

Association Between Impaired Fasting Glycemia, Cognition and Reduced Functional Capacity of Elderly People

Associação entre Alteração da Glicemia de Jejum, Cognição e Capacidade Funcional de Idosos

Mayra dos Santos Silva¹

Luiz Roberto Ramos²

Lígia M. Lucchesi³

Guiomar Silva Lopes⁴

1. Physiotherapist, Post doctorate of the Department of Public Health. Escola Paulista de Enfermagem, Federal University of São Paulo, São Paulo, Brazil. E-mail: mayra.santos@ig.com.br. Corresponding author.
2. Physician, Prof Dr of the Department of Preventive Medicine, Federal University of São Paulo, São Paulo, Brazil.
3. Physician, Profa Dra, Department of Psychobiology, Federal University of São Paulo, São Paulo, Brazil.
4. Doctor, Professor of the Department of Public Health. Escola Paulista de Enfermagem, Federal University of São Paulo, São Paulo, Brazil

Abstract

Objective: to investigate the possible association between altered fasting glycemia, cognitive deficit and reduced functional capacity. Methods: 802 elderly individuals aged over 60 years were selected. The elderly were submitted to evaluations that are included in Comprehensive Geriatric Assessment, Mini Mental State Examination and Daily Life Activity and Geriatric Depression Scale tests, as well as the laboratory blood glucose test. Results: The analysis of the results showed that there is a relationship between fasting glycemia, cognitive decline and functional capacity reduction. Conclusions: The results of the present study suggest that fasting hyperglycemia is a risk factor for the development of cognitive impairment and reduced functional capacity of the elderly.

Key words: fasting glucose alteration; cognitive decline; functional capacity.

Resumo

Objetiva-se investigar a possível associação entre a alteração da glicemia de jejum, o déficit cognitivo e a redução da capacidade funcional. Foram selecionados 802 idosos com idade igual ou superior a 60 anos que foram submetidos às questões incluídas na Avaliação Geriátrica Ampla (AGA), no Mini Exame do Estado Mental (MEEM), no teste da Escala de Depressão Geriátrica (GDS) e nos testes de Atividade da Vida Diária (AVD), além do exame laboratorial da glicemia de jejum. A análise dos resultados mostrou que há relação entre alteração da glicemia de jejum, o declínio cognitivo e a redução da capacidade funcional. Os resultados do presente estudo sugerem que a hiperglicemia de jejum é um fator de risco para o desenvolvimento da diminuição do desempenho cognitivo e para a redução da capacidade funcional de idosos.

Palavras-chave: Alteração da Glicemia de Jejum; Declínio Cognitivo; Capacidade Funcional.

Introduction

Associated with the increased longevity of the population is the growth of chronic noncommunicable diseases (CNCD), such as hypertension, type 2 diabetes and neurodegenerative diseases that tend to progress to dementia at more advanced ages.

Aging induces a decrease in muscle mass and loss of pancreatic beta cell function, favoring the onset of impaired fasting glycemia, noting that insulin binds to its receptors in muscle cells by activating the glucose transporter, which has the role of facilitating the diffusion of glucose into the muscle cell, thus participating in glycemic regulation. It has been shown that fasting blood glucose levels increase by about 0.06 mmol per decade of age ⁽¹⁾.

The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus ⁽²⁾ acknowledged in 2003 that there was a group of individuals in the population who had blood glucose levels which, while not meeting the criteria for Diabetes Mellitus (DM), were too high to be classified as normal, therefore, were considered as an intermediate state between glycemic homeostasis and diabetes. Fasting hyperglycemia is defined as the glycemia value of between 100-125 mg / dL after 8 hours of fasting. The oral glucose tolerance test is performed with the glycemia after an 8-hour fast, and a new measurement is taken after 2 hours of the intake of 75 g of glucose, and the value that characterizes the intolerance is between 140 -199 mg / dL. The group defined as impaired fasting glycemia and the glucose intolerance group have been considered as intermediate stages in the natural history of DM, now known as pre-diabetes ⁽²⁻³⁾.

Despite the scarce studies linking aging to impaired fasting glycemia, it can be seen that elderly individuals with impaired fasting glycemia have a 6 to 11-fold increased risk of developing diabetes at 7 years of age when compared to elderly individuals with normal glycemic levels ⁽¹⁻³⁾.

