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A Comparative Study of Audio: Visual Reaction Time in Anemic and Non-Anemic Adolescent Females

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Abstract

Anemia is a major health problem in developing countries. Adolescent females are at the higher risk of developing anemia because of their greater physiological demand and combined with increase menstrual losses and poor dietary intake. Decrease hemoglobin level may lead to decrease attentiveness and low neural metabolic activity. *Objectives:* To observe the effect of anemia on audio and visual reaction time in adolescent females and to find out correlation between hemoglobin and reaction time. *Material and Methods:* The study was conducted in the department of physiology, Jhalawar medical college, Jhalawar. Adolescent females between 17-19 years of age and belonging to similar socio-economic status were recruited for the study. After hemoglobin estimation by Sysmex XN 1000 auto analyzer . Two groups, group-I (n=35) with hemoglobin level ≥12 gm/dl and group-II (n=35) with hemoglobin level <12 gm/dl were made.Visual reaction time and auditory reaction time were measured by using reaction time software in computer programming language Visual Basic 6.0. *Results:* Significant difference in visual reaction time (VRT) and auditory reaction time (ART) was found between two groups. The mean VRT in group I was185.7143 ± 14.4070 and in group II was 221.1429 ± 20.5471.The mean ART in group I was 152.0000 ± 14.9115 and in group II was 172.5714 ± 15.9674 .VRT and ART shows negative correlation with hemoglobin(r-Value-0.619 and - 0.401 respectively), which was significant. *Conclusion:* Both visual reaction time and auditory reaction time were significantly increased in anemic adolescent females. Anemia may be responsible for the impairment of reaction time (sensori motor function) in females of the adolescent age group 17-19 years.

Keywords: Anemia; Reaction Time; Adolescent Females.

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Introduction

Anemia is defined as decrease in number of red blood cells or less than the normal quantity of hemoglobin in the blood [1].

Any of the three measures of concentration (hemoglobin, hematocrit, or number of red cells) may be used to establish the presence of anemia, but the blood hemoglobin concentration is often preferred because its accuracy and reproducibility equals or exceeds those of other measures, and it is most indicative of the pathophysiologic consequences of anemia [1].

WHO'S Hemoglobin thresholds used to define anemia are as follows [2].

Age or gender group	Hb threshold (g/dl)
Children (0.5-4.99 yrs)	11.0
Children (5-11.99 yrs)	11.5
Teens (12-15 yrs)	12.0
Women, non-pregnant (>15 yrs)	12.0
Women, pregnant	11.0
Men (>15 yrs)	13.0

Of all the nutritional deficiencies, iron deficiency anemia is a major public health problem in India. It is pervasive and effects all age-sex groups but the most severely affected are women in the reproductive age group and young children. It induces generalized as well as systemic health consequences, the important one being irreversible brain dysfunction [3].

Adolescent girls are at the risk of developing anemia especially iron deficiency anemia (IDA), because of their greater physiologic requirements, combined with increased menstrual losses and poor dietary intake [4].

Reaction time means time taken by an individual to react to external stimulus. It provides an indirect index of processing capability of the central nervous system [5].

Reaction time is a measure of function of sensorimotor association [6] and performance of an individual [5], it has physiological significance and is a simple and non-invasive test for peripheral as well as central neural structures [7].

The measurement of auditory (ART) and visual reaction time (VRT) has been used to evaluate the processing speed of central nervous system and co-ordination between the sensory and motor system [8].

The Reaction Time experiment was devised by the great physiologist, Helmholtz (1850). He used the reaction time method to measure the speed of nerve conduction, working with the motor nerve of the frog, Helmholtz stimulated a nerve attached to a muscle at a point some distance from the reacting muscle, Helmholtz reported that the speed of motor nerve conduction was 27m/sec in the motor nerve of frog; in man he calculated the speed of motor nerve conduction by the same method to be about twice as great.

Major factors that affect Reaction Time (RT) are [9]:

1. Types of reaction time experiment
2. Stimulus
3. Age
4. Gender
5. Left vs Right Hand
6. Distraction
7. Exercise
8. Fatigue etc.

The reaction time is also affected by mood, memory, psychological state, stress, and first time performance and behavioral and mental attitude of the individual [10].

Many studies have shown altered transmission in auditory and visual systems in infants and children with iron deficiency [11,12], but similar measurements are lacking in adolescents suffering from anemia.

So, the present study was undertaken to study the effects of anemia on auditory and visual reaction time in adolescent females.

