

INTERRELATIONSHIP BETWEEN DIET QUALITY AND DEPRESSIVE SYMPTOMS IN ELDERLY

A.P. GOMES¹, I. OLIVEIRA BIERHALS¹, A.L. GONÇALVES SOARES^{1,2}, N. HELLWIG^{1,3},
E. TOMASI¹, M.C. FORMOSO ASSUNÇÃO¹, H. GONÇALVES¹

1. Postgraduate Program in Epidemiology. Federal University of Pelotas; 2. MRC Integrative Epidemiology Unit at the University of Bristol, School of Social & Community Medicine, University of Bristol, Bristol, UK; 3. Postgraduate Program in Public Health. Federal University of Rio de Janeiro. Corresponding author: Ana Paula Gomes. Postgraduate Program in Epidemiology. Rua Marechal Deodoro, 1160 - 3º Piso. Pelotas, Rio Grande do Sul, Brazil. CEP: 96020-220. E-mail address: anapaulagomes.nutri@gmail.com

Abstract: *Background:* Several observational studies have shown association between diet quality and depression, but few studies have explored the interrelationship between these variables. *Objective:* The aim of this study was to assess the interrelationship between diet quality and depressive symptoms in elderly. *Design:* Cross-sectional study. *Setting:* Population based. *Participants:* 1,378 elderly in the city of Pelotas, Brazil. *Measurements:* The diet quality was assessed by a short food frequency questionnaire and the prevalence of depressive symptoms was estimated by the abbreviated Brazilian version of the Geriatric Depression Scale (GDS). The association between diet quality and depressive symptoms was assessed using logistic regression. *Results:* The prevalence of depressive symptoms was 15.3%. Elderly with low-quality diet were more likely to experience depressive symptoms, and the association was almost twice higher in males than in females (men OR = 3.8, 95% CI 1.4, 10.6; women OR = 2.1, 95% CI: 1.4, 3.3). On the other hand, depressive elderly had higher odds of consuming a low-quality diet (OR 2.4, 95% CI: 1.7, 3.8). *Limitations:* Self-reported data and cross-sectional design limit our conclusions. *Conclusions:* The choice of a low-quality diet was associated to a higher risk of depressive symptoms in elderly, and vice-versa. These results highlight the importance of encouraging the choice of healthy food habits, especially in depressed elderly, in order to promote healthy aging.

Key words: Diet quality, food habits, depression, cross-sectional studies.

Introduction

Depression affects about 300 million people worldwide, and it is a relevant and growing public health problem (1). Besides being considered the main cause of mental deficiency all over the world, depression is currently the second main contributor for the global burden of diseases, and it is estimated that it will be the first main cause of the global burden of diseases until 2030 (2-3). Depression is a highly prevalent disease in elderly people (4), and it is associated to increased risk of morbidity and mortality and decreased quality of life and well-being in this population.

Several studies have shown an association between lifestyle and development of depression, emphasizing the modifiable behavioral risk factors (5-6), such as diet. These studies suggest that a high-quality diet is associated to a decreased risk of depression (6-8). On the other hand, it is also possible that depressed individuals change their eating behaviors due to the disease (9-10).

Although the evidence for the relationship between diet and depression has increased throughout the last few years (8), a considerable part of the studies is limited to assessing the intake of nutrients or specific food and their association with depression, or the use of supplementary food as a mechanism to prevent depression (7, 11-13). However, the effect of diet on mental health is a complex process, depending not only on the interaction among the nutrients consumed, but also on the variety of food ingested in the diet (6, 7). The studies

which assess the association between diet quality and/or eating patterns and depression are predominantly carried out with adolescents (8, 14-17) and adults (6, 9, 18-19). Most of the studies carried out with elderly assess the effect of diet on the occurrence of depression (20), but not the reverse direction. Considering the aging trend of the world population due to the increase in life expectancy and decrease in fertility and mortality rates, this assessment in the elderly population plays an important role (21).

