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Number of years with type 2 diabetes is associated with suspicion of cognitive impairment in Chilean older adults: a cross-sectional study

Numero de años con diabetes mellitus tipo 2 y su asociación con la sospecha de deterioro cognitivo en personas mayores chilenas: un estudio transversal

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ABSTRACT

Introduction: The average life expectancy, as well as the prevalence of Type 2 diabetes (T2D), is increasing worldwide. Population-based studies have demonstrated that the duration of T2D has been associated with cognitive impairment. However, despite the high prevalence of T2D and cognitive impairment in Chile, the association between years with T2D and suspicion of cognitive impairment has not yet been investigated. The objective of this study was to investigate the association between duration of T2D and suspicion of cognitive impairment in Chilean older adults.

Material and Methods: 1,040 older adults aged ≥60 years from the Chilean National Health Survey (2009–2010) were included. Suspicion of cognitive impairment was assessed by the abbreviated Mini-Mental State Examination (MMSE). The number of years with T2D was self-reported and categorised into four groups. Poisson Regression analysis was used to assess the association between altered MMSE and the number of years with DM2, adjusted by potential confounders including socio-demographic, lifestyle, adiposity and health-related factors.

Results: When the analyses were adjusted for socio-demographic factors, people who had T2D for 15 to 24 and ≥25 years had 2.2-times (95% CI: 1.07; 3.33) and 5.8-times (95% CI: 3.81; 11.0) higher relative risk (RR) of cognitive impairment, compared to those without T2D. When the analyses were additionally adjusted for lifestyle and health-related covariates, the RR for cognitive impairment was 1.76-times (95% CI: 1.02; 2.50) and 4.54-times (95% CI: 2.70; 6.38) higher for those who had T2D for 14-24 years and ≥25 years, respectively.

Conclusions: Number of years with T2D was associated with suspicion of cognitive impairment. A longer duration of T2D was associated with a higher likelihood of cognitive impairment in the Chilean older population, independently of confounder factors included in the study.

Keywords: Aging; Cognitive Dysfunction; Diabetes Mellitus, Type 2.

RESUMEN

Introduction: La esperanza de vida está aumentando en todo el mundo, así como la diabetes tipo 2 (DM2). Estudios poblacionales han demostrado que la duración de la DM2 se ha asociado con el deterioro cognitivo. Sin embargo, a pesar de la alta prevalencia de DM2 y deterioro cognitivo en Chile, aún no se ha investigado la asociación entre años con DM2 y la sospecha de deterioro cognitivo. El objetivo del estudio fue investigar la asociación entre la duración de la diabetes mellitus 2 (DM2) y la sospecha de deterioro cognitivo en personas mayores chilenas.

Métodos: Participaron 1.040 personas ≥60 años de la Encuesta Nacional de Salud de Chile (2009-2010). El deterioro cognitivo se evaluó mediante el Mini Examen del Estado Mental abreviado (MMSE). El número de años con DM2 fue categorizado en cuatro grupos. Para valorar la asociación entre MMSE alterado y el número de años con DM2, se utilizó una regresión de Poisson, ajustados a posibles factores de confusión sociodemograficos, de estilos de vida, adiposidad y salud.

Resultados: Cuando se ajustaron los análisis por factores sociodemográficos, las personas con 15 a 24 y ≥25 años con DM2 presentaron 2,2 veces (IC 95%: 1,07; 3.33) y 5,8 veces (IC 95%: 3.81; 11.0) riesgo relativo (RR) de deterioro cognitivo, en comparación con aquellas sin DM2. Luego de ajustar adicionalmente los análisis para las covariables relacionadas con el estilo de vida y la salud, el RR para deterioro cognitivo fue 1.76 veces (IC 95%: 1.02; 2.50) y 4.54 veces (IC 95%: 2.70; 6.38) más alto para aquellas personas con 14-24 y ≥25 años de DM2.

Conclusiones: Se asoció el número de años con DM2 con la sospecha de deterioro cognitivo. Una mayor duración de la DM2 se asoció con una mayor probabilidad de deterioro cognitivo en la población mayor chilena.

Palabras claves: Envejecimiento; Disfunción Cognitiva; Diabetes Mellitus Tipo 2.

