Association between dietary carbohydrate quality index, obesity markers and mammographic findings in women treated by the Brazilian public health system

https://doi.org/10.56238/sevened2024.010-018

Ana Luiza de Rezende Ferreira Mendes[1], Helena Alves de Carvalho Sampaio[2], Antônio Augusto Ferreira Carioca[3], Luiz Gonzaga Porto Pinheiro[4], Paulo Henrique Diogenes Vasques, Daianne Cristina Rocha[5], Leandro Teixeira Cacau[6], Ayana Florencio de Meneses[7] and Ilana Nogueira Bezerra[8]

ABSTRACT

Obesity is a risk factor for breast cancer and diet can be a risk factor for this disease as well as contributing to overweight. Dietary carbohydrates are always under discussion as to potential harms in this context. There are no studies that identify obesity and dietary carbohydrates in relation to alterations present in mammographic examinations. The aim of this study was to evaluate whether there is an association between mammographic findings, carbohydrate quality index (IQC) and obesity. Methodology: The sample consisted of 620 women stratified according to the BreastImaging Reporting and Data System (BI-RADS) into two groups: and with abnormal mammographic findings. The following obesity markers were used: Body Mass Index, Waist Circumference, Waist/Hip Ratio, Waist/Height Ratio, A Body Shape Index, Body Roundness Index and Body Fat Percentage, the latter defined by ultrasound. The IQR was determined from two 24-hour food recalls and was composed of the following components: fiber, glycemic index, whole grain/total grain ratio, and solid/total carbohydrate ratio. Results: There were 219 (35.3%) women with abnormal mammographic findings. There was no difference between the two groups of women considering markers of obesity, except for waist circumference, with greater accumulation of abdominal fat among women with altered mammographic findings. There was no difference between the groups considering IQC and markers of obesity. Conclusion: In the group of women evaluated, there was no association between mammographic findings, obesity and carbohydrate quality index. Women with abnormal mammographic findings exhibit greater accumulation of abdominal fat, estimated by the waist circumference indicator.

Keywords: Obesity, Diet, Carbohydrate, Quality, Mammography.

[1] E-mail: luiza.mendes@uece.br
[2] E-mail: dr.hard2@gmail.com
[3] E-mail: aafc7@hotmail.com
[4] E-mail: luizgporto@uol.com.br
[5] E-mail: daiannerocha@hotmail.com
[6] E-mail: lcacau@usp.br
[7] E-mail: ayanafm@gmail.com
[8] E-mail: ilana.bezerra@uece.br

INTRODUCTION

Currently, the population has been suffering from the increase in chronic diseases, including breast cancer, which is the second most common of all cancers. Obesity stands out as one of the risk factors implicated in the onset of the disease, especially when there is an accumulation of fat in the central region (1).

Anthropometry is the most widely used method for diagnosing obesity, involving the determination of several indices or body relationships, in order to reduce the limitations of each one in terms of accuracy. The WCRF/AICR (2018) recommend that at least the body mass index (BMI), waist circumference (WC) and waist-to-hip ratio (WHR) be used, but there is also the waist-to-height ratio – WHtR (2), the A Body Shape Index – ABSI(3), the BodyRoundness Index (BRI) (4), among others.

In addition to obesity as a risk factor for breast cancer, a healthy diet has been recommended, with a higher intake of whole grains, fruits and vegetables and a reduction in the consumption of *fast foods and processed foods rich in fat, starch and sugar, as well as sugary drinks (1). From this perspective, it may be useful to evaluate the dietary carbohydrate quality index, as proposed by Zazpe et al.(5). Such an index determines a better quality for diets that are higher in fiber, whole grains and solid carbohydrates, as well as low glycemic index. In addition to controlling risk factors, there are screening methods for prevention or early detection of breast cancer. To this end, mammography has been used and, for its interpretation, in 1993 the American College of Radiology (ACR) developed a standardization system, the Breast ImagingReporting and Data System (BI – RADS), with periodic updates, the last one being in 2015(6).*

The evaluation of obesity and dietary quality, specifically considering carbohydrates, has not yet been performed based on mammographic findings. Thus, the objective of the present study was to evaluate the association between dietary carbohydrate quality index, obesity markers and mammographic findings in women treated by the Unified Health System (SUS).

