



ASSESSMENT OF COGNITIVE PERFORMANCE DURING PREGNANCY WITH MINI-COG AND AUDIO-VISUAL REACTION TIME: A CROSS-SECTIONAL STUDY

Physiology

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ABSTRACT

Background: pregnancy is associated with changes in almost all systems in women. It is hypothesized that the changes taking place in women during pregnancy might affect their cognition. The present study was conducted with the objectives of assessing cognitive performance of pregnant women with Mini-cog and Audio-visual reaction times and comparing it with that of non-pregnant women. **Methodology:** The study included a total 100 subjects with age ranging from 20 to 40 years. The study group included 50 pregnant women in any of the three trimesters. The control group consisted of 50 healthy non-pregnant women. All the subjects were matched in age as well as socio-economic and learning capabilities. The Mini-cog involved a simple Clock Drawing Task and a Three Item Recall Task (mini recall test). Both these tests were scored as per standard methods to find out the state of cognition i.e. normal or abnormal. The auditory and visual reaction times were measured by a device Response Analyzer using standard protocols and settings. **Results:** Cognition was found to be significantly altered in pregnant women, especially in primigravida during third trimester, in terms of significantly abnormal clock drawing and mini recall performance and significantly delayed audiovisual reaction times as compared to that of non-pregnant women. **Conclusion:** The impairment of cognitive functions during pregnancy might be due to effect of various structural, functional, hormonal or behavioural changes on the areas of brain involved in memory and perceptual motor coordination.

KEYWORDS

Audio-visual reaction time, Cognition, Mini-Cog, Pregnancy

INTRODUCTION

The word cognition comes from the Latin root cognoscere, which means "to know". It refers to everything that is related to knowledge. It is the ability that we have to assimilate and process the information that we receive from different sources (perception, experience, beliefs etc.) to convert them into knowledge. It includes different processes like learning, attention, memory, language, reasoning, decision making etc. which work together to integrate the new knowledge and create an interpretation of the world around us^[1].

Pregnancy is a state of remarkable change in a woman's body. It is characterised by most drastic hormonal fluctuations that women experience during their reproductive lives. In addition to the obvious physical changes, pregnancy also seems to have a major impact on the brain. The feeling of forgetfulness, inattention and mental foginess are common complaints reported by the pregnant women. Many of the hormones that play a key role in the establishment and maintenance of pregnancy have been found to influence selective cognitive functions^[2]. Though not all the studies support the idea that women experience declines in cognitive abilities during pregnancy, some investigators reported significantly poorer cognitive functioning in pregnant than in control women particularly during third trimester^[3].

The early changes in cognitive functions can be detected by several neuro-psychological and neuro-physiological tests which assess attention, learning and memory, executive functions, visuo-spatial skills, psychomotor abilities, perceptual skills and language abilities^[4]. The Mini-Cog is a simple, effective and easily administered screening tool that can uncover cognitive impairment in early stages^[5]. The tool consists of a simple Clock Drawing Task (CDT) and a Three Item Recall Task. The most remarkable feature of this tool is its simplicity and quickness.

Reaction time, the time interval between application of a stimulus and completing of the response, has also been recognized as a potentially powerful means to assess the processing capability of central nervous system and sensory-motor performance^[6].

Current literature on cognitive functioning in pregnancy is mixed, with

most research showing deficits in memory and attention during pregnancy^[3,7] or no difference between pregnant participants and controls^[8,9]. There is paucity of data on study about the assessment of cognition with mini-cog and audiovisual reaction time and hence the present study was intended with the objectives to evaluate cognitive performance in pregnant women by using the Mini-Cog task and Audio-Visual Reaction Time and to compare the cognitive performance of pregnant women with that of non-pregnant ones with same socio-economic and demographic characteristics.

MATERIAL AND METHODS

Study Design: The present study was designed as a cross-sectional study.