KEY MESSAGES

- Previous population-based studies have demonstrated that the duration of T2D is associated with cognitive impairment. However, the association between years with T2D and suspicion of cognitive impairment has not yet been investigated in Chile.
- The number of years with T2D was associated with suspicion of cognitive impairment.
- Individuals with more than 15 years with T2D had a higher likelihood of suspicion of cognitive impairment than those without T2D, independent of socio-demographic, lifestyle, anthropometric, adiposity and health-related factors.
- Findings support the need for regular cognitive assessment in older adults with T2D, especially those who have had T2D for a longer time.

INTRODUCTION

The average life expectancy is increasing worldwide. According to the World Health Organization (WHO), between 2015 and 2050, the number of older adults worldwide, aged 60 years and above, will increase from 12% to 22% (1). This increment in the number of older adults has also been observed in Chile, where the percentage of older adults is projected to increase from 11.4% in 2015 to 20% by 2040 (2).

Together with natural population ageing, the prevalence of non-communicable diseases (NCDs), such as type 2 diabetes (T2D), is also expected to increase (3). T2D is one of the four major risk factors for NCDs (1). In Chile, current statistics indicate that the prevalence of this disease has increased from 9.4% in 2010 to 12.3% in 2017 (4). Poor diet and lack of physical activity have been the main factors associated with its increasing prevalence (5).

Numerous population-based studies have demonstrated that T2D is a risk factor for cognitive impairment (6-8). Therefore, considering the increment in the older population with T2D in Chile, it is likely that the prevalence of older adults with cognitive impairment will rise as well (2, 4, 9, 10). The duration of T2D has also been associated with cognitive impairment as well as the metabolic disorder itself in European populations (11, 12). Furthermore, a long duration of T2D also increases the risk of clinical cerebral and subclinical infarctions (13) and is an atherogenic factor for cognitive impairments (13). However, despite the high prevalence of T2D and cognitive impairment in Chile, the association between years with T2D and cognitive impairment has not yet been investigated. Therefore, the aim of this study was to determine the associations between the duration of T2D and suspicion of cognitive impairment in older Chilean adults.

MATERIAL AND METHODS

Study Design

This cross-sectional study used data from the Chilean National Health Survey (CNHS) 2009-2010 (9). In general terms, CNHS 2009-2010 was a cross-sectional, probabilistic, geographically stratified, multistage population survey, which allowed obtaining the prevalence of health conditions in the Chilean population over 15 years of age, from urban and rural areas of 15 regions of the country. The total sample size was 7,549 households, of which 5,058 were expected, considering the potential non-response to the survey (30%) (9). From the 5,412 original participants from the CNHS, 1,040 individuals older than 60 years and with data available in T2D and MMSE were included in this analysis (9).

Availability of data and materials

All the CHNS 2009-2010 information is available on the webpage http://www.repositoriodigital.minsal.cl/handle/2015/601. Data access are available on http://epi.minsal.cl/bases-de-datos/.

Type 2 diabetes diagnosis

A fasting blood glucose level ≥126 mg/dl or self-reported medical diagnosis of T2D was considered as a diagnosis of T2D (9). Time of diagnosis of T2D was obtained through self-report (9). According to the time of diagnosis, the sample was divided into four groups: Group I: non-diabetic; Group II: 1 to 14 years 11 months; Group III: 15 to 24 years 11 months; Group IV: ≥25 years.

Suspicion of cognitive impairment

The global cognitive function of participants was determined by using the abbreviated version of the Mini-Mental State Examination test (MMSE) (14). The MMSE consists of six questions that evaluate temporal/spatial orientation, short-term memory, calculation, the evocation of words, ability to recall words, following commands, reading, writing a sentence and copying a drawing. A score lower than 13 points (maximum score=19 points) is indicative of mild cognitive impairment and was classified as suspicion of cognitive impairment in this study.

