REVISIONES

Relation of the Glycemic Control, Cognitive Function and Executive Function in the Elderly with Type 2 Diabetes: Systematic Review

Relación del Control Glucémico, Función Cognitiva y las Funciones Ejecutivas en el Adulto Mayor con Diabetes Tipo 2: Revisión Sistemática

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ABSTRACT

Objective: To evaluate the available evidence to demonstrate the relationship between glycemic control, cognitive function and executive functions in the Elderly with T2D.

Methods: Based on the model proposed by Cooper (2007) a literature review was conducted in English and Spanish, in 14 databases, Open Access, and the Google search engine. The validity of the studies was assessed through the CASPe a guide for case-control studies.

Results: 11 correlation studies were analyzed all of them demonstrated a relationship between glycemic control, cognitive impairment and executive function in the elderly with T2D. The studies coincide that the elderly with T2D evidence cognitive impairment, compared to the elderly without T2D, therefore that a deficit in the elderly exist to carry out executive functions.

Conclusions: Based on the available evidence there is a significant relationship in glycemic control and cognitive impairment in the AM with DT2, also a lower performance in functional mobility and verbal fluency.

RESUMEN

Objetivo: Revisar la evidencia disponible que demuestre la relación que existe entre el control glucémico, función cognitiva y las funciones ejecutivas en el AM con DT2.

Métodos: La búsqueda de la literatura se realizó en idioma inglés y español, en 14 bases de datos, Open acces, y en el buscador Google. En base al modelo propuesto por Cooper (2007), para la síntesis

de la literatura. Los estudios fueron evaluados para su validez, a través de la guía CASPe para estudios de casos y controles.

Resultados: Se analizaron 11 estudios de correlación, el 100% de los estudios mostró relación del control glucémico con el deterioro cognitivo y la función ejecutiva en AM con DT2. Los estudios concuerdan que los AM con DT2 presentan deterioro cognitivo, comparado con los AM sin DT2, por lo tanto existe déficit en el AM al realizar las funciones ejecutivas.

Conclusiones: Según la evidencia disponible existe una relación significativa en el control glucémico y el deterioro cognitivo en el AM con DT2, así mismo un menor desempeño en la movilidad funcional y la fluidez verbal.

INTRODUCTION

Type 2 diabetes (T2D) has become a public health problem for the Elderly due to the high prevalence, it is one of the most common diseases in this age group. In Mexico, affects the 19.2% of adults aged 60-69 years, its prevalence increases with age, at 75 years old, approximately 20% of the population suffers T2D and 44% are over 65 years [1]. The T2D is a multiple etiology syndrome, produced by the lack of insulin and / or the inability of the hormone to perform its effects properly, which leads to the development of associated diseases and complications such as retinopathy, nephropathy, neuropathy, loss of joint mobility and muscle strength. In addition, cognitive function also seems to be involved in the elderly with T2D.

The evidence shows that the elderly with T2D, is more likely to have cognitive impairment due to structural and functional changes in the central nervous system (CNS), resulting from the aging process, cortical and subcortical structures can undergo additional changes due to changes in metabolism associated with T2D [3,4]
It has been reported that cognitive impairment is inversely related to levels of type 1 insulin growth factor (IGF-1) in the elderly, an endogenous peptide with multiple effects on neuronal cells with neurotrophic responses, is involved in many processes that maintain brain homeostasis, so their presence at appropriate concentrations influences brain function [5,6]

There is evidence of their participation in neuronal maintenance, energy metabolism, neurogenesis and regulation of neurotransmitters; It is also involved in neuronal function processes as long-term memory and other cognitive activities [7,8].

The cognitive impairment probably limits the most complex processes, directly related to the frontal lobe, as executive function, which involves a set of cognitive skills, attention, working memory, monitoring, flexibility, inhibition, organization, decision making and knowledge, which controls the performance of complex activities, in the context of T2D this can influence to solve problems in the daily management of their condition, working memory, and planning [3,9]. In addition, cognitive impairment can potentially present new obstacles to personal care and to achieve glycemic control.

In many daily life activities, people need to perform more than one task at the same time, like walking or to communicate with others. Cognitive impairment during the execution of a double task, can be an important indicator of the functional state of the elderly with T2D. When two tasks running simultaneously, the performance of one or both can be decreased. The double task often involves both verbal and visual information, the performance of simultaneous tasks is complex and this could lead to a deficit in the management of glycemic control [14,15].

