TALITHA SILVA MENEGUELLI

ASSOCIAÇÃO ENTRE CONSUMO ALIMENTAR E FATORES DE RISCO CARDIOVASCULAR: UMA ANÁLISE A PARTIR DO GRAU DE PROCESSAMENTO DOS ALIMENTOS E DO POTENCIAL INFLAMATÓRIO DA DIETA - PROCARDIO-UFV

Dissertação apresentada à Universidade Federal de Viçosa, como parte das exigências do Programa de Pós-Graduação em Ciências da Nutrição, para obtenção do título de *Magister Scientiae*.

Orientadora: Helen Hermana Miranda Hermsdorff

Coorientadoras: Josefina Bressan

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APROVADA: 30 de julho de 2019.

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RESUMO

MENEGUELLI, Talitha Silva, M.Sc, Universidade Federal de Viçosa, julho de 2019 **Associação entre consumo alimentar e fatores de risco cardiovascular: uma análise a partir do grau de processamento dos alimentos e do potencial inflamatório da dieta - PROCARDIO-UFV.** Orientadora: Helen Hermana Miranda Hermsdorff. Coorientadoras: Josefina Bressan e Leidjaira Juvanhol Lopes.

As doenças crônicas não transmissíveis (DCNT), em especial as doenças cardiovasculares (DCV), estão entre as principais causas de mortalidade. O desenvolvimento dos fatores de risco cardiometabólico está relacionado ao consumo de alimentos caracterizado por um padrão ocidental, constituído por alimentos ultraprocessados e aqueles com o perfil pró-inflamatório. Desse modo, o objetivo foi avaliar a associação do consumo de alimentos de acordo com o grau de processamento e do potencial inflamatório da dieta com fatores de risco cardiometabólico em indivíduos com risco cardiovascular. Tratou-se de estudo transversal, com 325 indivíduos (18 a 84 anos, 135 homens e 190 mulheres) atendidos pelo Programa de Atenção à Saúde Cardiovascular da Universidade Federal de Viçosa – PROCARDIO-UFV (ReBEC, id: RBR-5n4y2g). Os dados do consumo alimentar foram avaliados por meio de um recordatório 24 h (R24h), em que os alimentos foram classificados de acordo com o grau de processamento pela classificação *NOVA*, potencial inflamatório mediante cálculo do Índice Inflamatório da Dieta (IID™), Índice de Alimentação Saudável (IAS), pelo método *a priori*, e padrões alimentares, pelo método *a posteriori*, sendo este último avaliado por análises de componentes principais (ACP). A partir dos prontuários foram obtidas informações sociodemográficas, antropométricas e de composição corporal, estilo de vida, bioquímicas, da pressão arterial (PA), história clínica e do consumo alimentar. As análises estatísticas foram realizadas nos *softwares* SPSS, versão 22, e STATA, versão 13, mediante aplicação dos testes adequados a cada hipótese, adotando nível de significância de 5%. Como resultados, quando avaliado o consumo por grau de processamento, a média da ingestão calórica total foi de 54,4% provenientes de alimentos *in natura* ou minimamente processados, 8,6% de ingredientes culinários, 11,1% de alimentos processados e 25,9% de alimentos ultraprocessados. Em cada um desses quatro grupos, os alimentos que mais contribuíram foram arroz (9,1%), óleos vegetais (4,3%), pão francês (7,4%) e doces industrializados (5,4%), respectivamente. Observou-se maior consumo de alimentos processados e ultraprocessados entre participantes mulheres, adultos, com maior nível de escolaridade, vivendo sem companheiros e que nunca fumaram. Em relação aos fatores de risco cardiometabólico, o consumo de alimentos processados e ultraprocessados se associou positivamente com a prevalência de obesidade abdominal avaliada pela RCQ (RP= 1,005; p-valor= 0,049) e perímetro da cintura (PC) (RP= 1,003; p-valor= 0,02), bem como com o colesterol total elevado (RP= 1,008; p-valor= 0,047) após todos os ajustes. Quando observado o consumo por refeições, obteve-se maior consumo de alimentos *in natura* ou minimamente processados no almoço e jantar e de ultraprocessados no café da manhã e lanche da tarde. Por sua vez, quando avaliado o IID, a média deste foi caracterizada por uma dieta neutra (0,15 ± 0,84) correspondente ao segundo tercil, e participantes mulheres, mais jovens e que nunca fumaram tiveram dieta mais pró-inflamatória. Em relação ao risco cardiometabólico e padrões alimentares, a dieta mais pró-inflamatória (IID ≥ 0,45) esteve positivamente associada com aumento da prevalência de excesso de peso (RP= 1,29; 95% IC 1,06-1,58), obesidade abdominal pela relação cintura/quadril (RCQ) (RP= 1,29; 95% IC 1,02-1,64), com uma dieta inadequada avaliada pelo IAS (RP= 1,52; 95% IC 1,15-2,01) e com padrão alimentar "não saudável" (RP= 2,94; 95% IC 1,03-8,35). Ademais, a dieta anti-inflamatória (IID < -0,22) esteve associada ao padrão alimentar "saudável" (RP= 3,71; 95% IC 1,54-8,90) e ao padrão alimentar "lanches saudáveis" (RP= 3,05; 95% IC 1,12-8,32). Conclui-se que o consumo de processados e ultraprocessados e a dieta mais pró-inflamatória estão positivamente associados com o aumento da prevalência de obesidade abdominal, mesmo em indivíduos que já apresentam risco cardiovascular. Estratégias nutricionais direcionadas para prevenção das DCNT, considerando perfil do grupo atendido e tipos de refeição devem ser encorajadas.

Palavras-chave: Risco Cardiovascular. Índice Inflamatório da Dieta. Processamento de alimentos. Classificação *NOVA*.

ABSTRACT

MENEGUELLI, Talitha Silva, M.Sc, Universidade Federal de Viçosa, July, 2019. **Association between dietary intake and cardiovascular risk factors: an analysis based on degree of food processing and inflammatory potential of the diet - PROCARDIO-UFV.** Advisor: Helen Hermana Miranda Hermsdorff. Co-Advisors: Josefina Bressan and Leidjaira Juvanhol Lopes.

Chronic non-communicable diseases (CNCD), especially cardiovascular diseases (CVD) are among the leading causes of mortality. The development of cardiometabolic risk factors are related to the consumption of foods characterized by a Western dietary pattern, consisting of ultra-processed foods and those with a pro-inflammatory profile. Thus, the objective was to evaluate the association of food consumption according to the degree of processing and the inflammatory potential of the diet with cardiometabolic risk factors in subjects with cardiovascular risk. This cross-sectional study was realized with 325 individuals (18 to 84 years, 135 men and 190 women) attended by the Cardiovascular Health Care Program of the Federal University of Viçosa - PROCARDIO-UFV (ReBEC, id: RBR-5n4y2g). The food consumption data were evaluated by a 24-h dietary recall (R24h), in which the foods were classified according to the degree of processing by the NOVA classification, inflammatory potential by calculation of the Dietary Inflammatory Index (DII™), Healthy Eating Index (HEI), *a priori* method, and dietary patterns, *a posteriori* method, the latter being evaluated by principal component analysis (PCA). From medical record was obtained information as sociodemographic, anthropometric and body composition, lifestyle, biochemical, blood pressure (BP), clinical history and food consumption. Statistical analyzes were performed using software SPSS version 22 and STATA version 13, using the appropriate tests for each hypothesis, adopting a significance level of 5%. As a result, when evaluated the consumption by degree of processing, the average total caloric intake was 54.4% from unprocessed or minimally processed foods, 8.6% from processed culinary ingredients, 11.1% from processed foods and 25.9% from ultra-processed foods. In each of these four groups, rice (9.1%), vegetable oils (4.3%), French bread (7.4%) and industrialized sweets (5.4%) were the main contributors, respectively. It was observed higher consumption of processed and ultra-processed foods among women, adults, the highly educated, those living without companions and never smoked participants. In relation to cardiometabolic risk factors, the consumption of processed and ultra-processed foods was positively associated with the prevalence of abdominal obesity assessed by WHR (RP = 1.005, p-value = 0.049) and waist circumference (WC) (PR =

1.003; p-value = 0.02), as well as in those with high total cholesterol (RP = 1.008; p-value = 0.047) after all adjustments. When food consumption was observed according to meal of the day, the consumption of unprocessed or minimally processed foods at lunch and dinner and ultra-processed foods at breakfast and afternoon snacks were obtained. In turn, when evaluated the DII, the mean was characterized by a neutral diet (0.15 ± 0.84), corresponding to the second tertile, and participants women, younger and those who never smoked had a more pro-inflammatory diet. When evaluating cardiometabolic risk and dietary patterns, the most pro-inflammatory diet (DII ≥ 0.45) was positively associated with an increase in the prevalence of excess body weight (PR = 1.29, 95% CI 1.06-1.58), waist-to-hip ratio (WHR) (PR = 1.29, 95% CI 1.02-1.64), inadequate diet assessed by HEI (PR= 1.52, 95% CI, 1.15-2.01) and "unhealthy" dietary patterns (PR= 2.94; 95% CI 1.03-8.35). While anti-inflammatory diet (DII <-0.22) was associated with a "healthy" dietary pattern (PR= 3.71, 95% CI 1.54-8.90) and "healthy snacks" dietary pattern (PR= 3.05, 95 % CI 1.12-8.32). It is concluded that the consumption of processed and ultra-processed and more pro-inflammatory diet are positively associated with the increased prevalence of abdominal obesity, even in individuals who already present cardiovascular risk. Nutritional strategies directed to the prevention of CNCD, considering the profile of the group attended and types of meal should be encouraged.

Keywords: Cardiovascular Risk. Dietary Inflammatory Index. Food processing. *NOVA* Classification.

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LISTA DE ABREVIATURAS E SIGLAS

ANOVA	Análise de variância
CATd	Capacidade antioxidante total da dieta
CT	Colesterol total
DASH	*Dietary Approaches to Stop Hypertension*
DCNT	Doenças crônicas não transmissíveis
DCV	Doenças cardiovasculares
DM	Diabetes mellitus
DP	Desvio Padrão
EUA	Estados Unidos da América
g	Grama
g/d	Grama por dia
GC	Gordura corporal
HAS	Hipertensão arterial sistêmica
HDL	Lipoproteína de alta densidade, do inglês *High density lipoprotein*
HOMA-IR	Modelo de avaliação da Homeostase, do inglês *Homeostasis model assessment index*
IAM	Infarto agudo do miocárdio
IBGE	Instituto Brasileiro de Geografia e Estatística
IID	Índice inflamatório da dieta
IMC	Índice de massa corporal
kcal	Quilocalorias
kg	Quilogramas
kg/m^2	Quilograma por metro ao quadrado
LDL	Lipoproteína de Baixa Densidade, do inglês *Low Density Lipoprotein*
m	Metro
MG	Minas Gerais
mL/d	Mililitro por dia
mg/dL	Miligrama por decilitro
mm/Hg	Milímetros de mercúrio
mmol/L	Milimol por litro
n	Tamanho Amostral
OMS	Organização Mundial da Saúde
OPAS	Organização Pan-Americana da Saúde

p	Nível de significância estatística
PA	Pressão arterial
PC	Perímetro da Cintura
PCR-US	Proteína C reativa ultrassensível
POF	Pesquisa de Orçamentos Familiares
PROCARDIO	Programa de Atenção à Saúde Cardiovascular
RCE	Relação cintura-estatura
RCQ	Relação cintura-quadril
REBEC	Registro Brasileiro de Ensaios Clínicos
RI	Resistência à insulina
RP	Razão de prevalência
R24h	Recordatório 24 horas
SPSS	*Social Package Statistical Science*
TACO	Tabela Brasileira de Composição de Alimentos
TCLE	Termo de consentimento livre e esclarecido
TG	Triglicerídeos
TyG	Índice triglicerídeos-glicemia, do inglês *triglyceride-glucose index*
UFJF	Universidade Federal de Juiz de Fora
UFV	Universidade Federal de Viçosa
USDA	*United States Department of Agriculture*
VCT	Valor calórico total
WHO	*Wolrd Health Organization*

SUMÁRIO

1 INTRODUÇÃO

As doenças crônicas não transmissíveis (DCNT) estão entre as principais causas de mortalidade no mundo e têm crescido a cada ano. Relatórios recentes da Organização Mundial da Saúde (OMS) indicam o registro de 41 milhões de óbitos no mundo por DCNT em 2016, correspondendo a 71% das mortes em escala mundial. Dentre as DCNT, prevalecem as doenças cardiovasculares (DCV), responsáveis por 17,9 milhões de mortes (aproximadamente 44%), seguidas do câncer, doenças crônicas respiratórias e diabetes mellitus (DM) (WHO, 2018).

No Brasil, 73,9% dos óbitos são por DCNT (BRASIL, 2018). Dados disponibilizados em 2013 pelo Instituto Brasileiro de Geografia e Estatística (IBGE) apontam a DCV como a principal causa de morte e responsável pelos maiores custos relacionados a internações hospitalares (IBGE, 2013). Destaca-se ainda que 21,4% da população brasileira apresenta hipertensão arterial sistêmica (HAS), 12,5% colesterol alto e 6,2% DM (IBGE, 2013).

Entre os fatores de risco para DCV, têm-se a obesidade, principalmente o excesso de gordura abdominal, a hipercolesterolemia, a hipertrigliceridemia, a resistência à insulina (RI) e a HAS (WHO, 2018). Além desses marcadores, a inflamação subclínica produzida pelo tecido adiposo por meio de adipocinas inflamatórias contribuem para o desenvolvimento de diversos fatores de risco cardiometabólico (CALDER et al., 2009, 2011; HERMSDORFF et al., 2010, 2011). Ainda, fatores de risco modificáveis associados ao estilo de vida, como tabagismo, sedentarismo, alimentação inadequada e uso abusivo de álcool, são os maiores contribuintes para o desenvolvimento das DCV (WHO, 2014).

Dos fatores modificáveis, a alimentação inadequada é o que mais tem contribuído para o surgimento das DCV (NASCIMENTO et al., 2018). Este fato se deve às mudanças no perfil alimentar da população ao longo dos anos, reflexo da transição nutricional, que iniciou com a mudança da população dos meios rurais para os meios urbanos, aumento da renda e a inserção da mulher no mercado de trabalho (DREWNOWSKI; POPKIN, 1997). Todas estas transformações traduzem uma "ocidentalização" dos hábitos alimentares, com elevado consumo de alimentos ultraprocessados, ricos em gordura saturada, gordura *trans*, sódio, açúcares e colesterol (LOUZADA et al., 2015a; MONTEIRO et al., 2013). A venda destes alimentos cresceu 43,7% em nível mundial e 50% na América Latina no período de 2000 a 2013, sendo os brasileiros um dos maiores consumidores de *fast food* (OPAS, 2015).

Como consequência desta transição, observa-se um consumo alimentar na população brasileira acima do recomendado em açúcar, gordura *trans* e sódio, ao passo que o consumo de fibras e potássio se apresentam insuficientes (LOUZADA et al., 2015a). De acordo com dados da Pesquisa de Orçamento Familiar (POF) 2008/2009, menos de 10% da população atingia as recomendações de consumo de frutas, legumes e hortaliças, com consumo abaixo do recomendado de fibras em 68% da população. O consumo de açúcar esteve acima do recomendado por 61%, o de gordura saturada (acima de 7% do consumo energético) por 82% e o de sódio em mais de 70% da população (POF, 2011).

Padrões alimentares como aqueles representados por alimentos *in natura* e minimamente processados, pela dieta DASH (*Dietary Approaches to Stop Hypertension*), ambos constituídos por frutas, legumes e hortaliças, e pela dieta mediterrânea (rica em frutas, hortaliças, grãos integrais, leguminosas, oleaginosas, peixes, produtos lácteos com baixo teor de gordura e consumo moderado de vinho) possuem alto teor de fibras, micronutrientes, fitoquímicos, gorduras poli-insaturadas e baixa resposta glicêmica, além de apresentarem um perfil anti-inflamatório (CALDER et al., 2011; FARDET, 2016). Ao passo que padrões ocidentais como aqueles constituídos por alimentos processados ricos em açúcar, sódio e gordura, e alimentos ultraprocessados constituídos por gordura saturada, gordura *trans*, sódio, açúcares de adição (principalmente frutose), aditivos alimentares, ricos em calorias, com maior resposta glicêmica e aqueles de origem animal ricos em gordura saturada, constituem um perfil pró-inflamatório (CALDER et al., 2011; LOUZADA et al., 2015a; MONTEIRO et al., 2010; MOUBARAC et al., 2013b).

Estudos têm demonstrado que não apenas o consumo de alimentos ultraprocessados, como também o aumento na disponibilidade destes alimentos está relacionado com o excesso de peso (CANELLA et al., 2014; CUNHA et al., 2017; LOUZADA et al., 2015b; MENDONÇA et al., 2016; MONTEIRO et al., 2018). Esta relação é vista também com outros fatores de risco cardiometabólico como HAS, perfil lipídico alterado (CT e LDL-c) e síndrome metabólica (MENDONÇA et al., 2017; RAUBER et al., 2015; RINALDI et al., 2016; TAVARES et al., 2012). Estudos de coorte publicados recentemente identificaram que o aumento no consumo de alimentos ultraprocessados esteve associado ao maior risco de mortalidade (KIM; HU; REBHOLZ, 2019; RICO-CAMPÀ et al., 2019; SCHNABEL et al., 2019).

Na mesma direção, estudos têm avaliado o potencial inflamatório da dieta e observado associações entre dieta pró-inflamatória com fatores de risco cardiometabólico como excesso de peso, obesidade abdominal, relação cintura/estatura (RCE) aumentada, hipertensão arterial, hipertrigliceridemia e componentes da síndrome metabólica (ANDRADE et al., 2018; GARCIA-ARELLANO et al., 2015; MAZIDI et al., 2018; NEUFCOURT et al., 2015; RUIZ-CANELA; BES-RASTROLLO; MARTÍNEZ-GONZÁLEZ, 2016). Uma meta-análise identificou relação positiva entre a dieta pró-inflamatória não apenas para o risco cardiovascular, mas também para todas as causas de mortalidade (NAMAZI; LARIJANI; AZADBAKHT, 2018).

Apesar das associações observadas entre o consumo de alimentos processados e ultraprocessados e de uma dieta pró-inflamatória com fatores de risco cardiometabólico, mudanças nesses padrões alimentares poderiam evitar um evento cardiovascular. Estudos mostram que a substituição de 50% no consumo de alimentos ultraprocessados, gordura saturada, gordura *trans*, sal e açúcar de adição pela mesma proporção de alimentos *in natura* e minimamente processados poderia reduzir em 44.190 o número de mortes por DCV das 390.400 previstas para 2030 (i.e. equivalente a 11%) (MOREIRA et al., 2018), e que uma dieta pró-inflamatória poderia agravar a incidência e mortalidade por DCV em até 36% (SHIVAPPA et al., 2018).

Diante disto, como a investigação do consumo alimentar no que diz respeito ao processamento de alimentos e ao caráter inflamatório ainda não está consolidada em brasileiros com risco cardiovascular, torna-se relevante a avaliação, objetivando uma melhor percepção da associação destes com os fatores de risco cardiometabólico. Assim, este estudo contribui com o intuito de compreender estas associações, para que estratégias e orientações nutricionais baseadas em evidências científicas possam colaborar para a prevenção de eventos cardiovasculares nesta população.

Nesse contexto, a hipótese é de que haja associações entre o consumo destes alimentos com fatores de risco cardiometabólico, embora estas possam não ser tão evidentes. Desta forma, uma investigação é necessária para compreender melhor o perfil alimentar deste público e entender qual o papel dos alimentos no que diz respeito ao grau de processamento e potencial inflamatório em relação ao risco cardiovascular.

Os achados deste estudo podem contribuir com outras pesquisas que estão sendo realizadas nesta população de risco, com o objetivo de melhorar a compreensão entre associações do perfil alimentar com fatores de risco cardiometabólico, almejando redução na incidência da DCV, que atualmente possui uma alta prevalência.

2 OBJETIVOS

2.1 Objetivo Geral

Avaliar a associação do consumo de alimentos de acordo com o grau de processamento e do potencial inflamatório da dieta com fatores de risco cardiometabólico em indivíduos com risco cardiovascular.

