HHS Public Access

Author manuscript

Alzheimers Dement. Author manuscript; available in PMC 2018 January 04.

Published in final edited form as:

Alzheimers Dement. 2016 August ; 12(8): 925–929. doi:10.1016/j.jalz.2016.03.017.

Waist circumference is correlated with poorer cognition in elderly type 2 diabetes women

Rebecca K. West[a,*], **Ramit Ravona-Springer**[b], **Anthony Heymann**[c,d], **James Schmeidler**[a], **Derek Leroith**[e], **Keren Koifman**[b], **Ryan C. N. D'Arcy**[f,g], **Xiaowei Song**[f,g], **Elizabeth Guerrero-Berroa**[a,h], **Rachel Preiss**[b], **Hadas Hoffman**[b], **Mary Sano**[a,h], **Jeremy M. Silverman**[a,h], and **Michal Schnaider-Beeri**[a,b]

[a]Department of Psychiatry, Icahn School of Medicine at Mount Sinai, New York, NY, USA

[b]The Joseph Sagol Neuroscience Center, Sheba Medical Center, Ramat Gan, Israel

[c]Maccabi Healthcare Services, Tel-Aviv, Israel

[d]Department of Family Medicine, The Sackler School of Medicine Tel Aviv University, Tel Aviv, Israel

[e]Department of Medicine, Icahn School of Medicine at Mount Sinai, New York, NY, USA

[f]Simon Fraser University, Metro Vancouver, British Columbia, Canada

[g]Surrey Memorial Hospital, Fraser Health, Metro Vancouver, British Columbia, Canada

[h]James J. Peters Veterans Affairs Medical Center, Bronx, NY, USA

Abstract

Introduction—Waist circumference is associated with type 2 diabetes (T2D) and cognition, yet the relationship between waist circumference and cognition in individuals with T2D is not well understood.

Methods—We studied the relationship of waist circumference with five cognitive outcomes (executive functioning, language/semantic categorization, attention/working memory, episodic memory, and an overall cognition measure) in 845 cognitively normal elderly with type 2 diabetes (T2D).

Results—In women, waist circumference was correlated with significantly lower language and/or semantic categorization performance ($P < .0001$), executive functioning ($P = .026$), and overall cognition ($P = .003$) after controlling for age, education, BMI, and cardiovascular, diabetes-related, *APOE* ε4, and inflammatory potential confounders. Attention/working memory ($P = .532$) and episodic memory ($P = .144$) were not associated with waist circumference. These correlations were not found in men.

*Corresponding author: Tel: 212-659-5603; Fax: 212-659-5626. rebecca.west@mssm.edu.

No potential conflicts of interest relevant to this article were reported.

Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jalz.2016.03.017.

Discussion—These results suggest that central adiposity in elderly women with T2D may increase their risk for dementia.

Keywords

Cognitive performance; Waist circumference; Type 2 diabetes mellitus; Risk factors; Dementia

1. Introduction

Waist circumference, considered an effective measure of central adiposity [1], has been associated with both type 2 diabetes (T2D) and cognition [2,3]. However, despite the consistent relationship between T2D and cognition [2] and the relevance of central adiposity to T2D [3], evidence of the impact of central adiposity to cognition in the context of T2D has rarely been reported. As central adiposity differs greatly for men and women, we examined the relationship of waist circumference with cognition for each sex, in a large cohort of T2D elderly participating in the Israel Diabetes and Cognitive Decline (IDCD) study, an investigation of the relationships of long-term T2D-related characteristics with cognitive decline. It was expected that larger waist circumference would be negatively associated with cognition. The study is a collaboration between the Icahn School of Medicine at Mount Sinai (ISMMS), NY, the Sheba Medical Center, Israel, and the Maccabi Healthcare Services (MHS), Israel.

2. Methods

Detailed methods of the IDCD are reported in the Supplementary Materials and in Beeri et al. [4]. Participants in the IDCD study were randomly selected from T2D individuals in the MHS Diabetes Registry. This study has recruited 1288 subjects, 897 of whom have completed a baseline evaluation. The IDCD study is approved by the ISMMS, Sheba, and MHS Institutional Review Board committees.