METHODOLOGY

This is a cross-sectional, analytical, quantitative study with women treated at a reference institution in mastology, located in Fortaleza, Ceará, Brazil. Data collection took place between June 2016 and February 2017.

The study followed all the recommendations of Resolution 466/12 of the National Health Council (7), and all procedures were approved by the Human Research Ethics Committee of the institution responsible for the study, under CAAE18054613.0.0000.5534 and under opinion No. 1,135,819.

The sample was a convenience sample, comprising 620 women. As inclusion criteria, women had to be over 18 years of age, without diagnosed cancer, not pregnant and not breastfeeding and participate in all data collection activities.

The participants were interviewed to obtain demographic, socioeconomic and dietary data. The mammographic reports were compiled. The presence of obesity was investigated by anthropometry and ultrasonography.

The mammographic reports were in accordance with the BI-RADS categories determined by the ACR (6):0 - incomplete evaluation, requiring a new examination; 1 - negative result; 2 - benign results; 3 - probably benign results; 4 - suspicious anomalies, biopsy indicates; 5 - highly suggestive results of malignancy, biopsy and definitive clarification indicated; 6 - known biopsy, proven malignancy. Women in the latter category were not included in the study.

The participants were stratified into two groups according to the above-mentioned reports: without (BI-RADS categories 1 and 2) and with (BI-RADS categories 0, 3, 4 and 5) abnormal mammographic findings. Categories 0 and 3 were included as altered because it is not possible to guarantee normality of the findings based on the examination.

Regarding anthropometric data, weight, height, WC and hip circumference (HC) were collected, according to the recommendations of the Centers for Disease Control and Prevention (CDC) (8).

With the measurements taken, the following anthropometric indices were calculated:

- Body Mass Index (BMI) = Weight (kg)/Height2 (m), and adults are classified according to the World Health Organization - WHO (9; 10) and the elderly according to the Pan American Health Organization - PAHO(11), In relation to the adult participants, the different degrees of thinness were grouped as thinness and the different degrees of obesity were grouped as obesity.
- Waist-to-hip ratio (WHR) = WC (cm)/HC (cm), and the normal value adopted by the WCRF/AICR (1) was adopted, which is < 0.85;
- Waist-to-height ratio (WHtR) = WC (cm)/height (cm), classified as adequate up to 0.5 (2);
- The Body Shape Index (ABSI) = CC/(IMC$^{(2/3)}$.height$^{(1/2)}$), classified as adequate up to 0.083 (3);
- BodyRoundness Index (BRI) = 364.2 – 365.5 x eccentricity, where eccentricity = 1/2 CC/π or 1/2 HRC/π, rated as adequate up to 5 (4);

WC was also evaluated in isolation, and was considered normal if it < 80 cm (1).

Body fat percentage (BF%) was determined by ultrasonography, using the BX2000 device (BodyMetrix Pro – IntelaMetrix, Inc.) and the protocol of Jackson et al.(12), which defines the abdomen, triceps and suprailiac region on the right side of the body as anatomical points for measurement. A fat percentage of up to 32% was considered adequate (13).

Food consumption was investigated through the 24-hour food recall (24hR), performed on two non-consecutive days, including one weekend. The first recall was performed in the first contact with the participant. For the second 24-hour R, the patients were contacted via telephone call (14).

This information was obtained from home measurements and converted into grams according to Brazilian tables (15; 16).

Food consumption data were initially entered into the Brazil Nutri Platform and later released into the *Statistical Analysis System* (SAS) (17). The data of the two days of 24h R24 were adjusted for intrapersonal variance using the *MultipleSourceMethod* (MSM) statistical program (18).