2.2 Objetivos Específicos

- Resumir e discutir as evidências da relação entre o consumo de alimentos de acordo com o grau de processamento e os fatores de risco cardiometabólico;
- Caracterizar a amostra segundo variáveis sociodemográficas, de estilo de vida e clínicas;
- Categorizar o consumo alimentar de acordo com o grau de processamento;
- Analisar o consumo de alimentos nas refeições de acordo com o grau de processamento;
- Avaliar a associação do consumo de alimentos por grau de processamento em percentual calórico com fatores de risco cardiometabólico;
- Estimar o índice inflamatório da dieta (IID);
- Investigar a ingestão de macro e micronutrientes e a contribuição calórica entre os tercis do IID;
- Avaliar a associação do potencial anti-inflamatório e pró-inflamatório da dieta com a qualidade da dieta e os fatores de risco cardiometabólico.

3 METODOLOGIA

3.1 Programa de Atenção à Saúde Cardiovascular (PROCARDIO-UFV)

O PROCARDIO-UFV é um programa de extensão em interface com a pesquisa que tem como objetivo melhorar o quadro clínico e a qualidade de vida de pacientes portadores ou que apresentam risco para DCV na comunidade acadêmica da Universidade Federal de Viçosa-MG. A metodologia de intervenção nutricional adotada no PROCARDIO-UFV está disponível no Registro Brasileiro de Ensaios Clínicos (ReBEC, id: RBR-5n4y2g).

Os critérios de inclusão são: ter idade acima de 20 anos; ser portador de doença cardiovascular ou apresentar um ou mais fatores de risco cardiometabólico, como: dislipidemias (TG $\geq$ 150 mg/dL, CT $\geq$ 200 mg/dL, HDL <40 ou 50 mg/dL para homens e mulheres, respectivamente); pré ou hipertensão arterial $\geq$ 130/85 mmHg; glicemia de jejum elevada ($\geq$ 100 mg/dL) ou DM diagnosticado; e IMC $\geq$ 25 kg/m² associado a um ou mais destes fatores citados previamente.

3.2 Aspectos Éticos

Este estudo é parte de um projeto guarda-chuva intitulado "Aplicação de diferentes estratégias de terapia nutricional no programa de atenção à saúde cardiovascular (PROCARDIO-UFV)", e foi aprovado pelo Comitê de Ética em Pesquisas com Seres Humanos da UFV (Of. Ref. nº 066/2012/CEPH), de acordo com a Resolução CNS 466/2012 (Anexo A). Todos os participantes foram convidados a ler e assinar o Termo de Consentimento Livre e Esclarecido (TCLE) em duas vias (Apêndice A), sendo incluídos no estudo apenas aqueles que assinaram o referido termo.

3.3 Casuística

Foram incluídos no presente estudo todos os indivíduos atendidos pelo PROCARDIO-UFV entre março de 2012 e dezembro de 2017 e que assinaram o TCLE, totalizando 330 indivíduos. Dentre estes, três foram excluídos por apresentarem dados incompletos e dois por superestimação da ingestão calórica (> 4.000 kcal/dia) (WILLETT, 2012). Ao final permaneceram 325 indivíduos.

3.4 Desenho do Estudo

Tratou-se de uma análise transversal realizada na linha de base, antes de iniciar a intervenção nutricional. Para tal, os dados foram coletados mediante consulta de prontuários durante o atendimento nutricional. As informações coletadas foram: idade, sexo, estado civil, renda familiar, escolaridade, motivo da consulta, uso de medicamentos, tabagismo, nível de atividade física, dados do consumo alimentar, avaliação antropométrica, exames bioquímicos e pressão arterial (PA).

3.5 Variáveis estudadas

3.5.1 Consumo Alimentar

O consumo alimentar foi avaliado por meio de um recordatório (R24h), referente ao dia anterior à primeira consulta (Anexo B). A ingestão calórica diária (kcal), macro e micronutrientes foram estimados por meio do software DietPRO®, versão 5.8. A 4ª edição da Tabela Brasileira de Composição de Alimentos foi priorizada (TACO, 2011). Para aqueles nutrientes ausentes nesta, a tabela USDA *National Nutrient Database for Standard Referencer Release* 20 foi utilizada (USDA, 2008). Foram avaliados os seguintes nutrientes:

caloria, proteína, carboidrato, lipídio, colesterol, fibra, cálcio, magnésio, ferro, sódio, zinco, vitamina B12, vitamina A, vitamina C, ômega-3, ômega-6, álcool, manganês, selênio e fitoesteróis.

Todas as preparações foram desmembradas em seus ingredientes conforme padronização e baseada em receitas (PINHEIRO et al., 2008; TACO, 2011). Quando não encontrado os ingredientes de uma preparação, utilizou-se a informação nutricional de rótulos. Além disso, foi padronizado o percentual de sal e óleo das preparações/alimentos (ARAÚJO; GUERRA, 2007; PINHEIRO et al., 2008), visto que estes ingredientes não são relatados com precisão nos R24h.

Todas as informações dos alimentos e nutrientes (quantidades em gramas ou mililitros) e a classificação dos alimentos de acordo com o grau de processamento foram tabuladas em uma planilha no Microsoft Excel.

3.5.1.1 Consumo de Alimentos por grau de processamento

A revisão sistemática presente neste trabalho foi realizada por dois pesquisadores independentes, nas seguintes bases de dados: PubMed, Bireme e Science Direct, sendo realizada até julho de 2018. Foram incluídos artigos originais e apenas com seres humanos, que avaliassem o consumo de alimentos por grau de processamento (variável exposição) com fatores de risco cardiometabólico como obesidade, diabetes, dislipidemias, hipertensão, resistência à insulina e DCNT em geral (variáveis desfecho). Não houve restrição de faixa etária, país/região/etnia, linguagem e data de publicação dos artigos.

Foram identificados um total de 3043 artigos, sendo analisados 2040 após exclusão das duplicatas. Ao final, foram selecionados 21 artigos, dos quais dois eram estudos ecológicos, treze transversais e seis longitudinais.

Para avaliação do consumo dos alimentos por grau de processamento no presente trabalho, estes foram divididos e classificados em quatro grupos diferentes como proposto por Monteiro et al. (2016), de acordo com a classificação *NOVA*:

- Grupo 1 (Alimentos *in natura* ou minimamente processados): os alimentos *in natura* são partes comestíveis de plantas ou de animais. Já os alimentos minimamente processados são alimentos *in natura* submetidos a processos mínimos como remoção de partes não comestíveis ou não desejadas, secagem, desidratação, trituração ou moagem, fracionamento, torra, cocção apenas com água, pasteurização, refrigeração ou congelamento, acondicionamento em embalagens, empacotamento a vácuo, fermentação não alcoólica e outros processos que não envolvem a adição de substâncias como sal, açúcar, óleos ou gorduras ao alimento *in natura*. Também são adicionados ao grupo 1 itens compostos por dois ou mais alimentos deste grupo, como granola de cereais, nozes e frutas secas, sem que haja adição de açúcar, mel, óleo, gorduras ou qualquer outra substância, além de alimentos deste mesmo grupo enriquecidos com vitaminas e minerais, afim de repor nutrientes perdidos no processamento do alimento *in natura*, como por exemplo farinha de trigo ou de milho enriquecida com ferro e ácido fólico. Além disso, permanecem neste grupo alimentos aos quais foram adicionados aditivos com o objetivo de preservar as propriedades originais do alimento, como antioxidantes usados em frutas desidratadas ou legumes cozidos e embalados a vácuo, e estabilizantes usados em leite ultrapasteurizado.
- Grupo 2 (Ingredientes culinários processados): itens de preparação culinária, os quais foram extraídos de alimentos do grupo 1 ou da natureza, e que receberam processos

como prensagem, moagem, pulverização, secagem e refino. Neste grupo também são incluídos: produtos compostos por duas substâncias pertencentes ao grupo (como manteiga com sal), produtos compostos por substâncias deste grupo adicionadas de vitaminas ou minerais (como o sal iodado) e vinagres obtidos pela fermentação acética do álcool de vinhos e de outras bebidas alcoólicas, pela semelhança de uso com outras substâncias pertencentes ao grupo também são incluídos. Itens deste grupo se adicionados de aditivos para preservar suas propriedades originais, como antioxidantes usados em óleos vegetais e antiumectantes usados no sal de cozinha, ou de aditivos que evitam a proliferação de micro-organismos, como conservantes usados no vinagre, permanecem neste grupo.

- Grupo 3 (Alimentos processados): caracterizado pela adição de sal, açúcar, óleo, vinagre ou outra substância do grupo 2, a um alimento do grupo 1, composto em sua maioria por dois ou três ingredientes. São realizados vários métodos de preservação e cocção, além da fermentação não alcoólica no caso de queijos e de pães. Produtos deste grupo quando adicionados de aditivos para preservar suas propriedades originais, como antioxidantes usados em geleias, ou para evitar a proliferação de micro-organismos, como conservantes usados em carnes desidratadas, permanecem neste grupo. Do mesmo modo, são incluídos neste grupo bebidas alcoólicas, como aquelas fabricadas pela fermentação alcoólica de alimentos do grupo 1, como vinho, cerveja e cidra.
- Grupo 4 (Alimentos ultraprocessados): produtos que contém cinco ou mais ingredientes. Permanecem neste grupo aqueles produtos compostos apenas por alimentos do grupo 1 ou do grupo 3 em que esses contiverem aditivos com função de modificar cor, odor, sabor ou textura do produto como por exemplo, iogurte natural com edulcorante artificial e pães com emulsificantes. Bebidas alcoólicas que sejam consideradas parte da alimentação, como aquelas fabricadas por fermentação de alimentos do grupo 1 seguida da destilação do mosto alcoólico (cachaça, uísque, vodca e rum) são também classificadas neste grupo.

Como as preparações mistas dificultam a classificação, foi adotado como critério para classificar estes alimentos os principais ingredientes contidos na preparação (aqueles em maiores quantidades). Caso a maioria dos ingredientes utilizados nesta preparação pertencesse ao grupo 1, este alimento/preparação foi classificado(a) neste grupo. Além disso, aqueles alimentos do grupo 1 acrescidos de ingredientes culinários processados, que melhoram a sua palatabilidade, como sal, açúcar e óleos, permaneceram classificados neste grupo.

Em cada um dos quatro grupos têm-se subgrupos, distribuídos da seguinte forma:

- Alimentos *in natura* ou minimamente processados: arroz; outros cereais; feijão, outras leguminosas; frutas; sucos de frutas ou de hortaliças; legumes e verduras; raízes e tubérculos; carne vermelha; aves e outras carnes; peixes e frutos do mar; miúdos; ovos ao natural; leite e iogurte natural; café e chá; água potável; nozes e sementes; cogumelos secos e frescos; especiarias, ervas aromáticas frescas ou secas; e demais ingredientes culinários do grupo 1.
- Ingredientes culinários processados: sal; açúcar e melado de vegetais diversos; mel extraído de colmeias e xarope de maple; óleos vegetais; gordura animal; amidos e féculas de milho ou de outros vegetais; e vinagre de vinho ou de outra bebida alcoólica.
- Alimentos processados: pão francês; queijos processados; conservas de verduras, legumes e leguminosas; carnes processadas; conserva de fruta; bebidas alcoólicas fermentadas; e oleaginosas adicionadas de sal/açúcar.
- Alimentos ultraprocessados: bolachas salgadas e salgadinhos; doces industrializados; cereais matinais; produtos panificados; pães ultraprocessados; queijos ultraprocessados; carnes ultraprocessadas; temperos e molhos industrializados; refeições prontas; refrigerantes; sucos artificiais; bebidas lácteas; bebidas alcoólicas destiladas; outras bebidas; e margarinas e patês.

3.5.1.2 Cálculo do Índice Inflamatório da Dieta (IID)

O IID é patenteado por pesquisadores da Universidade da Carolina do Sul nos EUA, que desenvolveram e atualizaram este índice (SHIVAPPA et al., 2014a). Desta forma, foi firmada parceria com estes pesquisadores para a realização do cálculo do IID. No presente estudo para obtenção do IID foram considerados 19 parâmetros alimentares, a saber: calorias, proteínas, carboidratos, lipídios, álcool, colesterol, fibra, ferro, magnésio, gordura monoinsaturada, ômega-6, gordura poli-insaturada, gordura saturada, selênio, gordura *trans*, zinco, vitaminas A, C e B12.

3.5.2 Risco Cardiometabólico

Não foi utilizado nenhum método de avaliação do risco cardiovascular entre os participantes, visto que para critérios de inclusão no PROCARDIO-UFV é necessário ter pelo menos um fator de risco cardiometabólico. O que faz com que todos os participantes apresentem risco cardiovascular.

O peso foi aferido pela balança digital eletrônica (Toledo® 2098PP, São Bernardo do Campo, Brasil), com capacidade máxima de 200 kg e precisão de 50 g e a estatura utilizando estadiômetro (Stanley®, CMS, Inglaterra), com extensão máxima de 2 metros, precisão de 0,5 milímetros. A partir destas medidas foi calculado o Índice de Massa Corporal (IMC) dividindo-se o peso pela altura ao quadrado.

A gordura corporal (GC) em percentual foi aferida por bioimpedância elétrica tetrapolar horizontal (Biodynamics® 310 model, Washington, USA), de acordo com protocolo padronizado (LUKASKI et al., 1986).

Para aferição de medidas antropométricas como os perímetros, foi utilizada fita métrica (2 metros de extensão), dividida em centímetros e subdivida em milímetros. O perímetro da cintura (PC) foi aferido em cima da cicatriz umbilical, enquanto o perímetro do quadril (PQ) foi medido na região glútea de maior proeminência. Em seguida, foi calculada a relação cintura/estatura (RCE) e a relação cintura/quadril (RCQ) (ASHWELL; HSIEH, 2005).

Os marcadores de resistência à insulina, como o *Homeostasis Model Assessment of Insulin Resistance* (HOMA-IR) e o *Triglyceride-Glucose Index* (índice TyG) foram calculados por meio das fórmulas (ABESO, 2009):

- HOMA-IR = [(glicemia de jejum (mg/dL)) x (insulinemia de jejum (μU/mL))] / 405
- TyG = Ln [triglicerídeos de jejum (mg/dL) x glicemia de jejum (mg/dL)/2]

A pressão arterial sistólica e diastólica foram aferidas com auxílio de um esfigmomanômetro mecânico de coluna de mercúrio (Missouri®, São Paulo, Brasil), com aproximação de 2 mmHg.

Os exames bioquímicos foram realizados em jejum no Laboratório de Análises Clínicas da Divisão de Saúde da UFV. Foram avaliados marcadores de risco cardiometabólico como glicemia de jejum, colesterol total (CT), LDL-c, HDL-c, triglicerídeos (TG), ferritina e ácido úrico, todos estes avaliados pelo método enzimático colorimétrico. Já leucócitos e plaquetas foram avaliados por método de impedância (microscopia) e a proteína C reativa ultrassensível (PCR-US) por imunoturbidimetria.

Para avaliação do excesso de peso, foi utilizado o Índice de Massa Corporal (IMC) e os pontos de corte considerados para adultos foram, sobrepeso entre 25,0 kg/m² e 29,9 kg/m² e obesidade maior ou igual a 30,0 kg/m² (WHO, 1998). Para idosos, foram considerados sobrepeso entre 28,0 kg/m² e 29,9 kg/m² e maior ou igual a 30 kg/m² obesidade (OPAS, 2002). Outros marcadores metabólicos foram avaliados, como descritos no Quadro 1. Vale ressaltar, que foram classificados com hipertensão arterial, hiperglicemia e dislipidemias aqueles indivíduos que utilizavam medicamentos para o controle destas patologias ou que apresentassem valores acima do ponto de corte.

Quadro 1 – Pontos de corte para fatores de risco cadiometabólico

Fatores de risco cardiometabólico	Marcador	Ponto de corte	Referência
Excesso de GC	%GC	Homens > 20% Mulheres > 30%	(BRAY, 2008)
Risco aumentado	RCQ	Homens > 1,0 Mulheres > 0,85	(WHO, 2000)
Obesidade abdominal	PC	Homens ≥ 90 cm Mulheres ≥ 80 cm	(ABESO, 2009)
Risco aumentado	RCE	> 0,5	(WHO, 2000)
RI	Índice TyG	> p75	---
	HOMA-IR	> 2,71 mg/dL	(SBD, 2018)
Hipertensão arterial	PA	≥ 140 e ≥ 90 mmHg	(SBC, 2016)
Hiperglicemia	Glicemia	≥ 100 mg/dL	(SBD, 2018)
Dislipidemias	HDL-c	Homens < 40 mg/dL Mulheres < 50 mg/dL	(SBC, 2013a)
	Colesterol	≥ 240 mg/dL	
	Colesterol não-HDL	≥ 160 mg/dL	
	LDL-c	≥ 160 mg/dL	
	Triglicerídeos	≥ 150 mg/dL	
Hiperuricemia	Ácido Úrico	≥ 6,0 mg/dL	(SBC, 2013a)
Inflamação	Ferritina	Homens ≥ 120 ng/ml Mulheres ≥ 80 ng/ml	(GODOY et al., 2007)
	PCR	≥ 3,0	(PEARSON et al., 2003)

GC: gordura corporal; RCQ: relação cintura/quadril; PC: perímetro da cintura; RCE: relação cintura/estatura; RI: resistência à insulina; PA: pressão arterial; PCR: proteína C reativa.

3.5.3 Características sociodemográficas e de estilo de vida

Na entrevista realizada na primeira consulta foram coletadas informações, por meio de prontuários preenchidos, tais como: idade; sexo; renda familiar em salários mínimos (até 2, de 2 a 4, de 4 a 10 ou mais de 10 salários); escolaridade (analfabeto, fundamental incompleto/completo, ensino médio incompleto/completo, superior incompleto/completo); estado civil (solteiro (a), casado (a), união estável, viúvo (a), separado ou divorciado (a)); vínculo com a UFV (servidor, estudante, familiar e cooperação); utilização de medicamentos; tabagismo (nunca fumou, fumante ou ex-fumante); nível de atividade física (não pratica ou pratica) e história clínica (excesso de peso, dislipidemia, hipertensão arterial, diabetes mellitus, hipotireoidismo, doença cardiovascular e esteatose hepática) (Anexo C).

3.6 Análise Estatística

Análise descritiva dos dados foi realizada por meio do cálculo de média e desvio-padrão para as variáveis quantitativas e distribuição de frequência para aquelas qualitativas. Para verificar a normalidade das variáveis foi utilizado o teste de Shapiro-Wilk em conjunto com a avaliação de histogramas, Q-Q plots, box-plots e coeficientes de assimetria e curtose.

Para comparação das médias foram realizados teste t de Student ou Mann-Whitney, ANOVA (seguidas do teste post hoc) ou Kruskal-Wallis, dependendo do número de grupos e normalidade dos dados. A comparação de proporções foi feita mediante teste qui-quadrado.

Na avaliação da associação entre o consumo de alimentos com o risco cardiometabólico, de acordo com o grau de processamento ou potencial inflamatório da dieta, foram estimadas as razões de prevalência (RP), por meio da regressão de Poisson com variância robusta. Os modelos foram ajustados por fatores considerados de confusão, de acordo com a literatura.

Os dados de consumo foram tabulados no Microsoft Excel e todas as análises foram realizadas pelos *softwares* SPSS, versão 22, e STATA, versão 13, adotando-se nível de significância de 5%.

4 RESULTADOS E DISCUSSÃO

4.1 Consumo de Alimentos Ultraprocessados e Risco Cardiometabólico: Uma Revisão Sistemática (ARTIGO 1)

ULTRA-PROCESSED FOOD CONSUMPTION AND CARDIOMETABOLIC RISK: A SYSTEMATIC REVIEW

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ABSTRACT

Background: The consumption of processed and ultra-processed foods (UPF) has been associated with the occurrence and development of chronic non-communicable diseases (CNCD). Given the importance of the theme in recent years and the lack of systematic reviews that addresses the relationship of these kind of foods with cardiometabolic risk factors, this review introduces an important discussion on the topic.

Objective: The purpose of this systematic review was to summarize and discuss evidence of the relationship between food consumption, according to degree of food processing and cardiometabolic risk factors.

Data sources: A systematic review was conducted in databases as PubMed, Bireme and Science Direct, the search in these databases were made until July 2018.

Study eligibility criteria: Studies were eligible when evaluated food consumption according to the degree of processing (minimally processed, processed or ultra-processed) and its association with specified cardiometabolic risk factors (obesity, diabetes, dyslipidemia, hypertension, insulin resistance), with no age group, country / region / ethnicity, language nor date restriction.

Setting: PRISMA was used to structure the present review and the quality of the studies included was assessed using the STROBE scale.