Participants at their baseline assessments of IDCD were initially cognitively normal (based on a Clinical Dementia Rating scale of zero and a diagnostic consensus conference). Participants had confirmed T2D, were above the age of 65 years, lived in central Israel, were fluent in Hebrew, and did not have any neurological or psychiatric conditions potentially affecting cognition.

Participants were assessed by a neuropsychologist and a physician experienced in assessment and diagnosis of dementia. Participants completed a broad neuropsychological battery [4], the basis for the outcome measures. Factor analysis summarized the neuropsychological measures into four domains: language/semantic categorization (similarities, letter fluency, category fluency), episodic memory (immediate recall, delayed recall, and recognition), executive functioning (trails A and trails B, constructional praxis, and digit symbol), and attention/working memory (diamond cancellation, digit span forward, and digit span backward). The neuropsychological tests scores were transformed into Z scores (reversing scores representing time: trails A, trails B, and diamond cancellation, reversed such that a high score represented good cognition) and summed for each domain. An overall cognition measure summed the scores of all four domains.

Waist circumference was measured in centimeters at the level of the umbilicus. For the cardiovascular and HbA1c covariates, we used the average of all the subject's measurements available in the MHS Diabetes Registry.

Statistical analysis

Partial correlations were performed to examine the association between waist circumference and the global and specific cognitive factors. As the distribution of body fat generally differs greatly for men and women [5], these partial correlations were calculated separately for each sex. In model 1, we controlled for age and years of education, well-established confounders for cognitive outcomes, and body mass index (BMI), a confounder for waist circumference. In model 2, we added potential confounders associated with dementia and/or central adiposity [2,6–12]: cardiovascular (HbA1c; creatinine; total, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) cholesterols; triglycerides; and diastolic and systolic blood pressure), diabetes-related (duration in the Diabetes Registry and diabetes medication status: no medication, insulin only, hypoglycemic medication only, combination of insulin with hypoglycemic medication), *APOE* ε4 genotype, and inflammation (CRP and IL-6).

3. Results

Characteristics of the sample as a whole and by sex are listed in Table 1. Men and women did not differ significantly in age, glucose, years in the Diabetes Registry, or HbA1c. Men had significantly greater years of education, creatinine, weight, waist circumferences, and MMSE scores. Women had significantly greater total, LDL, and HDL cholesterol, triglycerides, and BMI. See Table 1.

Using model 1, in women, waist circumference was significantly associated with poorer language/semantic categorization ($r = -0.206$, $P < .0001$, df = 316) and overall cognition ($r = -0.119$, $P = .036$, df = 316) but not executive functioning ($r = -0.056$, $P = .325$, df =315), attention/working memory ($r < -0.000$, $P = .998$, df = 316), or episodic memory ($r = -0.082$, $P = .151$, df = 316). In model 2, which accounted for additional potential confounders, the correlations were stronger: waist circumference was significantly associated with poorer language/semantic categorization ($r = -0.256$, $P < .0001$, df = 258), overall cognition ($r = -0.185$, $P = .003$, df = 258), and executive functioning ($r = -0.13$, $P = .026$, df = 257) but not with attention/working memory ($r = -0.039$, $P = .532$, df = 258) or episodic memory ($r = -0.091$, $P = .144$, df = 258). These relationships did not occur in men; none of the cognitive outcomes were significant in either models (see Table 2).

As expected, BMI was strongly correlated with waist circumference ($r = 0.682$, $P < .001$); however, it was not significantly correlated with any of the cognitive outcomes for women or men, controlling for age and education.

4. Discussion

In this sample of elderly with T2D, waist circumference as a measure of central adiposity was associated with lower overall cognition, language/semantic categorization, and executive performance in women, after adjusting for age, education, BMI, and a variety of

potential confounders. Measures of central adiposity, including waist circumference, have been shown to be associated with higher dementia, and Alzheimer's disease (AD) risk, and cognitive decline [2,13,14]. We extend findings from other studies of waist circumference by showing a correlation only for women and distinguishing among cognitive domains, namely language/semantic categorization and executive functioning. This is consistent with other findings indicating a relationship of executive functions [15] and verbal ability with the pre-T2D condition metabolic syndrome [15] in women.