The carbohydrate quality index (IQC) was calculated according to the protocol developed by Zazpe et al.(5), taking into account dietary fiber intake (g/d), glycemic index, whole grain/total grain ratio, and solid carbohydrate/total carbohydrate ratio in the diet. The consumption of whole grains represented the consumption of whole grains and their whole derivatives and the sum of grains and whole grains with grains and refined derivatives constituted total grains. Solid carbohydrates in the diet were represented by the amount of carbohydrate contained in solid foods and, in order to consider total carbohydrates, solid carbohydrates were added to net carbohydrates (those contained in sugary drinks and fruit juices). The values were summed to calculate the IQC, ranging from 4 to 20 points (5). The authors do not establish a cut-off point, but higher values mean better carbohydrate quality.

The determination of the GI of the meals followed the protocol proposed by the Food and Agriculture Organization - FAO/ World Health Organization - WHO Expert Consultation(19).

Statistical analysis was performed using SPSS software, version 20.0, and for all analyses, $p<0.05$ was adopted as the level of significance. The Kolmogorov-Smirnov test was used to verify the normality of the distribution of continuous variables. Categorical variables were evaluated using the chi-square test. The comparison of the means of the variables studied was performed using the ANOVA test. Spearman's correlation test was used to correlate the variables studied with the mammographic findings.

RESULTS

Regarding mammographic findings, 401 (64.68%) patients were diagnosed with unaltered mammographic findings and 219 (35.32%) with abnormal mammographic findings. The mean overall age of the women was 52.47 ± 9.83 years, with 52.08 ± 9.16 years with unaltered mammographic findings and 52.74 ± 9.08 years with altered findings. Table 1 shows the demographic and socioeconomic characteristics of the participants, according to mammographic findings. The majority were 50 years of age or older, with up to 8 years of schooling, married, non-white and with an income of up to 3 minimum wages per month.

Table 1 - Demographic and socioeconomic characteristics of the patients evaluated (n = 620), according to mammographic findings. Fortaleza, 2019

Variables	Mammographic findings [1]	
	Not Changed (n=401)	Changed (n=219)
Age range		
< 50	185 (46,13)	88 (40,19)
50-59	133 (33,17)	85 (38,81)
≥ 60	83 (20,70)	46 (21,00)
Years of study		
≤ 8	199 (49,62)	108 (49,31)
9 – 11	163 (40,65)	84 (38,36)
≥ 12	39 (9,73)	27 (12,33)
Marital status		
Married	213 (53,12)	114 (52,05)
Not married	188 (46,88)	105 (47,95)
Self-reported color		
White	84 (20,95)	43 (19,63)
Not White	317 (79,05)	176 (80,37)
Monthly income (SM)[2]		
≤ 1	25 (6,23)	15 (6,85)
1 – 3	284 (70,82)	165 (75,34)
> 3	77 (19,20)	34 (15,53)

1According to BreastImagingReportingand Data System – BI-RADS (ACR, 2015); 2One woman in the group of unaltered mammographic findings did not report her age; 3Brazilian minimum wage in 2016: R$ 880.00 and in 2017: R$ 937.00; 45 people with abnormal mammographic findings and 18 people with non-altered mammographic findings were unable to report monthly income.

Table 2 shows the proportion of women evaluated who had elevated values of obesity markers, according to mammographic findings. A high proportion of high values was observed in both groups, considering the more traditional markers, especially BMI. Considering ABSI, the proportions were low. There was a difference between the groups in relation to WC, with a higher proportion of women with abnormal mammographic findings having higher values ($p < 0.001$).

Table 2 - Proportion of elevated obesity markers (%) among the patients evaluated (n = 620), according to mammographic findings. Fortaleza, 2019

Obesity Markers[1]	Mammogram Findings[2]	
	Not Changed (n=401)	Changed (n=219)
BMI	78,80	80,37
WC	56,11	73,97
WHR	41,15	44,29
WHTR	51,12	58,45
ABSI	0,75	1,37
BRI	38,90	43,38
%BF	64,59	67,12

[1]BMI: Body Mass Index; WC: Waist Circumference; WHR: waist-to-hip ratio; WHtR: Waist-to-Height Ratio; ABSI:A Body Shape Index; BRI: BodyRoundness; %BF: body fat percentage; 2According to BreastImagingReporting and Data System – BI-RADS (ACR, 2015)

Table 3 shows the IQR data of the diet of the women evaluated, according to mammographic findings. Regarding these components, there is a low intake of fiber per day, a diet with an inadequate GI (moderate), with a low ratio of whole grains/total grains and solid/total carbohydrates. These data have repercussions on the overall IQC, which is also low.

