Caspian Journal of Neurological Sciences
"Caspian J Neurol Sci"

Journal Homepage: http://cjns.gums.ac.ir

Research Paper

Comparison of Cognitive Function in Different Trimesters of Pregnancy

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Citation Soleimani R, Asgharnia M, Jalali MM, Eslamdoust-Siahestalkhi F, Kafi Masule SM, Iranidoost-Haghigh R, et al. Iranidoost-HaghighiComparison of Cognitive Function in Different Trimesters of Pregnancy. Caspian J Neurol Sci. 2022; 8(3):156-162. https://doi.org/10.32598/CJNS.8.30.3.5

Running Title Cognition and Pregnancy.

https://doi.org/10.32598/CJNS.8.30.3.5

Article info:
Received: 05 Feb 2022
First Revision: 22 Jun 2022
Accepted: 26 Jun 2022
Published: 01 Jul 2022

ABSTRACT

Background: Although pregnancy is a normal function in women, it is considered as a stressful experience which is associated with many psychological and physical changes in pregnant women.

Objectives: This study aims to investigate and compare cognitive function in different trimesters of pregnancy.

Materials & Methods: This was a longitudinal cohort study. Participants were 76 pregnant women with a mean age of 30.09±6.23 years referred to Al-Zahra Hospital in Rasht, Iran during 2019-2020. Participants were assessed in three trimesters of pregnancy using the Wechsler Memory Scale (WMS) and Mini-Mental State Exam (MMSE). The multilevel mixed-effects linear regression and repeated measures ANOVA were used for data analysis. All analyses were done in SPSS software v. 19 and Stata v. 14.

Results: The mean score of WMS was significantly lower in the third trimester (84.95±12.07) than in the first and second trimesters (89.34±13.13 and 88.72±13.24, respectively) (P=0.001). The results of linear regression analysis showed no significant difference in MMSE score between different trimesters of pregnancy (P>0.05), while the WMS score was significantly different between different pregnancy trimesters; the change in WMS score was statistically significant only in the third trimester (P= 0.04).

Conclusion: No impairment in general cognitive function occur during pregnancy, but memory impairment may occur. In the third trimester, pregnant women have the poorest memory function.

Keywords: Cognition, Pregnant women, Pregnancy trimesters, Memory

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Highlights

- Memory function of pregnant women gradually decreases during pregnancy.
- Memory function of pregnant women is better in the first and second trimesters than in the third trimester of pregnancy.
- General cognitive function does not change considerably during pregnancy.

Introduction

Pregnancy is associated with many psychological and physical changes in women [1]. A significant number of women experience some cognitive changes known as pregnancy brain, baby brain, or "momnesia" [2]. Memory is an important part of cognition [3], and problems with memory and concentration are some of the symptoms reported by women during pregnancy [4]. In the study by Cuttler et al. on 61 pregnant and 24 non-pregnant women, results showed that pregnant women experienced memory impairment [5]. Two meta-analyses in 2007 and 2012 also indicated the significant negative effect of pregnancy on memory [6, 7]. A recent meta-analysis on 709 pregnant and 521 non-pregnant women showed that cognitive function was poorer in pregnant women which was more considerable in the third trimester [8]. In another study, symptoms of cognitive disorders including amnesia, behavioral disorders, confusion and reading problems were observed in 21 out of 51 pregnant women, and these symptoms were not related to age, weight gain, medical symptoms, or mood swings [9]. However, in some studies, the results were different. For example, in Christensen et al.'s study, changes in memory and cognition in late pregnancy were not noticeable [10].

There are significant hormonal fluctuations during pregnancy [1]. Hormonal changes are one of the factors that affect cognitive deficits [11-13]. Research has shown that these hormonal changes are more effective in late pregnancy and postpartum periods [14]. Cognitive function may be affected by stress hormones that are released during this period [13]. Maternal depression and pregnancy-related anxiety symptoms both are associated with decreased working memory [15]. The effect of maternal mood and anxiety on cognitive problems during pregnancy has also been shown in other study [16]. According to some controversial reports about changes in memory and cognitive function during pregnancy, considering the importance of pregnancy in the mental health of mothers and children, and given that scant research in Iran have been conducted in this field, the present study aims to investigate cognitive function during pregnancy. For this purpose, Wechsler Memory Scale (WMS) and Mini Mental State Examination (MMSE) were used to compare memory and cognition participants between different trimesters. We also assessed the impact of age, educational level, and number of pregnancies on cognitive function during pregnancy.

Materials and Methods

This was a longitudinal cohort study conducted on 83 pregnant women referred to Al-Zahra Hospital in Rasht, Iran during 2019-2020. Those who had willingness to participate in the study were recruited. Assuming the alpha error of 0.05 and a test power of 0.20 and based on the study by Wilson (23), the sample size was determined 83. Inclusion criteria were: No history of physical illness, hypothyroidism, hyperthyroidism, or other hormonal problems, serious psychiatric disorders based on an interview according to the diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, and no mental disability. Participants were evaluated in three trimesters of pregnancy, second, 5th and 8th months of pregnancy by completing the WMS and MMSE. Seven women did not complete the study due to some reasons, such as physical problems.