Study Groups:

Pregnant - It included female subjects (n = 50) diagnosed as having pregnancy^[10] in any of the three trimesters and registered with antenatal care (ANC) unit of the institution. Pregnant ladies up to third gravida were selected for the study. The pregnancy was confirmed with history of amenorrhea and various diagnostic tests such as Urine Pregnancy Test (UPT), Ultrasonography (USG), Fetal heart rate (FHR) and ballottement.

Non-pregnant (Control) - It constituted of non-pregnant women (n = 50) not having any known or diagnosed illness. These were selected from general population.

Each study group included subjects with age ranging from 20 to 40 years.

The participants in both the groups were matched in age, weight, learning capabilities and socioeconomic status.

Period And Place Of The Study: The study was conducted from 1st May 2019 to 30th June 2019 at Department of Physiology in coordination with Department of Obstetrics and Gynecology at Govt. Medical College, Gondia, Maharashtra in Central India.

Case Report Form: The predesigned case report form was prepared

having complete information of patient demographics as well as general and systemic examination and specific tests for cognition.

Inclusion And Exclusion Criteria: After taking a detailed history, thorough general and clinical examinations were done and those with normal vision, hearing and sound mental state were included in the study. Those with bad obstetric history, history of alcoholism, smoking, hypertension, stroke, hypercholesterolemia, visual or acoustic disturbances, neuromuscular weakness, diabetes mellitus and those diagnosed with dementia, depression were excluded from the study.

The study was approved by Institutional Ethics Committee (IEC) and written informed consent was obtained from each participant after explaining her the study protocol.

Study tools -

1. Mini-Cog Test^[5,11]

- Mini recall (Three item recall) test
- Clock drawing test

2. Auditory and visual reaction times^[6]

Mini-cog Test

In Mini-Cog task, the subject was told three simple words in vernacular language such as chaabi (key), kalam (pen) and table etc. and was asked to remember and repeat those three items after clock drawing test.

The subject was then given a pre-drawn circle (to minimize the effect of education) for clock drawing test and was asked to place the numbers on it to make it look like a clock. Then the subject was asked to draw the hands of the clock to indicate certain time, such as 11:10 (The time of 11:10 is more sensitive for revealing cognitive deficits than other times)^[12]. After the subject drew the clock, she was asked to repeat back the three items that were previously told. Clock drawing test was analyzed and scored as per Watson method^[13] as follows –

The clock is divided into four quadrants in clock-wise fashion as shown in the Figure 1. This technique does not score the hands, but focuses exclusively on the placement of numbers or symbols within each quadrant as shown in Figure 2.



Figure 1: showing quadrants of the clock face

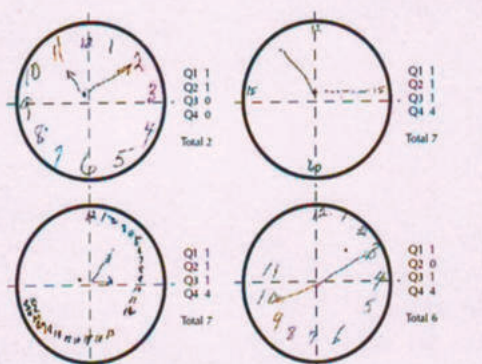


Figure 2: showing different scores of the clock drawing tests as per Watson Method^[14]

The number of digits in each quadrant is counted (clockwise from 12). Any three digits in each quadrant are considered correct. For any error in the quadrant I to III, the score is 1. For any error in quadrant IV, the score is 4. Score 0 to 3 means normal cognition. Score 4 to 7 indicates abnormal cognitive performance.

The three item recall task^[14] was scored as follows:
Recall of 0 item indicates cognitive impairment.

Recall of 1 to 2 items with an abnormal clock face indicates cognitive impairment.

Recall of 1 to 2 items with a normal clock face indicates no cognitive impairment.

Recall of three items indicates no cognitive impairment.

Clock drawing test and mini recall test can together be interpreted as per the algorithm shown in figure 3.