For the above mentioned, the approach in this review are glycemic control, cognitive function and executive functions, with the purpose of reviewing the available evidence showing the relationship between glycemic control, cognitive function and executive functions in the elderly with T2D.

METHODOLOGY

A literature review was performed based on the seven steps of Cooper (16): 1) problem formulation, 2) literature search, 3) gather information studies, 4) evaluation of the quality of studies, 5) analyze and integrate the results, 6) interpret the evidence and 7) present the results.

In the first step the variables of the study were defined: executive function, cognitive function, glycemic control. Then a search to identify systematic reviews or assessment reports was conducted in the Cochrane Library, and the following databases Centre for Reviews and Dissemination, Anual review, Dialnet, DynaMed, Medic Latina, Medline Ovid, MEDLINE with Full Text, CINAHL with full text, Embase, Psyc artcicles, Elsevier, Global issues incontext, Academic search complete, Evidence-based Practice Centers, Medline Plus, PubMed, The Campbell Collaboration, Open acces, and Google.
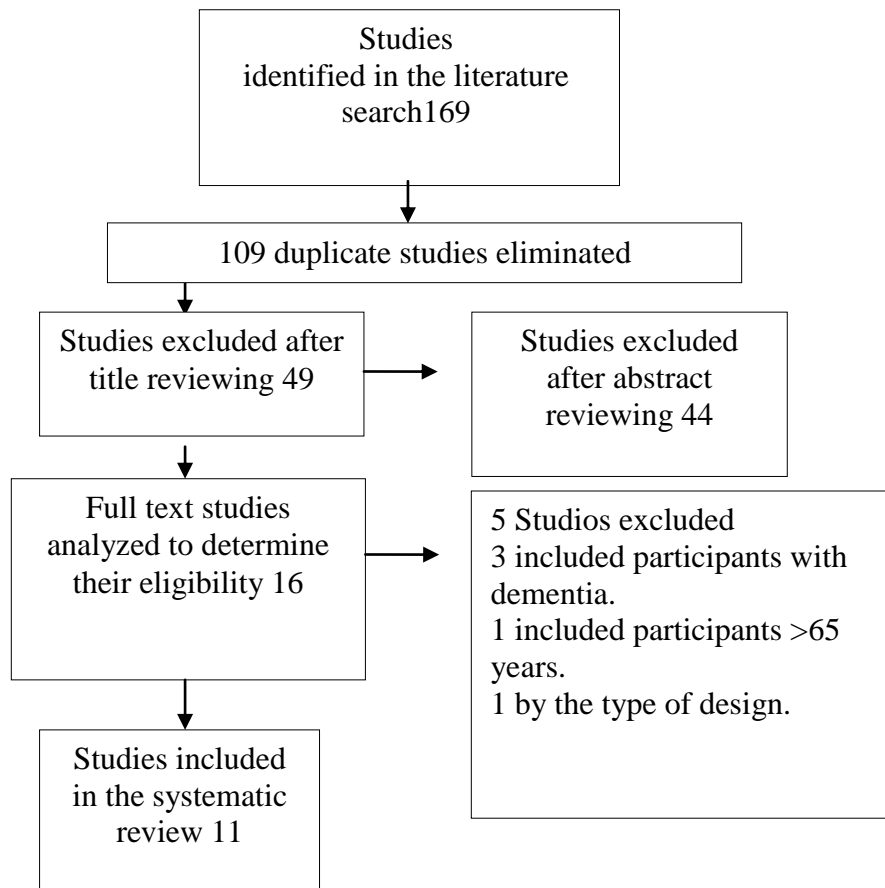
Combinations of the keywords: executive function, diabetes, elderly, Blood Glucose Self-Monitoring, attention, memory, cognition according to the Medical Suject Headings (MeSH) were used, in English and Spanish. Also a manual search was performed based on the reference lists of the review articles and additional potentially eligible studies, from October to November 2012. Boolean operators (AND, OR and NOT) were used for MEDLINE and EMBASE bases, truncation and wildcards ($, ", *, #) according to the chapter 6.4 of Cochrane search strategy were used [17].