The aim of this study was to assess the interrelationship between diet quality and depressive symptoms in elderly.

Methods

Cross-sectional, population-based study, comprising a research consortium of Masters' students (22), which aimed to assess distinct aspects of general health of the population aged 60 or more living in the urban area of the city of Pelotas, Brazil, in 2014.

The sample selection was carried out in two stages. Firstly, we selected the census sectors of the city, according to the Brazilian Institute of Geography and Economy (Instituto Brasileiro de Geografia e Economia -IBGE) census (23). Then, the households within each sector were systematically selected. Institutionalized elderly and those in enteral nutritional therapy were not included in the study sample.

To estimate the prevalence of depressive symptoms, we used the abbreviated Brazilian version of the Geriatric Depression

INTERRELATIONSHIP BETWEEN DIET QUALITY AND DEPRESSIVE SYMPTOMS IN ELDERLY

Scale – GDS (24). It consists of a screening instrument with 10 yes/no questions related to the seven days prior to the interview. For each affirmative answer a point was awarded, and the results ranged from zero to ten. We considered as having depressive symptoms the elderly who had a score ≥ 5 , a cut-off which has the best sensitivity and specificity for Major Depressive Disorder, according to the criteria of International Classification of Diseases (ICD-10) and the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (25).

Elderly dietary quality was assessed using a score developed for another study in the same population (26), which was called Elderly Dietary Quality Index (EDQ-I). The score awarded points ranging from 0 to 3 according to the intake frequency of 11 groups of food. The food groups considered in the study as “healthy” were rated in an increasing way (elderly who did not consume it = zero points; who consumed between 1-3 days/week = one point; who consumed between 4-6 days/week = two points, and who consumed every day in the previous before = three points). The food groups were the following: 1) rice and beans; 2) whole grain; 3) fruit; 4) vegetables; 5) milk and dairy products and 6) beef, fish, chicken or eggs. For the food items considered as “unhealthy”, the score range decreased (elderly who did not consume it = three points; who consumed between 1-3 days/week = two points; who consumed between 4-6 days/week = one point, and who consumed every day in the previous week = zero points). The food items considered as unhealthy were the following: 1) sweets, soft drinks and artificial juices; 2) fried food; 3) canned food and sausages; 4) ready-to-eat and frozen food; 5) fast food. Therefore, a higher score in the EDQ-I reflected a higher consumption of healthy food and lower consumption of unhealthy food. The total score of the EDQ-I was divided into tertiles: 1st tertile (lowest score) – low quality diet; 2nd tertile – intermediate quality diet; 3rd tertile – high-quality diet.

Household interviews were conducted by interviewers with at least secondary education and who received training for data collection and anthropometric measurements. To guarantee data quality, fieldwork supervisors (Masters’ students) directly controlled several stages of the fieldwork. A short version of the questionnaire was applied to 10% of the sample, which was selected randomly.

Initially, the sample was described according to socioeconomic and demographic characteristics, and the association of the covariates with the outcomes was assessed. Then, we assessed the interrelationship between diet quality and depressive symptoms. First, depressive symptoms were considered as the outcome and its association with diet quality was assessed using logistic regression, from which crude and adjusted odds ratios were obtained. Then, diet quality was used as the outcome and its association with depressive symptoms was assessed using multinomial logistic regression, and high-quality was considered the reference category. Crude and adjusted odds ratio were obtained as well. Demographic, socioeconomic and behavioral variables were used in the

adjusted analyses as potential confounders.

