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Original Article

Physiology Section

An Analysis into Metacognition and Family History of Diabetes Mellitus among First Year Medical Students

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ABSTRACT

Introduction: Medical course requires immense effort by the students to deal with vast curriculum and hence, the need to adopt metacognitive skill to cope up. Diabetes mellitus has an impact on cognition. Metacognition, being a component of cognition, is likely to be affected by diabetes. Children of diabetic parents have demonstrated insulin resistance which may contribute to metacognitive dysfunction. Hence, it is important to focus into the link between family history of diabetes and metacognition.

Aim: To evaluate the impact of family history (parents and grandparents) of diabetes mellitus on metacognition in medical students.

Materials and Methods: The present study was a questionnaire based cross-sectional study. Hundred first year medical students were recruited and they filled the Metacognitive Awareness (MA) questionnaire along with the details of the family history of diabetes. The metacognitive awareness questionnaire evaluated MA, its components (metacognitive knowledge and regulation) and their subcomponents. Positive history of diabetes in parents and grandparents were taken into account. The participants were then divided into two groups: with family history of diabetes (n=73) and without family history of diabetes (n=27). The metacognitive awareness and its subcomponents between the two groups were analysed using Student t-test between the groups (with and without family history). Pearson correlation was done to analyse the association between metacognition and family history of diabetes.

Results: Metacognitive knowledge (global score) was significantly lower in group with family history of diabetes (10.25±3.01 vs 12.04±3.2, p-value<0.05) as was metacognitive regulation global score (7.08±1.83 vs 7.99±1.36, p-value<0.05). Declarative knowledge and information management showed significant difference. Metacognitive knowledge showed a significant negative correlation with family history of diabetes (correlation coefficient = -0.263, p-value<0.01).

Conclusion: Students with family history of diabetes had reduced metacognitive awareness. The awareness that metacognitive dysfunction can occur in early age in individuals with family history of diabetes would help us to identify them and device strategies to delay or prevent metacognitive dysfunction.

Keywords: Cognitive dysfunction, Hyperinsulinemia, Insulin resistance, Metacognitive awareness

INTRODUCTION

Cognition refers to the ability to coordinate thought and action and direct it towards obtaining goals [1]. Metacognition, a subtype of cognition is defined as the activity of monitoring and controlling one's cognition and using this cognitive process to learn and remember [2]. As a medical student, it is of vital importance that the student acquires an efficient and goal-directed learning ability. It is also crucial that these students adopt the metacognitive awareness skills required to cope up with the vast medical curriculum. Metacognition, like a doctor's skill develops throughout the course of a person's life and can be honed to optimally perform in one's chosen career.

Metacognition is the awareness of one's own thinking process. Metacognitive awareness has two components: knowledge of metacognition and regulation of metacognition [3] which are inter-related. Awareness of one's own cognitive process is known as metacognitive knowledge [4] which includes subcomponents like declarative, procedural and conditional knowledge. Declarative knowledge is defined as the knowledge of the factors influencing how we learn and what we learn. Knowledge about the learning and memory strategies suited best to an individual is called procedural knowledge while conditional knowledge is the awareness of the conditions under which the student implements various cognitive strategies [5]. Metacognitive Regulation (MR) is defined as the steps taken to facilitate learning and memory. The components of MR are planning (create a plan for task completion), information management (understanding the task involved), debugging (identifying his competencies related to the task), evaluation (reforming the plan according to the needs) and monitoring (monitor the progress of the plan) [6].

Diabetes mellitus being an epidemic in India, its impact on our physical and mental well-being becomes a cause for concern [7]. The micro and macrovascular complications of diabetes mellitus are well documented. Numerous studies have proven cognitive dysfunction in diabetics [8,9]. In our study we focus on the metacognitive aspect of cognition. Hyperglycaemia with intracellular accumulation of Advanced Glycation End products (AGEs) and microvascular abnormalities were proposed to be the reason behind cognitive dysfunction in diabetics [10]. It's a well-known fact that a family history of diabetes is a high risk factor for the eventual development of diabetes in an individual [7,11,12]. Studies on offspring of gestational diabetic mothers also have shown both positive [13] and negative impact [14] on cognition.