Results: Studies have shown a positive association of UPF consumption with excess body weight, hypertension, dyslipidemia and metabolic syndrome features. In turn, processed culinary ingredients and minimally processed foods (which reflected in a healthier nutritional profile) were negatively associated with some cardiometabolic risk factors.

Conclusions: Current evidences indicate the need to monitor UPF intake in global population as well as nutritional education for health-food choices over life course. Furthermore, standardized classification to the degree of food processing as well as longitudinal analyses in future studies can help to improve comparisons between outcomes and establish cause-effect relationship between UPF intake and cardiometabolic risk.

Key words: dietary patterns; ultra-processed foods; obesity; cardiovascular disease.

INTRODUCTION

Food processing consists of a modification in natural and integral form of the food, obtained through physical, thermal and chemical changes, with the aim of improving its palatability, texture, color, taste, shelf life and nutritional quality (MONTEIRO et al., 2016). As food processing contributes to the increase in shelf life, also stand out the issues raised by processing in terms of food and nutritional security (ADAMS; WHITE, 2015; SHAHIDI, 2009).

According to the NOVA classification, processed foods are those that have addition of sugar, salt, oil or other processed culinary ingredients to a food in unprocessed or minimally processed foods group, and which mostly contain two to three ingredients (MONTEIRO et al., 2016). In turn, ultra-processed foods (UPF) have been defined as industrial formulations that use five or more ingredients that aim to improve the sensory attributes of foods using additives such as colorants, color stabilizers, flavorings, and artificial sweeteners (GIBNEY, 2018). UPF have recognizably large amounts of fat, sodium and refine sugars (MONTEIRO et al., 2018). When compared to the other groups, UPF had a much higher amount of added sugar, sodium, saturated fat and *trans* fat (LATASA et al., 2017; LOUZADA et al., 2015b; TSENG et al., 2018).

The consumption of processed and UPF has increased in recent years, mainly due to practicality for consumption and low cost (GUO et al., 2017; JUUL; HEMMINGSSON, 2015). In this sense, in a study with Spanish households the UPF sales increased from 8.4% to 13% between 1990 and 2000 (LATASA et al., 2017). Moreover, UPF sales increased by 43.7% worldwide and approximately 50% in Latin America in the period between 2000 and 2013 (OPAS, 2015).

Several studies developed in different countries as Brazil, Chile, Canada and United Kingdom have shown that high UPF consumption lead to nutritionally unbalanced diets and affect the risk for chronic non-communicable diseases (CNCD), such as excess weight, high blood pressure, dyslipidemias, elevated fasting glycemia and diabetes (CROVETTO; UAUY, 2012; JUUL; HEMMINGSSON, 2015; MARTINS et al., 2013; MONTEIRO et al., 2010; MOUBARAC et al., 2014a, 2013a, 2013b; RAUBER et al., 2015).

Given the importance of the theme in recent years and the lack of systematic reviews that addresses the relationship of these kind of foods with cardiometabolic risk factors, this review introduces an important discussion on the topic.

A food classification that categorizes foods according to the extent and purpose of food processing has become of great scientific relevance (ADAMS; WHITE, 2015; MOUBARAC et al., 2014b; OPAS, 2015) specially to facilitate the understanding of the adverse health effects of these food groups (MONTEIRO et al., 2016). Overall, the objective of this systematic review was to summarize and discuss evidence of the relationship between food consumption, according to degree of food processing and cardiometabolic risk factors.

METHODS

For this review, studies were identified by searching electronic databases (PubMed, Bireme and Science Direct) with MeSH and DeCS terms up to July 2018. The following terms were used: "*minimally processed foods", "processed foods", "ultra-processed foods", "ultraprocessed foods", "obesity", "overweight", "cardiometabolic risk", "hypertension", "insulin resistance", "diabetes", "cholesterol", "triglycerides", "noncommunicable chronic disease", "cardiovascular biomarkers"*. The association between these terms and expressions with the Boolean connectors (AND, OR) has been used.

The identification and selection of articles in all the databases were carried out by two independent researchers. The initial selection was made based on the title and abstract. Then, information about the articles was entered in a spreadsheet so they could be selected by the researchers, being authors, title, year of publication, study design, sample size, objective and main results. To be eligible, articles were original and human studies, evaluating the consumption of foods classified according to their degree of processing (exposure) and some type of cardiometabolic risk factors as obesity, diabetes, dyslipidemia, hypertension, insulin resistance and NCCD in general (outcome), with no age group, country / region / ethnicity, language nor date restriction. Additionally, editorials, summaries of presentations to meetings, review articles, and studies that did not consider the association between the degree of food processing and some of the cardiometabolic risk factors were excluded. Also, articles using dietary patterns without using as criteria classification for degree of food processing (as exposure variable) were excluded.

Moreover, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement was used to guide the writing of this systematic review. Methodological quality of observational studies included in this systematic review was evaluated using Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement in which consists of a checklist of 22 items (VANDENBROUCKE et al., 2014). All references were managed by reference manager software Mendeley Desktop Version 1.18.

A total of 3,043 articles were found by electronic database searching, and 2,040 titles and abstracts remained to be analyzed after removing duplicates. Thus, reviewer 1 and 2 selected 20 and 21 articles, respectively, and one article was included by manual search. Finally, a total of 21 articles were selected for this systematic review, 15 of which had been selected by both reviewers (Figure 1).

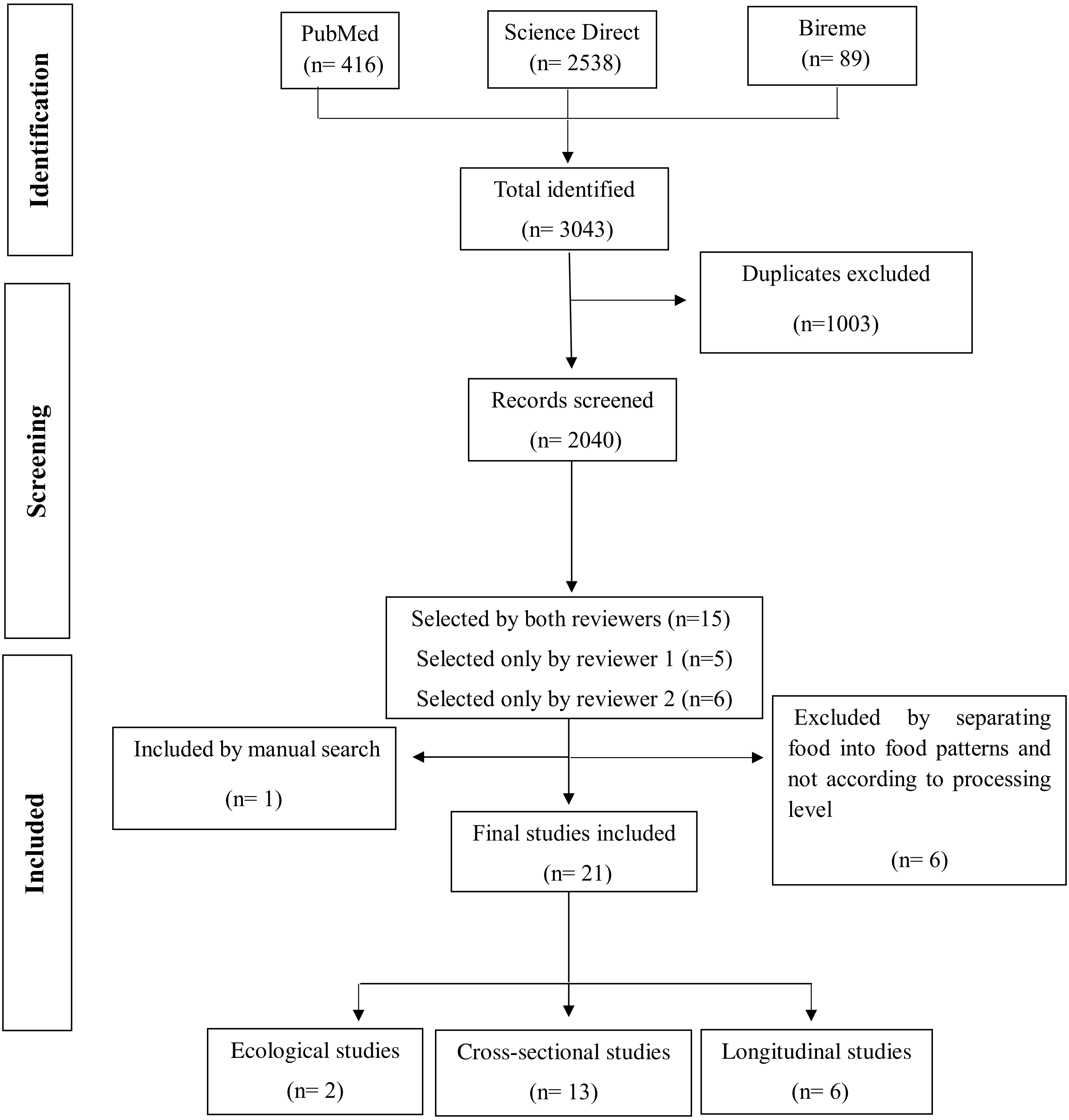

Figure 1 - Flowchart of the steps followed to obtain the articles selected for this review.

RESULTS

The main characteristics of the studies are presented in tables 1, 2 and 3, including potential confounders. Selected studies were performed in Brazil (n=10), Spain (n=2), USA (n=2), Guatemala (n=1), United Kingdom (n=1), Norway (n=1), Lebanon (n=1), Canada (n=1), Sweden (n=1), and other with 19 European countries (n=1). A total of two ecological, six longitudinal and 13 cross-sectional studies were included. The review covered different age-groups as children (n=2), adolescents (n=4), adults (n=7), pregnant women (n=2), mixed aged-groups (n=1), as well as households (n=5).

Food consumption was assessed using 24-h dietary recall (R24h) (n=6), Food-frequency questionnaire (FFQ) (n=11) and records (n=4). Regarding the classification of foods, 18 articles have used the NOVA classification proposed by Monteiro (ADAMS; WHITE, 2015; ALVES-SANTOS et al., 2016; CANELLA et al., 2014; D'AVILA; KIRSTEN, 2017; DE MELO et al., 2017; DJUPEGOT et al., 2017; JUUL et al., 2018; JUUL; HEMMINGSSON, 2015; LAVIGNE-ROBICHAUD et al., 2018; LOUZADA et al., 2015b; MENDONÇA et al., 2017; MONTEIRO et al., 2017; NASREDDINE et al., 2017; RAUBER et al., 2015; ROHATGI et al., 2017; SILVA et al., 2018; TAVARES et al., 2012). While two studies did not use the NOVA classification method (ASFAW, 2011; RINALDI et al., 2016). And another analyzed the dietary pattern in which the Western pattern was basically composed by processed and ultraprocessed foods according to NOVA (CUNHA et al., 2017).

Regarding cardiometabolic risk factors, 13 studies evaluated excess body weight as outcome, one analyzed hypertension, two studies evaluated both excess body weight and blood pressure, one altered lipid profile and four investigated metabolic syndromes. Excess body weight was assessed through elevated BMI in most studies that the outcome was excess body weight, and only three of these also assessed abdominal obesity by waist circumference (DE MELO et al., 2017; JUUL et al., 2018; SILVA et al., 2018).

In this sense, 11/15 studies presented positive association of UPF consumption with excess body weight (ALVES-SANTOS et al., 2016; ASFAW, 2011; CANELLA et al., 2014; DJUPEGOT et al., 2017; JUUL et al., 2018; JUUL; HEMMINGSSON, 2015; LOUZADA et al., 2015b; MENDONÇA et al., 2016; MONTEIRO et al., 2017; ROHATGI et al., 2017; SILVA et al., 2018), ¾ studies with metabolic syndrome (LAVIGNE-ROBICHAUD et al., 2018; RINALDI et al., 2016; TAVARES et al., 2012), one with hypertension (MENDONÇA et al., 2017) and another with altered lipid profile (RAUBER et al., 2015), independently of age-group or country/ region. Furthermore, one study showed that minimally processed foods consumption was inversely associated with excess body weight and another with metabolic syndrome (DE MELO et al., 2017; NASREDDINE et al., 2017). Also, one found inverse association between processed culinary ingredients consumption and body weight (ADAMS; WHITE, 2015).

The mean STROBE score of all studies was 19.67 (minimum of 15 and maximum of 22), indicating good methodological quality of selected studies for this review. Studies have generally described any efforts to address potential sources of bias and reported the generalization of the results (ADAMS; WHITE, 2015; ALVES-SANTOS et al., 2016; ASFAW, 2011; CANELLA et al., 2014; D'AVILA; KIRSTEN, 2017; DE MELO et al., 2017; DJUPEGOT et al., 2017; JUUL et al., 2018; JUUL; HEMMINGSSON, 2015; LAVIGNE-ROBICHAUD et al., 2018; LOUZADA et al., 2015b; NASREDDINE et al., 2017; RINALDI et al., 2016; SILVA et al., 2018). Many studies have not calculated the sample size (ADAMS; WHITE, 2015; ASFAW, 2011; JUUL et al., 2018; JUUL; HEMMINGSSON, 2015; LAVIGNE-ROBICHAUD et al., 2018; MENDONÇA et al., 2016, 2017; SILVA et al., 2018), but presented many participants (n= 811-21,803). Whilst in others the number of participants in the study was lower (n= 45-497) (ALVES-SANTOS et al., 2016; DE MELO et al., 2017; DJUPEGOT et al., 2017; RAUBER et al., 2015; RINALDI et al., 2016; ROHATGI et al., 2017; TAVARES et al., 2012). In addition to use potential confounders, some articles also included effect modifiers as demonstrated in the results (ADAMS; WHITE, 2015; CUNHA et al., 2017; JUUL et al., 2018; LAVIGNE-ROBICHAUD et al., 2018; LOUZADA et al., 2015a; MENDONÇA et al., 2016, 2017; MONTEIRO et al., 2017; ROHATGI et al., 2017). Finally, some studies did not mention the source of financing (ASFAW, 2011; RINALDI et al., 2016; TAVARES et al., 2012) and only one did not indicate the study limitations (ASFAW, 2011).

Table 1 - Characteristics of ecological studies that evaluated the relationship between ultra-processed food consumption and cardiometabolic risk factors**.**

Study population	**Food Surveys**	**Food Classification**	**Confounding variables**	**Variables/ Outcome**	**Results**	**Authors/Year/ Country**
National household budget surveys (1991 – 2008)	Food record (all foods and drinks), except foods and drinks consumed outside the house	NOVA classification Group 1: Unprocessed or minimally processed foods Group 2: Processed culinary ingredients Group 3: Processed foods Group 4: Ultra-processed foods	Countries' GDP per capita, squared GDP per capita, difference in years between the year of the obesity survey and the household food budget survey, a dummy variable for the method to assess obesity (measured=0; self-reported=1), prevalence of physical inactivity and prevalence of smoking	Obesity	Higher household availability of ultra-processed foods increases 0.25 percentage points in obesity prevalence	Monteiro et al., 2017 19 European countries
Households (n= 4000)	National Household Budget Surveys 3 interviews and registration of all expenses for a two-week period	NOVA classification Group 1: unprocessed/minimally processed Group 2: processed culinary ingredients Group 3: processed food products and ultra-processed products	-	BMI/overweight and obesity	Rates of obesity increased in parallel to ultra-processed food consumption from 1960 to 2010.	Juul *et al.*, 2015 Sweden

GDP: Gross domestic product

Table 2 - Characteristics of the cross-sectional studies that evaluated the relationship between ultra-processed food consumption and cardiometabolic risk factors.

Study population	Food Surveys	Food Classification	Confounding variables	Variables/ Outcome	Results	Authors/Year/ Country
Households (n = 21,803)	R24h (100 items)	Group 1: Unprocessed Group 2: Primary processed Group 3: Highly processed	Individual (sex, age, occupation, physical activity), household (income, education level of mothers and fathers, per capita value of meals consumed outside of the home, and per capita total food expenditure) and community level variables (location (urban/rural) and cluster level price of different food items)	BMI/overweight and obesity	A 10%-point increase in the share of partially processed foods from the total household food expenditure increases the BMI of family members by 3.95% A 10%-point increase in the share of highly processed food items increases individual BMI in 4.25%	Asfaw et al., 2011 Guatemala
Households (n=30,243)	Two R24h	NOVA classification Group 1: Unprocessed, minimally, ormoderately processed foods Group 2: Processed foods Group 3: Ultra-processed foods	Age, sex, race, region, urban status, education, income, smoking status and physical activity level. Individual's consumption of fruits, vegetables, and beans to evaluate if the association was independent of these other components of the diet. Additional adjustment for saturated fat, *trans* fat, and added sugar, fiber and total energy intake.	BMI/ excess weight and obesity	Mean BMI was 0.94 kg/m² higher among those in the top quintile of ultra-processed foods consumption. The adjusted odds ratio of being obese or excess weight were, respectively, 1.98 and 1.26 in the top quintile of ultra-processed foods intake.	Louzada et al., 2015 Brazil
Households (n= 55,970)	Records of all foods and drinks – 7 consecutive days	NOVA classification Group 1: Fresh or minimally processed foods Group 2: Processed culinary ingredientes Group 3: processed or ultra-processed products	Socio-demographic characteristics, percentage of expenditure on eating out of home, and dietary energy other than that provided by processed and ultra-processed products	BMI/ excess weight and obesity	Higher household availability of ultra-processed products increases BMI and the prevalence of excess weight and obesity	Canella et al., 2014 Brazil

Children (n=147)	3 R24h	Processed food (cake mix, chips, frozen food, nuggets, chocolate drinks, pudding mix, noodles, microwave popcorn, sugar-based breakfast cereal cookies) Food with high sugar and fat contente (chocolate, milk-based ice cream, sandwich cookies, wafers)	Sex, age and school	Triacylglycerol Glycemia	Positive association of processed foods intake and glycemia, and of processed food plus high sugar and fat content foods intake and glycemia and triacylglycerol	Rinaldi et al., 2016 Brazil
Adolescents (n =210)	Semi-quantitative FFQ (90 items)	NOVA classification Group 1: Unprocessed or minimally processed Foods Group 2: Processed culinary and food industry ingredients Group 3: Ultra-processed foods	Sociodemographic, behavioural and family history covariates	Metabolic syndrome	Higher intake of ultra-processed foods was associated with MetS	Tavares et al., 2011 Brazil
Adolescents (n = 784)	Semi-quantitative FFQ (90 items)	NOVA classification Group 1: Unprocessed or minimally processed Foods Group 2: Processed foods Group 3: Ultra-processed foods	Daily caloric intake	BMI and blood pressure	The normal weight adolescents present higher consumption of ultra-processed foods when compared to those who are overweight.	D'Avila; Kirsten, 2017 Brazil
Adolescents (n= 249)	FFQ (84 items)	NOVA classification Group 1: minimally processed foods Group 2: processed foods Group 3: ultra-processed foods	Sex and age	Blood pressure WC BMI Z-score /excess weight	Consumption of minimally processed foods was inversely associated with excess weight	De melo et al., 2017 Brazil
Adults (n=811)	R24h	NOVA classification Group 1: Unprocessed and minimally processed foods Group 2: Processed culinary ingredients Group 3: Processed foods	Age, sex, area of residence, total daily dietary energy intake, alcohol and smoking status	Metabolic syndrome	Higher quintiles of energy contribution of ultra-processed foods showed significant association with MetS	Lavigne-Robichaud et al., 2017 Canada

		Group 4: Ultra-processed foods				
Adults (n= 15 977)	Two R24h	NOVA classification Ultra-processed foods Non-ultraprocessed foods	Age, sex, educational attainment, race/ethnicity, ratio of family income to poverty, marital status, smoking and physical activity level.	BMI and WC/ excess weight and abdominal obesity	Ultra-processed food consumption was directly associated with excess weight and abdominal obesity	Juul et al., 2018 USA
Adults (n=2174)	Four-day Food Diary	NOVA classification Group 1: Unprocessed or minimally processed Foods Group 2: Processed ingredients Group 3: Ultra-processed food products	Gender, occupational social class, age and percentage of energy derived from alcohol	Body weight	Processed ingredients consumption was inversely associated with body weight	Adams et al., 2015 United Kingdom
Adults (n=320)	Semi-quantitative FFQ (80 items)	NOVA classification Group 1: Unprocessed and minimally processed foods Group 2: Processed culinary ingredients Group 3: Processed foods Group 4: Ultra-processed food and drink (UPF) products Dietary patterns: Ultra-processed foods Minially processed/processed	Sociodemographic and lifestyle characteristics; total energy intake	Metabolic syndrome Glucose HDL-C	Minimally processed/processed pattern was inversely associated with metabolic syndrom	Nasreddine et al., 2017 Lebanon
Adults (n = 497)	FFQ	NOVA classification Ultra-processed foods: ultra-processed dinner products, sweet/salty snacks & soft drinks and fast foods away from home	Sociodemographic and weight	BMI/excess weight	Overweight/obese participants were more likely to be categorized as high consumers of ultra-processed dinner products and fast foods than normal weight	Djupegot et al., 2017 Norway

Age between 35–74 years (n= 8977)	Semi-quantitative FFQ (114 items)	NOVA classification Group 1: Unprocessed or minimally processed foods Group 2: Processed culinary ingredients Group 3: Processed foods Group 4: Ultra-processed foods	Age; sociodemographic/ socio-economic characteristics; health-related behaviours and co-morbidities and consumption of unprocessed or minimally processed foods and processed culinary ingredients and total energy intake	BMI and WC/ overweight and obese	Individuals in the fourth quartile of percentage energy contribution from ultra-processed foods presented a higher BMI and WC, and higher chances of being overweight, obese and having significantly increased WC, compared with those in the first quartile	Silva et al., 2018 Brazil

R24h: 24-h dietary recall; FFQ: Food-frequency questionnaire; BMI: Body mass index; WC: Waist circumference

Table 3 - Characteristics of the longitudinal studies that evaluated the relationship between ultra-processed food consumption and cardiometabolic risk factors.