The demographic and socioeconomic variables assessed were: gender (male, female), age (60-69, 70-79, 80 or more), marital status (with partner, without partner), years of schooling (0, 1-3, 4-7, 8-10, 11 or more) and economic class, classified according to the Brazilian Economic Classification Criterion developed by the Associação Brasileira de Estudos Populacionais – ABEP (Brazilian Association of Market Research Companies) (A/B, C and D/E) (27). The behavioral variables were: current smoking status, which corresponded to use of at least one cigarette per day for more than one month (yes, no); alcoholic beverage intake in the 30 days prior to the interview (yes, no) and physical activity level, assessed by the International Physical Activity Questionnaire (IPAQ) (28), which classified as active those individuals who practiced ≥ 150 weekly minutes of leisure activity.

The analysis was performed using Stata 12.1 (Stata Corp, College Station, USA). The significance level adopted for the associations was 5%, and the sampling design was considered in the analysis. Analysis was stratified by gender when evidence of interaction was observed ($p < 0.05$).

The study was approved by the Research Ethics Committee of Faculty of Medicine of the Federal University of Pelotas, under protocol number 472.357/2013. All participants signed an Informed Consent Form.

Results

In this study, 1,844 elderly were eligible and 1,451 were interviewed, corresponding to 9.7% of loss and 11.6% of refusals. Complete information on the outcomes was available for 1,378 individuals, which constitute the sample for this study.

The demographic, socioeconomic, behavioral and health-related characteristics of the elderly are described in Table 1. The majority of the elderly was female (63.1%), aged 60 to 69 years (53.1%), belonged to the economic class C (52.8%) and studied up to 7 years (67.9%). With regard to marital status, the majority of the elderly lived with a partner (53.4%), and this proportion was lower in the older groups. About 80% of the elderly practiced insufficient leisure physical activity, 21.8% reported alcoholic beverage intake in the 30 days prior to the interview, and 12.9% were current smokers.

The prevalence of depressive symptoms was 15.3%, and it was higher in females, individuals without a partner, from lower economic classes, with lower schooling, who reported alcoholic beverage intake and who practiced insufficient leisure physical activity (Table 2). The EDQ-I ranged from 11 to 33, with average 24.2 (SD=3.8) and median 24.0 (data not showed in table). The prevalence of low quality diet was higher in males, from lower economic classes, with lower schooling, and individuals who smoked, reported alcoholic beverage intake and did not practice sufficient leisure physical activity (Table 2).

Table 1

Demographic, socioeconomic, behavioral and health-related characteristics of the elderly. Pelotas, Brazil, 2014 (N=1,378)

Variables	N	%
Gender		
Male	508	36.9
Female	870	63.1
Age (years)		
60 – 69	731	53.1
70 – 79	438	31.8
80 or more	207	15.1
Marital status		
Without partner	642	46.6
With partner	735	53.4
Economic class *		
A/B	457	34.8
C	694	52.8
D/E	163	12.4
Schooling (years)		
0	183	13.4
1 – 3	319	23.3
4 – 7	427	31.2
8 – 11	138	10.1
12 or more	301	22.0
Current smoking		
No	1,199	87.1
Yes	178	12.9
Alcohol intake in the previous 30 days		
No	1,075	78.2
Yes	300	21.8
Leisure physical activity		
Active	247	18.4
Insufficiently active	1,093	81.6

*Higher number of missing: 64

The association between dietary quality and depressive symptoms is shown in Table 3. In crude analysis, those elderly who consumed a low-quality diet had a higher odds of depressive symptoms than those who consumed a high-quality diet. This association was still evident after adjustment for confounders, and it was stronger for males (OR 3.78, 95% CI: 1.35, 10.57) than for females (OR 2.13, 95% CI: 1.35, 3.33). The odds of depressive symptoms was higher according the lower diet quality for both genders (Table 3).

Crude and adjusted analyses of the association between depressive symptoms and dietary quality are presented in

Table 4. After adjustment for confounders, those elderly who had depressive symptoms had higher odds of adhering a low-quality diet than those who had no depressive symptoms (OR 2.43, 95% CI: 1.59, 3.71). No association was observed for intermediate quality diet (OR 1.40, 95% CI: 0.91, 2.16).