More recent studies have shown that elevated fasting glycemia, a common clinical condition in aging, is considered a risk factor for the conversion of mild impairment of cognition to Alzheimer's disease. This relationship becomes crucial when we observe that 48% to 50% of the

populations of North America and Central America over 65 years of age have diabetes or pre-diabetes ⁽⁴⁾. In this way, it is a concern of the researchers to recognize early stages of the development of these diseases.

A study ⁽⁸⁾ with Japanese elderly people showed that hyperglycemia was associated with cognitive dysfunction, especially in the executive function domain, whereas insulin resistance was associated with memory impairment. The mechanisms involved in the alteration of fasting glycemia associated with cognitive function in the elderly have not yet been clarified, and this issue becomes important mainly because there is a growing number of elderly people who go from a condition of glycemic normality to a state of glycemic lack of control.

Cognitive decline is considered an intermediate state between normal aging and dementia, whose main characteristic is the impairment of episodic memory in the absence of other cognitive or functional deficits. It is possible that the decline of anterograde episodic memory, especially that in which is expressed in associative learning tasks, can be characterized as a predictive factor for dementia ⁽⁹⁾.

The change in glycemia has been related not only to cognition deficit, but also to the decline in functional capacity. Studies confirm that diabetes associated with depression becomes a risk for the development of cognitive decline in the elderly over time, especially among people aged 50-64 years ⁽¹⁰⁾.

Cognitive deficit can begin with losses in performing the more complex activities on a daily basis, followed by losses in other basic activities ⁽¹⁰⁾. Thus, some studies suggest that there are alterations in the performance of activities of their daily lives (ADLs) that would represent the first signs of mild cognitive impairment ⁽¹¹⁻¹²⁾.

One cannot overlook the influence of socioeconomic and educational factors on health conditions, including metabolic changes, functional capacity and cognitive performance ⁽¹¹⁻¹²⁾.

This study is based on a follow-up population survey of the elderly in São Paulo - Epidoso Project of the Federal University of São Paulo, whose data showed that more than 30% of the population of 1,108 elderly had fasting

glycemia. Given this observation, it became important to evaluate the profile of this group of elderly people.

Thus, this study aims to investigate the possible association between impaired fasting glycemia, cognitive deficit and reduced functional capacity.

Methods

This work is related to the population-based epidemiological study, with a cross-sectional design, with convenience (non-probabilistic) and exploratory sample. Of the 1,108 elderly individuals belonging to the Epidoso Project, 802 elderly individuals who met the criteria for inclusion in the study were selected, ie, 306 elderly were excluded because they had incomplete items in the evaluations or had diabetes. The sample consisted of elderly individuals of both genders and aged between 61 and 89 years. As inclusion criteria were adopted the following items: to have answered all the AGA questions; have performed laboratory blood glucose tests; and have agreed to participate in the survey. Elderly patients with diabetes mellitus and / or incomplete AGA were excluded.

The data were collected through the questionnaire used in the Epidoso project, the AGA (Comprehensive Geriatric Assessment), which includes a gerontological approach and that contains personal data and sociodemographic aspects, as well as questions about style and quality of life and self-assessment about the condition. Still, in AGA are contained questions about the global functionality or Daily Life Activities (ADLs), the Geriatric Depression Scale (GD) or the Geriatric Depression Scale (GDS) and on the assessment of cognition, using the State Mini Exam Mental (MMSE). The elderly also underwent laboratorial examination of fasting glycemia.

All the elderly signed a consent term, respecting the criteria of ethics in research. The national minimum wage of 2016 (R \$ 880.00) was used, as established by Presidential Decree No. 8.618, dated 01.01.2011, as a reference in the presentation of data on family income.

In the evaluation on lifestyle and health conditions, there were questions about

alcoholism, smoking, life satisfaction, complaints and comorbidities. The body mass index (BMI) was obtained using the following formula: (weight) kg/(height)²m², being classified as low-weight BMI <23, eutrophy 23 ≤ BMI <28; overweight between 28 ≤ BMI <30 and obesity BMI ≥ 30, according to WHO recommendations (1989) ⁽¹³⁾. The measurement was obtained in the narrower region of the abdomen or at the midpoint between the last rib and the iliac crest. The cut-off points for risks of metabolic and cardiovascular complications associated with obesity were those adopted by the WHO (1989), which considers normal up to 80 cm for women and 94 cm for men, being considered high risk ≥ 102 cm for men and ≥ 88 cm for women.