Table 3 - Distribution of patients evaluated according to dietary carbohydrate quality index (IQC) and mammographic findings. Fortaleza, 2019

IQC Components	**Mammographic findings[1]**			
	Not changed n = 401		**Changed n = 219**	
	Average	**DP**	**Average**	**DP**
Fibers	15,0	7,72	14,0	7,21
Sugar level	67,2	6,06	66,8	6,79
Whole/total grain ratio	0,34	0,24	0,34	0,26
Solid/total carbohydrate ratio	0,55	0,13	0,53	0,13
IQC global	12,2	2,90	11,9	3,31

[1]According to Breast Imaging Reporting and Data System – BI-RADS (ACR, 2015)

Table 4 shows the relationship between the analyzed variables and the IQC tertiles. There was no difference considering mammographic findings, demographic and socioeconomic data, and obesity markers. As expected, there was a difference considering the components of the IQC, since they were distributed in tertiles of consumption.

There was no correlation between IQC, mammographic findings, and obesity markers (Table 5).

Table 4 - Relationship between mammographic findings, demographic and socioeconomic variables and obesity markers according to the tertiles of the dietary carbohydrate quality index (IQC) in the women evaluated (n = 620). Fortaleza, Brazil, 2019

Variables	**Carbohydrate Quality Index**			**p***
	1° tertile	2° tertile	3° tertile	
Mammographic findings, altered[1]	62 (29,4%)	88 (38,8%)	78 (37,1%)	0,093
Age, ≥ 60 years[1]	43 (20,5%)	48 (21,1%)	45 (21,4%)	0,184
Education, ≤ 8 years[1]	106 (50,2%)	108 (47,6%)	107 (51,0%)	0,816
Skin color, white[1]	45 (21,3%)	48 (21,1%)	37 (17,6%)	0,560
Family income, 1 to 3 SM[1]	161 (76,3%)	157 (69,2%)	147 (70,0%)	0,349
BMI (kg/m²)[2]	28,9 (5,2)	28,8 (4,6)	28,9 (4,7)	0,942
BMI, overweight[2]	163 (78,4%)	179 (79,2%)	166 (80,2%)	0,900
Waist circumference (cm) [2]	86,2 (11,1)	86,4 (10,0)	86,0 (10,5)	0,938
High waist circumference[2]	109 (52,7%)	141 (62,3%)	121 (59,0%	0,083
RCQ[2]	0,8 (0,1)	0,8 (0,1)	0,8 (0,1)	0,511
high WHR[1]	81 (39,1%)	90 (40,2%)	87 (42,5%)	0,757
%GC2	32,9 (4,4)	33,2 (4,2)	33,3 (4,0)	0,608
High BF%[1]	125 (62,2%)	141 (63,2%)	142 (70,2%)	0,174
RCE[2]	0,6 (0,1)	0,6 (0,1)	0,6 (0,1)	0,832
ABSI[2]	0,07 (0,00)	0,07 (0,00)	0,07 (0,00)	0,341
BRI[2]	4,7 (1,7)	4,8 (1,4)	4,7 (1,4)	0,801
Glycemic index (%)[2]	70,8 (6,1)	67,1 (6,1)	62,9 (4,8)	<0,001
Dietary fiber (g) [2]	9,7 (4,8)	13,9 (6,0)	19,5 (7,7)	<0,001
Whole/total grain ratio[2]	0,2 (0,2)	0,3 (0,2)	0,5 (0,2)	<0,001
Solid/total carbohydrate ratio[2]	0,5 (0,1)	0,5 (0,1)	0,6 (0,1)	<0,001

Values expressed as 1n(%) or 2mean (standard deviation). *Chi-square test or ANOVA.