Socio-demographic, anthropometric, lifestyle and health-related data

Socio-demographic data were collected for all participants, including age, sex, place of residence (rural and urban), and education level (primary, secondary or further education). Body mass index (BMI) was calculated as weight/height2 and classified using the WHO criteria (Underweight: <18.5

kg/m2; normal: 18.5 to 24.9 kg/m2; overweight: 25.0 to 29.9 kg/m2; obese: ≥30.0 kg/m2 (15). Central obesity was defined as waist circumference >88 cm for women and >102 cm for men (9). This was measured at the mid-axillary line at the midpoint between the costal margin and the iliac crest by an ergonomic circumference measuring tape. Lifestyle behaviours were collected using self-reported questionnaires. Smoking status was categorised into non-smoker, ex-smoker or smoker. Dietary intake of fruit and vegetables was collected using a food frequency questionnaire. Participants were asked, 'In a typical/ordinary week, how many days do you eat fruit?' and 'In a typical/ordinary week, how many days do you eat vegetables?' which was then converted into grams (9). Alcohol consumption was self-reported and collected using the "Alcohol Use Disorders Identification Test" (AUDIT) a 10-questionnaire developed by the WHO (16) and adapted for use in Chile (17) that determine a person's dangerous alcohol consumption (8≥ points). Physical activity levels (PA), including moderate and vigorous intensities and transport-related PA, were determined using the Global Physical Activity Questionnaire version 2 (GPAQ v2) (18). PA was categorised into: inactive individuals (<600 MET/min/week) and active individuals (≥600 MET/min/week) (19). Sedentary behaviour was derived using the following question: 'How much time do you usually spend sitting or reclining on a typical day?' (19).

Statistical analyses

The characteristics of the population are presented as mean and standard deviation for normally distributed variables and as median and their 25th and 75th percentile for continuous variables not normally distributed. Anderson-Darling test was applied to check normal distribution assumptions. Categorical variables were presented as percentages with their respective 95% CI.

To investigate the association between an altered MMSE score and number of years with T2D, we used Poisson regression with the vce (robust) option to obtain robust standard errors for the parameter estimates as recommended by Cameron and Trivedi to control for mild violation of underlying assumptions (20). Results were reported as relative risk (RR) and their 95% confidence intervals (95% CI). To estimate the trend for suspicion of cognitive impairment across the number of years with T2D, the latest was fitted into the model as an ordinal variable. All statistical analyses were adjusted by confounding variables using four incremental statistical models: Model 0 was unadjusted; Model 1 was adjusted by socio-demographic factors (age, sex, education level and place of residence (rural or urban)); Model 2 was adjusted for Model 1 plus lifestyle factors (total PA, sitting time, fruit and vegetable intakes, alcohol intake, smoking); Model 3 was adjusted by Model 2, but also by BMI and blood pressure. For all statistical analyses,

STATA MP v16 program was used, and all the results were weighted to the CNHS 2009-2010 design. The level of significance was defined as $p < 0.05$.

Ethical Approval

The CNHS 2009 – 2010 was approved by the Ethics Committee of the School of Medicine of the Pontificia Universidad Católica de Chile. All participants who took part in the CNHS 2009 – 2010, provided written consent before the start of the study. Participants were excluded from this study if they withdrew at any point or did not complete all proposed tests (9).

RESULTS

The characteristics of the population by MMSE status are presented in Table 1. Participants with an altered MMSE were on average older, more likely to be females (58.1% (95% CI: 48.4; 67.2)), to live in urban regions (77.1% (95% CI: 68.1; 84.2)) and to have a lower education level (86.7% (95% CI: 78.7; 92.0)) in comparison to those who had a normal MMSE score. Regarding anthropometric variables, participants with an altered MMSE score had a lower BMI (27.2 kg/m2 (95% CI: 26.26; 28.2)), greater levels of central obesity (94.3 cm (95% CI: 91.7; 96.9) and a higher likelihood of being underweight (25.5% (95% CI: 17.9; 34.9)). Regarding lifestyle variables, total PA and prevalence of health and wellbeing were lower in participants with an altered MMSE score.

Table 1. Population characteristics by suspicion of cognitive impairment status.