Study population	Food Surveys	Food Classification	Confounding variables	Variables/ Outcome	Results	Authors/Year/ Country
Pregnant women (n= 189)	Semi-quantitative FFQ (82 items)	NOVA classification Group 1: Unprocessed or minimally processed food Group 2: Food industry ingredients Group 3: Processed food products Group 4: Ultra-processed food products	Age and BMI	BMI	Positive association of pre-pregnancy BMI with the variation of ultra-processed food intake	Alves-Santos *et al*., 2016 Brazil
Pregnant women and neonate (n=45)	One-month FFQ	NOVA classification Group 1: Unprocessed or minimally processed food Group 2: Processed culinary ingredient Group 3: Processed food Group 4: Ultra-processed food	Maternal age, race, socioeconomic status, weight status, average daily energy and fat intake, and time spent in moderate physical activity. Gestational age at time of measurement was also used to evaluate the relationship with newborn body composition	Gestational weight Neonatal Thigh and Subscapular skinfold thickness	A 1%-point increase in PEI-UPF increase 1.33 kg gestational weight and 0.22 mm in thigh skinfold, 0.14mmin subscapular skinfold and 0.62 percentage points of total body adiposity	Rohatgi *et al*., 2017 USA
Childrens (n=345)	2 R24h	NOVA classification Group 1: unprocessed and minimally processed foods Group 2: processed culinary ingredients Group 3: processed and ultra-processed products	Sex, group status in the early phase, birth weight, family income, maternal schooling, and BMIz score and total energy intake at age 7-8	Total cholesterol LDL-C	Higher ultra-processed product consumption increases total cholesterol and LDL-C	Rauber et al., 2014 Brazil
Adolescents (n=1035)	FFQ (72 items)	Ultra-processed foods	Type of school (public or private), sex, physical activity levels, and underreporting.	BMI and %body fat/ adiposity indicator	Inverse association between UPF consumption and BMI and % body fat both at baseline and at follow-up	Cunha et al., 2017 Brazil

Adults (n=8451)	Semiquantitative FFQ (136 items)	NOVA classification Group 1: unprocessed and minimally processed foods Group 2: processed culinary ingredients Group 3: processed food Group 4: ultra-processed food and drink products	Age, sex, marital status, educational status, baseline BMI, physical activity, television watching, siesta sleep, smoking status, snacking between meals, and following a special diet	BMI	Higher ultra-processed food consumption increase risk of developing overweight or obesity	Mendonça et al., 2016 Spain
Adults (n=14790)	Semiquantitative FFQ (136 items)	NOVA classification Group 1: unprocessed and minimally processed foods Group 2: processed culinary ingredients Group 3: processed food Group 4: ultra-processed food and drink products	Age, sex, physical activity, hours of television watching, baseline body mass index, smoking status, use of analgesics, following a special diet at baseline, family history of hypertension, hypercholesterolemia, and alcohol consumption, total energy intake, olive oil intake, and fruit and vegetable consumption	Hypertension	Higher ultra-processed food consumption increases risk of developing hypertension	Mendonça et al., 2016 Spain

R24h: 24-h dietary recall; FFQ: Food-frequency questionnaire; PEI-UPF: Percent of energy intake from ultra-processed foods

DISCUSSION

Degree of food processing and cardiometabolic risk factors

Most studies showed a positive association of UPF consumption with excess body weight, hypertension, total cholesterol and LDL-c, and metabolic syndrome; all recognized as cardiometabolic risk factors, regardless of age or ethnicity / nationality. UPF have traditionally high content of *trans* fats, saturated fats, sodium, sugars as well as low fiber and mono and polyunsaturated fats (MONTEIRO et al., 2010, 2012b; MOUBARAC et al., 2013b; OPAS, 2015). In addition, these kinds of foods have higher energy density and glycemic response and lower satiety, compared to non-processed foods (FARDET, 2016).

Both *trans* and saturated fats are commonly used by the food industry to improve palatability and texture of the product, as well as prolong shelf life (REVOREDO et al., 2017). However, they result in health damage, mainly due to the increase in LDL-c and the reduction of HDL-c (KENNEDY et al., 2009). Excessive saturated fat intake also may result in hypertrophy of adipocytes and general white adipose tissue enlargement (MUIR et al., 2018). These fatty acids have important role on pro-inflamamatory status (ROCHA et al., 2016; ROCHA; BRESSAN; HERMSDORFF, 2017). All these outcomes may contribute to a higher cardiometabolic risk.

In relation to sodium, salt is widely used as a way of food conservation, aiming to extend the "shelf life" and improve taste. Thus, UPF and processed foods are manufactured by adding salt. According to the World Health Organization (WHO), the average of salt intake is 9 to 12 grams/day, much higher than recommended (5 grams/day). The WHO still stands that 2.5 million of deaths could be prevented each year if global salt consumption was reduced to the recommended level (WHO, 2012). A study in the United States showed that 45.4% of deaths from cardiometabolic diseases in 2012 were related to diet, and among these, the highest number of deaths occurred due to high sodium intake (9.5%) (MICHA et al., 2017).

Finally, added sugars are commonly found in UPF and have gained prominence, since high intake increases the risk of obesity, type 2 diabetes mellitus, hypertriglyceridemia and cancer (FIOLET et al., 2018; JUUL et al., 2018; SILVA et al., 2018). In fact, excess of dietary fructose has resulted in impaired VLDL catabolism and increased VLDL synthesis, with subsequent increase in triglycerides, LPL inactivation and high accumulation in visceral adipose tissue (ZAKIM, 2009). In this context, high fructose corn syrup is of great utility in the food industry as UPF sweetener, becoming the major source of added sugars. A study in the USA showed that added sugars represented on average one of five food calories from UPF (21.1%), values greatly than that found in processed foods (2.4%) and in unprocessed foods or minimally processed and processed culinary ingredients, all three together (3.7%) (MARTINEZ STEELE et al., 2016). Packed juice, commonly consumed by children and adolescents, has a high content of added sugars and usually contains refined carbohydrates such as sucrose, fructose, glucose and sorbitol, which contributes to an increased caloric intake between 0.44 and 0.64 kcal/ml or more (HEYMAN; ABRAMS, 2017). In addition, enriched sugar food provides empty calories, without nutritional benefits, being associated with childhood obesity when consumed in excess (MALIK; SCHULZE; HU, 2006).

Furthermore, the present review showed that few studies have used waist circumference as a cardiometabolic risk factor, considering those who used this marker for metabolic syndrome. Although BMI is a recognized adiposity indicator, extensively applied in epidemiological studies (WELLENS et al., 1996; WORLD HEALTH ORGANIZATION, 2000), it does not consider body fat distribution (total vs central adiposity). In turn, waist circumference is also an anthropometrical measurement of easy application, which presents stronger relation to cardiometabolic risk and is also strongly related to the low-grade pro-inflammatory state (DE OLIVEIRA et al., 2014; HERMSDORFF et al., 2010, 2011, 2014; KLEIN et al., 2007; MARTÍNEZ-GONZÁLEZ et al., 2014; PEREIRA et al., 2015).

Moreover, the studies showed positive association of processed and UPF consumption with cardiometabolic risk factors in pregnant women, with an impact on the newborns, which means in the early stages of life, from neonates to children and adolescents. This situation is worrying, since the consumption of UPF in Brazil is increasing among children and adolescents (MALLARINO et al., 2013; RELVAS; BUCCINI; VENANCIO, 2018; WENDT, 2018). Childhood is a critical period for creating healthy eating habits and promoting lifelong health (RAMOS; STEIN, 2000). On the other hand, excessive intake of fats, sodium and sugars by UPF consumption in substitution of vitamins and minerals intake by the consumption of foods with high nutritive content, could result in metabolic changes with an impact on the CNCD development in an early manner as well (OPAS, 2015). In addition, consumption of UPF can eventually lead to dysbiosis, increasing the susceptibility to the development of autoimmune diseases such as type 1 diabetes and celiac disease in genetically predisposed children (AGUAYO-PATRÓN; CALDERÓN DE LA BARCA, 2017).

Among those studies that did not observed association between UPF consumption and cardiometabolic risk, Adams & White (2015) and De Melo et al (2017) presented inverse association of processed ingredients and minimally processed foods with excess body weight, respectively. In fact, the use of processed culinary ingredients is accompanied by the consumption of unprocessed or minimally processed foods, as they are used in home-made preparations, considered healthier. In addition, the last one found a relationship in the consumption of sausage and prevalence of overweight when analyzing each food separately. For another two studies, D'avila & Kirsten (2017) and Cunha et al (2017), the authors argumented that high prevalence of physical activity, limited access to UPF, and low daily caloric intake among participants could have contributed to no significant association and inverse association, respectively.

All these factors discussed lead us to reinforce the stimulus to reduce the consumption of UPF since the traditional dietary patterns of many countries have been superior to these products.

Food Classification according to the degree of processing

Many studies have evaluated the association between UPF intake and cardiometabolic risk. There are several food classification systems, particularly developed in different countries, each with its peculiarities, in which some of them do not present a clear criterion to define the degree of processing (MOUBARAC et al., 2013b). The NOVA classification was well evaluated and can be used by several countries (MOUBARAC et al., 2014b).

What is noticed by this review is that although most studies have used the NOVA classification, there are differences in some food classification within each group and in the terminology used in some groups, which can cause confusion in the interpretation of some associations and results. In addition, some studies have used other classifications that not NOVA.

Louzada et al (2015b) added moderately processed foods in the first group, which grouped foods that had an edible part removed and no substance added (LOUZADA et al., 2015b). The study by Alves-Santos et al (2016) used only foods containing fat and sugar in group 2 and because this, the group name was fat and sugar (ALVES-SANTOS et al., 2016). Already in the study of D'Avila et al (2017) foods like oils, fats, flours, pasta, starch, and sugars were grouped within processed foods (group 2) (D’AVILA; KIRSTEN, 2017). In the study of De Melo et al (2017) foods such as butter, olive oil, salt added to salad and sugar added in drinks were included in the group of processed (DE MELO et al., 2017). And in another study alcoholic beverages were analyzed separately (JUUL; HEMMINGSSON, 2015). Although these studies used the NOVA classification, a lack of standardization in relation to the degree of food processing for some foods were observed, and caution is needed when analyzing associations between food groups according to the degree of processing and the outcomes.

Besides that, for some studies caution is required in interpreting the results. Although the study by Nasreddine et al (2017) has used the NOVA classification, and classified nuts and seeds in the group of processed, and fish and low-fat dairy products in the group of minimally processed, when evaluated dietary pattern, nuts, seeds, fish, low-fat milk and dairy products were grouped in ultra-processed, because they were considered foods ready-to-eat, being necessary caution in the interpretation of the results. Also, Cunha et al (2017) evaluated dietary patterns and observed that "Western pattern" consisted of processed and ultra-processed foods according with the NOVA classification, however they evaluated foods from these two groups together.

The two studies that did not use the NOVA classification (ASFAW, 2011; RINALDI et al., 2016) separated foods into two processing groups: processed foods in which they included foods as nuggets, chocolate drinks and microwave popcorn, and another group that classified foods into high sugar and fat content (RINALDI et al., 2016). The study accomplished by Asfaw et al (2011) used the classification developed in Guatemala in which it divided the food into unprocessed, partially processed and highly processed foods and according to Moubarac et al (2014b) evaluation it has the limitation for not distinguishing domestic processing methods of industrial methods (MOUBARAC et al., 2014b).

As already evaluated by others, the NOVA classification was well classified within the evaluation criteria and can be used by different countries. Due to this fact, it is important to have a standardization of the classification method for level of comparison and evaluation between food consumption according to the degree of processing and outcomes.

Strengths and Limitations

The strong point of this review was no restriction for age-groups and nationalities, reinforcing external validity of our discussion and worrying about the health consequences of UPF consumption in global population. In turn, this systematic review presents some limitations. Although most of the studies used the NOVA classification, lack of standardization made comparisons and discussion of study results difficult. In addition, most of the studies had a cross-sectional design, which does not allow a cause-effect relationship.

CONCLUSION

In this review, the consumption of UPF was positively associated with cardiometabolic risk-related outcomes, regardless of age and country, indicating caution to intake of this food-group in global population and the importance of nutritional education regarding health-food choices over life course. Furthermore, standardized classification to the degree of food processing as well as longitudinal analyses in future studies can achieve better comparisons between outcomes and establish cause-effect relationship between UPF intake and cardiometabolic risk.

4.2 Alimentos minimamente processados versus processados e ultraprocessados em indivíduos com risco cardiovascular (ARTIGO 2)

MINIMALLY PROCESSED VERSUS PROCESSED AND ULTRAPROCESSED FOOD IN INDIVIDUALS WITH CARDIOMETABOLIC RISK

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ABSTRACT

Objective: To evaluate the association between food consumption classified by degree of processing and cardiometabolic risk factors in a population at risk of cardiovascular disease.

Design: A cross-sectional study conducted in a Cardiovascular Health Care Program (PROCARDIO-UFV, ReBEC ID: RBR-5n4y2g). Food consumption was evaluated by a 24 h dietary recall and classified according to the NOVA classification. Sociodemographic, lifestyle, anthropometric and clinical data were obtained through standard protocols or medical records.

Setting: Academic community of the Federal University of Viçosa, Viçosa - MG.

Participants: 325 adults and older adults (58.5% women, 42 ± 16 years), who present a cardiovascular risk factor.

Results: Individuals who presented a higher consumption of unprocessed and minimally processed foods, and culinary ingredients had lower prevalence of abdominal obesity and high total cholesterol while those who presented a higher consumption of processed and ultra-processed food had a higher prevalence of abdominal obesity, waist/ hip ratio (PR= 1.005; p-value= 0.049), waist circumference (PR= 1.003; p-value= 0.02) and high total cholesterol (PR= 1.008; p-value= 0.047). In addition, a higher consumption of processed and ultra-processed foods was found among women, adults, the highly educated, single individuals and those who have never smoked. In relation to type of meal, a greater consumption of unprocessed and minimally processed food was observed at lunch and dinner while a higher consumption of ultra-processed occurred at breakfast and snack time.

Conclusions: The results indicate an association between degree of food processing and cardiometabolic risk factors, such as abdominal obesity and hypercholesterolemia, even though the study population already has at least one risk factor for cardiovascular disease, reinforcing the importance of individualized nutrition orientation that takes into account the profile of the target population as well as types of meals.

KEYWORDS: Women; Young; Marital status; Cardiovascular disease; Food processing

INTRODUCTION

Cardiovascular diseases (CVD) are the leading cause of death, accounting for 17.9 million deaths worldwide as of 2016 (WHO, 2018). Brazil is no exception, in fact CVD is the main cause of death and hospitalization cost related to CVD is the most expensive (IBGE, 2014). This scenario is associated with the increasing prevalence of cardiometabolic risk factors, such as hypertension, dyslipidemias, insulin resistance, diabetes mellitus and overweight among individuals in Brazil (IBGE, 2014) and worldwide (WHO, 2018), due to inadequate dietary intake and sedentary lifestyle (GONZÁLEZ; FUENTES; MÁRQUEZ, 2017; YU; MALIK; HU, 2018).

In this context, the frequency of cardiometabolic risk factors has grown concomitantly with the household availability of processed and ultra-processed foods and consequent consumption of the same, mainly due to their practicality and low cost. Furthermore, the caloric contribution of unprocessed and minimally processed foods to dietary intake continues to decrease (MONTEIRO et al., 2017). Between 2000 and 2013, the sale of ultra-processed foods in the world and Latin America increased 43.7% and 50%, respectively (OPAS, 2015). Similarly, in Brazil, the consumption of processed and ultra-processed foods increased between 2002-2003 and 2008-2009, whereas the consumption of unprocessed and minimally processed foods decreased simultaneously (MARTINS et al., 2013).

Food processing is the modification of natural and whole foods by physical, chemical or thermal processes. Processed foods contain added salt, sugar and oil (GIBNEY, 2018), while ultra-processed foods are rich in saturated fat, *trans* fat, sodium, added sugars, mainly fructose and contain food additives. Thus, ultra-processed foods are energetically dense and highly palatable, providing higher glycemic response and less satiety, in addition to being cheaper (LOUZADA et al., 2015a; MONTEIRO et al., 2012a, 2010; MOUBARAC et al., 2013b). In comparison, unprocessed and minimally processed foods are rich in fiber, micronutrients, polyunsaturated fats, phytochemicals, have low glycemic response and provide satiety (FARDET, 2016).

Many studies have associated food according to degree of processing with clinical outcomes (ADAMS; WHITE, 2015; CANELLA et al., 2014; DJUPEGOT et al., 2017; JUUL et al., 2018; LOUZADA et al., 2015b; MELO et al., 2017; MENDONÇA et al., 2016, 2017; MONTEIRO et al., 2017; RAUBER et al., 2015; REVOREDO et al., 2017; RINALDI et al., 2016; SILVA et al., 2018). However, no studies have evaluated this association in a population with cardiovascular risk. Given that approximately 390,400 CVD deaths are expected in Brazil by 2030 and 50% reduction in ultra-processed consumption and increase in the same proportion of unprocessed and minimally processed foods can reduce deaths by 11% (MOREIRA et al., 2018), the investigation of food intake by degree of processing in individuals at risk of cardiovascular disease and possible associations is important. Furthermore, there is a need to evaluate whether the consumption of processed and ultra-processed foods offers additional risks to individuals who present cardiometabolic alterations.

In view of the above, we evaluated the association of food consumption according to degree of processing with cardiometabolic risk factors in a population with cardiovascular risk.

MATERIAL AND METHODS

Study design and sample

This study is a cross-sectional study conducted with a population who utilize the services of the Cardiovascular Health Care Program of the Federal University of Viçosa (PROCARDIO-UFV). The program is directed towards individuals in the academic community who present cardiovascular risk factors. All data were collected at baseline, defined as the first consultation (before the patient receives any nutrition intervention). The nutrition intervention methodology of PROCARDIO-UFV is available in the Brazilian Registry of Clinical Trials (ReBEC, id: RBR-5n4y2g) and the inclusion criteria have been previously described (ALMEIDA et al., 2016; RODRIGUES et al., 2017; SILVEIRA et al., 2018b).

Data collected from consultations between March 2012 and December 2017 (n = 330 individuals) were used. Three individuals were excluded due to incomplete data and two individuals due to overestimation of caloric intake (> 4,000 kcal / day)(WILLETT, 1998) resulting in 325 individuals who participated in the study.

This study was approved by the Human Research Ethics Committee of UFV (Ref. No. 066/2012 / CEPH), in accordance with Resolution CNS 466/2012, and all participants signed the Informed Consent Form (ICF).

Food consumption assessment and classification according to the degree of processing

Food consumption was assessed through a 24-hour dietary recall (R24h) related to the day prior to consultation, and a five-step multiple-pass method was employed by trained interviewers to minimize possible sources of bias (CONWAY et al., 2003). The portions were quantified in grams (g) with standard home measurements(PINHEIRO et al., 2010). Caloric intake was estimated in DietPRO® software, version 5.8, using the Brazilian Food Composition Table (TACO)(TACO, 2011).