Table 5 - Relationship between obesity markers, carbohydrate quality index and mammographic findings of the women evaluated (n = 620). Fortaleza, Brazil, 2019

	Mammographic Findings						
	Not Changed						
	BMI	WC	WHR	WHtR	%G	ABSI	BRI
Carbohydrate Quality Index	0,030 (0,544)	0,003 (0,955)	-0,003 (0,946)	0,013 (0,791)	0,035 (0,485)	-0,032 (0,521)	0,021 (01677)
	Changed						
	BMI	WC	WHR	WHtR	%G	ABSI	BRI
Carbohydrate Quality Index	-0,025 (0,706)	0,028 (0,675)	0,035 (0,601)	0,017 (0,795)	0,012 (0,864)	0,018 (0,789)	-0,012 (0,858)

Spearman's correlation. Values expressed in r(p).

DISCUSSION

In the present study, the proportion of women with excess weight and body fat was high, as evidenced by the obesity markers evaluated. The presence of obesity compromises the quality of the mammographic examination and can lead to false positive results. Castro-Ibarra et al.(20) evaluated 9061 mammographic reports, adopting a stratification different from that adopted in the present study: BI-RADS 4 and 5, which were called positive findings, versus BI-RADS 1, 2 and 3, which were called negative. The authors found, among the altered (positive) findings, 40.9% of false positives, finding a significantly higher proportion of obesity among them, diagnosed based on BMI.

Total body fat and abdominal fat and weight gain during adulthood are recognized as risk factors for the development of postmenopausal breast cancer (1), although the effect is not yet well explained for premenopausal women (1, 21, 22, 23). However, there was no association between mammographic findings and these markers, except for WC, which was higher among women with abnormal findings.

Studies have suggested that waist circumference can predict total mortality (24; 25), and the incidence of certain cancers, including breast, endometrial, and colorectal cancers, better than BMI (26; 27).

Not only WC, but measures of abdominal adiposity have shown stronger associations with metabolic risk factors, including insulin (28), which in turn is linked to increased risk of breast and colorectal cancers (29). It has been seen that the BRI predicts the risk of cardiovascular disease and is able to show more clearly the location of excess fat mass in the individual, when considering WC in its formula (4). Maessen et al. (30) state that the BRI better reflects total adiposity and the location of visceral fat than BMI, and that, therefore, its increase better predicts the impairment of total individual health.

Another anthropometric indicator that is being used and that was measured here is the ABSI. The presence of altered values was very low, but this indicator was developed to estimate total mortality (3), so that in healthy women, as in the case of the present study, it may have limited value in diagnosing nutritional status. A study by Kabat et al.(31), which evaluated the association of obesity markers with cancer risk, also did not detect an association between ABSI and breast cancer risk. These authors evaluated data from the Women's Health Initiative, with 7039 women who developed breast cancer at a 12.7-year follow-up.

It seems appropriate to follow the WCRF/AICR recommendation regarding the measurement of BMI, WC and WHR as a way to monitor the nutritional evolution of the population from the perspective of cancer prevention. In this study, the markers used were not useful in differentiating women with altered findings from those with unaltered findings, but the fact that there was a difference in WC points to the importance of measuring it in mammography screening routines. Usually, WC measurement is not part of such routines.

On the other hand, the data point to the general non-influence of obesity on mammographic findings, so that the involvement of its markers in the onset of cancer does not necessarily involve a previous alteration of mammograms.

There was also no relationship between obesity markers and dietary carbohydrate quality index. However, the diet of the women evaluated needs improvement in this regard.

The solid or liquid form of carbohydrates is an important component, and studies suggest that there is a direct relationship between sugar-sweetened beverages and long-term weight gain, as well as obesity-related diseases (32; 33). Consumption of foods such as whole grains, fruits, and vegetables are inversely associated with weight gain (34; 35; 36). In the study by Kim et al.(37), IQR was inversely associated with the prevalence of obesity.

