolism are the action potential of neurotransmitter in neuronal cells and synaptic plasticity forming.[1,11] Synaptic plasticity is the process of neuronal pathways formation and synapse transmission for neurons resulting in neuronal activity that leads to attention and memory.[12-14] Low hemoglobin level could interfere the neuronal cell metabolism and impulse delivery.[15-16] If this happens, the process of thinking and cognitive brain function in particular executive function may be disturbed.[17-18]

This research on the correlation between hemoglobin level, attention, and working memory scores in medical students who attended Atlas Medical Pioneer (AMP) Basic Program XXI was conducted to find correlations between hemoglobin level, attention, and working memory scores that are beneficial for medical students during their activities related to adventure and very dangerous activities that need attention and working memory in terms of coordination, determination of accurate and fast decisions, receiving various new information from AMP program and other activities in their daily life.

Methods

A cross-sectional study was done involving 46 medical students (27 males and 19 females)

who attended AMP Basic Program XXI, who met these inclusion criterias: have completed the basic program, signed informed consent and passed laboratory examinations. The subject that had not enough sleep before the test, took some medication, or consumed foods and drinks that contained caffein were excluded. The hemoglobin level was measured using the cyanmethemoglobin method. The measurement of attention used 3 types of tests, namely Trail Making Test A and B and Stroop Test, while the measurement of working memory used 3 types of tests, namely Digit Span Forward Test, Digit Span Backward Test, and Digit Symbol Test.

The study was conducted from September to November 2012 in Jatinangor Campus of the Faculty of Medicine, Universitas Padjadjaran and Laboratory of Clinical Pathology in Dr.Hasan Sadikin General Hospital.

Our study used Shapiro-Wilk normality test to determine the distribution of variables. Digit Symbol Test, Digit Span Backward Test, Trail Making Test B, and Stroop test had *p* Value>0.05 which showed normal distribution of data while Digit Span Forward Test and Trail Making Test A had *p* Value <0.05 showing that the distribution of data was non-normally distributed. Because the number of data was less than 50, the correlation between the variables in our study were measured by using Pearson Test.[13]

Results

In male students, from 27 people, there were 25 people with normal hemoglobin level and 2 people with low hemoglobin level. Whereas in female students, from 19 people, there were 15 people with normal hemoglobin level and 6 people with low hemoglobin level. The female students were more likely to have low hemoglobin level compared to male students. The mean age of all subjects was 19 years old

The correlation between the hemoglobin level and the attention score in male students for Trail Making Test A and Trail Making Test B was very weak and insignificant value (r=0.144, *p*=0.474; r=0.332, *p*=0.091). The correlation between the hemoglobin level and the attention score for Stroop test was weak and insignificant (r= -0.320, *p*=0.103). The negative correlation showed the opposite correlation.

The correlation between the hemoglobin level and the attention score in female students for Trail Making Test A and Stroop Test was very weak and insignificant (r=0.121, p=0.622; r=0.137, *p*=0.576). The correlation between the hemoglobin level and the attention scores for Trail Making Test B was weak and insignificant (r=-0.232, *p*=0.338). The negative correlation showed the opposite correlation.

The correlation between the hemoglobin level and the working memory score in male students for Digit Symbol Test was weak and insignificant (r=0.256, *p*=0.197). The correlation between the hemoglobin level and the working memory score for Digit Span Forward Test was moderate and significant (r=0.419, *p*=0.029). The correlation between the hemoglobin level for Digit Span Backward Test was very weak and insignificant (r=0.113, *p*=0.576).

The correlation between the hemoglobin level and working memory score in female students for Digit Symbol Test was moderate and insignificant (r=0.412, *p*=0.080). The correlation between the hemoglobin level and working memory score for Digit Span Forward Test and Digit Span Backward Test was very weak and insignificant (r=-0.299, *p*=0.213; r=0.028, *p*=0.909). The negative correlation showed the opposite correlation.

Discussion

Based on our study, there is evident of weak correlation between hemoglobin level and attention and working memory scores in medical students who attended AMP Basic Program XXI. However, statistically, the correlation between the hemoglobin level and the attention and working memory scores are mostly insignificant. There are some negative

Table 1 Student Demographics

		Hemoglobin Levels			Mean Age (min-max)
		Normal	Low	Total	
Gender	Male	25	2	27	19 (18–22)
	Female	15	4	19	19 (18–22)
Total		40	6	46	

Table 2 Correlation between Hemoglobin Level and Attention Score in Male Students

		Trail Making A	Trail Making B	Stroop Test
Hemoglobin Level Male (n=27)	r	0.144	0.332	-0.320
	p	0.474	0.091	0.103

* r=coefficient of correlation, p= significance value, n= the number of data

Table 3 Correlation between Hemoglobin Level and Attention Score in Female Students

		Trail Making A	Trail Making B	Stroop Test
Hemoglobin Level Female (n=19)	r	0.121	-0.232	0.137
	p	0.662	0.338	0.576

* r= coefficient of correlation, p=significance value, n= the number of data

results in this study showing the opposite direction because some medical students with higher hemoglobin level in fact have a low test result and vice versa. This may be due to the confounding factors that affect a person's attention and working memory such as crowded environment and individual conditions e.g. condition of the cardiovascular system, hemoglobin characteristics, nutrition, history of disease, motivational factors, and physical activity, which may affect the results of this study. [4,7-8]

Our study has limitations. First, the sample is small. Second, inadequate environment test and general condition that can interfere the study participants when answering the test. Third, the characteristics of hemoglobin

Table 4 Correlation between Hemoglobin Level and Working Memory Score in Male Students

		Digit Symbol	Digit Span Forward	Digit Span Backward
Hemoglobin Level Male (n=27)	r	0.256	0.419	0.113
	p	0.197	0.029	0.576

* r= coefficient of correlation , p= significance value, n= the number of data

Table 5 Correlation between Hemoglobin Level and Working Memory Score in Female Students

		Digit Symbol	Digit Span Forward	Digit Span Backward
Hemoglobin Level Female (n=19)	r	0.412	-0.299	-0.028
	p	0.080	0.213	0.909

* r= correlation coefficient, p= significance value, n= number of data

such as partial pressure of oxygen (PO2), potential hydrogen (pH), partial pressure of carbon dioxide (PCO2), temperature, and 2,3-bipshosphoglycerate concentration were not checked. Therefore, to have more significant results, further study with bigger sample, adequate environment test, and assessment of all characteristics of hemoglobin is needed.

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