Food was classified into four distinct groups based on the NOVA classification, which discriminates foods according to the nature, extent and purpose of processing (MONTEIRO et al., 2016). Group 1 (unprocessed and minimally processed foods) is composed of unprocessed foods mainly edible parts of plants or animals and minimally processed foods are unprocessed foods subjected to processes such as removal of inedible or unwanted parts, drying, dehydration, crushing or grinding, fractioning, roasting, boiling, pasteurization, refrigeration or freezing, packaging, vacuum packaging, non-alcoholic fermentation and other processes that avoid the addition of substances such as salt, sugar, oils or fats; Group 2 (processed culinary ingredients) consists of cooking ingredients extracted from foods in group 1 or nature; Group 3 (processed foods) is characterized by the addition of salt, sugar, oil, vinegar or other substances of group 2 to group 1 food items, composed mostly of two or three ingredients; Group 4 (ultra-processed foods) are products which contain five or more ingredients of Group 1 foods or Group 3 foods containing additives which modify the color, odor, flavor or texture of the final product (MONTEIRO et al., 2016). The consumption of each group was evaluated as a percentage of total energy consumption.

Cardiometabolic risk factors assessment

Weight, height and waist circumference were measured according to the PROCARDIO-UFV protocol (SILVA et al., 2015). Adults and older adults with BMI ≥ 25.0 and BMI ≥ 28.0 kg / m² , respectively were classified as having excess weight (OPAS, 2002; WHO, 2000). Abdominal obesity was defined as waist circumference ≥ 90 cm and ≥ 80 cm for men and women, respectively (ABESO, 2016). Excess body fat was evaluated as total body fat > 20% and > 30% for men and women, respectively (BRAY G, BOUCHARD C, 1998), and was measured using a horizontal tetrapolar electric bioimpedance equipment (Biodynamics® 310 model, Washington, USA) according to a specific protocol (BRAY G, BOUCHARD C, 1998).

Blood samples were collected after a 12-hour fast and the serum concentrations of glycemia, HDL-c, LDL-C, total cholesterol and triglycerides were measured by a colorimetric enzymatic method. The homeostasis model assessment of insulin resistance (HOMA-IR) was calculated by the formula: [(glycemia mg / dL) x (insulinemia μU / mL)] / 405 and Triglyceride glucose index (TyG) by the formula: Ln [fasting triglycerides (mg / dL) x fasting plasma glucose (mg / dL)/2] (SIMENTAL-MENDÍA; RODRÍGUEZ-MORÁN; GUERRERO-ROMERO, 2008). Cardiometabolic risk factors were: fasting glycemia ≥100 mg / dL or the use of oral antidiabetics or insulin; HDL-c <40 mg / dL and <50 mg / dL for men and women, respectively; LDL-c ≥ 160 mg / dL; total cholesterol ≥ 240 mg / dL; non-HDL cholesterol ≥ 160 mg / dL or use of statins for each of these markers; triglycerides ≥ 150 mg / dL or use of fibrates; HOMA-IR > 2.71(SBC, 2013a; SBD, 2018); and TyG index above the 75th percentile.

Blood pressure was measured by a mercury sphygmomanometer (Missouri®, São Paulo, Brazil), with an approximation of 02 mmHg[44], being considered arterial hypertension if pressure was ≥ 140/90 mmHg or antihypertensive medication use.

Sociodemographic data assessment

Information on age, sex, sociodemographic characteristics such as family income by minimum wage, education (illiterate, incomplete primary education, complete primary education, incomplete high school education, complete high school education, incomplete college education, college degree), marital status (stable union, divorced or widowed), clinical history (diabetes, hypertension, dyslipidemias, hepatic steatosis, hypothyroidism), lifestyle related to smoking (smokers, ex-smokers or non-smokers) and level of physical activity (whether individual practices or not) and use of medications, were collected from medical records.

Statistical analysis

Data were presented as mean ± standard deviation or absolute and relative frequency. The normality of the variables was evaluated by the Shapiro-Wilk test. Mann-Whitney and Kruskal-Wallis tests were performed to investigate possible differences in caloric intake (percent) of the two groups (unprocessed, minimally processed foods and culinary ingredients; and processed and ultra-processed foods) according to the characteristics of the sample.

Food consumption (in % calorie) according to degree of food processing (unprocessed and minimally processed, and culinary ingredients; and processed and ultra-processed foods) and its association with cardiometabolic risk factors was evaluated by Poisson regression analysis with robust variance through prevalence ratio (PR), adopting a significance level of 5%. The models were adjusted by sex, age, level of education, marital status and lifestyle (smoking and physical activity practice). All statistical analyses were performed using SPSS, version 22.0, and Stata, version 13.0.

RESULTS

Among the participants, 135 (41.5%) were males. According to cardiometabolic risk factors in our population, 71.6% had excess weight; 39.2% diabetes; 58.6% hypertension and dyslipidemia: 45.6% had hypercholesterolemia, 45.9% high LDL-c, 63.5% low HDL-c and 48% hypertriglyceridemia. Table 1 presents the descriptive characteristics of the samples as well as food consumption data according to degree of processing. It is noted that a high consumption of processed and ultra-processed foods was observed among women compared to men, adults compared to older adults, highly educated individuals (college degree/incomplete college degree), individuals living without a partner (single, widowed or divorced) and individuals who never smoked. The risk factors by food consumption according to degree of processing are presented in Figures 1 and 2. Individuals without hyperglycemia and hypertension and those with normal plasma HDL-c levels had a higher consumption of processed and ultra-processed foods. No statistically significant associations were found with other cardiometabolic risk factors evaluated (excess weight, excess body fat, WHR, abdominal obesity, WHtR, insulin resistance by TyG and HOMA-IR, hypercholesterolemia, high LDL-c, high non-HDL cholesterol and hypertriglyceridemia).

Table 1 - Daily caloric intake (% kcal) of unprocessed or minimally processed foods and processed culinary ingredients and processed and ultra-processed foods according to sample characteristics (n = 325)

Variables	n (%)	Unprocessed or minimally processed and processed ingredients	P-valor	Processed and ultra-processed	P-valor
Sex					
Male	135 (41.5)	**68.8 ± 17.9**	< 0,001	**31.2 ± 17.9**	< 0,001
Female	190 (58.5)	**60.4 ± 17.7**		**39.6 ± 17.7**	
Age group					
Adults	261 (80.3)	**62.1 ± 18.2**	< 0,001	**37.9 ± 18.2**	< 0,001
Elderly	64 (19.7)	**71.3 ± 16.5**		**28.7 ± 16.5**	
Schooling					
Until complete primary school	69 (22.5)	**73.2 ± 17.3[a]**	< 0,001	**26.8± 17.3[a]**	< 0,001
High school (incomplete and complete)	56 (18.2)	**70.7± 15.2[a]**		**29.3 ± 15.2[a]**	
College education (incomplete and complete)	182 (59.3)	**58.7 ± 17.9[b]**		**41.3 ± 17.9[b]**	
Family income					
Up to 4 minimum wages	196 (67.6)	62.3 ± 18.5	0.08	37.7 ± 18.5	0.08
> 4 minimum wages	94 (32.4)	66.1 ± 17.1		33.9 ± 17.1	
Marital status					
Single/widower/divorced	160 (49.5)	**59.2 ± 18.5**	< 0.001	**40.8 ± 18.5**	< 0.001
Married/stable partnership	163 (50.5)	**68.6 ± 16.9**		**31.4 ± 16.9**	
Smoking					
Smoker/former smoker	100 (31.8)	**68.4 ± 17.9**	**0.01**	**31.6 ± 17.9**	**0.01**
Never smoked	214 (68.2)	**61.6 ± 17.8**		**38.4 ± 17.8**	
Physically active					
No	149 (46.4)	64.4 ± 17.8	0.56	35.5 ± 17.8	0.56
Yes	172 (53.6)	63.4 ± 18.4		36.6 ± 18.4	

Data are expressed as mean and standard deviation (SD). P-values are provided by Mann-Whitney test for variables with two categories and Kruskal-Wallis test for variables more than 2 categories (post hoc Dunn-Bonferroni) in which different letters indicate statistical difference between groups.

*p < 0.05; **p < 0.01; ***p < 0.001.

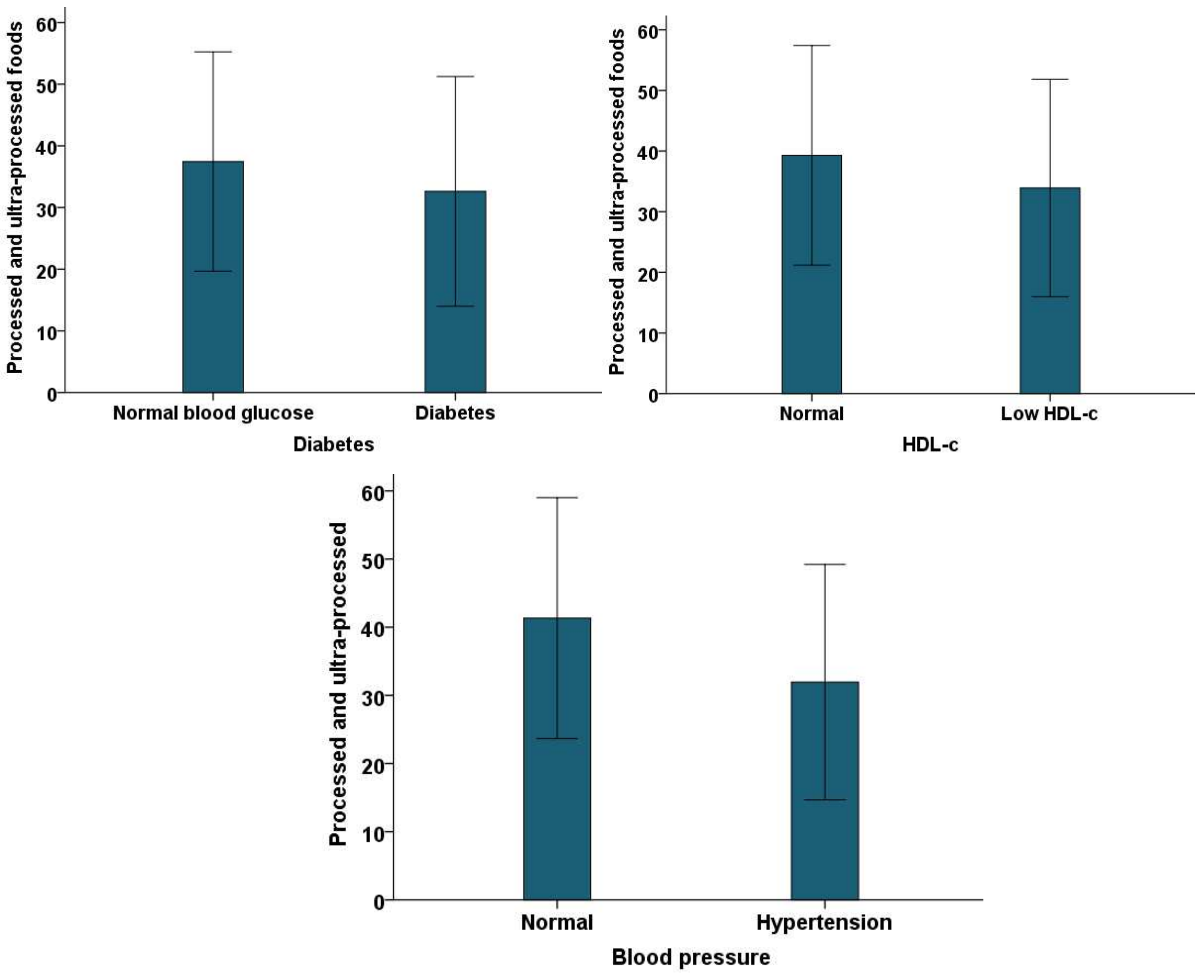

Figure 1 – Daily caloric intake (% kcal) of processed and ultra-processed foods according to cardiometabolic risk factors.

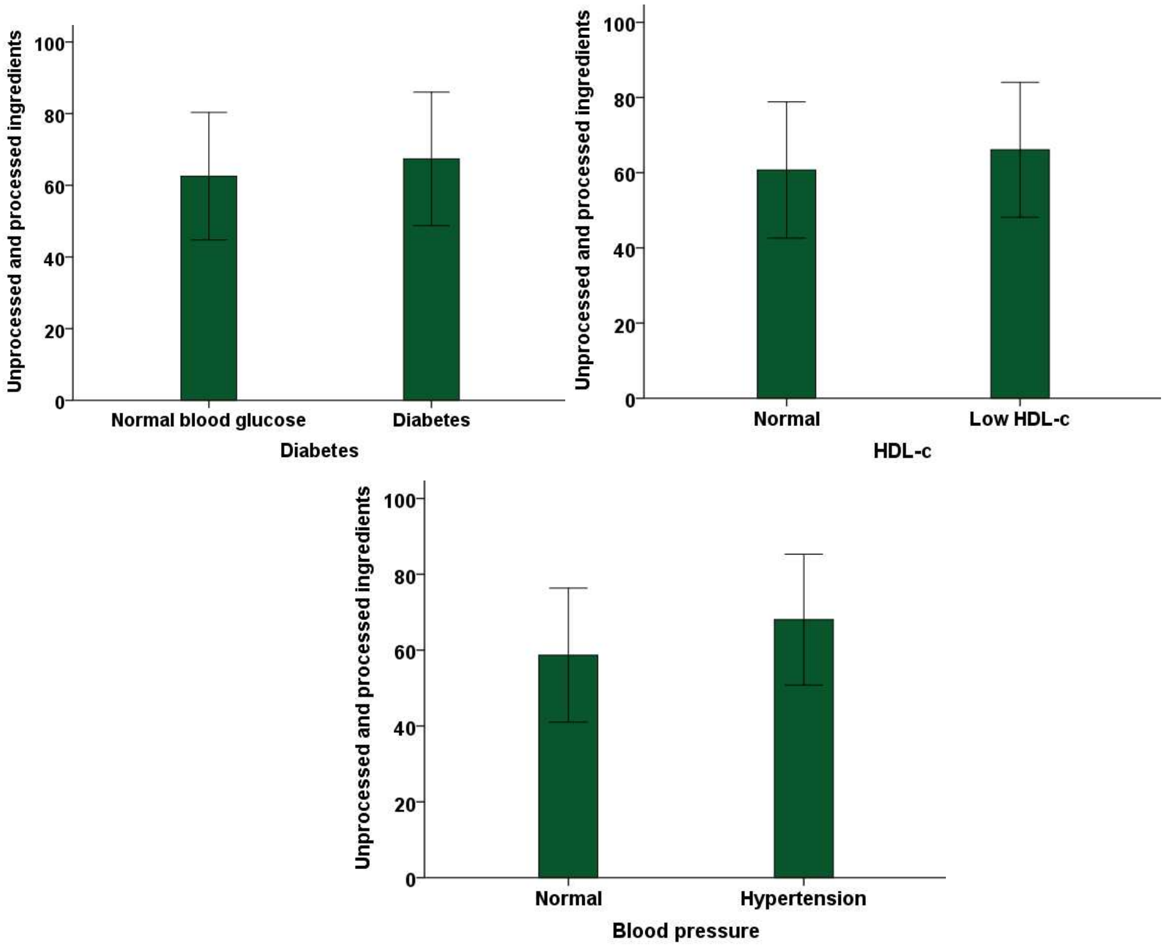

Figure 2 – Daily caloric intake (% kcal) of unprocessed or minimally processed foods and processed culinary ingredients according to cardiometabolic risk factors.

The caloric contribution for unprocessed and minimally processed foods and ultra-processed foods were 54.4% and 25.9%, respectively (Table 3). Rice (9.1%), red meat (7.9%) and poultry and other types of meat (7.8%) mostly contributed to calories from unprocessed and minimally processed food, while industrialized sweets (5.4%), ultra-processed breads (4.5%) and salty snacks (4.3%) were the main foods that contributed to calories from ultra-processed foods.

Table 2 - Caloric contribution of food groups and subgroups on daily energy intake

Foods by degree of processing	**Kcal**		**Average energy intake (%)**
	Mean	**SD**	
Unprocessed or minimally processed foods	**943.2**	**437.9**	**54.4**
Rice	158.5	119.8	9.1
Red meat	137.0	218.6	7.9
Poultry and other meat	135.6	201.8	7.8
Bean	107.9	109.3	6.2
Fruits	92.9	119.7	5.4
Other cereals	90.2	163.8	5.2
Milk and yogurt	77.6	101.2	4.5
Vegetables	33.0	42.8	1.9
Roots and tubers	22.7	68.2	1.3
Coffee and tea	19.7	25.9	1.1
Fruit or vegetable juices	19.0	51.6	1.1
Eggs	18.5	46.7	1.1
Others*	30.6	93.7	1.8
Processed culinary ingredientes	**149.3**	**122.7**	**8.6**
Vegetable oil	74.2	63.9	4.3
Sugar	48.1	66.4	2.8
Animal fat	24.8	72.6	1.4
Others†	2.2	17.0	0.1
Processed foods	**192.8**	**185.0**	**11.1**
French bread	127.6	143.2	7.4
Processed cheeses	49.5	91.6	2.8
Wine and beer	8.4	45.6	0.5
Others ‡	7.4	39.4	0.4
Ultra-processed foods	**448.5**	**411.2**	**25.9**
Sweets	94.4	159.9	5.4
Ultra-processed breads	78.0	114.0	4.5
Sweet or savoury packaged snacks	73.8	144.4	4.3
Ready meals	46.1	159.7	2.7
Margarines and spreads	37.3	112.9	2.1
Ultraprocessed meats§	33.9	99.7	2.0
Milk drinks	26.0	55.9	1.5
Ultra-processed cheeses (curd cheese and cheddar)	18.0	48.9	1.0
Industrialized juices	13.8	40.7	0.8
Soft drinks	13.2	48.1	0.8
Condiments/meat and chicken extracts and instant sauces	8.9	29.6	0.5
Others‖	5.2	27.7	0.3

*Others: Nuts and seeds; spices and aromatic herbs fresh or dried; fishes and sea food; other legumes; offal; water; mushrooms

†Others: Starches extracted from corn and other plants; honey, salt

‡Others: Canned/bottled vegetables, fruits and legumes; salted, cured, or smoked meats; canned fish; salted or sugared nuts and seeds

§Ultra-processed meats: Mortadella; ham; sausage; nuggets; burgers

|Others: Breakfast cereals; alcoholic drinks followed by distillation as whisky, gin, rum and vodka; energy drinks and fruit drinks

When consumption was evaluated based on type of meal, we observed a higher consumption of unprocessed and minimally processed foods at lunch and dinner, and ultra-processed foods at breakfast and snack time (Figure 3).

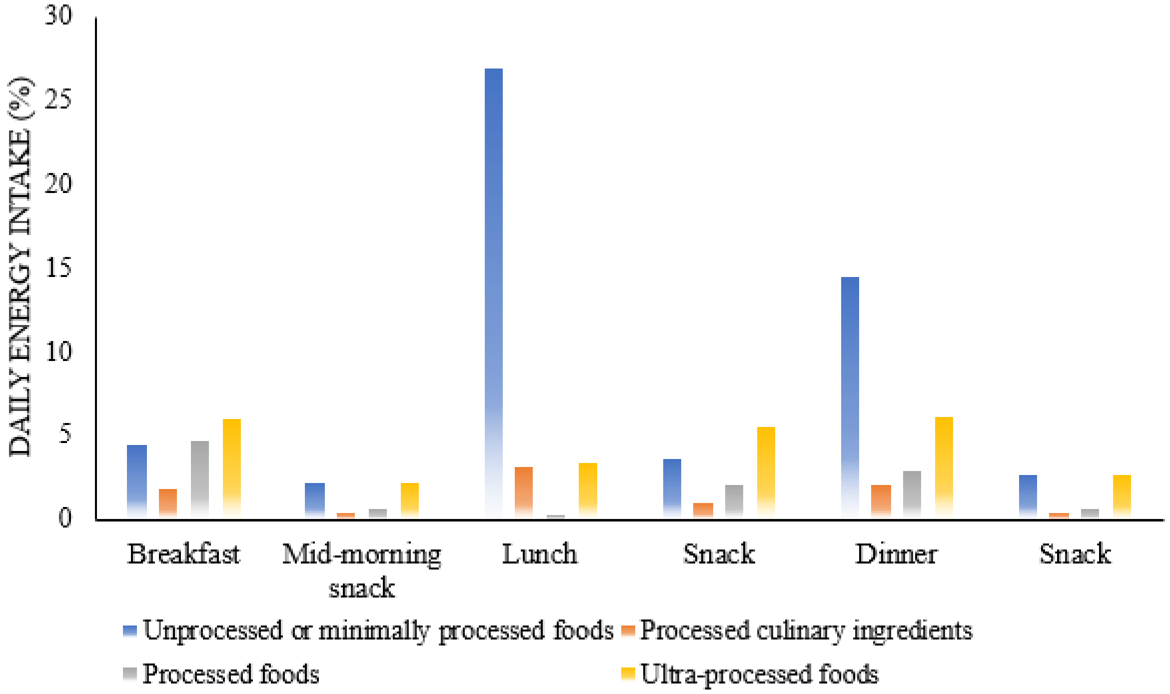

Figure 3 - Daily caloric intake (%) according to the degree of processed foods between meals. Data expressed as mean.