In addition, carbohydrates are linked to cancer risk. In a review by Ludwig et al.(38), consumption of grains with high GI, potato products and added sugars were found to be associated with obesity, diabetes, cardiovascular disease and some cancers, while non-starchy vegetables, whole fruits, legumes and whole grains appeared as protective foods. According to Eslamian et al. (39), diets with high GI and GL increase the risk of developing breast cancer, while high fiber intake decreases this risk. A review by Makarem et al.(40) pointed to the deleterious effect of sugars and sugary drinks on cancer risk.

A study conducted in the Black Women's Health Study showed that women who did not consume sugary drinks when compared to those who had intake levels $\geq$ 250 g/day had a significant 27% reduction in the risk of breast cancer (41).

In a systematic review with meta-analysis by Xiao et al.(42), it was demonstrated that the consumption of whole grains was inversely associated with the risk of breast cancer. The authors suggest that reduced insulin response and blood glucose control may be a potential pathway through which whole grains may reduce the risk of breast cancer.

In the present study, no association was found between mammographic findings, obesity and IQR, indicating that, although both nutritional status and diet require improvement, the indicators used do not interfere with the type of finding.

This is the first study to evaluate the effect of breast cancer risk factors on mammographic findings. Although the relationship has not been demonstrated in relation to these findings, a high proportion of the women evaluated are obese, with accumulation of abdominal fat and a low-fiber diet, with inadequate GI and low ratio of whole grains/total grains and solid/total carbohydrates, compromising the IQC. It should also be noted that the only proven relationship, which is greater WC in women with abnormal mammographic findings, needs further investigation.

CONCLUSION

In the group of women evaluated, there was no association between mammographic findings, obesity and carbohydrate quality index. Women with abnormal mammographic findings exhibit greater accumulation of abdominal fat, estimated by the waist circumference indicator.

REFERENCES

1. World Cancer Research Fund / American Institute for Cancer Research. (2018). Diet, Nutrition, Physical Activity and Cancer: a global perspective. Continuous Update Project Expert Report 2018.

2. Ho, S. Y., Lam, T. H., & Janus, E. D. (2003). Waist to stature ratio is more strongly associated with cardiovascular risk factors than other simple anthropometric indices. Annals of Epidemiology, 13, 683-691. https://doi.org/10.1016/S1047-2797(03)00067-X

3. Krakauer, N. Y., & Krakauer, J. C. (2012). A new body shape index predicts mortality hazard independently of body mass index. PLoS One, 7(11), e39504. doi: 10.1371/journal.pone.0039504.

4. Thomas, D. M., Bredlau, C., Bosy-Westphal, A., Mueller, M., Shen, W., Gallagher, D., et al. (2013). Relationships between body roundness with body fat and visceral adipose tissue emerging from a new geometrical model. Obesity (Silver Spring), 21, 2264–2271. doi: 10.1002/oby.20408.

5. Zazpe, I., Sanchez-Tainta, A., Santiago, S., de la Fuente-Arrillaga, C., Bes-Rastrollo, M., Martinez, J. A., et al. (2014). Association between dietary carbohydrate intake quality and micronutrient intake adequacy in a Mediterranean cohort: the SUN (Seguimiento Universidad de Navarra) Project. British Journal of Nutrition, 111(11), 2000-2009. doi: 10.1017/S0007114513004364.

6. American College of Radiology (ACR). (2015). Breast Imaging Reporting and Data System (BI-RADS®) (5th ed.). Reston: American College of Radiology.

7. Brasil. Ministério da Saúde. Conselho Nacional de Saúde. Comissão Nacional de Ética em Pesquisa. (2012). Resolução nº 466, de 12 de dezembro de 2012. Recuperado de www.conselho.saude.gov.br.

8. Centers for Disease Control and Prevention, National Health and Nutrition Examination Survey (NHANES). (2013). Anthropometry Procedures Manual.