The MMSE is a universally used test to evaluate the cognitive function of the elderly, and the cutoff point for establishing cognitive decline was <23 points ⁽¹⁴⁾. The gross score was corrected for schooling and age, whose cutoff points, in these cases should be 19 points for illiterates, 23 points for those who had one to three years of schooling, 24 for those with seven years of schooling and 28 points for those with more than seven years of schooling.

GDS is a validated instrument used for the screening of depression in the elderly, which contains 15 questions to which scores are scored, whose sum when greater than 5 points suggests symptoms of depression.

The ADL questionnaire refers to 15 questions about activities related to self-care and to managing life in and outside the home. This evaluation indicates the functional independence and autonomy of the elderly, and the higher scores represent a greater limitation and autonomy impairment.

The study was approved by the Ethics and Research Committee of the Federal University of São Paulo on April 1, 2011 (0330/11). The data were analyzed using the Statistical Software package. The complete descriptive analysis was performed for all quantitative variables and the distribution of the relative frequency (percentages) for all qualitative variables. The categorical data were analyzed by chi-square (X²) and presented as odds ratio (OR). For the analysis of correlations, the Pearson's correlation test was used through the linear regression equation. A significance level

of 5% ($p < 0.05$) was adopted with a confidence interval of 95%.

Results

The characteristics of the elderly sample of the Epidoso Project, composed of 802 elderly people, were traced according to Table 1. The average age of the population was 72.62 years old, between 61 and 89 years old and predominantly female (64, 7%). The sample was stratified by age group: 60-70 years (342 elderly, 120 men and 222 women); 71-80 years old (322 elderly, 117 men and 205 women); and over 80 years (138 elderly with 46 men and 92 women). Among the elderly, 54.7% are married and 38.2% are widows, and this percentage has become greater among the elderly women over the age of 80 (47.1%). The evaluation of the economic profile showed that the situation of this population was more in keeping with the "middle class", with better living conditions, since the average income was 4.5 ± 6.4 minimum wages and most of their schooling (65.2%) was superior to 8 years of study. It is important to emphasize that high schooling was a characteristic of mostly men, since 48% of women had lower education, on average up to 5 years of schooling.

The cognitive test (MMSE) showed that 658 elderly people (82%) had a normal score, with an average score of 27.5; and 144 elderly (17.9%) had altered cognition with a score < 23 points. In relation to GDS, 640 elderly people (79.9%) were found with normal values (< 5 points on the scale) and 161 elderly (20.1%) with values > 5 points, suggesting symptoms of depression.

In the functional test (ADLs), 127 elderly (15.4%) presented alterations or impairment of the functions, with score > 5 points; and 675 elderly patients (84.1%) presented a score corresponding to normality ($p: 0.01$).

The average fasting glycemia of the elderly in the sample showed a value above the normal parameters (105.64 mg / dL), characterizing fasting hyperglycemia. The average body mass index was 27.16, a value classified as overweight, and 68.9% of the elderly, of both sexes, presented altered values of abdominal circumference, above 80 cm in women and above 94 cm among men, which raises the risk of developing obesity and heart complications. Regarding lifestyle, 514

elderly (64%) reported not being smokers and 501 (62.4%) did not consume alcoholic beverages.

Table 1. Description of the sample of the Aging Study Center of the Federal University of São Paulo, SP, Brazil, 2017.