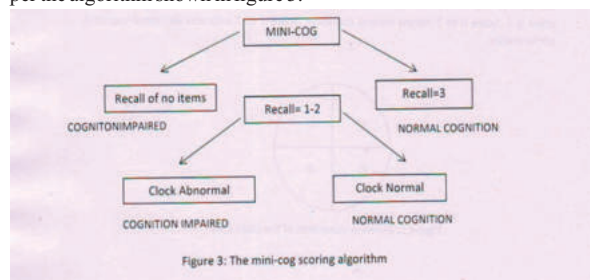


Figure 3: The mini-cog scoring algorithm

Auditory Reaction Time And Visual Reaction Time

Auditory and visual reaction times were measured by using the device "Response Analyzer" by Medicaid Systems, Chandigarh, India in a quiet room with good visibility conditions. The device has a display range of 0 to 9.999 sec. and accuracy of ± 0.002 sec. Auditory reaction time was recorded for high frequency sound whereas visual reaction time was recorded for red light. All subjects with same dexterity (e.g. right handers) were selected and were asked to use index finger of their right hands to press the response switch.

Scoring Of Auditory And Visual Reaction Times

After giving sufficient trials, three readings were recorded for auditory as well as visual reaction times. The best of three readings i.e. the shortest reaction time was considered for the statistical analysis^[15].

Statistical Analysis

The mini-cog scores data was analyzed by using "Fisher's exact test" to find out statistical difference, if any, between the compared values.

The reaction time data was analyzed by using students unpaired t test. p value less than 0.05 was considered as an indicator of statistically significant difference between the compared values.

OBSERVATION AND RESULTS

Gravid status and trimester wise distribution of pregnant women were shown in Table I and II respectively. Out of total 50 pregnant women, 26 (52%) were primigravida and 26 (52%) belonged to third trimester.

Table I: Gravid Status Of Pregnant Women

Gravid status	Number of cases	Percentage of total
Primigravida (first time pregnant)	26	52
Gravida 2 (second time pregnant)	18	36
Gravida 3 (third time pregnant)	6	12

Table II: Trimester-wise Distribution Of Pregnant Women

Trimester (duration of pregnancy)	Number of cases	Percentage of total
First (from week 1 to end of week 12)	4	8
Second (from week 13 to end of week 26)	20	40
Third (from week 27 to end of pregnancy)	26	52

Mean values of age, body mass index (BMI), clock drawing test (CDT), mini recall test (MRT) and audio-visual reaction times have been tabulated in Table III.

Table III: Comparison And Analysis Of Various Parameters In Control And Pregnant Groups

Parameter	Control (Non-pregnant)	Pregnant
Mean age $\pm$ SD (years)	30.28 $\pm$ 7.91	24.44 $\pm$ 3.10
Mean BMI $\pm$ SD	22.86 $\pm$ 4.33	22.15 $\pm$ 3.52
CDT	Abnormal in 19	Abnormal in 38
MRT	Normal	Abnormal in 20 subjects
Mean ART $\pm$ SD (seconds)	0.393 $\pm$ 0.183	0.905 $\pm$ 0.465*

Mean VRT ± SD (seconds)	0.394 ± 0.187	0.781 ± 0.426*
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*: p value less than 0.05

There was no statistically significant difference in age as well as BMI of control and pregnant group. Analysis of data of clock drawing test by Watson criteria and that of threetem recall test by Mini-Cog score revealed abnormal clock drawing test in 19 non-pregnant women (including 4 subjects who were unable to draw the clock). Rest of the non-pregnant did not show any cognitive impairment (Watson score: 0-3 and mini recall score: Recall of 1 to 2 items with a normal clock face or Recall of all three items correctly). Whereas, out of 50 pregnant women examined by the same tests, 38 subjects (including 7 subjects who were unable to draw the clock) showed abnormal clock drawing test and 20 subjects showed abnormal three item recall test (Watson score: 4-7 and mini recall score: Recall of 0 item or Recall of 1 to 2 items with an abnormal clock face). Remaining pregnant subjects showed these scores within normal range. Out of 28 pregnant women who showed recall of 1 to 2 items, 20 subjects showed abnormal clock drawing test whereas 8 subjects drawn normal clock face as indicated by combined analysis of clock drawing and mini recall tests (Table IV).

