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Influência do envelhecimento, diabetes e condições bucais no consumo alimentar

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RESUMO

Introdução: A nutrição desempenha um papel importante na saúde sistêmica e oral, podendo afetar o estado nutricional dos indivíduos e desencadear uma variedade de doenças orais e sistêmicas. Visto que a perda do paladar pode ser uma característica do envelhecimento, mudanças no consumo alimentar relacionadas a ela podem levar a um aumento do risco de distúrbios relacionados a dieta, como por exemplo a Diabetes Mellitus tipo 2 (DM2) ou cárie em idosos. **Objetivo:** Verificar como diferentes condições bucais e sistêmicas relacionadas ao DM2 influenciam no consumo de macronutrientes em adultos e idosos. **Métodos:** Dois estudos foram realizados: uma revisão sistemática e um estudo transversal. A revisão sistemática foi relatada de acordo com o PRISMA e a busca foi realizada em quatro bases de dados, bem como na literatura cinzenta. A qualidade metodológica foi avaliada usando as ferramentas do Joana Briggs Institute para estudos observacionais. A síntese quantitativa foi feita através de metanálise. Já o estudo transversal foi relatado de acordo com o STROBE e incluiu 170 pessoas com ≥35 anos, atendidos no Hospital Universitário de Brasília. Os desfechos foram consumo de macronutrientes (carboidratos, lipídeos, fibras, proteínas), avaliados a partir de um questionário de frequência alimentar. Variáveis sociodemográficas, antropométricas, de sangue e saliva foram analisadas. Modelos não ajustados e ajustados de regressões de Poisson foram realizados. **Resultados:** Na revisão, N=18 estudos observacionais foram incluídos, representando um total de 2.728 indivíduos, sendo 1.680 adultos com idade entre 18-59 anos e 1.048 idosos com ≥60 anos. Os idosos apresentaram perda da percepção do paladar significativa comparado com os adultos para os sabores doce, salgado e umami. No estudo transversal, observamos que o estado de saúde bucal pode interferir no consumo de macronutrientes, sendo que pessoas que relatam alteração no paladar tem mais risco de consumir quantidades altas de carboidrato, aquelas que usam prótese tem mais chances de apresentar um baixo consumo de fibra, a taxa de fluxo salivar está associada a uma redução de chance de ter um alto consumo de lipídeo e indivíduos idosos tendem a ter maior chance de consumir proteína inadequadamente. **Conclusão:** A mudança no consumo alimentar é influenciada pela percepção do paladar e por condições bucais presentes. Uma dieta alterada, como o consumo inadequado dos macronutrientes pode contribuir para o surgimento ou agravo de problemas bucais, no que denominamos de Ciclo vicioso da má Nutrição e Doenças Orais.

PALAVRAS-CHAVE: Envelhecimento; Consumo de Macronutrientes; Diabetes Mellitus; Doença Periodontal; Cárie Dentária; Cárie radicular; Uso de prótese; Perda Dentária.

ABSTRACT

Introduction: Nutrition plays an important role in systemic and oral health, potentially affecting individuals' nutritional status and triggering a variety of diseases, including oral diseases. Given that taste disfunctions can be a feature of aging, related changes in food consumption may lead to an increased risk of diet disorders, such as type 2 Diabetes Mellitus (T2D) and caries in the elderly. **Objective:** Examine how different oral and systemic conditions related to T2D influence macronutrient consumption in adults and elderly. **Methods:** Two studies were conducted: a systematic review and a cross-sectional study. The systematic review was reported according to PRISMA, and the search was conducted in four databases as well as in grey literature. Methodological quality was assessed using the Joanna Briggs Institute tools for observational studies. Quantitative synthesis was performed through meta-analysis. The cross-sectional study was reported according to STROBE. It included 170 individuals aged ≥35 years, treated at the University Hospital of Brasília. Outcomes were macronutrient consumption (carbohydrates, lipids, fibers, proteins), assessed using a food frequency questionnaire. Sociodemographic, anthropometric, blood, and saliva variables were collected. Unadjusted and adjusted Poisson regression models were performed. **Results:** In the review, N=18 observational studies were included, representing a total of 2,728 individuals, with 1,680 adults aged 18-59 years and 1,048 elderly (≥ 60 years). Elderly exhibited significantly lower taste perception compared to adults for sweet, salty, and umami flavors. In the cross-sectional study, it was observed that oral health status can change macronutrient consumption. People who report changes in taste are at higher risk of consuming high amounts of carbohydrates; those who use dentures are more likely to have low fiber intake; salivary flow rate is associated with a reduced likelihood of high lipid consumption; and elderly individuals tend to have a higher chance of inadequate protein consumption. **Conclusion:** Changes in food consumption are influenced by taste perception and existing oral conditions. An altered diet, such as inadequate macronutrient intake, can contribute to the onset or worsening oral problems, in what we call the “Vicious Cycle of Poor Nutrition and Oral Diseases”.

KEYWORDS: Aging; Macronutrient Consumption; Diabetes Mellitus; Periodontal Disease; Dental Caries; Root Caries; Denture Use; Tooth Loss.