9. World Health Organization. (1995). Physical status: the use and interpretation of anthropometry. Geneva: World Health Organization. (Technical Report Series, 854)

10. World Health Organization. (1998). Obesity: preventing and managing the global epidemic. Geneva: World Health Organization. (WHO Technical Report Series 894)

11. Organización Panamericana de la Salud. División de Promoción y Protección de la Salud (HPP). (2002). Encuesta Multicentrica salud beinestar y envejecimiento (SABE) em América Latina el Caribe: Informe Preliminar. Recuperado de www.opas.org/program/sabe.htm.

12. Jackson, A. S., Pollock, M. L., & Ward, A. (1980). Generalized equations for predicting body density of women. Medicine & Science in Sports & Exercise, 12(3), 175–181.

13. Lohman, T. G., Roche, A. F., & Martorell, R. (1991). Anthropometric standardization reference. Abridged.

14. National Cancer Institute. (2017). Dietary Assessment Primer, 24 hour Dietary Recall (24hr) At a Glance. National Institutes of Health. http://dietassessmentprimer.cancer.gov/

15. Pinheiro, A. B. V., Lacerda, E. M. A., Benzecry, E. H., & Gomes, M. C. S. et al. (2008). Tabela para avaliação de consumo alimentar em medidas caseiras. São Paulo, SP: Atheneu.

16. Instituto Brasileiro de Geografia e Estatística. (2011). Tabela de medidas referidas para os alimentos consumidos no Brasil. Rio de Janeiro: IBGE. 351p.

17. Statistical Analysis System - SAS. (1999). SAS/STAT user´s guide. (Release 8.0). Cary.

18. Haubrock, J., Nöthlings, U., Volatier, J., Dekkers, A., Ocké, M., Harttig, U., et al. (2011). Estimating usual food intake distributions by using the multiple source method in the epic-potsdam calibration study. Journal of Nutrition, 141, 914-920. doi: 10.3945/jn.120394.

19. Food and Agriculture Organization of the United Nations. (1997). Carbohydrates in human nutrition: report of a joint FAO/WHO expert consultation. Rome, 150 p.

20. Castro-Ibarra, M., Menchaca-Diaz, R., Cabrales-Ruvalcaba, J., & Gomez, RAL-V. (2016). False positive result in mammography and its association with the presence of obesity: a case-control study. Gaceta Médica de México, 152, 453-456.

21. Anderson, G. L., & Neuhouser, M. L. (2012). Obesity and the risk for premenopausal and postmenopausal breast cancer. Cancer Prevention Research, 5(4), 515–521. doi: 10.1158/1940-6207.

22. Pierobon, M., & Frankenfeld, C. L. (2013). Obesity as a risk factor for triple-negative breast cancers: a systematic review and meta-analysis. Breast Cancer Research and Treatment, 137(1), 307–314. doi: 10.1007/s10549-012-2339-3.

23. Emaus, M. J., van Gils, C. H., Bakker, M. F., Bisschop, C. N., et al. (2014). Weight change in middle adulthood and breast cancer risk in the EPIC-PANACEA study. International Journal of Cancer, 135(12), 2887-2899. doi: 10.1002/ijc.28926.

24. Kuk, J. L., & Ardern, C. I. (2009). Influence of age on the association between various measures of obesity and all-cause mortality. Journal of the American Geriatrics Society, 57(11), 2077-2084. doi: 10.1111/j.1532-5415.2009.02486.

25. Petursson, H., Sigurdsson, J. A., Bengtsson, C., Nilsen, T. I., & Getz, L. (2011). Body configuration as a predictor of mortality: comparison of five anthropometric measures in a 12 year follow-up of the Norwegian HUNT 2 study. PLoS One, 6(10), e26621. doi: 10.1371/journal.pone.002662.

26. Canchola, A. J., Chang, E. T., Bernstein, L., Largent, J. A., Reynolds, P., Deapen, D., Ursin, G., & Horn-Ross, P. L. (2010). Body size and the risk of endometrial cancer by hormone therapy use in postmenopausal women in the California Teachers Study cohort. Cancer Causes & Control, 21(9), 1407-1416. doi: 10.1007/s10552-010-9568-8.