Table IV: Number Of Participants In Control And Pregnant Groups Showing Combined Results Of Mini Recall And Clock Drawing Tests

MRT and CDT combined	Control (Non-pregnant)	Pregnant
Recall of 1 to 2 items with abnormal clock drawing test	0	15
Recall of 1 to 2 items with unable to draw the clock	1	05
Recall of 1 to 2 items with normal clock drawing test	2	08

The results of the odds ratio depict that pregnant women are at 32.67% higher risk of developing cognitive impairment (Table V).

Table V: Odd's Ratio Between Pregnant And Non-pregnant Groups

Participants (n=100)	Cognition impaired	Normal cognition	Odd's ratio
Pregnant (n=50)	20	30	32.67
Non pregnant (n=50)	1	49	

Auditory and visual reaction times were found to be significantly delayed in pregnant as compared to that of control ($p < 0.05$) as shown in the Table III.

The observations revealed that pregnant group exhibited diminished performance on tests of immediate verbal memory as well as perceptual and executive functions.

DISCUSSION

Many women report increased forgetfulness and reduced cognitive functioning during pregnancy. We applied a mini-cog and audio-visual reaction time tests to investigate the association between pregnancy and changes in cognitive functioning. The comparison of age and BMI in control and pregnant groups did not reveal any significant difference. This suggested that both the groups were age and BMI matched. The analysis of clock drawing test and mini recall test showed significantly abnormal cognitive performance in pregnant women as compared to that of control. These differences in cognitive parameters were also found between different trimesters as well as different gravida status of the pregnant women. In our study, the impairment in cognition in pregnant women was found particularly during third trimester of pregnancy. It was also noted that primigravida females showed significantly abnormal performance with mini-cog. The pregnant group also showed significantly delayed response to auditory and visual stimuli. These findings suggestive of impaired cognitive functions especially memory and executive functions during pregnancy are consistent with those reported by various investigators^{[16][17][3]}.

The diminished performance on the tests of immediate verbal memory, perceptual and executive functions in pregnant women might be due to slowing of attention and psychomotor speed in them. Several changes taking place in women during pregnant state may explain lower cognitive functions during pregnancy. These changes may be structural, functional, hormonal or behavioural in nature. One of the recent studies has reported that pregnancy was associated with reduced

grey matter volume of brain areas involved in social cognition^[18]. Selective impairment of processes involved in working memory and recall might also be affected in pregnant women^[3].

The perceived cognitive impairments during pregnancy may also result from depressed mood or expectations concerning the effect of pregnancy on cognition^[19]. It was reported that maternal depressive symptoms and pregnancy-related anxiety symptoms were both associated with decrements in visuo-spatial working memory and executive functioning^[7].

Cognitive changes during pregnancy may also be related to altered gestational neuronal plasticity as a result of altered levels of Human Chorionic Gonadotropin, Cortisol and Prolactin leading to poorer performance in certain cognitive domains like executive functions and recall memory^[17,20].

It was concluded that cognitive functions e.g. memory and executive functions were affected during pregnancy particularly during the third trimester. Reduced grey matter volume in the areas of brain involved in cognition, effect of fluctuating levels of different hormones on these areas and anxiety and depressed mood associated with pregnancy might be responsible for the diminished capacity of information processing and impaired perceptual-motor coordination in pregnant women.

It was inferred that pregnant ladies might have trouble in handling day to day activities due to impaired cognition in them during pregnancy. The impact of these cognitive deficits on everyday life can be significant. Hence early detection of such deficits is important as cognitive functions may affect maternal ability to deal with demands of pregnancy and later parenting. Further research is needed to explore the aetiology of cognitive impairment during pregnancy, to establish the impact of altered cognition on day to day cognitive functioning of pregnant women and to know whether memory and executive functions return to pre-partum performance level after giving birth.

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