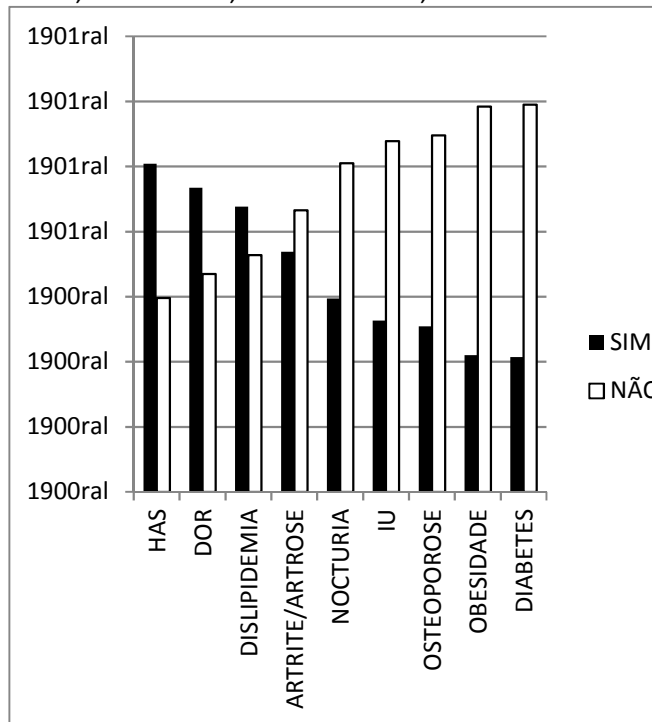
Variables	Average	DP
Age	72,62	7,52
Gender		
Male	283	7,30
Female	519	7,61
Income	4,5	6,4
Body mass index	27,16	4,86
Abdominal circumference		
Male	139,01	55,46
Female	87,51	46,37
Daily life activity	2,84	3,56
Mini Mental State Exam	27,50	2,87
Geriatric depression scale	3,16	3,30
Glycemia	105,64	29,70
Marital status	(N)	%
Single	83	10,3
Married	438	54,7
Widowed	219	27,3
Divorced	62	7,7
Smoker		
Yes	288	35,9
No	514	64,1
Schooling (Years)		
Illiterate	11	1,3
< 4 years	59	7,3
5 to 8 years	209	26,2
> 9 years	523	65,2

Source: research data

Among the comorbidities and self-reported complaints, hypertension-hypertension (62%); pain (58%); dyslipidemia (54%); arthritis / arthrosis (46%); nocturia (37%), urinary incontinence (UI) and osteoporosis (31%). Obesity presented in 26.1% of the elderly population and diabetes in 25.8%, as

shown in Graph 1.

Graph 1. Comorbidities and self-reported complaints of the sample from the Center for the Study of Aging at the Federal University of São Paulo, SP, Brazil, 2017



Source: research data

Using the Odd Ratio test, of the 144 individuals with low scores in the cognitive test (MMSE), 92 of them (63.9%) had fasting glycemia alterations and 52 (36.1%) were normoglycemic. Among individuals with normal cognitive performance, 268 (44.2%) had fasting glycemia and 338 (55.8%) were normoglycemic. These data suggest that there is an increased OR risk: 2:23 (1:53 - 3:25) of the individual with fasting hyperglycemia develop cognitive deficit, and the correlation was statistically significant ($X^2 = 22.91$, $p < 0, 0001$).

Using the Pearson correlation test (r), we observed a negative correlation of glycemia with cognitive performance ($r = -0.009$, $p = 0.01$), that is, as blood glucose values increase, the MMSE test values decrease. Among men, the correlation between glycemia and BMI was established, according to Table 2.

Table 2. Correlation of glycemia with other variables (income, life satisfaction, smoking, sex, schooling, test for cognition, age and body mass

index) of the Aging Studies Center of the Federal University of São Paulo, Brazil, 2017.

Effect on blood glucose	Standardized Beta Coefficient	t	p
Constant		6.926	0.000
Income	-0.039	-0.929	0.353
Life satisfaction	-0.017	-0.398	0.691
Smoker	0.016	0.364	0.716
Male gender	-0.204	-4.535	0.000*
Education	0.039	0.821	0.412
Mini Mental State Exam	-0.170	-3.575	0.000*
Geriatric depression scale	0.011	0.262	0.793
Age	0.013	0.298	0.766
Body mass index	0.124	3.027	0.003*

Source: research data

When correlating the variables (age, smoking, satisfaction with life, BMI, marital status, education, gender and income) with GDS, it was observed that there is a negative relation with income, that is, the higher the income, the lower the chance of depression. However, there was a positive relation between BMI and dissatisfaction with life and depression, that is, the higher the BMI and the dissatisfaction with life, the higher the GDS score, meaning there are symptoms of depression.