In relation to cardiometabolic risk factors, after adjustments, the consumption of unprocessed and minimally processed foods and culinary ingredients was negatively associated with WHR (PR = 0.995; p-value = 0.049), waist circumference (PR = 0.997; p-value = 0.02) and high total cholesterol (PR = 0.992; p-value = 0.047), whereas the consumption of processed and ultra-processed foods was positively associated with WHR (PR = 1.005; p-value = 0.049), waist circumference (PR = 1.003, p-value = 0.02), and total cholesterol (PR = 1.008, p-value = 0.047). Thus, it is noted that a 1% increase in processed and ultra-processed food consumption is associated with an increase in the prevalence of abdominal obesity (0.3% by WC and 0.5% by WHR) and a 0.8% increase in total cholesterol (Table 4).

Table 3 - Associations between percentage of energy from unprocessed or minimally processed foods and processed culinary ingredients group and processed and ultra-processed foods group and cardiometabolic risk factors (n=325)

Cardiometabolic risk factors	Unprocessed/minimally processed foods and culinary ingredients		Processed and ultra-processed foods	
	Model 1 PR (p-value)	Model 2 PR (p-value)	Model 1 PR (p-value)	Model 2 PR (p-value)
Excessive body weight	0.998 (0.42)	0.997 (0.23)	1.002 (0.42)	1.002 (0.23)
Excessive body fat	0.999 (0.82)	0.999 (0.98)	1.000 (0.82)	1.000 (0.98)
Abdominal obesity (WHR)	0.996 (0.09)	**0.995 (0.049)**	1.004 (0.09)	**1.005 (0.049)**
Abdominal obesity (WC)	0.998 (0.08)	**0.997 (0.02)**	1.002 (0.08)	**1.003 (0.02)**
Abdominal obesity (WHtR)	0.998 (0.15)	0.997 (0.052)	1.002 (0.15)	1.003 (0.052)
Insulin resistance (TYG)	0.994 (0.35)	0.991 (0.15)	1.006 (0.35)	1.009 (0.15)
Insulin resistance (HOMA-IR)	1.004 (0.56)	1.007 (0.34)	0.996 (0.56)	0.993 (0.34)
Hypertension	1.001 (0.56)	0.999 (0.96)	0.998 (0.56)	1.000 (0.96)
Hyperglycemia	0.998 (0.69)	0.995 (0.20)	1.001 (0.69)	1.005 (0.20)
Low HDL	1.001 (0.68)	0.999 (0.75)	0.999 (0.68)	1.001 (0.75)
Hypercholesterolemia	0.994 (0.13)	**0.992 (0.047)**	1.006 (0.13)	**1.008 (0.047)**
High non-HDL cholesterol	0.996 (0.11)	0.995 (0.09)	1.004 (0.11)	1.005 (0.09)
High LDL	0.998 (0.55)	0.995 (0.28)	1.002 (0.55)	1.004 (0.28)
Hipertriglyceridemia	1.000 (0.88)	0.998 (0.64)	0.999 (0.88)	1.002 (0.64)

PR, prevalence ratio; WHR, waist-to-hip-ratio; WC, waist circumference; WHtR, waist-to-height-ratio

Association evaluated by Poisson regression models, using robust variance.

Model 1: adjusted by sex and age.

Model 2: Model 1 + schooling, marital status, smoking and physical activity.

DISCUSSION

In the present study, individuals who consumed higher proportions of processed and ultra-processed foods had a higher prevalence of abdominal obesity and hypercholesterolemia. Obesity, especially abdominal fat (subcutaneous and intra-abdominal), is one of the main factors associated with cardiovascular risk. However, few studies have evaluated the association between food intake according to degree of processing and abdominal obesity (NASREDDINE et al., 2017; STEELE et al., 2019; TAVARES et al., 2012); most investigations evaluate overall obesity based on BMI (ADAMS; WHITE, 2015; CANELLA et al., 2014; JUUL; HEMMINGSSON, 2015; LOUZADA et al., 2015b; MENDONÇA et al., 2016; MONTEIRO et al., 2017; RAUBER et al., 2015).

It is known that unprocessed and minimally processed foods are inversely associated with glycemic response and positively associated with satiety (HALL et al., 2019), unlike processed and ultra-processed foods (FARDET, 2016). The high glycemic load of the latter, leads to an increase in insulin production and consequent body weight gain (LUDWIG, 2002). In addition, added sugars, mainly fructose, induce lipogenesis leading to an accumulation of fat in the liver and adipose tissue (CHONG;

FIELDING; FRAYN, 2007; PARKS et al., 2018). According to data from several countries, the intake of added and free sugars increases among the quintiles of ultra-processed foods (GIBNEY, 2018).

In turn, high saturated and *trans* fat consumption increases the levels of total and LDL cholesterol (HU et al., 2018; MENSINK et al., 2014), although in several countries small variation in fat intake has been observed between quartiles/quintiles of ultra-processed foods (GIBNEY, 2018). In contrast, higher fat intake in Brazil was associated with higher consumption of ultra-processed foods (GIBNEY, 2018), which reinforces the association found in our study. In addition, an intervention study also found an association between unprocessed food consumption and reduction in total cholesterol, which converges with our findings (HALL et al., 2019).

Considering our results, it is worth making some considerations about UPF consumption in the study population. The consumption of French bread (a low-cost food available to all) (APLEVICZ et al., 2014; FERREIRA et al., 2019) is a traditional food culture of the Brazilian population, it is therefore not surprising that it was the mostly consumed processed food. Similar findings have been reported in other studies conducted in Brazil (LOUZADA et al., 2015a). On the other hand, the most consumed ultra-processed food was sweets which followed the same dietary pattern of the Brazilian population (LOUZADA et al., 2015a). In this context, French bread, sweets and cookies are foods rich in sugar, have high glycemic load, and the latter are rich in fat. The consumption of the mentioned foods may contribute to weight gain, as well as cardiometabolic alterations, such as hypercholesterolemia and greater accumulation of abdominal fat (KRAKOFF et al., 2018).

In general, culinary ingredients are used in the preparation of unprocessed foods, previously stated as nutritionally rich, with low glycemic response and high satiety (FARDET, 2016), which explains the inverse association of both food groups with the cardiometabolic risk factors studied. It is worth noting that the proportion of energy from unprocessed and minimally processed foods was high (54.4%), however, this value was low (25.9%) for ultra-processed foods contrary to other countries where ultra-processed foods were higher in proportion than unprocessed foods (ADAMS; WHITE, 2015; BARALDI et al., 2018; JUUL et al., 2018; NASREDDINE et al., 2017; ROHATGI et al., 2017). The differences observed may also be related to the fact that our study was conducted in a small city with few fast-food chains.

Most studies conducted with the Brazilian population, reported a greater contribution of unprocessed and minimally processed foods and a lower contribution of ultra-processed foods, in agreement with our results (ALVES-SANTOS et al., 2016; LOUZADA et al., 2015a; SILVA et al., 2018). However, more studies especially population-based studies, are necessary to confirm this observation despite greater evidence of the consumption of unprocessed and minimally processed foods than other food groups among the Brazilian population. Unprocessed and minimally processed foods that mainly contributed to calories were rice, beef and beans, major components of the diet of most Brazilians (BARBOSA, 2007), which resulted in their higher participation. Another aspect worth noting is the lower consumption of processed and ultra-processed foods in our study population which may have contributed partly to the absence of association with some of the evaluated cardiometabolic risk factors. Given that the subjects of the study have some form of pathology and undergo medical follow-up, they may be more informed about the role of food in the prevention of diseases and thus, make healthy food choices due to concerns with cardiometabolic health.

An unprecedented observation of this study was the evaluation of the food consumption according to meal of the day. A higher consumption of unprocessed and minimally processed was observed at lunch and dinner, which is expected, although this consumption was lower at dinner compared to lunch. A hypothesis is that the habit of eating real food at dinner has been replaced by the high consumption of breads, cheeses, margarines and cookies, which are not usually eaten at lunch. At breakfast, the high consumption of processed and ultra-processed foods is due to the higher consumption of bread, margarine and Minas Gerais cheese, while during snack time, this trend is related to the high consumption of breads, cookies (cream-cracker and maisena) and cereal bars (data not shown), which are typically present in the breakfast and snack of Brazilians. It is hoped that future studies evaluate which meals of the day account for the frequent consumption of these foods in order to elucidate their relationship with cardiometabolic risk factors, which is also important for the implementation of effective strategies.

The most consumed processed and ultra-processed foods were breads and sweets which may have contributed to their higher consumption among women due to greater craving for carbohydrates (ABDELLA et al., 2019; LLUCH et al., 2000; SANDOVAL-INSAUSTI et al., 2019). The higher consumption of processed and ultra-processed foods among younger individuals compared to older individuals can be related to nutrition transition from traditional dietary patterns to more western patterns over generations (BEZERRA et al., 2013a; DREWNOWSKI; POPKIN, 1997; SCHNABEL et al., 2019; SROUR et al., 2019; STEELE et al., 2019). This finding corroborates with a previous study conducted with the same population of the present study, which identified that older people had a better diet quality based on Healthy Eating Index (HEI)(SILVEIRA et al., 2019). As observed in our samples and other studies (BEZERRA et al., 2015; SCHNABEL et al., 2019), single individuals reported eating out frequently, which may also explain the higher consumption of processed and ultra-processed foods among this population group since these foods are mostly eaten outside the home (BEZERRA et al., 2013b).

Strengths and limitations

The positive points of the study consist of the analysis of all the four food groups under the NOVA classification and their association with cardiometabolic outcomes (MOUBARAC et al., 2014b). Also, the combined use of a R24H, an open-ended food questionnaire and a multi-pass method by trained researchers provided extensive details on foods consumed. To the best of our knowledge, this study is the first to evaluate the distribution of unprocessed and minimally processed foods, culinary ingredients, processed and ultra-processed foods based on meals of the day. Given that no studies have evaluated the food consumption of individuals at risk of cardiovascular disease according to degree of processing, our findings contribute to knowledge on nutrition strategies for this population. As a limitation, the study was conducted based on information collected with a 24-hour dietary recall, despite being considered valid (WILLETT, 1998) and extensively used in epidemiological studies (BARALDI et al., 2018; FIOLET et al., 2018; JUUL et al., 2018). In addition, the consumption of processed and ultra-processed foods may be underestimated since underreporting is common among populations with excess weight (LISSNER; HEITMANN; BENGTSSON, 2000).

CONCLUSION

The consumption of unprocessed and minimally processed foods was inversely associated with abdominal obesity and hypercholesterolemia, while the consumption of processed and ultra-processed foods had a direct association. Our findings indicate that a reduction in the intake of processed and ultra-processed foods even in individuals diagnosed with cardiovascular risk is beneficial. Thus, the profile of target groups and meal composition should be taken into consideration when implementing nutrition education strategies aimed at improving eating habits.

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Conflict of Interest: The authors declared no conflict of interest.

4.2 Índice Inflamatório da Dieta é Associado com Excesso de peso e Padrões Alimentares em Indivíduos com Risco Cardiometabólico (ARTIGO 3)

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DIETARY INFLAMMATORY INDEX IS ASSOCIATED WITH EXCESSIVE BODY WEIGHT AND DIETARY PATTERNS IN SUBJECTS WITH CARDIOMETABOLIC RISK

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Abstract: Unhealthy eating habits can trigger chronic inflammation in organs and tissues, and subsequent cardiovascular risk. Thus, this study aimed to evaluate the potential association of Dietary Inflammatory Index (DII™) score with cardiometabolic risk factors and *a priori* and *a posteriori* dietary patterns in adults and elderly Brazilians (42 ± 16 years) from a health care program. This cross-sectional study was carried out with 248 individuals (138 women and 110 men) from a Cardiovascular Health Care Program of the Universidade Federal de Viçosa (PROCARDIO-UFV, ReBEC ID number: RBR-5n4y2g). Sociodemographic and clinical characteristics, lifestyle and anthropometric data were assessed by standardized protocols. DII scores were calculated froma 24 h-recall, and dietary patterns were determined by *a posteriori* method, as Principal Component Analysis (PAC), and *a priori* method, as Healthy Eating Index (HEI). The mean DII was 0.15 ± 0.84. The subjects included in the most pro-inflammatory category (3rd tertile) were more likely to be individuals with excessive body weight, increased waist-to-hip ratio and lower quality diet assessed by PAC and HEI. The most pro-inflammatory diet was associated with excessive body weight as well as other worse dietary patterns.

Keywords: *Dietary Inflammatory Index (DII™), Healthy Eating Index (HEI), Principal Component Analysis (PCA), dietary patterns, cardiometabolic risk, inflammation*

1. Introduction

Unhealthy eating habits and deleterious lifestyles, such as smoking and sedentariness, may trigger chronic inflammation thereby contributing to increased cardiometabolic risk and development of chronic noncommunicable diseases (CNCD), such as cardiovascular diseases (CVD), diabetes mellitus (DM) and cancer (DENOVA-GUTIERREZ et al., 2018; PETERSEN et al., 2017; SHIVAPPA et al., 2014b, 2017a; SILVEIRA et al., 2018a). According to World Health Organization (WHO) in 2016, CNCD accounted for 41 million deaths, among these 17.9 million (44%) were by CVD, 9 million (22%) by cancer and 1.6 million (4%) by diabetes (WHO, 2018).

In turn, dietary pattern analysis allows the combination of foods consumed by a population and the identification of both protective and harmful dietary factors for the development of CNCD (CALTON et al., 2014; CAVICCHIA et al., 2009; SILVEIRA et al., 2018a). Dietary pattern analysis can be performed *a priori* or *a posteriori*. The first uses indexes, which can evaluate the adequacy of food intake based on guidelines recommendations previously determined, such as Dietary Inflammatory Index (DII™) (KENNEDY et al., 1995; SHIVAPPA et al., 2014a), Healthy Eating Index (HEI) (FISBERG; SLATER; BARROS, 2004) and Dietary Quality Index (DQI) (HOSSEINI; WHITING; VATANPARAST, 2016). The second one is based on statistical analysis of food consumption data to develop new dietary patterns, such as factor analysis and Principal Component Analysis (PCA) (BARBARESKO et al., 2013; SILVEIRA et al., 2018a).

Moreover, a dietary pattern may be anti-inflammatory, as in the case of the Mediterranean diet, or be pro-inflammatory, such as Western diet, and therefore contribute to the prevention or development of CNCD (CLARK et al., 2019; NEALE; BATTERHAM; TAPSELL, 2016; RUIZ-CANELA et al., 2015; SHIVAPPA et al., 2017a; SILVEIRA et al., 2018a; TURNER-MCGRIEVY et al., 2015; WHO, 2018). The DII was developed and validated in 2009 (CAVICCHIA et al., 2009) and updated in 2014 (SHIVAPPA et al., 2014a) to evaluate the inflammatory effect of diet on health and disease. The index is based on extensive literature review and resulted in 45 dietary parameters (macronutrients, micronutrients and bioactive compounds such as teas, flavonoids and spices) based on theirinfluence on the inflammatory markers includinginterleukin (IL)-1β, IL-4, IL-6, IL-10, tumor necrosis factor (TNF)-α and C-reactive protein (CRP) (GARCIA-ARELLANO et al., 2015).

Some studies have identified positive associations between DII scores and overweight or obesity in Poland, Spain, USA and Mexico populations (ALKERWI et al., 2014; GARCIA-ARELLANO et al., 2015; NEUFCOURT et al., 2016; WIRTH et al., 2016a). However, the association of this index in subjects at highcardiometabolic risk withdietary patterns has rarely been reported (GARCIA-ARELLANO et al., 2015; WIRTH et al., 2016a), especially in the Brazilian population (CARVALHO et al., 2019).

Therefore, the hypothesis of this study is that a more pro-inflammatory diet is associated with cardiometabolic risk factors.

This study aimed to evaluate the potential association of Dietary Inflammatory Index (DII™) score with cardiometabolic risk factors and *a priori* and *a posteriori* dietary patterns in adults and elderly Brazilians from a Cardiovascular Health Care Program.

2. Materials and Methods

2.1. Subjects

The Cardiovascular Health Care Program (PROCARDIO-UFV) performs nutritional intervention in the academic community of the Universidade Federal de Viçosa (UFV). The inclusion criteria are: age > 20 years; diagnosis of cardiovascular disease or have cardiometabolic risk factors, as previously described (ALMEIDA et al., 2016; RODRIGUES et al., 2017; SILVEIRA et al., 2019).

The Ethics Committee in Human Research of the Universidade Federal de Viçosa approved the protocol of the present study (Of Ref. No. 066/2012/CEPH). All subjects provided written informed consent, according to the general recommendations of the Declaration of Helsinki. The PROCARDIO-UFV is registered in the Brazilian Registry of Clinical Trials (ReBEC: RBR-5n4y2g).

In this cross-sectional study, we included data from 248 individuals (138 women and 110 men), adults and elderly (42 ± 16 years), participants in the PROCARDIO-UFV from March 2012 until July 2017, who presented complete medical records to study analysis.

2.2. Food consumption, HEI, PCA and DII

The food intake was estimated using a 24-hour recall (24HR) using a 5-step multiple-pass method carried out by a trained dietitian, for better data collection quality (CONWAY et al., 2003). Portion size was estimated using standard food quantities (grams) including food photographs and a standard manual on portions of food and household measures.

Micronutrients (iron, fiber, magnesium, vitamin C, zinc, selenium, vitamin A and vitamin B12), macronutrients, n-6 fatty acids and alcohol were analyzed using DietPRO® software, version 5.8, using Brazilian table of food composition (TACO, 2011).

The dietary patterns were determined by PCA, as previously described (SILVEIRA et al., 2018b). Five patterns were identified as "Traditional", "Caloric", "Unhealthy", "Healthy" and "Healthy Snacks". Scores greater than or equal to zero were considered positive for the dietary patterns. Each pattern was characterized by a group of foods as rice and tubers, beans, vegetable oils, non-leafy vegetables, meats, fish and eggs (grilled, cooked or roasted) for the "Traditional"; meat, offal and eggs (fried), processed meat, sweets and sugar, soft beverages and artificial juices for the "Caloric", "Unhealthy" was represented by fast food and pasta; "Healthy" was composed by whole grain food and nuts, milk, dairy, fruits and natural juices and finally "Healthy Snacks" by leafy vegetables, chicken salad sandwich.

For the Healthy Eating Index (HEI) analysis, the revised index for the Brazilian population was used, and the median (71 points) was considered to classify the diet as adequate (greater than 71 points) and inadequate (lower than 71 points) (PREVIDELLI et al., 2011).

The design and development of DII has been described previously (CAVICCHIA et al., 2009; SHIVAPPA et al., 2014a). Briefly, the DII was calculated using a scoring algorithm based on a review of 1,943 articles that showed the association of 45 food parameters with six inflammatory biomarkers (IL-1b, IL-4, IL-6, IL-10, TNF-α and CRP). Food parameters evaluated in the articles were positively marked (+1) if the effect was considered pro-inflammatory, negatively (-1) in the case of an anti-inflammatory effect, or zero, if the parameters did not produce a significant change in the biomarkers. The 24HR-derived food and nutrient consumption was first adjusted for total energy (i.e., per 1000 kilocalories) and then standardized to a globally representative energy-adjusted dietary database, which was constructed based on dietary intake from 11 populations living in different regions of the world. From this, the energy-adjusted standardized dietary intake (expressed as z-scores of the referent database and then as centered proportions) was then multiplied by the literature-derived inflammatory effect score for each DII component. Individual scores were then summed to determine the overall

DII (DII™) score for everyone, with positive scores, representing a more pro-inflammatory diet, and negative values, representing more anti-inflammatory diets (SHIVAPPA et al., 2014a).