	Normal MMSE	Suspicion of cognitive impairment (MMSE <13)
Socio-demographics		
Total (n)	935	105
Age (years)	69.8 (69.3; 70.3)	76.1 (74.4; 77.8)
Sex (%)		
Women	60.8 (57.8; 63.9)	58.1 (48.4; 67.2)
Men	39.3 (36.2; 42.4)	42.0 (32.8; 51.9)
Zone of residence (%)		
Urban	83.5 (81.0; 85.8)	77.1 (68.1; 84.2)
Rural	16.5 (14.2; 19.0)	22.9 (15.8; 31.9)
Education (%)		
< 8 years	59.1 (56.0; 62.3)	86.7 (78,7; 92.0)
8 to 12 years	33.0 (30.1; 36.1)	12.4 (7.3; 20.2)
>12 years	7.8 (6.3; 9.7)	1.0 (0.1; 6.5)
Anthropometrics		
BMI (kg/m^2)	28.7 (28.4; 29.0)	27.2 (26.26; 28.2)
Weight (kg)	70.6 (69.7; 71.5)	65.3 (62.6; 67.9)
Height (m)	1.56 (1.56; 1.57)	1.54 (1.52; 1.57)
Waist circumference (cm)	95.5 (94.7; 96.3)	94.3 (91.7; 96.9)
Central obesity (%)		
Normal	51.2 (48.0; 54.4)	47.6 (38.2; 57.2)
Obese	48.8 (45.6; 52.0)	52.4 (42.8; 61.8)
Nutritional status (%)		
Underweight	8.6 (7.0; 10.6)	25.5 (17.9; 34.9)
Normal	33.4 (30.4; 36.5)	22.5 (15.4; 31.7)
Overweight	32.8 (29.9; 35.9)	33.3 (24.8; 43.1)
Obesity	25.2 (22.5; 28.1)	18.6 (12.2; 27.4)

Lifestyle		
Total Physical Activity (MET-h/week)*	32.0 (2.6; 108.0)	2.0 (0; 36.0)
Physical inactivity (%)		
Active	68.4 (65.4; 71.4)	41.0 (31.9; 50.6)
Inactive	31.6 (28.6; 34.6)	59.0 (49.4; 68.1)
Sitting time (h/day)	3.2 (3.0; 3.3)	4.2 (3.7; 4.7)
Fruits and vegetables intake (g/day)	231.3 (222.0; 240.6)	207.2 (181.3; 233.2)
Alcohol intake (g/day)*	21.8 (16.1; 36.4)	19.3 (14.7; 46.2)
Smoking status (%)		
Never	50.7 (47.5; 53.9)	59.0 (49.4; 68.1)
Former Smoker	33.5 (30.5; 36.6)	32.4 (24.1; 42.0)
Current Smoker	15.8 (13.6; 18.3)	8.6 (4.5; 15.7)

Mean and 95% CI was used for continuous variables. Percentage and 95% CI was used for categorical variables. *Variables not normally distributed were presented as median and their 25^{th} and 75^{th} percentile.

Furthermore, the prevalence of physical inactivity, sitting time and alcohol intake was higher in the altered MMSE group than individuals with a normal MMSE. Finally, the number of years with T2D was greater for those with altered MMSE in comparison to those with a normal MMSE (10.6 years versus 15.2 years) (Table 1).

The characteristics of the population by the duration of T2D are presented in Table 2. To summarise, individuals with ≥25 years since T2D was diagnosed were older, more likely to be women (78.6% (95% CI: 49.32; 93.24)), live in urban settings (92.9% (95% CI: 61.1; 99.1)) and to have lower levels of education (78.6% (95% CI (49.3; 93.2)). This group also had a higher obesity prevalence (46.2% (95% CI (21.6;72.8)). Those with 25 years or more with T2D had the highest prevalence of physical inactivity (57.1%) and sedentary behaviour (4.5 h/day). This group also showed the highest frequency of altered MMSE (21.2%).

Table 2. Population characteristics by categories of the number of years with diabetes.