Central adiposity increases with age and is a risk factor for T2D and cardiovascular diseases [8], which in turn are risk factors for cognitive impairment [7]. Waist circumference has been identified as a predictor of cognitive impairment [2], and this relationship may be stronger in T2D. Furthermore, central adiposity is associated with several cardiovascular risk factors (such as hypertension and high cholesterol [5]), themselves associated with dementia [16], suggesting cardiovascular risk factors as an underlying mechanism for the relationship between waist circumference and cognition. However, controlling for cardiovascular risk factors left the results essentially unchanged suggesting that other biological factors underlie this correlation. Central adiposity and cognitive function also likely share common factors, especially lifestyle factors and genetics; these relationships remain to be clarified.

The sex-specific impact of central adiposity on cognition deserves attention. Women face increased central adiposity after having children; a greater number of children have been associated with AD neuropathology in women but not men [17]. Furthermore, menopausal-related changes may place women at greater cardiovascular risks. Reduced ovarian hormones increase the risk of cardiovascular disease [18]. Control of cardiovascular risk factors, such as cholesterol and blood pressure, tends to be poorer in women [19]. Therefore, in women, the relationship between central adiposity and dementia may be strengthened by poor control of these factors. Women with more metabolic syndrome factors have been found to be at greater risk of poor performance on measures of executive and language functioning [15]. Consistent with that, we found significantly higher levels of total, LDL, and HDL cholesterol and triglycerides in women.

Interestingly, BMI was not associated with cognition. As central tissue fat increases and body fat is redistributed in older individuals [8], BMI may not be the ideal predictor of cardiovascular disease and cognitive decline; waist circumference controlling for BMI may better represent central adiposity. A relatively high BMI may be even associated with a reduced risk of cognitive decline and cardiovascular disease in the elderly [8]. Waist circumference, on the other hand, correlates well with more objective imaging techniques of central adiposity (for example, in women, there is a correlation of $r = 0.87$ between waist circumference and visceral adipose tissue measured by computed tomography [20]), making it a simple but reliable proxy for central adiposity [1].

Limitations include the cross-sectional outcomes, precluding causal conclusions, and lack of magnetic resonance imaging, which could shed light into the contributions of cerebrovascular disease. Furthermore, although waist circumference is considered a good proxy for central adiposity [1], imaging techniques (such as x-ray absorptiometry scans) of central adiposity may be more precise. This study is strengthened by a large sample, strong

validity for T2D diagnosis and cardiovascular variables, and a broad cognitive assessment, permitting examination of global and specific cognitive domains. Future studies may focus on potential mechanisms linking measures of central adiposity to cognitive decline enhancing opportunities to identify health behaviors and adiposity-related treatments that may reduce cognitive impairment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This study was supported by NIA grants R01 AG034087 to Dr. Beeri and P50 AG05138 to Dr. Sano, the Helen Bader Foundation, and the Alzheimer's Association grant MNIRGD-14-321113 to Dr. Guerrero-Berroa, and the Irma T. Hirschl Scholar award to Dr. Beeri.

R.K.W. conducted statistical analysis and wrote the manuscript. R.R.S. researched data, reviewed and/or edited the manuscript. J.S. provided statistical guidance and reviewed and/or edited manuscript. D.L. reviewed and/or edited manuscript and contributed to discussion. K.K. researched data. E.G-B reviewed and/or edited manuscript. H.H. researched data. J.M.S. reviewed/edited manuscript. A.H. researched data. M.S.B. designed the study, performed the experiments, analyzed and researched data, and reviewed/edited the manuscript. R.C.N.D. and X.S. reviewed and/or edited the manuscript. M.S.B. is the guarantor of this work. As guarantor, M.S.B. had full access to all the data in the study, takes responsibility for the integrity of the data and the accuracy of the data analysis, and reviewed the manuscript.