Material and method

The study was conducted in the Department of Physiology, Jhalawar Medical College, Jhalawar from October 2017 to September 2018.

Apparently healthy adolescent girls between 17-19 years of age and belonging to similar socioeconomic status were recruited for the study

They were all screened and categorized into two groups depending on their hemoglobin status.

- *Control Group:* Hb ≥ 12 gm/dl constitute *Group I* (n=35).
- *Anemia Group:* Hb < 12gm/dl constitute *Group II* (n=35).

1. Inclusion criteria:

- Age 17-19 yrs female
- Apparently healthy i.e. No medical and psychiatric illness
- Similar socio-economic status

2. Exclusion criteria

- Acute/chronic disease/infection
- Physical/mental illness
- Hearing or visual disorder
- Hemolytic anemia
- History of blood transfusion, iron and vitamin supplementation within one month.

The subjects were briefed about the study protocol and informed consent was taken.

Age and anthropometric parameters were measured which included weight and height so that the two groups were comparable for study.

The study was done during the post menstrual phase of the menstrual cycle to avoid any alteration in their values due to premenstrual phase. The recordings were conducted at the same time of the day in the morning, between 9-11AM about 2 hrs after light breakfast.

The technique was explained to each and every subject and this was followed by demonstrating the procedure and giving three practical trials to make them familiar with the software and to eliminate any kind of fear and apprehension.

Following Parameters Were Studied

Sensorimotor Functions

1. Visual reaction time (VRT)
2. Auditory reaction time (ART)

Procedure

Hematological Test

Hemoglobin estimation in gm/dl was done by sysmex XN 1000 Autoanalyser.

Recording of Sensorimotor Functions

Visual Reaction Time and Auditory Reaction Time were measured by Reaction Time Software.

The Reaction Time Software

The Program for measuring reaction time was prepared indigenously in computer programming language Visual Basic 6.0 [18]. This provides the graphic user interface to user. This software presented ten trials of the visual or auditory stimulus to the subject separately. The cues were presented with a random order or timing to minimize the bias arising from prior anticipation. After ten trials the software yielded minimum of all the trials as the reaction time for a particular type of stimulus.

The Visual Stimulus

The visual stimulus consists of colored mini bulb that flashes in the center of the screen. During sequential trials, the color of the minibulbwas kept constant as green light stimulus for recording the visual reaction time.

The Auditory Stimulus

The auditory stimulus consists of a computer generated beep of 3000 Hz/200msec, presented to both ears. The frequency and duration of the stimulus were kept constant over sequential trials but the duration between two beeps varied randomly in order to prevent bias arising from prior anticipation.

High frequency beep stimuli were selected for recording auditory reaction time

Procedure

All the subjects were subjected to ART and VRT recording in a quiet room in the Department of Physiology, Jhalawar Medical College, Jhalawar. The subjects were asked to sit in front of the screen and to put the index finger of their dominant hand lightly on the "Enter" button of the keyboard. They were asked to press the "Enter" button as quickly as possible when a visual or auditory stimulus was presented to them. Three consecutive reading of each stimulus were recorded. The lowest reading was taken as reaction time.

Statistical analysis was done by Students unpaired 't' test and Pearson's correlation coefficient with the help of appropriate software.

Results

The mean VRT in group I (Control) was 185.7143 ± 14.40705; while mean VRT in group II (anemic) was 221.1429 ± 20.54714 (Table 1)

The Visual reaction time was significantly prolonged in group II (anemic) as compared to group I (control) and this is highly significant ($p < 0.001$).

Our finding of an increase in Visual reaction time in group II, anemic indicates a decreased sensorimotor performance.

Table 1: Visual Reaction Time in Group I and Group II

Parametar	Group I (Control)	Group II (Anemic)	p value
VRT (msec)	185.7143 ± 14.40705	221.1429 ± 20.54714	p < 0.000*

* Significant

The mean ART in group I (control) was 152.0000±14.91150; while mean ART in group II (anemic) was 172.5714±15.96740 (Table 2).

The Auditory reaction time was significantly prolonged in group II (anemic) as compared to Group I (control) and this is highly significant ($p<0.001$).

Our finding of an increase in Auditory reaction time in group II (anemic) indicates a decreased sensorimotor performance.

Pearson correlation coefficient that is r value which is - 0.619. This value indicates strong negative correlation between these two parameters Hemoglobin and Visual Reaction Time (VRT) (Table 3).