The decline in cognition due to diabetes mellitus is proven [15] and hence, it stands to reason that metacognition would also be affected by it. Metacognition is an emerging skill during childhood and shows life-long growth [6]. The prevalence of diabetes mellitus in the parent may demonstrate a stunting of the metacognitive growth in the offspring. Hence, our study focuses on the effect of family history of diabetes on metacognition which is unexplored. We hypothesise that a person with family history of diabetes is not only at a higher risk of getting diabetes but also may develop metacognitive dysfunction at an early age.

We propose that if any negative impact of family history of diabetes is proven, necessary interventions in the form of moulding metacognitive skills and optimal lifestyle enhancement strategies can be inculcated at a fairly young age.

MATERIALS AND METHODS

The participants were first year MBBS students in a Jubilee Mission Medical College and Research Institute, Thrissur, Kerala. Institutional ethical approval was obtained. All the first year medical students aged between 18-20 years, willing to participate in the study formed the inclusion criteria. Complete sampling method was used to determine the sample size. After obtaining their informed consent, 100 students filled out personal data which included the details of the family history of diabetes and metacognitive awareness questionnaire. Positive history of diabetes in parents and grandparents were taken into account. Based on the family history of diabetes they were divided into two groups with (FH+) and without (FH-) family history of diabetes.

Metacognitive awareness questionnaire was proposed by Schraw and Dennison. It includes 52 questions of the true and false variety. For every answer marked 'true' a score of 1 is given and 0 for 'false'. The total score indicates the total metacognitive awareness in medical students. Metacognitive awareness is divided broadly into two categories namely metacognitive knowledge (sub components: procedural, declarative and conditional knowledge) includes 17 questions and regulation (sub components: debugging, planning, information management, evaluation and comprehension monitoring) includes 35 questions. The score in each category is also calculated [16].

STATISTICAL ANALYSIS

The data was analysed using SPSS software version 20.0. The data was normally distributed and hence were represented as Mean±SE. Student t-test was done to analyse the difference in metacognitive awareness between FH+ and FH- group. Pearson correlation evaluated the relationship between metacognitive awareness, its components and family history of diabetes.

RESULTS

Out of 100 students who participated in the study, 73 students had family history of diabetes (FH+). India being the diabetic capital of the world [7], it was not surprising to find only 27 students without family history of diabetes (FH-). Of the FH+ group, 70% had only one family member with diabetes, while 30% had more than one member with diabetes.

[Table/Fig-1] shows the general characteristics of the study population. Both the groups (FH+ and FH-) were similar in their anthropometric parameters (weight, height and BMI).

[Table/Fig-2] compares metacognitive awareness and its components knowledge and regulation between the two groups. Metacognitive awareness knowledge was significantly higher in FH- group compared to FH+ group (36±6.94 Vs 32.9±6.67). Metacognitive knowledge, a subcomponent of MA also showed similar result.

[Table/Fig-3] compares the metacognitive knowledge levels in students with and without family history of diabetes mellitus. The mean value was consistently higher in the group without family history of diabetes, of which metacognitive declarative knowledge was significantly higher in the group without family history of diabetes (5.3±1.83 Vs 4.27±1.73).

[Table/Fig-4] compares the subcomponents of metacognitive regulation between the two groups. Of the metacognitive regulation parameters, information management showed significant difference between the groups (7.99±1.36 Vs 7.08±1.83).

Correlation between family history of diabetes and metacognitive awareness, knowledge and metacognitive regulation has been shown in [Table/Fig-5]. Metacognitive awareness and knowledge showed a significant negative correlation with family history of diabetes.

Variables	FH- (n=27)	FH+ (n=73)	p-value
Age (years)	19.19±0.14	19.3±0.12	0.653
Height (cm)	166.28±1.7	163.69±1.06	0.190
Weight (kg)	59.5±2.06	57.39±1.39	0.284
BMI (kg/m^2)	21.47±0.55	21.33±0.37	0.660

[Table/Fig-1]: Subject characteristics.
Data represented as Mean±SE. Independent t-test showed no significant difference between the two groups. FH- represents group without family history of diabetes, FH+ represents group with family history of diabetes.

Variables	FH- (n=27)	FH+ (n=73)	p-value
Metacognitive awareness	36±6.94	32.9±6.67*	0.034
Metacognitive knowledge	12.04±3.2	10.25±3.01*	0.04
Metacognitive regulation	23.96±4.2	22.60±4.76	0.229

[Table/Fig-2]: Metacognitive awareness and its components between the two groups.
Data represented as Mean±SD. Independent t-test. *p<0.05. FH-represents group without family history of diabetes, FH+ represents group with family history of diabetes.