Table 3. Correlation of the geriatric depression scale with the other variables (age, smoking, life satisfaction, body mass index, marital status, schooling, sex and income) of the Center for the Study of Aging at the Federal University of São Paulo, SP, Brazil, 2017.

Effect on the geriatric depression scale	Standardized Beta Coefficient	t	p
Constant		-0.061	0.951
Age	-0.101	-0.246	0.806
Smoker	0.007	0.178	0.859
Life satisfaction	0.322	0.505	0.000*
Body mass index	0.079	0.207	0.038*
Marital state	0.037	0.949	0.343
Education	-0.032	-0.796	0.427
Gender	0.054	0.286	0.199
Income	-0.092	-2.347	0.019*

Source: research data

Among women, it was observed that factors such as increasing age, being a smoker, widowed or separated and with low level of schooling are associated with worse cognitive performance, according to Table 4.

Table 4. Relationship between cognition, age, smoking, life satisfaction, body mass index, marital status, schooling, sex and income of the Aging Study Center of the Federal University of São Paulo, SP, Brazil, 2017.

Effects on cognition	Standardized Beta Coefficient	t	p

n	t		
Constant		18.152	0.000
Age	-0.199	-5.490	0.000*
Smoker	-0.086	-2.276	0.023*
Life Satisfaction	0.43	1.224	0.221
Body mass index	0.26	0.732	0.465
Marital state	-0.072	-2.027	0.043*
Education	0.410	11.217	0.000*
Gender	-0.108	-2.781	0.006*
Income	0.08	0.220	0.826

Source: research data

The analysis of the relationship between glycemia and functionality (ADLs), using the Pearson correlation test (r), showed that there is a positive correlation between these variables ($r = 0.000$, $p = 0.01$), that is, the increase in glycemia values is associated with reduced functionality or increased ADL score.

Discussion

With the worldwide aging of the population, the Center for Aging Studies at the Federal University of São Paulo has become a benchmark in research in the area. The initial estimate of the sample showed that 31% of the population of this study center had impaired fasting glycemia, so the focus of the study was based on the evaluation of these elderly patients. The high frequency of glycemic change in this population differed from data from other samples of elderly people, such as

Campina Grande (Paraíba), for example, with a rate of 28.75%, while among the elderly in North America a percentage of 46% was found in 47% change in fasting blood glucose (1-2-15).

Brazil, as well as other peripheral countries, deals with deep social inequalities which are expressed in the health conditions and in the chances of aging ⁽¹⁶⁾. In the city of São Paulo, the population surpassed 11 million and 900 thousand inhabitants, being one (1) million and 500 thousand represented by the population aged 60 and over, the elderly being concentrated in the central districts ⁽¹⁷⁾. These findings demonstrate that aging and health are dependent on social determinants.

Glycemic control, as well as other variables, is influenced by socioeconomic conditions that affect food and access to health services, with a significant impact on morbidity and mortality in the population ⁽¹⁸⁾. However, in the present study, a high index of fasting glycemia was observed, even though this population presents a good socioeconomic condition.

In the sample studied, this correlation between health conditions and social determinants was evident when we noticed the association of a higher income (approximately 4.5 minimum wages) with high schooling, but only prevalent in the male population.

In the preventive premise of identifying the factors associated with fasting hyperglycemia, the findings of this study revealed a correlation between fasting glycemia and altered cognitive performance, and among women, this correlation was influenced by age and schooling. Here it is clear that elements of the patriarchal culture and unequal gender policy have not allowed women born in the 1940s and 1950s, currently 60 to 70 years old, to complete their education and thus present the result of lower schooling with a higher risk of cognitive alteration when compared to men and younger women ⁽¹⁸⁾.

The feminization of aging was present in the sample, age and gender are two of the main factors pointed out by demographers in establishing differences among members of the population. The presence of a large number of older women is, in many societies, a recent demographic phenomenon and indicates a life expectancy of around 7 years longer than men.

The increase in female longevity is accompanied by the higher percentage of widowhood, which can be explained by women's natural longevity and remarriage, which is more commonly observed among men ⁽¹⁹⁾.