27. Kabat, G. C., Heo, M., Wactawski-Wende, J., Messina, C., Thomson, C. A., Wassertheil-Smoller, S., & Rohan, T. E. (2013). Body fat and risk of colorectal cancer among postmenopausal women. Cancer Causes & Control, 24(6), 1197-1205. doi: 10.1007/s10552-013-0199-8.

28. Ashwell, M., Gunn, P., & Gibson, S. (2012). Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. Obesity Reviews, 13(3), 275-286. doi: 10.1111/j.1467-789X.2011.00952.

29. Kabat, G. C., Kim, M. Y., Strickler, H. D., Shikany, J. M., Lane, D., Luo, J., Ning, Y., Gunter, M. J., & Rohan, T. E. (2012). A longitudinal study of serum insulin and glucose levels in relation to colorectal cancer risk among postmenopausal women. British Journal of Cancer, 106(1), 227-232. doi: 10.1038/bjc.2011.512.

30. Maessen, M. F., Eijsvogels, T. M., Verheggen, R. J., Hopman, M. T., Verbeek, A. L., & de Vegt, F. (2014). Entering a new era of body indices: the feasibility of a body shape index and body roundness index to identify cardiovascular health status. PLoS One, 9(9), e107212. doi: 10.1371/journal.pone.0107212.

31. Kabat, G. C., Matthews, C. E., Kamensky, V., Hollenbeck, A. R., & Rohan, T. E. (2015). Adherence to cancer prevention guidelines and cancer incidence, cancer mortality, and total mortality: a prospective cohort study. The American Journal of Clinical Nutrition, 101(3), 558-569. doi: 10.3945/ajcn.114.094854.

32. Malik, V. S., Popkin, B. M., Bray, G. A., Despres, J. P., Willett, W. C., & Hu, F. B. (2010). Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. Diabetes Care, 33(11), 2477-2483. doi: 10.2337/dc10-1079.

33. Hu, F. B. (2013). Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. Obesity Reviews, 14(8), 606-619. doi: 10.1111/obr.12040.

34. Du, H., van der, A. D., Boshuizen, H. C., Forouhi, N. G., Wareham, N. J., Halkjaer, J., et al. (2010). Dietary fiber and subsequent changes in body weight and waist circumference in European men and women. American Journal of Clinical Nutrition, 91(2), 329-336. doi: 10.3945/ajcn.2009.28191.

35. Mozaffarian, D., Hao, T., Rimm, E. B., Willett, W. C., & Hu, F. B. (2011). Changes in diet and lifestyle and long-term weight gain in women and men. The New England Journal of Medicine, 364(25), 2392-2404. doi: 10.1056.

36. Fogelholm, M., Anderssen, S., Gunnarsdottir, I., & Lahti-Koski, M. (2012). Dietary macronutrients and food consumption as determinants of long-term weight change in adult populations: a systematic literature review. Food Nutr Res, 56. doi: 10.3402/fnr.v56i0.19103.

37. Kim, D. Y., Kim, S. H., & Lim, H. (2018). Association between dietary carbohydrate quality and the prevalence of obesity and hypertension. J Hum Nutr Diet. doi: 10.1111/jhn.12559.

38. Ludwig, D. S., Hu, F. B., Tappy, L., & Brand-Miller, J. (2018). Dietary carbohydrates: role of quality and quantity in chronic disease. British Medical Journal, 361, k2340. doi: 10.1136/bmj.k2340.

39. Eslamian, G., Amirjannati, N., Rashidkhane, B., Sadeghi, M. R., & Hekmatdoost, A. (2012). Intake of food group and idiopathic asthenozoospermia: a case-control study. Human Reproduction, 27(11), 3328-3336. doi: 10.1093/humrep/des311.

40. Makarem, N., Bandera, E. V., Nicholson, J. M., & Parekh, N. (2018). Consumption of Sugars, Sugary Foods, and Sugary Beverages in Relation to Cancer Risk: A Systematic Review of Longitudinal Studies. Annual Review of Nutrition, 38, 17-39. doi: 10.1146/annurev-nutr-082117-051805.