ART also shows negative correlation with hemoglobin, which is significant. Pearson's correlation coefficient that is r value which is - 0.401 this value indicates negative correlation between these two parameters Hemoglobin and Auditory Reaction Time (ART) (Table 4).

Table 2: Auditory Reaction Time in Group I and Group II

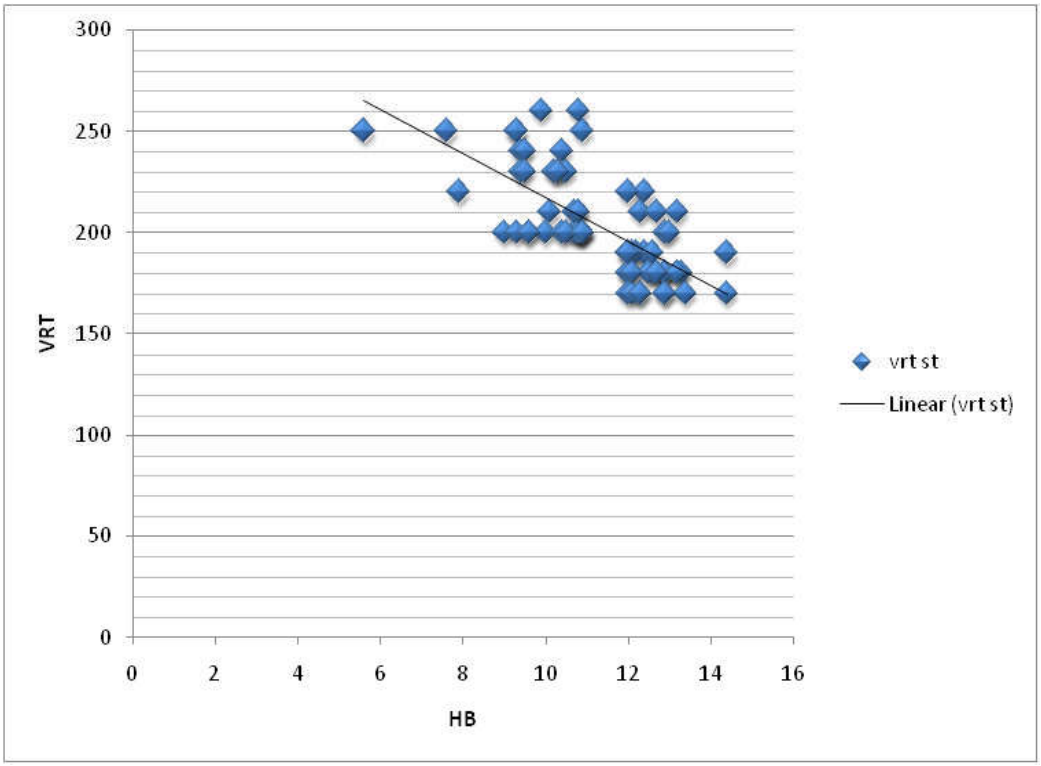
Parameter	Group I (Control)	Group II (Anemc)	p value
ART (msec)	152.0000 ± 14.91150	172.5714 ± 15.96740	p<0.0001*

* Significant

Table 3: Correlation between Hemoglobin and Visual Reaction Time (VRT)

Parameters	Mean	SD	N	r-Value	p-Value
Hb (gm/dl)	11.3000	1.64616	70	-0.619**	<0.0001**
VRT (m.sec.)	203.4286	25.07298	70		