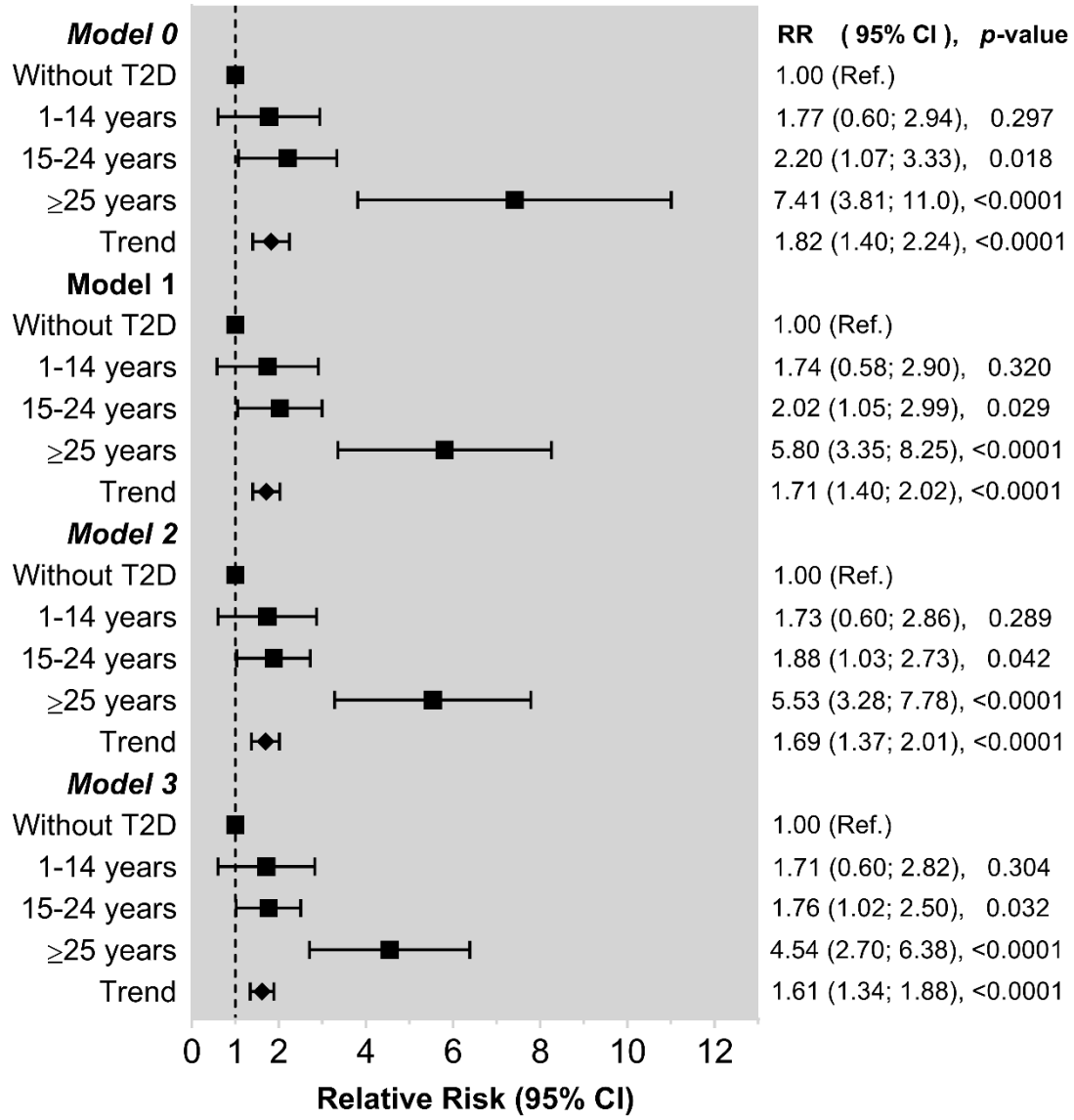
	Without diabetes	1-14 years	15-24 years	>25 years
Socio-demographics				
Total (n)	852	125	49	14
Age (years)	70.5 (70.3; 71.3)	57.6 (56.1; 59.1)	67.1 (64.5; 69.6)	72.4 (68.4; 76.3)
Sex (%)				
Women	60.0 (56.8; 63.3)	59.0 (50.3; 67.5)	65.3 (50.9; 77.3)	78.6 (49.32; 93.24)
Men	39.9 (36.6; 43.2)	40.8 (32.5; 49.7)	34.7 (22.7; 49.1)	21.43 (6.8; 50.7)
Place of residence (%)				
Urban	82.2 (79.6; 84.7)	83.2 (75.6; 88.8)	89.8 (77.5; 95.3)	92.9 (61.1; 99.1)
Rural	17.7 (15.3; 20.4)	16.8 (11.1; 24.4)	10.2 (4.3; 22.5)	7.1 (9.2; 3.9)
Education (%)				
< 8 years	61.7 (58.4; 64.9)	60.0 (51.1; 68.2)	65.3 (50.9; 77.3)	78.6 (49.3; 93.2)
8 to 12 years	31.2 (28.2; 34.4)	31.2 (23.7; 39.9)	28.6 (17.6; 42.8)	21.4 (6.7; 50.7)
>12 years	7.0 (55.0; 9.0)	0.9 (4.9; 15.2)	0.6 (2.0; 17.5)	0
Anthropometrics				
BMI (kg/m^2)	28.2 (27.9; 28.5)	30.4 (29.7; 28.5)	30.7 (28.8; 32.6)	30.4 (27.1; 33.8)
Weight (kg)	69.2 (68.4; 70.1)	75.6 (74.0; 77.3)	74.5 (70.7; 78.3)	74.2 (64.5; 84.0)
Height (m)	1.56 (1.56; 1.57)	1.58 (1.56; 1.59)	1.57 (1.54; 1.59)	1.55 (1.51; 1.59)
Waist circumference (cm)	94.6 (93.9; 95.4)	98.4 (97.1; 99.8)	100.2 (97.0; 103.4)	99.8 (92.5; 107.1)
Central obesity (%)				
Normal	52.6 (49.2; 55.9)	41.6 (33.3; 50.5)	46.9 (33.4; 60.9)	42.9 (20.0; 69.3)
Obese	47.4 (44.1; 50.8)	58.4 (49.5; 66.7)	53.1 (39.1; 66.6)	57.1 (30.7; 80.0)
Nutritional status (%)				
Underweight	10.8 (8.8; 13.1)	5.6 (2.7; 11.4)	12.8 (5.8; 25.8)	15.9 (3.6; 46.6)
Normal	33.2 (30.1; 36.4)	31.5 (23.9; 40.8)	25.5 (15.0; 40.0)	7.7 (0.9; 41.1)
Overweight	34.1 (31.0; 37.4)	29.0 (21.7; 37.7)	21.3 (11.8; 35.4)	30.8 (11.5; 60.3)
Obesity	21.9 (19.2; 24.9)	33.9 (26.1; 42.7)	40.4 (27.3; 55.0)	46.2 (21.6; 72.8)