References

1. Cornier M, Despre J, Lopez-jimenez F, Rao G. A Scientific Statement From the American Heart Association. Circulation. 2011; 124:1996–2019. [PubMed: 21947291]
2. Abbatecola AM, Lattanzio F, Spazzafumo L, Molinari AM, Cioffi M, Canonico R, et al. Adiposity predicts cognitive decline in older persons with diabetes: A 2-year follow-up. PLoS One. 2010; 5:1–7.
3. Lindstrom J, Tuomilehto J. The Diabetes Risk Score. Diabetes Care. 2003; 26:725–31. [PubMed: 12610029]
4. Beeri MS, Ravona-Springer R, Moshier E, Schmeidler J, Godbold J, Karpati T, et al. The Israel Diabetes and Cognitive Decline (IDCD) study: Design and baseline characteristics. Alzheimers Dement. 2014; 10:769–78. [PubMed: 25150735]
5. Tchernof A, Després JP. Pathophysiology of human visceral obesity: an update. Physiol Rev. 2013; 93:359–404. [PubMed: 23303913]
6. Seliger SL. Moderate Renal Impairment and Risk of Dementia among Older Adults: The Cardiovascular Health Cognition Study. J Am Soc Nephrol. 2004; 15:1904–11. [PubMed: 15213280]
7. Kloppenborg RP, van den Berg E, Kappelle LJ, Biessels GJ. Diabetes and other vascular risk factors for dementia: Which factor matters most? A systematic review. Eur J Pharmacol. 2008; 585:97–108. [PubMed: 18395201]
8. Chang SH, Beason TS, Hunleth JM, Colditz GA. A systematic review of body fat distribution and mortality in older people. Maturitas. 2012; 72:175–91. [PubMed: 22595204]
9. West RK, Ravona-Springer R, Schmeidler J, Leroith D, Koifman K, Guerrero-Berroa E, et al. The association of duration of type 2 diabetes with cognitive performance is modulated by long-term glycemic control. Am J Geriatr Psychiatry. 2014; 22:1055–9. [PubMed: 24534521]
10. Beeri MS, Schmeidler J, Silverman JM, Gandy S, Wysocki M, Hannigan CM, et al. Insulin in combination with other diabetes medication is associated with less Alzheimer neuropathology. Neurology. 2008; 71:750–7. [PubMed: 18765651]

11. Roberts RO, Cha RH, Mielke MM, Boeve BF, Knopman DS, Petersen RC. Risk and protective factors for cognitive impairment in persons aged 85 years and older. Neurology. 2015; 84:1854–61. [PubMed: 25854867]
12. Wichmann MA, Cruickshanks KJ, Carlsson CM, Chappell R, Fischer ME, Klein BE, et al. Long-Term Systemic Inflammation and Cognitive Impairment in a Population-Based Cohort. J Am Geriatr Soc. 2014; 62:1683–91. [PubMed: 25123210]
13. Kerwin DR, Gaussoin SA, Chlebowski RT, Kuller LH, Vitolins M, Coker LH, et al. Interaction between body mass index and central adiposity and risk of incident cognitive impairment and dementia: Results from the women's health initiative memory study. J Am Geriatr Soc. 2011; 59:107–12. [PubMed: 21226681]
14. Beydoun MA, Beydoun HA, Wang Y. Obesity and central obesity as risk factors for incident dementia and its subtypes: A systematic review and meta-analysis. Obes Rev. 2008; 9:204–18. [PubMed: 18331422]
15. Dearborn JL, Knopman D, Sharrett AR, Schneider AL, Jack CR Jr, Coker LH, et al. The Metabolic Syndrome and Cognitive Decline in the Atherosclerosis Risk in Communities Study (ARIC). Dement Geriatr Cogn Disord. 2014; 38:337–46. [PubMed: 25171458]
16. Whitmer RA, Sidney S, Selby J, Johnston SC, Yaffe K. Midlife cardiovascular risk factors and risk of dementia in late life. Neurology. 2005; 64:277–81. [PubMed: 15668425]
17. Beeri MS, Rapp M, Schmeidler J, Reichenberg A, Purohit DP, Perl DP, et al. Number of children is associated with neuropathology of Alzheimer's disease in women. Neurobiol Aging. 2009; 30:1184–91. [PubMed: 18079025]
18. ManuYang XP, Reckelhoff JF. Estrogen, hormonal replacement therapy and cardiovascular disease. Curr Opin Nephrol Hypertens. 2011; 20:133–8. [PubMed: 21178615]
19. Franzini L, Ardigò D, Cavalot F, Miccoli R, Rivellese AA, Trovati M, et al. Women show worse control of type 2 diabetes and cardiovascular disease risk factors than men: Results from the MIND. IT Study Group of the Italian Society of Diabetology. Nutr Metab Cardiovasc Dis. 2013; 23:235–41. [PubMed: 22397873]
20. Pouliot MC, Despres JP, Lemieux S, Moorjani S, Bouchard C, Tremblay A, et al. Waist Circumference and Abdominal Sagittal Diameter: Best Simple Anthropometric Indexes of Abdominal Visceral Adipose Tissue Accumulation and Related Cardiovascular Risk in Men and Women. Prev Cardiol. 1994; 73:460–8.