Data collection tools

Demographic information was recorded using a demographic form surveying age, occupation, and place of residence. The WMS was used to measure memory which was developed by Wechsler created in 1945 [17]. The scale consisted of 7 subscales; personal and current information (score 0-6), orientation (score 0-5), mental control (score 0-9), logical memory (score 0-23), digits span (score 0-15), visual reproduction (score 0-14), and associate learning (score 0-21) [18]. In this scale, the corrected score is obtained by adding total score of subscales to the fixed score of different age groups. Finally, the memory quotient score is determined based on the

corrected score. Ryan et al. reported a Cronbach's alpha coefficient of 0.75 for the reliability of this scale in healthy individuals and 0.89 in patients with psychiatric disorders [19]. For its Persian version, the construct validity and face validity were assessed by Sarrami. The construct validity assessment by factor analysis showed a three-factor model of WMS (logical memory, visual reproduction, and digits span), and a significant correlation between items was reported. Also, there was high face validity. Cronbach's alpha coefficient for the reliability of Persian version was reported 0.85 [20].

We used the MMSE to measure the general cognitive function of women, which is a brief test of cognitive status. This scale was developed in 1975 by Folestein et al. [21]. It is one of the most common cognitive screening tools in the world, which has been translated into many languages without much change. The total score of this test is between 0 and 30. Questions on this scale assess temporal and spatial orientation, word registration, attention and calculation, word recall, language, and visual construction [22]. A higher score in this test indicates a better cognitive status. The test-retest reliability of this scale is 0.82-0.98 [21]. Assuming the alpha error of 0.05 and a test power of 0.20 and based on the study by Wilson [23], the sample size was determined 83. For its Persian version, the results have shown its ability to distinguish memory functions between healthy and patients groups at 95% confidence interval, and has a Cronbach's alpha coefficient of 0.81 for its reliability [23].

Statistical analysis

After data collection, they were analyzed in SPSS software v. 19 and Stata v. 14 applications. Quantitative data were described by frequency and percentage, while qualitative data were presented by Mean±SD. The normality of data distribution was examined using Shapiro-Wilk test. If it was not normal, the data transform method was used. Iinferential statistics such as multilevel mixed-effects linear regression and repeated measures ANOVA were used to analyze the data. The statistical significance level was set at 0.05.

Results

Participants were 76 pregnant with a Mean±SD age of 30.09±6.23 years. Table 1 shows their demographic characteristics. The mean MMSE and WMS scores in different trimesters of pregnancy are presents in Table 2. Based on the results, the mean scores of MMSE were not significantly different between the trimesters (P>0.05), but the difference in the mean WMS scores were statistically significant (P=0.001).

Multilevel mixed-effects linear regression analysis was used to evaluate the effect of demographic variables. Since MMSE scores had no normal distribution, it was transformed to $MMSE^3$ (cubic form) (Table 3).

Table 1. Demographic characteristics of pregnant women

Variables		No. (%)
Place of residence	Urban areas	58(76.3)
	Rural areas	18(23.7)
Educational level	<Diploma	24(31.6)
	Diploma	31(40.8)
	>Diploma	21(27.6)
Occupation	Housewife	66(86.8)
	Employed	10(13.2)
Number of Pregnancy	1	32(42.1)
	2	26(34.2)
	3	12(15.8)
	>3	6(7.9)

Table 2. Mean scores of MMSE and WMS in different trimesters of pregnancy

Variables		Mean±SD	F	P*
MMSE	First trimester	28.6±1.39	2.551	0.088
	Second trimester	28.13±1.40		
	Third trimester	28.00±1.45		
WMS	First trimester	89.34±13.13	28.375	0.001
	Second trimester	88.72±13.24		
	Third trimester	84.95±12.07		

* Repeated measures ANOVA.

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Table 3. Results of linear regression models of $MMSE^3$ for different trimesters of pregnancy

Trimester	Original		Model 1		Model 2		Model 3	
	$MMSE^3$		Age		Age+Educational Level		Age+Educational Level+ Number of Pregnancies	
	β	P	β	P	β	P	β	P
1st	Ref		Ref		Ref		Ref	
2nd	157.64	0.75	157.64	0.75	157.64	0.71	157.64	0.72
3rd	-143.35	0.77	-143.35	0.77	-143.35	0.74	-143.35	0.74

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Compared to the first trimester, the score of $MMSE^3$ increased by 6.31 in the second trimester (P=0.75) and decreased by 5.15 in the third trimester (P=0.77), but were not statistically significant. Age, educational level, and number of pregnancies had no significant effect on the $MMSE^3$ score during different trimesters.