Metacognitive knowledge subcomponents	FH- (n=27)	FH+ (n=73)	p-value
Procedural knowledge	3.04±1.02	2.79±1.08	0.182
Declarative knowledge	5.3±1.83	4.27±1.73*	0.011
Conditional knowledge	3.70±1.23	3.19±1.21	0.17

[Table/Fig-3]: Metacognitive knowledge subcomponents between the two groups.
Data represented as Mean±SD. Independent t-test. *p<0.05. FH- represents group without family history of diabetes, FH+ represents group with family history of diabetes.

Metacognitive regulation subcomponents	FH- (n=27)	FH+ (n=73)	p-value
Information management	7.99±1.36	7.08±1.83*	0.045
Debugging	4.37±0.69	4.25±0.86	0.356
Planning	3.67±1.66	3.74±1.57	0.928
Comprehension monitoring	4.11±1.6	4.08±1.65	0.927
Evaluation	3.89±1.42	3.45±1.36	0.240

[Table/Fig-4]: Metacognitive regulation subcomponents betweenthe two groups.
Data represented as Mean±SD. Independent t-test. *p<0.05.FH- represents group without family history of diabetes, FH+ represents group with family history of diabetes.

Variables	Metacognitive awareness	Metacognitive knowledge	Metacognitive regulation
Family history of diabetes mellitus	-0.204*	-0.263**	-0.105

[Table/Fig-5]: Correlation between global metacognitive scores and family history of diabetes.
Pearson correlation.*p<0.05, **p<0.01.

DISCUSSION

In the present study, presence of family history of diabetes showed a negative impact on metacognitive awareness, especially, metacognitive knowledge in first year medical students. Though the underlying mechanism is not explored extensively, the following mechanisms could be speculated. Hyperglycaemia is known to produce organ dysfunction, altered neurotransmitter levels and impaired learning abilities in diabetics [17]. Normoglycaemic offspring of diabetic parents have demonstrated insulin resistance [18] which may contribute to cognitive dysfunction by any one or a combination of the following mechanisms:

1. Inflammatory marker elevation;
2. Hypothalamo-pituitary adrenal axis dysfunction with elevated serum cortisol levels. Hypercortisolemia could cause cognitive dysfunction [19,20].

The role of insulin in the brain is neurotropic. It exerts an influence over neurotransmission, synaptic plasticity and cognitive process

[21]. Hyperinsulinemia due to insulin resistance downregulates insulin receptors resulting in a reduction of insulin levels in brain which enhances neurodegeneration and ageing [22]. Evolution is responsible for the dramatic increase in the size and complexity of the prefrontal cortex which correlates with the evolved behaviour exhibited by humans [1]. Cognition is known to be a function of the prefrontal cortex [23]. The development of cognition and prefrontal cortex go in line.

Even though metacognition remains a dynamic process throughout life, maximum development occurs during adolescence till the age of 20 years which is the approximate age of our students [23]. Cerebral glucose metabolic rate as measured by PET scan shows cognitive task related changes in the prefrontal cortex in healthy adults. The same task in pre-diabetics showed a widespread activation of the brain in and around the prefrontal area [24] which depicts early functional abnormality. A student with a positive family history of diabetes mellitus may exhibit insulin resistance which can be linked to the poorer metacognitive performance in them [18,25]. So we propose that, early onset of insulin resistance in students with family history of diabetes could cause a decrease in metacognition, which should be recognised early and appropriate intervention has to be undertaken to prevent the full blown metacognitive dysfunction as they age. To our knowledge, there is no medical literature available on family history of diabetes and metacognition. The inverse relationship with family history of diabetes mellitus with metacognition emphasises the importance of the role of insulin played on the metacognitive behaviour of the student.

LIMITATION

Blood glucose and insulin levels were not recorded in our students which could have been used to ensure normoglycaemia and determine insulin resistance. These measurements could have strengthened our findings.

CONCLUSION

The current study found a decreased metacognitive awareness in students with family history of diabetes. Metacognitive development is a dynamic process and subject to influence by various factors, family history of diabetes being one of the major factors. The awareness that metacognitive dysfunction can occur in early age in individuals with family history of diabetes would help us to identify them and device strategies to delay or prevent metacognitive dysfunction.

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