Discussion

This study showed an interrelationship between diet quality and depressive symptoms in elderly. A low-quality diet was associated with a higher odds of depressive symptoms, and this association was stronger for males than females. At the same time, depressed elderly had a higher odds of adopting a low-quality diet, and this association was similar across genders.

Both depression and low-quality diet have been independently associated to a higher risk of morbidity and mortality, as well as a decreased quality of life. An emerging body of evidence has suggested that nutrition plays an important role in mental health (29), showing that unhealthy diets are associated to higher levels of depression in many populations (9, 30-32). In line with this evidence, we observed in our study that the choice of a low-quality diet, characterized by a low consumption of healthy food and a high consumption of unhealthy food, was associated to a higher odds of depression in elderly. Other studies carried out in elderly, although using different methodologies, have found similar results (20, 33). A recent meta-analysis showed that elderly who adopted more to a healthy pattern, characterized by a high consumption of vegetables, fruit, whole grains and fish, had a lower risk of depression (7). However, the authors did not find any association between the choice of a Western diet pattern and depression, and they attribute this lack of association to a small number of studies and to low statistical power (7).

A possible explanation for the association between diet quality and depression is that diet modulates physiological factors which play a part in depression, such as inflammatory and oxidative processes, plasticity and cerebral function, as well as the stress response system, and, consequently, could contribute in the development of depression (10). Some studies have shown that the consumption of a diet rich in antioxidants, vitamins, minerals and fibers is associated with lower systemic inflammation (34), whilst Western diet (35-36) or diets with low quantity of essential nutrients, like magnesium (37-38), are associated with higher systemic inflammation. On the other hand, inflammation leads to increased oxidative stress, which is pointed as a risk factor for depression (39).

Our study showed that depressive symptoms can lead to a poorer dietary intake, which was also observed in other studies (10, 32). Few studies have assessed the role of depression on dietary intake or quality in elderly, and some of them have suggested that depressed individuals are more likely to consume a higher quantity of sugar- and fat-rich food intending to attenuate anguish feeling (9, 40). However, they also consume a lower quantity of fruit and vegetables (41), which could

INTERRELATIONSHIP BETWEEN DIET QUALITY AND DEPRESSIVE SYMPTOMS IN ELDERLY

Table 2

Depressive symptoms and diet quality according to demographic, socioeconomic, behavioral and health-related characteristics of the elderly. Pelotas, Brazil, 2014 (N=1,378)

Variables	Depressive symptoms Total: 211 (15.3%) n (%)	p-value	Low diet quality Mean (SD):19.9 (1.85) n (%)	Intermediate diet quality Mean (SD): 24.5 (1.14) n (%)	High diet quality- Mean (SD): 28.7 (1.61) n (%)	p-value
Gender		<0.001				<0.001
Male	50 (9.8)		210 (41.3)	180 (35.4)	118 (23.2)	
Female	161 (18.5)		255 (29.3)	342 (39.3)	273 (31.4)	
Age (years)		0.602				0.018
60 – 69	114 (15.6)		250 (34.2)	299 (40.9)	182 (24.9)	
70 – 79	70 (16.0)		146 (33.3)	158 (36.1)	134 (30.6)	
80 or more	27 (13.0)		69 (33.3)	65 (31.4)	73 (35.3)	
Marital status		<0.001				0.672
Without partner	122 (19.0)		210 (32.7)	244 (38.0)	188 (29.3)	
With partner	89 (12.1)		255 (34.7)	278 (37.8)	202 (27.5)	
Economic class		<0.001				<0.001
A/B (Highest)	50 (10.9)		116 (25.4)	188 (41.1)	153 (33.5)	
C	108 (15.6)		259 (37.3)	253 (36.5)	182 (26.2)	
D/E	41 (25.2)		74 (45.4)	56 (34.4)	33 (20.3)	
Schooling (years)		0.006				0.002
0	32 (17.5)		75 (41.0)	65 (35.5)	43 (23.5)	
1 – 3	61 (19.1)		118 (37.0)	119 (37.3)	82 (25.7)	
4 – 7	72 (16.9)		150 (35.1)	162 (37.9)	115 (26.9)	
8 – 11	19 (13.8)		49 (35.5)	52 (37.7)	37 (26.8)	
12 or more	27 (9.0)		70 (23.3)	121 (40.2)	110 (36.5)	
Current smoking		0.085				<0.001
No	176 (14.7)		371 (30.9)	464 (38.7)	364 (30.4)	
Yes	35 (19.7)		94 (52.8)	58 (32.6)	26 (14.6)	
Alcohol intake in the previous 30 days		0.002				<0.001
No	182 (16.9)		337 (31.4)	413 (38.4)	325 (30.2)	
Yes	29 (9.7)		127 (42.3)	108 (36.0)	65 (21.7)	
Leisure physical activity		<0.001				0.016
Active	13 (5.3)		67 (27.1)	95 (38.5)	85 (34.4)	
Insufficiently active	189 (17.3)		384 (35.2)	419 (38.3)	290 (26.5)	