Lifestyle				
Total Physical Activity (MET-h/week)*	31.2 (0; 105.4)	48.0 (3.3; 152)	15.0 (0; 88.6)	4 (0; 72.0)
Physical inactivity (%)				
Active	68.0 (64.7; 71.0)	60.0 (51.1; 68.2)	46.9 (33.4; 60.9)	42.9 (20.0; 69.3)
Inactive	32.0 (29.0; 35.3)	40.0 (31.8; 48.9)	53.1 (39.1; 66.6)	57.1 (30.7; 80.0)
Sitting time (h/day)*	3.4 (3.2; 3.5)	3.7 (3.4; 4.0)	4.3 (3.6; 5.0)	4.5 (3.0; 6.0)
Fruits and vegetables intake (g/day)	221.9 (213.1; 230.6)	231.8 (216.4; 247.3)	262.0 (255.5; 298.5)	279.4 (201.2; 357.7)
Alcohol intake (g/day)*	20.7 (16.1; 36.5)	21.8 (13.9; 39.9)	26.2 (13.9; 50.7)	54.1 (21.9; 83.8)
Smoking status (%)				
Never	50.7 (47.3; 54.1)	52.0 (43.2; 60.7)	63.3 (48.9; 75.6)	57.1 (30.7; 80.0)
Former Smoker	33.5 (30.4; 36.7)	37.6 (29.5; 46.4)	20.4 (11.3; 34.1)	35.7 (15.1; 63.4)
Current Smoker	15.9 (13.5; 18.5)	10.4 (6.1; 17.1)	16.3 (8.3; 29.8)	7.1 (0.9; 38.9)

Mean and 95% CI was used for continuous variables. Percentage and 95% CI was used for categorical variables. *Variables not normally distributed were presented as median and their 25^{th} and 75^{th} percentile.

The association between the number of years with T2D and suspicion of cognitive impairment is presented in Figure 1. Compared to individuals without T2D, those with 15-24 years or ≥25 years with T2D presented a higher likelihood of suspicion of cognitive impairment under the non-adjusted model (RR: 2.20 [95% CI:1.07; 3.33] and 7.41 [95% CI:3.81; 11.0]). Nevertheless, after accounting for socio-demographic, lifestyle and health-related factors, the association was slightly attenuated (RR: 1.76 [95% CI:1.02; 2.50] and 4.54 [95% CI:2.70; 6.38]) for those with 15-24 years or >25 years with T2D, respectively (Figure 1). No statistically significant association was reported for individuals with 1 to 14 years with T2D, compared to those without T2D (Figure 1).

Figure 1. Association between the number of years with diabetes and suspicion of cognitive impairment in older adults.