This study showed that among men there is a correlation between the change in fasting blood glucose and the increase in body mass. It's important to remember that most of the elderly were overweight, a finding that may lead to the assumption that the presence of abdominal fat, which was prevalent among men, would be closely related to elevated glycemia. It is common for elderly people with impaired fasting glucose to have an increase in triglyceride levels and waist circumference, and a higher risk of converting mild cognitive decline into dementia over a two-year period (1-2). The anatomical variation of body fat distribution is an important indicator of metabolic complications, more than BMI ⁽²⁰⁾.

It is important to point out the scarcity of epidemiological studies on the frequency of pre-diabetics in the Brazilian elderly population. Fasting hyperglycemia, cognitive impairment, and functional dependence appear to form an interrelational cycle. The reduction of muscle mass in aging favors sedentary lifestyle and the lower uptake of glucose by muscles and can lead to fasting hyperglycemia, in addition to favoring changes in the ADLs, and the latter may precede frames of cognitive impairment ^(5-10-11- 12). Older people with impairment in cognitive function are 4.4 times more likely to present disabilities in the performance of ADLs than those who do not present cognitive impairment ⁽¹⁹⁾.

Conclusion

The feminization of aging brings with it several positive and negative factors for the elderly and their families, since it may be associated with a greater social risk and, at the same time, a restructuring of the relational space. Older women are potentially at risk due to the aging process, which makes them more vulnerable to disability due to physical, social or affective conditions. Patriarchal sovereignty is still present in women's daily lives.

The results of this study evidenced the influence of social determinants on health and the

aging process. Infectious diseases have been replaced by chronic noncommunicable diseases, and today we are witnessing the world's diabetes pandemic. These data make us reflect on the need for a broad knowledge of risk and prevention factors, as well as investments in new technologies and strategies for elderly health care, aiming at greater effectiveness of treatment and reduction of complications of chronic diseases.

The aging process was associated with fasting hyperglycemia in several articles and also in our population. The present study revealed an interactive effect between the change in fasting glycemia on cognitive decline and on functional capacity reduction. In summary, this work suggests that fasting hyperglycemia is a risk factor and a predictor of cognitive decline and functional capacity reduction. Preventive strategies for fasting hyperglycemia in the elderly population may be the pathway to diabetes prevention and complications related to glucose metabolism, such as cognitive decline and functional disability.

References

- Schmidt MI, Hoffmann JF, Diniz MFS, Lotufo PA, Griep RH, Bensenor IM, et al. High prevalence of diabetes and intermediate hyperglycemia - The Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). *Diabetol Metab Syndr* [Internet]. 2014 [acesso em 12/09/2017];6(123):1-9. Available in: <https://dmsjournal.biomedcentral.com/articles/10.1186/1758-5996-6-123>.
- American Diabetes Association. Classification and diagnosis of diabetes mellitus. Sec. 2. In *Standards of Medical Care in Diabetes—2016*. *Diabetes Care* [Internet]. 2016 [acesso em 12/09/2017];39(1):S13–S22. Available in: http://care.diabetesjournals.org/content/38/Supplement_1/S8.
- Anjana RM, Shanthi Rani CS, Deepa M, et al. Incidence of diabetes and prediabetes and predictors of progression among Asian Indians: 10-year follow-up of the Chennai Urban Rural Epidemiology Study (CURES). *Diabetes Care* [Internet]. 2015 [acesso em 12/09/2017];38:1441–1448. Available in: <https://www.ncbi.nlm.nih.gov/pubmed/2590678>.
- Caspersen CJ, Thomas GD, BA, Beckles GLA, Bullard KM. Secular changes in Prediabetes indicators among older-adult Americans, 1999–2010. *Am J Prev Med* [Internet]. 2015 [acesso em 12/09/2017]; 48(3): 253–263. Available in: <https://www.ncbi.nlm.nih.gov/pubmed/25601724>.
- Umegaki H, Makino T, et al. The associations among insulin resistance, hyperglycemia, physical performance, diabetes mellitus, and cognitive function in relatively healthy older adults with subtle cognitive dysfunction. *Front Aging Neurosci*. [Internet]. 2017 [acesso em 12/09/2017]; 23(9):72. Available in: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5362585/>.
- Biundo R, Weis L, Antonini A. Cognitive decline in Parkinson's disease: the complex picture. *npj Parkinson's Disease* [Internet]. 2016 [acesso em 12/09/2017]; 2:16018. Available in: <https://www.nature.com/articles/npjparkd201618>.
- Downer B, Vickers BN, Snih SA, Raji M, Markides KS. Effects of comorbid depression and diabetes mellitus on cognitive decline in older Mexican Americans. *Journal of the American Geriatrics Society* [Internet]. 2016 [acesso em 12/09/2017]; 64(1): 109-117. Available in: <https://www.ncbi.nlm.nih.gov/pubmed/26782859>.
- Dias EG, Andrade FB, Duarte YAO, Santos JLF, Lebrão ML. Advanced activities of daily living and the incidence of cognitive impairment in the elderly: SABE Study. *Cad. Saúde Pública* [Internet]. 2015 [acesso em 12/09/2017]; 31 (8). Available in: http://www.scielo.br/scielo.php?pid=S0102-311X2015000801623&script=sci_abstract&tlng=es.
- Paula JJ, Albuquerque MR, Lage GM, Bicalho MA, Romano-Silva MA, Malloy-Diniz LF. Impairment of fine motor dexterity in mild cognitive impairment and Alzheimer's disease dementia: Association with activities of daily living.