ABEP: Associação Brasileira de Estudos Populacionais (Brazilian Association of Market Research Companies), IPAQ: International Physical Activity Questionnaire.

result in a lower diet quality. A case-control study carried out by Payne et al (2012) showed that depressed elderly consumed less fruit, vegetables and antioxidants than non-depressed (41). The association of depression with poorer diets could be due to the appetite modification frequently occurred after the disease development. Modification of appetite is a common symptom among those diagnosed with major depression, and it is one of the diagnostic criteria of depression in DSM-V (9-10).

Strengths and limitations

The cross-sectional design of this study does not allow the establishment of a causal relationship in the association between diet quality and depressive symptoms, thus some caution is needed in the interpretation of the results. In addition, although the analysis has been adjusted for potential confounders, it is possible that both depression and diet may be influenced by another factor not measured in this study, then we cannot rule out residual confounding.

The short food frequency questionnaire (FFQ) used in this

Table 3

Crude and adjusted analysis of the association between dietary quality and depressive symptoms. Pelotas, Brazil, 2014 (N=1,378)

Dietary quality	Male		Female	
	OR Depressive Symptoms (95% CI)	p-value	OR Depressive symptoms (95% CI)	p-value
Crude		0.001		<0.001
Low	4.07 (1.54; 10.70)		2.59 (1.64; 4.10)	
Intermediate	1.76 (0.61; 5.07)		1.58 (1.00; 2.49)	
High	1.00		1.00	
Adjusted ^a		0.003		0.001
Low	3.78 (1.35; 10.57)		2.13 (1.35; 3.33)	
Intermediate	1.55 (0.44; 5.49)		1.39 (0.85; 2.26)	
High	1.00		1.00	

a. Adjusted for gender, age, marital status, education, economic class, leisure physical activity, current smoking, and alcohol intake in the previous 30 days.

Table 4

Adjusted analysis between depressive symptoms and dietary quality in elderly. Pelotas, 2014 (N=1,378)

Depressive symptoms	Dietary quality (EDQ-I)				
	Low		Intermediate		High
	Crude OR (95% CI)	Adjusted OR ^a (95% CI)	Crude OR (95% CI)	Adjusted OR ^a (95% CI)	Reference category
No	1.00	1.00	1.00	1.00	1.00
Yes	2.51 (1.68; 3.75)	2.43 (1.59; 3.71)	1.53 (1.01; 2.32)	1.40 (0.91; 2.16)	1.00

a. Adjusted for gender, age, marital status, education, economic class, leisure physical activity, current smoking, and alcohol intake in the previous 30 days

study might not have captured all the food components of the eating habits of the elderly. However, the main objective of the FFQ was to differentiate the dietary quality among those depressed and not depressed instead of providing accurate measure of the dietary consumption. Still, the usage of a short FFQ in research has advantages in relation to longer versions, once it facilitates its applicability and has a better adherence from the interviewees (42). Other possible limitation is the use of a screening instrument, which captures depressive symptoms instead of diagnose of depression.