**Highly Significant

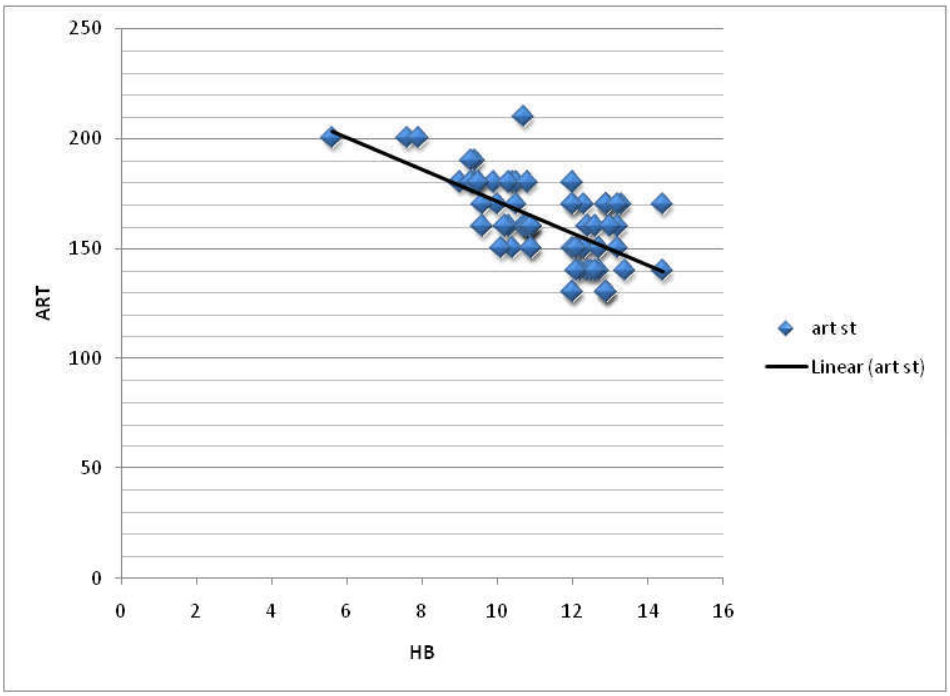


Graph 1: VRT shows strongly negative correlation with Hemoglobin, which is highly significant.

Table 4: Correlation between Hemoglobinand Auditory Reaction Time (ART)

Parameters	Mean	SD	N	r-Value	p-Value
Hb (gm/dl)	11.3000	1.64616	70	- 0.401**	0.001**
ART (m.sec.)	162.2857	18.50745	70		

**Highly Significant



Graph 2: Correlation between Hemoglobinand Auditory Reaction Time (ART)

Discussion

In the present study, group II- subject with anemia demonstrated a significant increase in both visual reaction time (VRT) and auditory reaction time (ART) when compared to control group.

Reaction time is an indirect index of processing capability of the central nervous system and is an inexpensive means for determination of sensory motor performance of an individual [5]. Hence, an increase in the value of both VRT and ART is Suggestive of deterioration in sensorimotor performance, as observed in the present study.

Anemia produces generalized weakness and fatigue [13]. These symptoms along with other symptoms of anemia such as tiredness, poor concentration, poor attention and irritability could be the reason of prolongation of VRT and ART. Whether the origin is in central or peripheral nervous system is still unknown. Studies in this regard have been scarce.

Wed and oski [14] found that anemic children had a longer latency period than non-anemic subjects on visualization of an after image.

Kabakus et al. [15] used nerve conduction studies to suggest that peripheral neuropathy may develop in children having iron deficiency anemia and the symptoms may improve by iron therapy.

A case report by leis et al. [16] concluded that spinal motor neuron excitability is not reduced in iron deficiency anemia as depicted by bilateral median and common peroneal nerve F wave studies, where F wave mean latency, chrono-dispersion, persistence and mean amplitude were within the normal range between anemic and control group.

Yehuda et al. [17] found that people who received iron for iron deficiency anemia reported improved memory, attention, mood and energy before any improvement in hemoglobin indices.

Murray et al. [18] found that administration of iron in young women resulted in an improvement in both performance and the time taken to complete the reaction time task.

In the present study auditory reaction time is shorter than visual reaction time. The reason is that for auditory reaction time, sound entering the ear can reach appropriate receptors with particular

no loss of time. For visual reaction time the rods and cones are not excited by light directly and the intervening photochemical process takes appreciable time. It is shown that whilesound reaches in 2 m.sec, whereas when a light thrown into the eye, activity reaches visual cortex in 20-40 m.sec, but when retina is by passed bydirect electrical stimulation for the optic nerve, the cortical latency is as little as 2-5 m.sec. Compared with the ear the eye takes long time to get its message started along the nerve to brain. Thus, one can account for most and perhaps all of the differences between visual and auditory reaction time [19]. Our observations are in agreement with many studies including Madan Mohan et al. (1992) [20], Malathi and Parulkar (1989) [21], Kapoor et al. (1993) [22] and Saha et al. (1996) [23].

Correlation studies revealed a significant negative correlation between hemoglobin and reaction time (visual reaction time and auditory reaction time).

Conclusion

The present study showed that anemia is responsible for the impairment of reaction time (sensorimotor function) in females of the adolescent age group i.e. 17-19 years. Thus, anemia could be the reason for impaired sensorimotor performance (audio-visual reaction) and autonomic disturbances seen in adolescent females.

Prevention, early detection and treatment of anemia will go a long way in reducing morbidity due to complications of anemia.

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