Compared to the first trimester, the mean WMS scores decreased by 0.6 and 4.4 in the second and third trimesters, respectively, but the change in WMS score was statistically significant (P=0.04) only in the third trimester (Table 4). Beta values did not change in different regression models, indicating that covariances had no effect on the score of WMS. Therefore, age, educational and number of pregnancies had no significant effect on the WMS score.

Discussion

The findings of the present study showed that the WMS scores of women decreased significantly during pregnancy. This indicates that the memory function of pregnant women gradually decreases during pregnancy. The poorest function was observed in the third

Table 4. Results of linear regression models of WMS for different trimesters of pregnancy

Trimester	Original		Model 1		Model 2		Model 3	
	WMS		Age		Age+Educational Level		Age+Educational Level+Number of Pregnancies	
	β	P	β	P	β	P	β	P
1st	Ref		Ref		Ref		Ref	
2nd	-0.62	0.77	-0.62	0.76	-0.62	0.73	-0.62	0.73
3rd	-4.39	0.04	-4.39	0.03	-4.39	0.02	-4.39	0.02

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trimester. However, the MMSE scores did not change significantly during pregnancy. According to the findings, it was not possible to predict general cognition and memory based on demographic variables, including age, educational level, and number of pregnancies during different pregnancy trimesters.

The results of the present study are consistent with the results of studies that showed the association of pregnancy with memory deficits [5-8]. A recent meta-analysis found that overall cognitive, memory, and executive functions decreased in the third trimester of pregnancy compared to controls. Although the memory impairment was significant in most cases, it was mild; it was about forgetting appointments rather than forgetting important events such as job [8]. Consistent with the results of Davies et al. our results showed that memory decreased significantly during pregnancy, but without significant change in general cognition. Another study suggested that cognitive reorganization might occur with minor disturbances in working memory, general cognition, information processing speed, and abstract reasoning during pregnancy [7]. The results of the present study, in line with the results of most studies in different countries, supported the fact that changes in cognitive function occur during pregnancy. Pregnancy is a period with physical, psychological, hormonal and social changes; at this stage period, the risk of emotional and mental illnesses increases [7].

One of the possible reasons for explaining memory impairment is cortisol, a steroid hormone that increases during pregnancy [24] and negatively affects cognitive function [25]. In addition, Ramanoël et al. emphasized the role of gray matter volume on cognitive function [26]. Research has shown that the volume of gray matter in the brain decreases during pregnancy which continues for at least two years after pregnancy [27]. Zeeman et al. used Magnetic resonance imaging to measure low cerebral blood flow during pregnancy. They found that blood flow to the middle and posterior cerebral arteries decreased, but the mechanisms and significance of this reduction were unknown [28]. On the other hand, this period can be associated with anxiety, stress [29], and concerns about pregnancy, childbirth, fetal health, and maternal responsibilities [30, 31]. Studies have shown that mothers experience more anxiety in the first and third trimesters of pregnancy [31]. This anxiety may lead to changes in cognitive function [32].

Among the limitations of the present study, one was the small sample size and other was the exclusion of patients with severe cognitive problems and comorbidities, which limits the study to a specific population. Using a larger sample size is recommended for better generalizability in future studies. Furthermore, other aspects of cognition and memory such as executive and working memory are recommended to be examined using a follow-up study.

Conclusion

The memory function of pregnant women is better in the first and second trimesters than in the third trimester of pregnancy, while their general cognitive function do not change considerably during pregnancy. Moreover, there is no significant difference in memory and general cognitive function during pregnancy among pregnant women with different age, educational level, and number of pregnancies.

Ethical Considerations

Compliance with ethical guidelines

All study procedures were in compliance with the ethical guidelines of the Declaration of Helsinki 2013. The study was approved by the Ethical Committee of Guilan University of Medical Sciences (Code: IR.GUMS.REC.1397.373). Prior to the study, the study objectives and methods were explained to the participants, and they were assured of the confidentiality of their personal information. Informed consent was obtained from them to participate in the study.

Funding

This paper was extracted from the PhD dissertation of the sixth author. The study was funded by Guilan University of Medical Sciences (Grant No.: 97100210).

Authors contributions

Conceptualization, investigation, methodology, Writing-review & editing: All authors; Formal analysis: Mir Mohammad Jalali; Writing-original draft: Fatemeh Eslamdoust-Siahestalkhi; Supervision: Robabeh Soleimani, Maryam Kousha, Maryam Asgharnia; Funding acquisition: Robabeh Soleimani; Data collection: Rahman Iranidoost-Haghighi.

Conflict of interest

The authors declared no conflicts of interest.

Acknowledgements

The authors would like to thank Guilan University of Medical Sciences and the women who participated in this study for their support and cooperation.

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