The methodological quality of the study, which enabled the use of a random and representative sample of the elderly of the city of Pelotas is a positive aspect which has to be highlighted. Moreover, the assessment of the interrelationship between diet and depressive symptoms contributes with the body of evidence in this field, encouraging future longitudinal studies investigating this association.

Conclusion

This study suggests an interrelationship between diet quality and depressive symptoms in the elderly. Considering this,

the encouragement of a healthy eating as a way to promote healthy aging is important, as so the need of nutritional attention in depressed individuals due to the higher risk of having a low-quality diet. Studies addressing the mediators of this relationship, like nutritional biomarkers, should be carried out to better understand the possible mechanisms through which diet could result in a poorer mental health and to elucidate forms of interventions.

Collaborations: APG participated in all stages of the study, including the proposal of the research question, the data analysis and manuscript writing. IOB and ALGS participated in the manuscript writing and reviewed the final draft. NH, ET, MCFA and HG reviewed all the drafts of the manuscript and contributed with suggestions to the work.

Acknowledgments: This research received founding from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), provients from Programa de Excelência Acadêmica (PROEX).

Conflict of Interest: All authors declare that they have no conflict of interest and funding sources.

Ethical standard: The study was approved by the Research Ethics Committee of Faculty of Medicine of the Federal University of Pelotas, under protocol number 472.357/2013. All participants signed an Informed Consent Form.