Were included in the review cross-sectional studies expressed glycemic control relationship with the executive functions in participants >65 years of age with T2D, and were excluded those studies in which participants were dementia-related diagnoses.

To select the articles to include in the review, at first the abstract was review to identify studies that met the criteria established. Then a full text reading was done, quality and risk of bias through its internal validity was assessed, it took into account the design type, sampling, sample size, reliability instruments, congruence of objective and the statistical used and results, a CASPe Guide [18] was also used to evaluate the study case and controls, which consists of 11 questions, the first two are for elimination, if the answer to those two questions was yes will continue with the remaining questions, otherwise the study was removed, the response options are: yes, no, I do not know.

The question number 3 of the CASPe [18] guide was removed because the evaluated studies do not have enough information to be answered, and it does not provide additional information about the quality of the studies evaluated at this stage, some studies were eliminated because of lack of methodological quality, that results reports little consistency with the proposed objectives. The following diagram shows the process of selection of studies during the phases of the review [19].

Figura 1. Flowdiagram different phases of the systematic review.

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                    ┌─────────────────────┐
                    │      Studies        │
                    │ identified in the   │
                    │  literature         │
                    │   search169         │
                    └─────────┬───────────┘
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                    │ 109 duplicate       │
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         │ Studies excluded after│─────▶│ Studies excluded     │
         │ title reviewing 49    │      │ after abstract       │
         │                       │      │ reviewing 44         │
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         │ Full text studies     │      │ 5 Studios excluded       │
         │ analyzed to determine │─────▶│ 3 included participants  │
         │ their eligibility 16  │      │ with dementia.           │
         │                       │      │ 1 included participants  │
         │                       │      │ >65 years.               │
         │                       │      │ 1 by the type of design. │
         └────────────┬──────────┘      └──────────────────────────┘
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         │ Studies included      │
         │ in the systematic     │
         │ review 11             │
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RESULTS

The studies analyzed [2,20-29] who met the inclusion criteria for this review was eleven, the characteristics are presented in Table 1. The number of participants with DT2 in the studies ranged from 1398 to 40 participants per study.

The results of this systematic review provide evidence of the transverse, longitudinal and case-control studies demonstrate relationship of glycemic control, cognitive function and executive functions in the elderly with T2D. Moreover, these results reveal the impact of cognitive impairment in development of the executive functions of the elderly with T2D. Studies evidence that glucose levels causes a cognitive impairment. In addition, the cognitive impairment is associated with a deficit in care activities which affects glycemic control [21]. However, other studies showed that cognitive capacity affects the ability of individuals to carry out the glycemic control, and poor glycemic control in turn impairs cognitive function, especially in diet and exercise [21,22,24,28,29].

Also it was found that glucose levels are associated with cognitive function and impaired executive function, on the contrary, in people without T2D, there is not a clear association between baseline levels of fasting glucose, executive function and memory, there was no relationship at high levels of glucose [2,22,23,28]. Similarly T2D is associated with performance in delayed recall but not immediate recall. T2D was associated with cognitive impairment and verbal fluency test, they found that poor glycemic control is associated with alterations in performance composite measures

(double tasks) and activities of daily living of executive function [2,22,29]. Table 1 shows the relationship of the variables of the studies analyzed in this review.

Table 1. Selected articles about the relationship of cognitive impairment and Executive Function with Glycemic Control

Author / Year	Sample / Design	Glycemic Control	Cognitive impairment	Funciones Ejecutivas		
				(SC) (DLA)	Fluency verbal	Task double
Feil, Zhu & Sultzer, 2012 [20]	N= 1398 Age = 70 Correlational	Glycosylated hemoglobin	*	*		
Munshi, Hayes, Iwata, Lee, Weinger, 2012 [21]	N= 145 Age M=77 correlational	Glycosylated hemoglobin	*	*	*	
Anagawa et al., 2011 [22]	N= 16 Age M= 70 correlational	Niveles de glucosa en ayunas	*		*	
Nguyen et al., 2010 [23]	N= 95 Age > 60 correlational	Glycosylated hemoglobin	*	*		
Euser, et al., 2010 [24]	N= 3428 Age = 61-97 correlational	Fasting glucose levels	*			
Van Harten et al Munshi et al., 2006 [25]	N= 60 Age = 70 correlational	Glycosylated hemoglobin	*			
Van Harten et al., 2006 [26]	N= 92 Age M=73.2 correlational	Glycosylated hemoglobin	*			
Hagemann, Sartory, Hader, Kobberli 2005 [27]	N=260;129 CD Age 650 Correlational	Glycosylated hemoglobin	*	*	*	
Alvarenga, Pereirall, Anjos, 2005 [2]	N= 40; 20 CD Age = ≥ 60 correlational	Fasting glucose levels	*		*	*
Debling, Amelang, Hasselbach, Sturmer, 2005 [28]	N= 740 Age = 70 correlational	Fasting glucose levels	*	*		
Mogi, et al., 2004 [29]	N= 69 Age 60-85 correlational	Glycosylated hemoglobin	*-			