The DII score in this study was based in the following 19 food parameters, obtained using the 24HR: n-6 fatty acids, iron, fiber, magnesium, zinc, selenium, vitamin C, vitamin A, vitamin B12, carbohydrates, proteins, lipids, cholesterol, *trans*, saturated, mono and polyunsaturated fats, energy (kcal) and alcohol. In the present study, the DII was categorized into tertiles, whereas first (< -0.22), second (≥ -0.22 and <0.45), and third (≥ 0.45) tertiles were the most anti-inflammatory, neutral and the most pro-inflammatory tertile, respectively.

2.3. Cardiometabolic risk factors assessment

Weight, height and waist circumference (WC) were measured according to the protocol standardized by PROCARDIO-UFV previously described (SILVA et al., 2015). The body mass index (BMI) was calculated and classified as excessive body weight to BMI ≥ 25.0 kg/m² for adults (WHO, 1998) and BMI ≥ 28.0 kg/m² for elderly (OPAS, 2002). Abdominal obesity was considered as WC ≥ 90 for men and ≥ 80 cm for women (DE OLIVEIRA et al., 2014). Waist-to-height ratio (WHtR) > 0.5 and waist-to-hip ratio (WHR) > 1.0 for men and > 0.85 for women were considered a cardiometabolic risk (WHO, 2000). Percentage of body fat (%BF) was estimated by horizontal tetrapolar electric bioimpedance (Biodynamics® 310 model, Washington, USA), according to the protocol proposed (LUKASKI et al., 1986), and values > 20% for men and > 30% for women were considered as excessive body fat (BRAY G, BOUCHARD C, 1998).

The blood was collected after a 12-hour fasting. Serum concentrations of glucose, HDL and LDL cholesterol, total cholesterol (TC), triglycerides (TG), ferritin and uric acid were analyzed by the enzymatic colorimetric method. The ultrasensitive immunoturbidimetry method assessed serum concentration of ultrasensitive C-reactive protein (CRP). Triglyceride-glucose (TyG) index was calculated according to the formula: Ln [fasting triglycerides (mg/dL) x fasting plasma glucose (mg/dL)/2] and Homeostasis model assessment of insulin resistance (HOMA-IR) by the formula: [(fasting glucose (mg/dL)) x (fasting insulin (µU/mL))] / 405 (HANAK et al., 2004; SBC, 2010, 2013b; SIMENTAL-MENDÍA; RODRÍGUEZ-MORÁN; GUERRERO-ROMERO, 2008).

Cholesterol, triglycerides and LDL were considered elevated if values ≥240 mg/dL, ≥150 mg/dL and ≥160 mg/dL, respectively, as well as cut-off points for HDL <40 mg / dL for men and <50 mg / dL for women (SBC, 2013b, 2013a). Besides that, uric acid was considered elevated if ≥ 6 mg/dL (SBC, 2013a).

CRP was categorized as recommended by the US Centers for Disease Control and Prevention (CDC) and the American Heart Association, with values ≤ 3.0 mg/dL being considered adequate and those >10 mg/dL (presented by four individuals) excluded, since they may indicate acute inflammation (PEARSON et al., 2003). For analysis of the ferritin and the TyG index, the 75th percentile of the sample was used as the cut-off point, being greater than or equal to 207 and 5.01, respectively. For HOMA-IR and fasting glucose, high values were considered above 2.71 and ≥ 100 mg/dL, respectively (SBD, 2018).

Blood pressure was measured using a mechanical mercury sphygmomanometer (Missouri®, São Paulo, Brazil) with approximately 02 mmHg considering high blood pressure values ≥ 140/90 mmHg (SBC, 2016). Moreover, the participants were the ones to report medical diagnosis of diabetes, hypertension and dyslipidemias and the use of medications.

2.4. Other characteristics of sample

The information about age (years), income (did not report; up to 2 minimum wages; 2 to 4 minimum wages; 4 to 10 minimum wages and more than 10 minimum wages), smoking (never smoked or smoked), physical activity and diagnosed diseases as well as information about medicine use (statins, antihypertensive and oral hypoglycemic) was obtained by semi-structured questionnaire elaborated specially for the PROCARDIO-UFV study.

2.5. Statistical Analysis

Descriptive analysis was performed for the main variables of interest. The distribution of the variables was verified by means of boxplot graphs, histogram, kurtosis and skewness values. The analysis of variance (ANOVA) was used to compare averages between DII tertiles, followed by Tukey and Bonferroni *post hoc* tests. The Pearson's chi-squared test was used to evaluate the distribution of the qualitative variables among the DII tertiles. Poisson regression models were performed to analyze the association of DII (independent variable) with cardiometabolic risk factors and dietary patterns (dependent variables), using the second tertile (neutral inflammation) as reference. Multiple Poisson regression models were adjusted for age, sex, income, smoking, physical activity and statin, antihypertensive and oral hypoglycemic use. The Hosmer & Lemeshow test was used to verify the fit of the final model. The prevalence ratio (PR) with 95% confidence interval (95% CI) was used as an effect measure. All statistical analysis were performed using SPSS software version 22.0 and Stata version 13.0, considering a significance level of 5%.

3. Results

The mean age of the participants was 42 years, ranging from 20 to 80 years, 55.6% were female and 69.8% had excessive body weight. The mean DII was 0.15 ± 0.84. Those subjects with most pro-inflammatory diet (third tertile) were more likely to be women, nonsmokers, and non-diabetics. They also had lower mean age and WHR, compared to the most anti-inflammatory diet (first tertile) (Table 1).

Table 1 - Sociodemographic, clinical and lifestyle characteristics of sample (n=248), according to the tertiles of the Dietary Inflammatory Index

	Dietary Inflammatory Index		
Variables	**T1**	**T2**	**T3**
Age (years)¤	**49 ± 15**[a]	**40 ±16**[b]	**38 ±15**[b]
Sex¤			
Male	**48 (43.6%)**[a]	**30 (27.3%)**[b]	**32 (29.1%)**[b]
Female	**34 (24.6%)**[a]	**53 (38.4%)**[b]	**51 (37%)**[b]
Lifestyle			
Never smoked¤	**44 (26.4%)**[a]	**61 (36.5%)**[b]	**62 (37.1%)**[b]
Physical activity practice	42 (30.7%)	50 (36.5%)	45 (32.8%)
Diagnosed diseases			
Diabetics†	**19 (45.2%)**[a]	**16 (38.1%)**[a]	**7 (16.7%)**[b]
Hypertensive	36 (37.9%)	32 (33.7%)	27 (28.4%)
Use of medicines			
Oral antidiabetic†	**17 (7%)**[a]	**10 (4.1%)**[a]	**5 (2.1%)**[b]
Insulin	2 (0.8%)	4 (1.6%)	0
Antihypertensive†	**41 (16.8%)**[a]	**31 (12.7%)**[a]	**24 (9.8%)**[b]
Cholesterol reducers†	**33 (13.6%)**[a]	**24 (9.9%)**[ab]	**18 (7.4%)**[b]
Fibrates	8 (3.3%)	4 (1.6%)	4 (1.6%)
Weight control	0	2 (0.8%)	1 (0.4%)
Anthropometric			
BMI	28.6 ± 5.1	28.4 ± 6.1	29.1 ± 5.0
WHtR	0.6 ± 0.1	0.6 ± 0.1	0.6 ± 0.1
WHR¤	**1.0 ± 0.1**[a]	**0.9 ± 0.1**[b]	**0.9 ±0.1**[b]
% BF	30.4 ± 7.3	30.4 ± 9.5	30.9 ± 7.2
Biochemical			
Triglycerides	177.0 ± 98.6	177.9 ± 125.1	162.1 ± 82.4
TyG	4.8 ± 0.3	4.8 ± 0.3	4.7 ± 0.3
Fasting glucose	107.26 ± 38.36	100.32 ± 31.02	93.97 ± 31
HOMA-IR	2.5 ± 1.7	3.0 ± 2.9	2.4 ± 1.3
Ferritin	169.9 ± 126.9	122.0 ± 141.6	146.7 ± 200.1
CRP	2.4 ± 2.9	2.1 ± 2.0	2.5 ± 2.5
Uric acid	4.8 ± 1.5	4.3 ± 1.5	4.4 ± 1.5
TC	197.5 ± 47.8	207.0 ± 40.4	212.6 ± 41.9
HDL	44.2 ± 11.2	47.9 ± 13.9	50.1 ± 16.1
LDL	118.3 ± 44.1	126.5 ± 35.1	129.2 ± 36.6
Non-HDL	158.6 ± 39.2	153.3 ± 46.8	162.3 ± 39.2

DII Tertiles Ranges: T1: < - 0.22; T2: ≥ - 0.22 and < 0.45; T3: ≥ 0.45.†P < 0.05; ¤P < 0.01. BMI is in kg/m²; ferritin is in µg/L; CRP is in mg/L; triglycerides, fasting glucose, uric acid, TC (total cholesterol), HDL, LDL and non-HDL (non-HDL cholesterol) are in mg/dL WHtR: waist-to-height ratio; WHR: waist-to-hip ratio; %BF: body fat percentage; TyG: triglyceride-glucose index; HOMA-IR: homeostasis model assessment of insulin resistance; CRP: C-reactive protein. Quantitative variables expressed as mean ± standard deviation and categorical variables in absolute and relative values. Values are determined using chi-square test (post hoc adjusted by Bonferroni) for qualitative variables or ANOVA (post hoc Tukey) for continuous variables in which different letters indicate statistical difference between tertiles.

Regarding diet composition, subjects included in the third tertile of DII had higher mean values of energy, lipid, cholesterol, monounsaturated fat and saturated fat, while those included in the first tertile had higher intakes of carbohydrates, omega 6, iron, fiber, magnesium, vitamin C, zinc and polyunsaturated fatty acids (Table 2).

Table 2 - Energy and nutrient intake according to the tertiles of the Dietary Inflammatory Index

	Dietary Inflammatory Index		
Variables	**T1**	**T2**	**T3**
Energy¤	**1652.7±538.4[a]**	**1564.8±500.0[a]**	**1953.8±614.0[b]**
Carbohydrate¤	**245.2±44.4[a]**	**231.77±39.6[a]**	**208.9±47.3[b]**
Protein	81.7±20.2	77.8±21.1	76. 6±26.6
Lipid¤	**76.7±14.9[a]**	**83.9±13.3[b]**	**93.7±17.1[c]**
Cholesterol¤	**182.9±121.7[a]**	**212.7±144.8[ab]**	**244.6±219.7[b]**
Saturated fat¤	**24.7±6.0[a]**	**29.2±5.7[b]**	**34.8±9.6[c]**
Trans fat	1.4±1.00	1.8±1.4	2.8±7.8
MUFA¤	**26.5±18.0[a]**	**28.8±5.5[a]**	**32.0±7.3[b]**
PUFA¤	**17.4±4.3[a]**	**16.5±4.8[ab]**	**14.8±5.8[b]**
Omega 6†	**12.0±3.8[a]**	**11.2±3.9[ab]**	**9.7±4.9[b]**
Iron¤	**11.1±3.7[a]**	**9.7±3.0[b]**	**8.3±3.1[c]**
Fiber¤	**37.7±15.8[a]**	**28.5±7.7[b]**	**16.6±6.3[c]**
Magnesium¤	**258.2±83.8[a]**	**207.4±5.7[b]**	**150.5±4.9[c]**
Vitamin C¤	**241.5±19.2[a]**	**95.7±11.4[b]**	**56.1±9.0[b]**
Zinc†	**11.5±4.5[a]**	**11.0±6.0[ab]**	**9.5±5.3[b]**
Selenium	99.6±36.0	98.0±33.7	92.3±31.7
Vitamin A	260.8±1034.9	404.3±1122.1	268.1±201.1
Vitamin B12	4.3±7.9	4.8±8.3	3.9±2.8
Alcohol % v/v	0.9±5.3	0.5±4.2	0.7±3.9

DII Tertiles Ranges: T1: < - 0.22; T2: ≥ - 0.22 and < 0.45; T3: ≥ 0.45. †P < 0.05; ¤P < 0.01. MUFA: monounsaturated fatty acid; PUFA: polyunsaturated fatty acid. Energy is in kcal; Carbohydrate is in g; Protein is in g; Lipid is in g; Cholesterol is in g; Saturated fat is in g; *Trans* fat is in g; MUFA is in g; PUFA is in g; Omega 6 is in g; Iron is in mg; Fiber is in g; Magnesium is in mg; Vitamin C is in mg; Zinc is in mg; Selenium is in mg; Vitamin A is in mg; Vitamin B12 is in mg; Alcohol is in %v/v. Variables expressed as mean ± standard deviation. Values are determined using ANOVA test (post hoc Tukey) in which different letters indicate statistical difference between tertiles.

Interestingly, highest DII tertile (most pro-inflammatory diet) was associated with excessive body weight (PR: 1.29; 95%CI: 1.06 - 1.58) and increased WHR (PR: 1.29; 95%CI: 1.02-1.64) even after all adjustments. However, there was an association between DII and higher WHtR when adjusted only by sex and age (PR: 1.16; 95%CI: 1.01-1.33) (Table 3).

Table 3 - Prevalence ratio for cardiometabolic risk factors according to the tertiles of the Dietary Inflammatory Index

Outcome variables		Model 1 PR (95% CI)	Model 2 PR (95% CI)	Model 3 PR (95% CI)
Excessive body weight	T1	1.00(0.80-1.26)	0.97(0.77-1.23)	1.00(0.79-1.26)
	T2	1	1	1
	T3	**1.28(1.05-1.56)†**	**1.25(1.02-1.52)†**	**1.29(1.06-1.58)†**
WHtR	T1	0.98(0.86-1.12)	0.98(0.86-1.13)	0.99(0.86-1.14)
	T2	1	1	1
	T3	**1.16(1.01-1.33)†**	1.14(0.99-1.31)	1.14(0.99-1.32)
WHR	T1	1.01(0.79-1.27)	0.95(0.74-1.23)	0.97(0.75-1.26)
	T2	1	1	1
	T3	**1.33(1.06-1.67)†**	**1.27(1.01-1.60)†**	**1.29(1.02-1.64)†**
Excessive body fat	T1	1.16(0.95-1.43)	1.08(0.87-1.33)	1.09(0.88-1.34)
	T2	1	1	1
	T3	1.23(1.00-1.51)	1.12(0.91-1.38)	1.14(1.93-1.40)
Fasting glucose	T1	0.80(0.52-1.23)	0.69(0.44-1.06)	0.66(0.42-1.04)
	T2	1	1	1
	T3	0.74(0.46-1.21)	0.65(0.39-1.09)	0.72(0.44-1.17)
TyG	T1	0.77(0.48-1.24)	0.69(0.42-1.12)	0.67(0.40-1.11)
	T2	1	1	1
	T3	0.57(0.32-1.00)	0.57(0.32-1.01)	0.56(0.32-1.00)
HOMA-IR	T1	1.05(0.60-1.84)	0.93(0.54-1.60)	0.99(0.57-1.72)
	T2	1	1	1
	T3	0.97(0.54-1.73)	0.78(0.44-1.40)	0.92(0.51-1.69)
TC	T1	1.06(0.58-1.94)	0.95(0.51-1.77)	0.90(0.50-1.63)
	T2	1	1	1
	T3	1.26(0.73-2.16)	1.16(0.67-2.01)	1.10(0.63-1.93)
HDL-C	T1	0.96(0.77-1.20)	0.95(0.75-1.20)	0.95(0.75-1.20)
	T2	1	1	1
	T3	0.96(0.76-1.22)	0.97(0.77-1.24)	1.02(0.81-1.30)
LDL-C	T1	1.68(0.87-3.25)	1.51(0.77-2.95)	1.42(0.74-2.71)
	T2	1	1	1
	T3	1.16(0.60-2.27)	1.13(0.58-2.20)	1.04(0.53-2.05)
Non-HDL cholesterol	T1	0.91(0.63-1.31)	0.87(0.60-1.28)	0.84(0.58-1.20)
	T2	1	1	1
	T3	1.14(0.83-1.56)	1.13(0.82-1.56)	1.03(0.75-1.40)
TG	T1	0.97(0.69-1.34)	0.92(0.67-1.27)	0.92(0.67-1.26)
	T2	1	1	1
	T3	0.91(0.66-1.25)	0.88(0.64-1.21)	0.88(0.64-1.20)
SBP/DBP	T1	0.85(0.60-1.22)	0.87(0.60-1.25)	0.87(0.60-1.26)
	T2	1	1	1
	T3	0.85(0.58-1.24)	0.82(0.55-1.22)	0.83(0.55-1.25)
CRP	T1	0.99(0.53-1.83)	0.72(0.37-1.40)	0.76(0.41-1.42)
	T2	1	1	1
	T3	0.93(0.45-1.92)	0.73(0.34-1.58)	0.71(0.33-1.51)

Ferritin	T1	1.13(0.60-2.13)	1.20(0.59-2.44)	1.34(0.58-3.13)
	T2	1	1	1
	T3	0.95 (0.46-1.95)	0.72 (0.33-1.57)	0.80(0.35-1.85)
Uric acid	T1	1.01(0.36-2.87)	1.33(0.38-4.69)	1.53(0.49-4.76)
	T2	1	1	1
	T3	0.49(0.13-1.76)	0.78(0.18-3.31)	0.76(0.20-2.94)

DII Tertiles Ranges: 1: < - 0.22; 2: ≥ - 0.22 and < 0.45; 3: ≥ 0.45. †P<0.05. Excessive body weight (BMI ≥ 25 kg/m² for adults; ≥ 28 kg/m² for elderly); WHtR > 0.5; WHR (> 1 for men; > 0.85 for women):; Excessive body fat (%BF> 20% for men; > 30% for women); Fasting glucose ≥ 100 mg/dL; TyG ≥ 5.01; HOMA-IR ≥ 2.71; TC ≥ 240 mg/dL; HDL-C (<40 mg/dL for men; <50 mg/dL for women); LDL-C ≥ 160 mg/dL; Non-HDL cholesterol ≥ 160 mg/Dl; TG ≥ 150 mg/dL; SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg; CRP > 3 mg/dL; Ferritin > 207 (µg/L); Uric acid ≥ 6 mg/dL. DII: dietary inflammatory index; PR: prevalence ratio; 95% CI: 95% confidence interval; WHtR: waist-to-height ratio; WHR: waist-to-hip ratio; %BF: body fat percentage; TyG: triglyceride-glucose index; HOMA-IR: homeostasis model assessment of insulin resistance; TC: total cholesterol; HDL-C: high density lipoprotein; LDL-C: low density lipoprotein; TG: triglyceride; SBP: systolic blood pressure; DBP: diastolic blood pressure; CRP: C-reactive protein. Model 1: adjusted for age and sex. Model 2: Model 1 + income + smoking + physical activity. Model 3: Model 2 + statin use + antihypertensive use + oral hypoglycemic use.

In addition, the lowest tertile of DII (the most anti-inflammatory diet) was inversely associated with inadequate diet (HEI below 71 points) (PR: 0.57; 95%CI: 0.38-0.88), while the highest tertile (the most pro-inflammatory) was directly associated with inadequate diet (PR: 1.52; 95%CI: 1.15-2.01). From the five dietary patterns obtained by the PCA method, DII was associated with three. After all adjustments, the lowest DII tertile was associated with "Healthy" (PR: 3.71; 95%CI: 1.54-8.90) and "Healthy snacks" (PR: 3.05; 95%CI: 1.12-8.32), while the highest DII tertile was associated with more "Unhealthy" diets, (PR: 2.94; 95%CI: 1.03-8.35) (Table 4).