INTERRELATIONSHIP BETWEEN DIET QUALITY AND DEPRESSIVE SYMPTOMS IN ELDERLY

References

- WHO. Depression. Fact sheet. February 2017. Available from: <http://www.who.int/mediacentre/factsheets/fs369/en/>
- Global Burden of Disease Study 2013 Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet* (London, England). 2015;386(9995):743-800. doi:10.1016/S0140-6736(15)60692-4.
- Mathers, C., Fat, D. M., Boerma, J. T., & World Health Organization. (2008). *The global burden of disease: 2004 update*. Geneva, Switzerland: World Health Organization.
- Santos KT, Fernandes MH, Reis LA, Coqueiro RS, Rocha SV. Depressive symptoms and motor performance in the elderly: a population based study. *Brazilian Journal of Physical Therapy*. 2012;16:295-300.
- Cassidy K, Kotymia-English R, Acres J, Flicker L, Lautenschlager NT, Almeida OP. Association between lifestyle factors and mental health measures among community-dwelling older women. *Australian and New Zealand Journal of Psychiatry*. 2004 2004/01/01;38(11-12):940-7.
- Quirk S, Williams L, O'Neil A, Pasco J, Jacka F, Housden S, et al. The association between diet quality, dietary patterns and depression in adults: a systematic review. *BMC Psychiatry*. 2013;13(1):175.
- Lai JS, Hiles S, Bisquera A, Hure AJ, McEvoy M, Attia J. A systematic review and meta-analysis of dietary patterns and depression in community-dwelling adults. *Am J Clin Nutr*. 2014 Jan;99(1):181-97.
- O'Neil A, Quirk SE, Housden S, Brennan SL, Williams LJ, Pasco JA, et al. Relationship Between Diet and Mental Health in Children and Adolescents: A Systematic Review. *American Journal of Public Health*. 2014;104(10):e31-e42.
- Jacka FN, Cherbuin N, Anstey KJ, Butterworth P. Does reverse causality explain the relationship between diet and depression? *J Affect Disord*. 2015 Apr 1;175:248-50.
- Kiecolt-Glaser JK, Jaremka LM, Hughes S. Psychiatry and social nutritional neuroscience. *World Psychiatry*. 2014;13(2):151-2.
- Tolmunen T, Hintikka J, Ruusunen A, Voutilainen S, Tanskanen A, Valkonen V-P, et al. Dietary folate and the risk of depression in Finnish middle-aged men: a prospective follow-up study. *Psychother Psychosom*. 2004;73(6):334 - 9.
- Sanchez-Villegas A, Henriquez P, Figueiras A, Ortuno F, Lahortiga F, Martinez-Gonzalez M. Long chain omega-3 fatty acids intake, fish consumption and mental disorders in the SUN cohort study. *Europ J Nutr*. 2007;46(6):337 - 46.
- Murakami K, Mizoue T, Sasaki S, Ohta M, Sato M, Matsushita Y. Dietary intake of folate, other B vitamins, and omega-3 polyunsaturated fatty acids in relation to depressive symptoms in Japanese adults. *Nutrition*. 2008;24(2):140 - 7.
- Jacka F, Mykletun A, Berk M, Bjelland I, Tell G. The association between habitual diet quality and the common mental disorders in community-dwelling adults: the hordaland health study. *Psychosom Med*. 2011;73(6):483 - 90.
- Jacka F, Kremer P, Leslie E. Associations between diet quality and depressed mood in adolescents: results from the Health Neighbourhoods study. *Aust NZ J Psychiat*. 2010;44(5):435 - 42.
- Jacka FN, Rotheron C, Taylor S, Berk M, Stansfeld SA. Diet quality and mental health problems in adolescents from East London: a prospective study. *Soc Psychiatry Psychiatr Epidemiol*. 2013 Aug;48(8):1297-306.
- Weng T, Hao J, Qian Q. Is there any relationship between dietary patterns and depression and anxiety in Chinese adolescents? *Public Health Nut*. 2011;25:1 - 10.
- Appelhans BM, Whited MC, Schneider KL, Ma Y, Oleski JL, Merriam PA, et al. Depression severity, diet quality, and physical activity in women with obesity and depression. *J Acad Nutr Diet*. 2012 May;112(5):693-8.
- Nanri A, Kimura Y, Matsushita Y, Ohta M, Sato M, Mishima N, et al. Dietary patterns and depressive symptoms among Japanese men and women. *Eur J Clinical Nutrition*. 2010;64(8):832 - 9.
- Jacka FN, Cherbuin N, Anstey KJ, Butterworth P (2014) Dietary Patterns and Depressive Symptoms over Time: Examining the Relationships with Socioeconomic Position, Health Behaviours and Cardiovascular Risk. *PLoS ONE* 9(1): e87657. doi: 10.1371/journal.pone.0087657