- Revista Brasileira de Psiquiatria [Internet]. 2016 [acesso em 12/09/2017]; 38: 235–238. Available in: <https://www.ncbi.nlm.nih.gov/pubmed/27508398>.
13. World Health Organization. Regional Office for Europe. Nutrition Unit.; Instytut Żywności i Żywienia (Poland) . Measuring obesity: classification and distribution of anthropometric data. Copenhagen, Denmark: WHO [Internet].1989 [acesso em 12/09/2017]. Available in: <http://www.worldcat.org/title/measuring-obesity-classification-and-description-of-anthropometric-data-report-on-a-who-consultation-on-the-epidemiology-of-obesity-warsaw-21-23-october-1987/oclc/68197223>.
14. Folstein MF, Folstein SE, McHugh PR. "Minimal state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. [Internet]. 1975; [acesso em 12/09/2017];12(3):189-98. Available in: <https://www.ncbi.nlm.nih.gov/pubmed/1202204>.
15. Rocha RS. Glycemic profile of elderly people belonging to the University open to maturity. Completion of a course presented at the State University of Paraíba for a bachelor's degree in nursing [Internet]. 2016[acesso em 12/09/2017]. Available in: <http://dspace.bc.uepb.edu.br/jspui/bitstream/123456789/12217/1/PDF%20%20Rafaela%20Santos%20Rocha.pdf>
16. Iamamoto MV. Brazil of inequalities: "social issue", work and social relations. SER social [Internet]. 2013 [acesso em 12/09/2017]; 15 (33):261-384. Available in: <http://www.cressrn.org.br/files/arquivos/FaPa10y8kQ65voJ4T345.pdf>
17. IBGE. Brazilian Institute of Geography and Statistics. National Household Sample Survey (Pnad) [Internet] 2015. [acesso em 12/09/2017]; Available in: <http://www.ibge.gov.br/home/presidencia/noticias/25072002pidoso.shtm>.
18. Leist AK, Hessel P, Avendano M. Do economic recessions during early and mid-adulthood influence cognitive function in older age? J Epidemiol Community Health [Internet]. 2014 [Acesso em 12/09/2017]; 68:151-8. Available in: <https://www.ncbi.nlm.nih.gov/pubmed/24258197>.
19. Kamo T, Nishida Y. Direct and indirect effects of nutritional status, physical function and cognitive function on activities of daily living in Japanese older adults requiring long-term care. Geriatr Gerontol Int. [Internet]. 2014 [acss in 12/09/2017]; 14:799-805. Available in: <https://www.ncbi.nlm.nih.gov/pubmed/24215649>.
20. Haghghatdoost F, Amini M, Feizi A, Iraj B. Are body mass index and waist circumference significant predictors of diabetes and pre-diabetes risk: Results from a population-based cohort study. [Internet]. 2017 [access in 12/09/2017]; 8(7):365-373. Available in: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5507834/>.