Table 4 - Prevalence ratio for Healthy Eating Index and dietary patterns according to the tertiles of the Dietary Inflammatory Index

Outcome variables		Model 1 PR (95% CI)	Model 2 PR (95% CI)	Model 3 PR (95% CI)
HEI < 71	T1	**0.57(0.38-0.87)¤**	**0.60(0.39-0.92)†**	**0.57(0.38-0.88)¤**
	T2	1	1	1
	T3	**1.49(1.16-1.92)¤**	**1.56(1.19-2.06)¤**	**1.52(1.15-2.01)¤**
DP Traditional	T1	1.53(0.74-3.19)	1.55(0.72-3.36)	1.62(0.75-3.49)
	T2	1	1	1
	T3	0.73(0.27-1.98)	0.72(0.24-2.17)	0.73(0.24-2.24)
DP Caloric	T1	0.55(0.20-1.49)	0.67 (0.23-1.95)	0.56 (0.20-1.59)
	T2	1	1	1
	T3	0.97(0.45-2.12)	1.01(0.42-2.40)	0.89(0.37-2.15)
DP Unhealthy	T1	1.49(0.54-4.15)	2.23(0.67-7.40)	2.37(0.73-7.65)
	T2	1	1	1
	T3	1.88(0.79-4.45)	2.89(1.00-8.38)	**2.94(1.03-8.35)†**
DP Healthy	T1	**3.00(1.36-6.59)¤**	**3.70(1.54-8.89)¤**	**3.71(1.54-8.90)¤**
	T2	1	1	1
	T3	1.26(0.49-3.24)	1.43(0.49-4.20)	1.32(0.46-3.83)
DP Healthy snacks	T1	**3.32(1.18-9.36)†**	**3.11(1.12-8.62)†**	**3.05(1.12-8.32)†**
	T2	1	1	1
	T3	0.61(0.15-2.48)	0.38(0.08-1.89)	0.40(0.08-2.01)

DII Tertiles Ranges: 1: < - 0.22; 2: ≥ - 0.22 and < 0.45; 3: ≥ 0.45. †P < 0.05; ¤P < 0.01. DII: dietary inflammatory index; PR: prevalence ratio; 95% CI: 95% confidence interval; HEI: Healthy Eating Index; DP: dietary pattern. Model 1: age + sex. Model 2: Model 1 + income + smoking + physical activity. Model 3: Model 2 + statin use + antihypertensive use + oral hypoglycaemic use.

4. Discussion

The present study demonstrated that the most pro-inflammatory DII scores were associated with excess adiposity in adults and elderly individuals with cardiometabolic risk factors. We emphasize that this is one of the first studies that investigated the DII with cardiovascular risk factors and dietary patterns of the Brazilian population. Previous study carried out with multiple sclerosis patients in Brazil verified that the DII score was directly correlated with BMI in those patients in the progressive stage of the disease (r = 0.556, p = 0.025) (DA COSTA SILVA et al., 2018), though the other study carried out in Brazil did not find an association between DII with insulin resistance and metabolic syndrome (CARVALHO et al., 2019).

Our findings are corroborated by other studies in Spain and the USA (RUIZ-CANELA et al., 2015; SHIN et al., 2017; SHIVAPPA et al., 2017b). Altogether, results suggest diet-induced inflammation may contribute to increasing or maintaining excessive body weight. The relationship between inflammation and adiposity excess may be bidirectional - overweight may induce inflammation, whereas a pro-inflammatory diet may lead to increasing or maintaining excess adiposity (JIN; FLAVELL, 2013). One possible mechanism that explains this relationship is the activation of molecular processes associated with Toll-like receptors and Nod-type receptors, which in turn induce the activation of inflammatory markers in adipose tissue (SALAS-SALVADÓ et al., 2006). Furthermore, a meta-analysis has identified significant association between pro-inflammatory diet and risk for CVD events and mortality (SHIVAPPA et al., 2018).

Although this study found no association between DII with other cardiometabolic risk factors as we expected, other studies also did not observe such an association (ALKERWI et al., 2014; ALMEIDA-DE-SOUZA et al., 2018; M S EID et al., 2018; SOKOL et al., 2016; WIRTH et al., 2015a). Noteworthy, the mean of the DII (0.15) of our sample did not characterize a pro-inflammatory diet in general, but in the ORISCAV-LUX study conducted with 1352 people they also did not present a pro-inflammatory diet in general (ALKERWI et al., 2014). Our results are different from thoseobserved in other studies in which the DII was much higher. Cross-sectional analysis from Polish-Norwegian Study (PONS) and National Health and Nutrition Examination Survey (NHANES) presented a DII mean of 0.93 ± 1.44 (JIN; FLAVELL, 2013) and 0.87 ± 1.08 (WIRTH et al., 2015b), respectively. In a case control study with women that aborted, the DII was 1.51± 0.63 in cases and 1.22± 0.63 in controls (VAHID et al., 2017). Based on that, this may have contributed to the lack of association with some anthropometric and biochemical markers related to cardiometabolic risk in our study.

In addition, higher percentage of diabetics, smokers or ex-smokers, i.e., individuals who are at elevated risk for the development of CVD were in the first tertile of the DII (more anti-inflammatory diet). These individuals may have received medical and nutritional guidance at some point, and had become more concerned about their health, and therefore began consuming a healthier diet. This previous guidance in life-course of subjects with cardiometabolic risk may have contributed to the lack of association with other cardiometabolic markers. The same was observed in other studies in which people with metabolic syndrome, particularly with abdominal obesity and high blood pressure, had a diet with an anti-inflammatory profile (ALKERWI et al., 2014).

We also presented a positive association between most anti-inflammatory diet and healthier dietary patterns, such as "Healthy" and "Healthy snacks" from PCA (a posteriori method), as well as positive association between most pro-inflammatory diet and inadequate diet (a priori method) and “Unhealthy” pattern (a posteriori method). We highlight that this is one of the few studies that evaluated the association between DII and dietary patterns. The dietary pattern may present anti-inflammatory characteristics, as in the case of the Mediterranean diet, or pro-inflammatory, such as Western diet, contributing to the prevention or development of CNCD (BARBARESKO et al., 2013; DENOVA-GUTIERREZ et al., 2018; SHIVAPPA et al., 2017a; SILVEIRA et al., 2018a). This difference is due to the nutritional composition of these food patterns, the first one characterized by the high content of anti-inflammatory nutrients and antioxidants, and the second by excessive consumption of foods of animal origin, sources of saturated fat and cholesterol, responsible for changes in the lipid profile (KAHLEOVA; LEVIN; BARNARD, 2018). The pro-inflammatory diet activates the immune system (with secretion of pro-inflammatory cytokines) and increases the expression of adhesion molecules, with consequent inflammatory process in vascular tissue (CAMARGO-RAMOS et al., 2017; GARCIA-ARELLANO et al., 2015; SHIVAPPA et al., 2018). On the other hand, studies have shown that the Vegetarian and Mediterranean diets reduce inflammatory markers such as CRP and IL-6 and improve endothelial function (BARBARESKO et al., 2013; PETERSEN et al., 2017; SCHWINGSHACKL; HOFFMANN, 2014).

This is the first study to associate DII with anthropometric and biochemical variables, and dietary patterns in Brazilians with cardiovascular risk. An additional strength is the use of Energy-Adjusted Dietary Inflammatory Index to evaluate these associations, which eliminates any influence of energy intake. Therefore, we suggest that other studies should be performed with different age groups and with longitudinal design. As limitations, we used a 24-hour recall, which does not reflect a habitual intake. However, this method has been used thoroughly with success in other epidemiologic studies (ANDRADE et al., 2018; FILGUEIRAS et al., 2018), including DII analyses (CAMARGO-RAMOS et al., 2017; NA; KIM; SOHN, 2018; SHIN et al., 2017; SHIVAPPA et al., 2017a, 2017b; WIRTH et al., 2015b, 2016b). Although we were able to compute the DII from only 19 of the 45 potential items of food and nutrients that could be used to calculate this index, other published studies also derive DII scores from a sub-optimal number of items, and the ability to still detect significant associations suggests that this has only caused to a potential underestimated of the associations (CAMARGO-RAMOS et al., 2017; RAMALLAL et al., 2015; SHIVAPPA et al., 2017a, 2017c; SOKOL et al., 2016).

5. Conclusions

In this population of Brazilian middle-aged and elderly adults, the most pro-inflammatory diet was observed in individuals with excessive body weight and in those with a worse dietary pattern, diagnosed both by *a priori* and *a posteriori* method. These results contribute to a better understanding of the role of diet on inflammatory processes related to excess adiposity in a population with cardiovascular risk, a common situation among Brazilians. More studies with longitudinal design are required to discern the association between diet associated inflammation and cardio-metabolic risk factors in other south American populations of high-risk adults.

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Statement of Competing Interests

The authors declared no conflict of interest. However, we do wish to disclose that Dr. James R. Hébert owns controlling interest in Connecting Health Innovations LLC (CHI), a company planning to license the right to his invention of the dietary inflammatory index (DII) from the University of South Carolina in order to develop computer and smart phone applications for patient counseling and dietary intervention in clinical settings. Dr. Nitin Shivappa is an employee of CHI.

5 CONCLUSÃO GERAL

Diante dos nossos resultados, concluímos que:

O maior consumo de alimentos processados e ultraprocessados se associou com maior prevalência de obesidade abdominal pela RCQ e PC e colesterol total elevado, sendo estes mais consumidos por mulheres, adultos jovens, não fumantes, de maior escolaridade e que vivem sozinhos na nossa amostra já diagnosticada com risco cardiometabólico.

Quando avaliado o consumo por refeições, notou-se maior consumo de alimentos *in natura* e minimamente processados no almoço e jantar e de alimentos ultraprocessados no desjejum e lanche da tarde.

Uma dieta pró-inflamatória se associou com maior prevalência de excesso de peso e obesidade abdominal aferida pela RCQ e a uma dieta de pior qualidade caracterizada por uma dieta ocidental, sendo mais consumida por mulheres, indivíduos mais jovens e não fumantes.

Uma dieta anti-inflamatória foi associada a padrões alimentares saudáveis, além de ter sido mais consumida por homens, fumantes ou ex-fumantes e entre os mais velhos.

Em conjunto, nossos resultados indicam a necessidade de estratégias de educação alimentar e nutricional para modificação dos hábitos alimentares e redução desse risco, com ênfase no grau de processamento e potencial inflamatório da dieta e tipos de refeições.

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APÊNDICE A - Termo de Consentimento Livre e Esclarecido

UNIVERSIDADE FEDERAL DE VIÇOSA
CENTRO DE CIÊNCIAS BIOLÓGICAS
DEPARTAMENTO DE NUTRIÇÃO E SAÚDE

TERMO DE CONSENTIMENTO LIVRE ESCLARECIDO (Em duplicata)

Convidamos você a participar, voluntariamente, do estudo titulado "Aplicação de diferentes estratégias de terapia nutricional no Programa de Atenção à Saúde Cardiovascular – PROCARDIO-UFV", cujo objetivo é estudar qual estratégia de tratamento nutricional tem maior efeito na adesão e na melhora clínica do paciente participante do PROCARDIO.

Para participar do estudo, você deverá permitir o uso de seus dados do protocolo de atendimento PROCARDIO, a saber, medições de peso, altura e perímetros da cintura e quadril; medições da pressão arterial, dados bioquímicos resultantes de análises de sangue, urina ou fezes; dados sobre seus hábitos de vida e hábitos alimentares; para futura sistematização e análises desses dados. Caso seja oferecida a você a participação em atividades como consultas telefônicas curtas (5-10 minutos) ou oficinas e grupos de discussão, você terá o direito de decidir se quer participar ou não de ditas atividades. Além disso, você não terá nenhum gasto por sua participação nesse estudo.

A decisão de participar desse estudo é completamente voluntária. Você poderá se recusar a participar ou sair do estudo a qualquer momento depois de dar o seu consentimento, e esta atitude não lhe trará prejuízos no futuro. Em qualquer momento, você poderá fazer perguntas sobre o estudo ou esclarecer dúvidas. Você poderá entrar em contato com Profa. Dra. Helen Hermana Miranda Hermsdorff ou a nutricionista Hatanne Carla Fialho e Moraes para esta finalidade através dos telefones 31-3899-1269 e 31-38991401, respectivamente.

Os resultados de todas as análises baseadas em dados do protocolo PROCARDIO serão apresentados, comunicados e/ou publicados, sempre preservando sua confidencialidade e privacidade. Para isso, cada paciente é identificado a partir de um código e, não por seu nome. Ao assinar este documento, confirmo que me foi explicado o objetivo deste estudo, os procedimentos a que serei submetido, os riscos e os benefícios potenciais que eu possa experimentar, e os possíveis destinos dos resultados que serão obtidos neste estudo. As perguntas que foram feitas foram satisfatoriamente respondidas, li e compreendi este termo de consentimento, ficando em meu poder uma cópia do mesmo. Portanto, assino e dou meu consentimento para participar deste estudo.

Viçosa, _____ de ______________ de_______.

Voluntário: _________________________ Pesquisador: _____________________

RG: _______________________________ RG:____________________________

____

Profª. Dra. Helen Hermana M. Hermsdorff

Coordenadora

ANEXO A – Parecer do Comitê de ética

MINISTÉRIO DA EDUCAÇÃO
UNIVERSIDADE FEDERAL DE VIÇOSA
COMITÊ DE ÉTICA EM PESQUISA COM SERES HUMANOS-CEPH

Campus Universitário – Divisão de Saúde -Viçosa, MG - 36570-000 - Telefone: (31) 3899-3783

Of. Ref. Nº 066/2012/CEPH

Viçosa, 27 de junho de 2012

Prezada Professora:

Cientificamos Vossa Senhoria de que o Comitê de Ética em Pesquisa com Seres Humanos, em sua 3ª Reunião de 2012, realizada nesta data, analisou e aprovou, sob o aspecto ético, o projeto intitulado "*Aplicação de diferentes estratégias de terapia nutricional no programa de atenção à saúde cardiovascular PROCARDIO-UFV*".

Atenciosamente,

Professora Patrícia Aurélia Del Nero
Comitê de Ética em Pesquisa com Seres Humanos-CEPH
Presidente

À Professora
Helen Hermana Miranda Hermsdorff
Departamento de Nutrição e Saúde - DNS

ANEXO B - Recordatório 24 horas

RECORDATÓRIO 24 HORAS

Data:____/____/____

	ALIMENTOS	**MEDIDAS CASEIRAS**
Desjejum Hora: Local:		
Colação Hora: Local:		
Almoço Hora: Local:		
Lanche Hora: Local:		
Jantar Hora: Local:		
Ceia Hora: Local:		

ANEXO C – Prontuário de atendimento (PROCARDIO-UFV)

UNIVERSIDADE FEDERAL DE VIÇOSA
DIVISÃO DE SAÚDE / DEPARTAMENTO DE NUTRIÇÃO E SAÚDE e DEPARTAMENTO DE MEDICINA E ENFERMAGEM

PROCARDIO

Responsável Nutrição: ________________ **Responsável Enfermagem: _________**

DATA:_____/_____/_____ **Nº inscrição Paciente: ______**

1. IDENTIFICAÇÃO DO PACIENTE
Nome Completo: ____ Endereço (rua, bairro, nº): ____________________________________ ____ Telefone:____________________Celular:______________________ Email:____
Data de nascimento:____/___/_____ Idade:__ Sexo: 1○ M 2○ F
Estado Civil: 1○ Solteiro/a 2○ Casado/a 3○ União estável 4○ Viúvo/a 5○ Separado ou divorciado/a 6○ Outros____
Cor/raça: 1○Branco 2○Negro 3○Amarelo 4○Indígena 5○Parda
Renda familiar: 1○ Não Informou 2○ Até 2 Salários 3○ De 2 a 4 Salários 4○ De 4 a 10 Salários 5○ Mais de 10 salários
Quantas pessoas vivem com você? (**NÃO inclui o paciente**)__________pessoas Mora em República? 1○Não 2○Sim
Escolaridade: 1○ Analfabeto 2○ Fundamental Completo 3○ Fundamental Incompleto 4○ Ensino Médio Completo 5○ Ensino Médio Incompleto 6○ Superior Completo 7○ Superior Incompleto 8○ Não Informado
Vínculo com a UFV: 1○ Servidor 2○ Estudante 3○ Familiar 4○ Cooperação **Profissão:____________**
Lazer: ____
Meio de locomoção: ____

Motivo da Consulta:

1○ Perda de peso   3○ HAS   5○ Hipotireoidismo

2○ Dislipidemias   4○ DM. Tipo:________

6○ DCV:____

7○ Esteatose   8○ Outros:________________________________

Encaminhamento ao Serviço: Iniciativa própria: 1○ Não .Qual médico:______________________

2○ Sim

Tem costume de procurar a Unidade Básica de Saúde – UBS ou outro serviço de saúde ou só a DSA? (Apenas para prevenção ou tratamento)

1○ Não

2○ Sim________________________________

2. ROTEIRO CLÍNICO-ENFERMAGEM

Terapia Farmacológica* – (Exceto Suplementos) (Avaliar a cada Três Meses)

Presença de reações de hipersensibilidade/intolerância a fármacos? 1□ Não 2□ Sim

Especificar: ____

Data	Medicamento	Dose	Uso regular Não (1)/ Sim (2)	Via de adm.	Horário	Tempo de uso

Tabagismo (**Avaliar a Cada Três Meses)**

Data	Não (1)	Já fumou (2)	Quanto tempo parou (anos)	Sim (3)	N° de cigarros ao dia	Duração/ Anos	Tratamento Não (1)/ Sim (2)	Medicação Qual (is)	Reposição de nicotina Não (1)/ Sim (2)

Etilismo (**Avaliar a Cada Três Meses)**

Data	Não (1)	Bebe Eventualmente (tipo, dose e frequência) (2)	Bebe todos os dias (tipo, dose e frequência) (3)	Tem vontade de parar	Ex-etilista Não (1)/ Sim (2)	Quanto tempo parou

Exame Cardiovascular **(PA realizar em toda consulta)**

Data	Pressão Arterial Sistólica	Pressão Arterial Diastólica

Atividade Física **(Avaliar a Cada Três Meses)**

Nos últimos **<u>3 meses</u>**, quantos dias por semana você praticou exercício físico ou esporte?
1 ○ Nenhum, não pratica (sedentário) 2 ○ Sim (preencher tabela)

Data	Tipo de exercício	Frequência diária	Faz menos de 150 min/semanais (1h30min) de intensidade leve a moderada	Faz entre 150-300 min/semanais (1h30min-5h) de intensidade moderada	Faz mais de 300 min/semanais (>5h) de intensidade moderada a alta

<u>3. ROTEIRO CLÍNICO-NUTRICIONAL</u>

Inquérito alimentar

1) Onde você faz suas refeições (almoço e jantar)?

○ Casa ○ RU ○ Restaurante

2) Se come em casa, quem prepara a comida?

1○ Você mesmo (a) ○ Esposo (a) 2○ Outros (Secretária, pais, colegas, esposo) 3○ Ambas Opções

3) Quem compra os alimentos que você consome em casa?

1○ Você mesmo (a) ○ Esposo (a) 2○ Outros (Secretária, pais, colegas, esposo) 3○ Ambas Opções

4) Consumo de açúcar

Em que preparações você usa açúcar?____

Qual o consumo mensal no domicílio?____________Para quantas pessoas (**inclui o paciente**)? 999○Não Usa

5) Consumo de sal

Como é sua alimentação em relação ao sal? 1○ Normal 2○Pouco 3○Muito 4○Não Informou 5○Não Usa

Acrescenta sal na salada ou no seu prato? 1○ Não 2○ Sim

6) Consumo de gordura

Gordura utilizada para preparo dos alimentos: 1○ Banha 2○ Óleo vegetal Que tipo?_______________3○ Ambas

Qual o consumo mensal no domicílio?________Para quantas pessoas (**inclui o paciente**)? ____________________

O que você faz com a gordura visível da carne?

Tira antes de cozinhar? 1○ Não 2○ Sim

Tira antes de comer? 1○ Não 2○ Sim

Come? 1○ Não 2○ Sim

7) Com que tempera a salada? 1○Nada 2○Azeite de oliva 3○ Óleo 4○Maionese 5○Molhos prontos 6○Vinagre 7○Sal 8○Outros: _______________
8) Você usa adoçantes? 1○ Não 2○ Sim Marca e Tipo:_________________________ Como utiliza (preparações, adoçantes, suco de caixinha, refrigerantes, produtos diets etc.):____

9) Você utiliza outros temperos: 1○ Naturais (cebola, alho, cheiro verde, orégano, manjericão, sal de ervas, sal etc.) 2○Industrializado (Sazon, Caldo Knorr, Fondor, etc.) 3○Ambas as Opções
10) Seguiu alguma dieta para emagrecer no último ano? 1○ Não 2○ Sim Que tipo?____ 1○Sem Intervenção Nutricional 2○Com Intervenção Nutricional
11) Toma algum tipo de suplemento? 1○ Não 2○ Sim Qual?____
12) Você muda seus hábitos alimentares no final de semana? 1○ Não 2○ Sim Como?____
13) Você faz associação entre o consumo alimentar (aumenta ou diminui) em situações de estresse, depressão, tristeza? 1○ Não 2○ Sim Que tipo de associação?____
OBSERVAÇÕES (gostos, aversões, alergias, intolerâncias, etc.):