- Bongaarts J. Human population growth and the demographic transition. *Philos Trans R Soc Lond B Biol Sci*. 2009 Oct 27;364(1532):2985-90.
- Barros AJD, Menezes AMB, Santos IS, Assunção MCF, Gigante D, Fassa AG, et al. O Mestrado do Programa de Pós-graduação em Epidemiologia da UFPEL baseado em consórcio de pesquisa: uma experiência inovadora. *Revista Brasileira de Epidemiologia*. 2008;11:133-44.
- IBGE. Censo Demográfico. In: Instituto Brasileiro de Geografia e Estatística. 2010.
- Almeida OP, Almeida SA. Short versions of the geriatric depression scale: a study of their validity for the diagnosis of a major depressive episode according to ICD-10 and DSM-IV. *Int J Geriatr Psychiatry*. 1999 Oct;14(10):858-65.
- DSM-IV-TR. Manual Diagnóstico e Estatístico de Tratamento de Transtornos Mentais. Porto Alegre: Artes Médicas; 2002.
- Gomes AP, Soares AL, Gonçalves H (no prelo). Baixa qualidade da dieta de idosos: estudo de base populacional no Sul do Brasil. *Ciênc saúde coletiva*. 2016; 21(11): 3417-3428. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-81232016001103417&lng=en.
- Associação Brasileira de Empresas de Pesquisa (ABEP). Critério de classificação econômica Brasil. São Paulo: ABEP; 2014.
- Matsudo S, Araújo T, Marsudo V, Andrade D, Braggion G. Questionário internacional de atividade física (IPAQ): estudo de validade e reprodutibilidade no Brasil. *Rev bras ativ fís saúde*. 2001;6(2):5-18.
- Murakami K, Sasaki S. Dietary intake and depressive symptoms: a systematic review of observational studies. *Mol Nutr Food Res*. 2010 Apr;54(4):471-88.
- Kuczmarski M, Cremer Sees A, Hotchkiss L, Cotugna N, Evans M, Zonderman A. Higher healthy eating index-2005 scores associated with reduced symptoms of depression in an urban population: findings from the healthy aging in Neighborhoods of diversity across the life span (HANDLS) study. *J Amer Dietetic Assoc*. 2010;110(3):383 - 9.
- Li N, Pang L, Chen G, Song X, Zhang J, Zheng X. Risk factors for depression in older adults in Beijing. *Can J Psychiatry* 2011; 56: 466-73.
- Jacka F, Kremer P, Berk M, de Silva-Sanigorski A, Moodie M. A prospective study of diet quality and mental health in adolescents. *PLoS One*. 2011;6(9):e24805.
- Akbaraly TN, Brunner EJ, Ferrie JE, Marmot MG, Kivimaki M, Singh-Manoux A. Dietary pattern and depressive symptoms in middle age. *The British Journal of Psychiatry*. 2009;195(5):408-413. doi:10.1192/bjp.bp.108.058925.
- Chrysohou C, Panagiotakos DB, Pitsavos C, Das UN, Stefanadis C. Adherence to the Mediterranean diet attenuates inflammation and coagulation process in healthy adults: The ATTICA Study. *J Am Coll Cardiol*. 2004 Jul 7;44(1):152-8.
- Kiecolt-Glaser JK. Stress, Food, and Inflammation: Psychoneuroimmunology and Nutrition at the Cutting Edge. *Psychosomatic medicine*. 2010;72(4):365-9.
- Lopez-Garcia E, Schulze MB, Fung TT, Meigs JB, Rifai N, Manson JE, et al. Major dietary patterns are related to plasma concentrations of markers of inflammation and endothelial dysfunction. *Am J Clin Nutr*. 2004 Oct;80(4):1029-35.
- Chacko SA, Song Y, Nathan L, Tinker L, de Boer IH, Tylavsky F, et al. Relations of dietary magnesium intake to biomarkers of inflammation and endothelial dysfunction in an ethnically diverse cohort of postmenopausal women. *Diabetes Care*. 2010 Feb;33(2):304-10.
- King DE, Mainous AG, 3rd, Geesey ME, Woolson RF. Dietary magnesium and C-reactive protein levels. *J Am Coll Nutr*. 2005 Jun;24(3):166-71.
- Ng F, Berk M, Dean O, Bush AI. Oxidative stress in psychiatric disorders: evidence base and therapeutic implications. *Int J Neuropsychopharmacol*. 2008 Sep;11(6):851-76.
- Dallman MF, Pecoraro N, Akana SF, La Fleur SE, Gomez F, Houshyar H, et al. Chronic stress and obesity: a new view of «comfort food». *Proc Natl Acad Sci U S A*. 2003 Sep 30;100(20):11696-701.
- Payne ME, Steck SE, George RR, Steffens DC. Fruit, vegetable, and antioxidant intakes are lower in older adults with depression. *J Acad Nutr Diet*. 2012 Dec;112(12):2022-7.
- Chiara VL, Barros M-E, Costa LP, Martins PD. Redução de lista de alimentos para questionário de frequência alimentar: questões metodológicas na construção. *Rev Bras Epidemiol* 2007; 10 (3):410-20. 10.1590/S1415-790X2007000300012