RESEARCH IN CONTEXT

1. Systematic review

Literature searches using PubMed were conducted to ascertain original and review articles, using combinations of keywords including “diabetes,” “adiposity,” “visceral fat,” “waist circumference,” “sex differences,” and “cognition.” These articles suggested an association between central adiposity/visceral fat and cognition and a potential sex difference in this relationship. PubMed search did not identify studies reporting on relationships of central adiposity/visceral fat with overall cognition or specific cognitive domains in the context of type II diabetes (T2D).

2. Interpretation

We found larger waist circumference to be associated with overall cognitive functioning, language/semantic categorization, and executive functioning, in women with T2D. This relationship remained robust when adjusting for socio-demographic, cardiovascular and diabetes-related confounders, and also for BMI.

3. Future directions

Future studies should seek to clarify mechanisms underlying the relationship between central adiposity, sex, and cognition in individuals with T2D, which may provide a foundation for identifying interventions for limiting cognitive decline in those with T2D.

Table 1

Participant characteristics

Characteristics	Entire sample, M (SD)	Sex	Mean	SD	*t*	df	*P*
Age last seen (y)	71.97 (4.70)	Male	71.90	4.66	−0.53	843	.594
		Female	72.07	4.77			
Years of education	13.14 (3.41)	Male	13.41	3.45	2.89	730.765	.004
		Female	12.72	3.32			
Waist circumference (cm)	103.90 (11.84)	Male	106.15	10.57	6.98	817	< .001
		Female	100.40	12.83			
Glucose (mg/dL)	135.06 (20.77)	Male	135.63	20.75	0.98	832	.326
		Female	134.18	20.81			
Creatinine (mg/dL)	1.00 (.25)	Male	1.10	0.25	19.68	797.989	.000
		Female	0.89	0.13			
Total cholesterol (mg/dL)	180.3 (24.8)	Male	172.24	22.32	−12.76	832	.000
		Female	192.77	23.30			
LDL cholesterol (mg/dL)	101.39 (19.66)	Male	98.47	19.33	−5.41	832	.000
		Female	105.88	19.35			
HDL cholesterol (mg/dL)	47.73 (10.87)	Male	44.015	8.65	−12.74	565.571	.000
		Female	53.44	11.47			
Triglycerides (mg/dL)	157.12 (63.59)	Male	152.07	66.29	−2.86	832	.004
		Female	164.88	58.47			
Years in diabetes registry	8.71 (2.63)	Male	8.84	2.50	1.85	646.723	.071
		Female	8.50	2.79			
Weight (kg)	79.23 (13.83)	Male	83.10	12.71	10.57	664.593	.000
		Female	73.23	13.35			
MMSE (score)	28.00 (1.79)	Male	28.17	1.63	3.34	610.609	.001
		Female	27.74	1.99			
BMI (%)	28.36 (4.40)	Male	27.97	3.94	−2.97	573.808	.003
		Female	28.95	4.99			
HbA1c (%)	6.79% (.78)	Male	6.78	0.84	−0.19	795.828	.851
		Female	6.79	0.67			

Table 2

Partial correlations of waist circumference and the cognitive factors, controlling for socio-demographic (age, years of education), anthropomorphic (BMI) and cardiovascular (HbA1c, creatinine, total, LDL, and HDL cholesterols, triglycerides, diastolic and systolic blood pressure, and duration of T2D, T2D medication, inflammation (CRP and IL-6), and *APOE* ε4

Cognitive factors	*r* (*P*) males	*r* (*P*) females
Overall cognition	−0.024 (.624)	−0.185 (.003)
Language/semantic categorization	−0.038 (.437)	−0.256 (<.0001)
Attention/working memory	0.030 (.534)	−0.039 (.532)
Executive	−0.033 (.497)	−0.138 (.026)
Episodic memory	−0.021 (.671)	−0.091 (.144)

Abbreviations: BMI, body mass index; LDL, low-density lipoprotein; HDL, high-density lipoprotein; T2D, type 2 diabetes.