DLA= Daily life activities; SC= Self-care; * significance p<0.001; *- negative significance

Table 2. Measuring Instruments for the Variables of the Studies of the review

Author / Year	Glycemic Control	Cognitive impairment	Executive functions		
			DLA (SC)	Verbal fluency	Double task
Feil, 2012 [20]	GH	Mini Mental State Examination (MMSE) designed for use in telephone surveys	validated scale (Fitzgerald et al, 1996; Nicklett & Liang, 2010), 5 domain, Likert Scale		
Munshi, 2012 [21]	GH	Trail Making Test- parts A & B	Clock-in-a-Box test Dysexecutive Questionnaire (DEX)	Phone mic Verbal fluency	
Anagawa et al., 2011 [22]	FGL	MMSE El Trail Making Test Stroop Color-Word Symbol Digit, (WAIS-R)		Words list	
Nguyen et al., 2010 [23]	GH	Digit span test Wechsler Memory Scale-III	Knowledge test diabetes self-care questionnaire		
Euser, et al., 2010 [24]	FGL	MMSE			
Munshi et al., 2006 [25]	GH	MMSE			
Harten et al., 2006 [26]	GH	Neuropsychological tests MRI of the brain.			
Hageman, 2005 [27]	GH	MMSE	validated scale (Fitzgerald et al, 1996; Nicklett & Liang, 2010), 5 domain, Likert Scale	Mentioning 20 DLA	
Alvarengai, 2005 [2]	FGL	TUG Cognitive test	Debling	Animal category Test number of correct answers obtained in a minute	TUG aged reliability testting
Debling, 2005 [28]	FGL	Telephone interview of cognitive status and the East Boston Memory test (EBMT).	Eating habits Questions		
Mogi, et al., 2004 [29]	GH	MMSE, Test symbols , stroop colors			

GH= Glycosylated hemoglobin. FGL= Fasting glucose levels. Domains 1= Taking medication for diabetes, 2= exercise regularly, 3 = after a recommended eating plan, 4= blood glucose level for review, 5= check the presence of wounds or sores in the feet. Likert scale= 1 = very hard that I could not do it at all, 2 = very difficult, almost never do this, 3 = difficult, but I managed some of the time, 4 = not difficult, I've gotten most of the time, and 5 = is not difficult, I have absolutely right.. (WAIS-R)= subtest of the Wechsler Adult Intelligence Scale Revise

DISCUSSION

The projected increase in T2D and the deterioration in cognitive function of the elderly represent a major public health problem to the society [30,31].

The results suggest a complex association between cognitive function and glycemic control in this population. This review of 11 studies demonstrate the idea that executive function will harm the T2D related to knowledge and later self-care behaviors, interfering with glycemic control. In addition, self-care is a central component to achieve glycemic control, current data suggest that impaired executive function may interfere with the ability of older adults to perform functions of daily living and related T2D care [31]

It has been demonstrated that executive function may endanger the care capacity to perform activities of daily living, develop complex tasks necessary for self-care, such as controlling blood glucose and insulin, medication, diet modification and physical activity [3,21].

CONCLUSION

Although executive function may be related to glycemic control, understanding the mechanisms of such an association it is limited. These results confirm previous observations, this review suggests continue examining the findings that explain the positive and negative relationship of executive function on glycemic control, it is considered necessary to conduct additional research to identify that at what period of time from the diagnosed in the elderly with T2D occurs deterioration in cognitive function, and develop interventions that allow to examine in greater depth if the age or the T2D is the cause of limiting to carry out the executive functions in the elderly.

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