Data are presented as Relative Risk (RR) and their respective confidence intervals (95% CI) estimated with Poisson regression. The reference group was assigned to those without diabetes. The IRR for trend indicates the relative risk of cognitive impairment by one category increase in the number of years with T2D. A value greater than 1 indicates a higher relative risk for cognitive impairment. Model 0 - non adjusted; Model 1 - adjusted by socio-demographic factors (age, sex, education level and place of residence); Model 2 - adjusted by Model 1, but also by lifestyle factors (total physical activity, sitting time, fruit and vegetable intakes, alcohol intake, smoking); Model 3 - adjusted by Model 2, plus BMI and blood pressure.

DISCUSSION

The main finding of this study was that older Chilean adults with more than 15 years of T2D, had a higher likelihood of suspicion of cognitive impairment in comparison to those without T2D, independent of socio-demographic, lifestyle, anthropometric, adiposity and health-related factors. Roberts et al. reported that the earlier the onset of T2D, the more brain atrophy in later-life. This occurs over several years before the first cognitive impairment symptoms (21). Therefore, total brain volume loss has been proposed as the causal pathway for the association of T2D with cognitive decline and impairment (21).

Similar to our findings, there is a growing body of evidence to support the association between the time of T2D diagnosis and cognitive disorders in older adults (11-13, 22-26). Several studies showed that individuals with a longer duration of T2D are at a greater risk of developing cognitive impairment and dementia (22, 27), with the duration of T2D being a mediator of dementia onset (26). Mejía-Arango et al. have shown that Mexican participants with T2D have a greater likelihood of developing dementia (RR: 2.08 [95% CI:1.59;2.73]) (28). Moreover, Salinas-Contreras et al. determined that subjects with T2D were reported a higher risk of developing dementia compared with those without T2D (HR:1.87 [95% CI: 1.2;2.7]) (29). Also, Petermann-Rocha et al. reported a higher risk of suspicion of cognitive impairment in Chilean older adults with T2D than those without T2D (30).

The association between T2D and dementia also is extended to dementia subtypes, including vascular dementia (31), non-specific dementia and Alzheimer's disease (26). Individuals with T2D for 15 years or longer were reported to have an earlier onset of vascular dementia by 5.7 years, compared with non-diabetic individuals. Hazari et al. (2015) found that patients with over five years of T2D had prolonged P300 latencies (Cognitive Event-related potential) compared to patients with five or fewer years of disease duration and control group. Furthermore, the effect of T2D on dementia is greater after ten years with the disease (24-26). The same pattern was observed in individuals with Alzheimer's disease and non-specific dementia, but the mean difference in age was less marked, 2.4 and 3.4 years, respectively (26). Both microvascular and macrovascular complications (26), clinical cerebral infarctions and sub-clinical infarctions (25) are strongly associated with long T2D duration, suggesting that T2D contributes to the pathophysiology and clinical expression of cognitive impairment and dementia through these mechanisms (26).

Strengths and Limitations

One of the main strengths of this study is using standardised protocols of the CNHS 2009-2010. The CNHS was implemented to collect biological, health and lifestyle data. However, it is also important to highlight the limitations of this study. Although the MMSE was validated in the Chilean population, it is only a screening tool for cognitive impairment. Furthermore, the time of diagnosis of T2D was self-reported by the participant. In addition, as this study was cross-sectional, it does not allow any causal inferences to be drawn from the results. Besides, number of individuals with cognitive impairment were relatively low and we can not discard the effects of unmeasured confoduing factors in the asocaitions reported.

CONCLUSION

This study corroborates current evidence, which proposes that a long duration of T2D is a risk factor for suspicion of cognitive impairment in older adults. These findings support the need for regular cognitive assessment in older adults with T2D, especially those who have had T2D for longer. This group of patients might have a higher likelihood of cognitive impairment development; hence they may become a target for early screening strategies aimed to prevent or delay the onset of this disease as well as other cardiovascular common complications of T2D. Further research is needed to investigate whether the observed associations between years with T2D and cognitive impairment in this population are causally related and what biological mechanisms might be involved.

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AUTHORS' CONTRIBUTIONS

AB, FPR, and CCM conceived and designed this study; AB, FPR and CCM contributed to the data analysis; AB, FPR, HW, CR and CACM wrote the paper. All authors read and approved the final manuscript.

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COMPETING INTERESTS

The authors declare no conflict of interest.

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