SUMÁRIO

1.**CAPÍTULO 1- INTRODUÇÃO, REVISÃO DE LITERATURA E OBJETIVOS** 14

1.1 INTRODUÇÃO 14

1.2 REVISÃO DE LITERATURA 17

1.2.1 Dieta / Nutrição / Macronutrientes 17

1.2.2 Carboidratos 17

1.2.3 Fibras 18

1.2.4 Gorduras e Lipídeos 19

1.2.5 Proteínas 20

1.2.6 Condições bucais que podem influenciar no consumo alimentar 21

1.2 JUSTIFICATIVA 23

1.3 OBJETIVOS 24

1.3.1 Geral 24

1.4.2 Específicos 24

1.4 REFERÊNCIAS 25

2. CAPÍTULO 2- REVISÃO SISTEMÁTICA - CHANGES IN TASTE PERCEPTION IN OLDER ADULTS AND ITS POTENTIAL IMPACT ON CARBOHYDRATE CONSUMPTION: A SYSTEMATIC REVIEW AND META-ANALYSIS 29

2.1 ABSTRACT 29

2.2 INTRODUCTION 30

2.3 METHODS 32

2.4 RESULTS 36

2.5 DISCUSSION 39

2.6 CONCLUSIONS 42

3.7 REFERÊNCIAS 43

3. CAPÍTULO 3- ESTUDO TRANSVERSAL - MACRONUTRIENT CONSUMPTION IN ADULTS AND RELATIONSHIP WITH ORAL AND SYSTEMIC PARAMETERS: A CROSS-SECTIONAL STUDY 51

3.1 ABSTRACT 51

3.2 INTRODUCTION 53

3.3 METHODS 55

3.4 RESULTS 60

3.5 DISCUSSION 62

3.6 CONCLUSION 65

3.7 REFERENCES 66

4. CAPÍTULO 4 – DISCUSSÃO GERAL E CONCLUSÕES DA DISSERTAÇÃO 75

4.1 DISCUSSÃO GERAL 75

4.2 CONCLUSÕES 78

4.3 REFERÊNCIAS 79

5. CAPÍTULO 5 – PRESS RELEASE 81

Material Suplementar 82

1.CAPÍTULO 1 - REVISÃO DE LITERATURA E OBJETIVOS

1.1 INTRODUÇÃO

A expectativa de vida vem aumentando constantemente e segundo a Organização Mundial de Saúde (OMS), em 2019, a população global com 60 anos ou mais era de pouco mais de um bilhão de pessoas. As projeções indicam que esse número poderá crescer para 1,4 bilhão até 2030 e atingir 2,1 bilhões até 2050 [1]. Com o envelhecimento da população mundial, tem-se observado um aumento de doenças crônicas não transmissíveis (DCNT) [2]. Dentre elas, podemos destacar a Diabetes Mellitus (DM), uma doença metabólica crônica que eleva os níveis de glicose sanguínea, na qual pode causar danos sérios em diversos órgãos, incluindo coração, vasos sanguíneos, olhos, rins e nervos. O também DM traz consequências para a saúde bucal, sendo a periodontite é a sexta complicação altamente prevalente em indivíduos com DM. Além disso, as alterações gerais do fluxo salivar estão entre as mais significativas, resultando na mudança do ambiente bucal. Essa e outras manifestações bucais da DM podem influenciar sua atividade cariogênica e o próprio microbioma oral [3,4,5].

A doença periodontal causa impactos negativos, como a mobilidade, perda dentária, afeta negativamente a função mastigatória e estética, além de prejudicar a qualidade de vida [3]. Juntamente com a doença cárie, as doenças periodontais são as principais causas de perda dentária [6,7,8]. Um estilo de vida com padrões alimentares saudáveis contribui para o controle e redução deste tipo de enfermidade.

A perda dentária pode levar a alterações na capacidade de mastigação, mas essa funcionalidade não é apenas pelo número total de dentes perdidos e é influenciada pela distribuição dos dentes presentes, devendo estes ocluírem com os dentes antagonistas para que atuem de modo funcional [4,9]. A função mastigatória reduzida influência nas escolhas alimentares, causando uma dieta não equilibrada e aumentando o risco para doenças crônicas, como DM, câncer, doenças cardiovasculares e obesidade [4,5]. Ou seja, há um ciclo vicioso, em que uma alimentação inadequada aumenta o risco de surgimento e/ou agravamento de doenças sistêmicas e bucais, o que pode levar à perda dentária. Essa perda dentária, por sua vez, piora a forma como esses indivíduos se alimentam, reiniciando o ciclo.

O envelhecimento também pode está associado com o declínio da percepção do paladar e piorar essa situação [10]. Estudos mostraram que há um aumento dos limiares de detecção e reconhecimento do paladar associado ao envelhecimento e as classificações de intensidade dos compostos do paladar podem diminuir com a idade [11], podendo causar distúrbio relacionados a dieta, por exemplo, um consumo maior de alimentos açucarados. Isso pode resultar em problemas bucais, como por exemplo a cárie coronária e radicular.

A cárie radicular, que é uma condição incidente na população idosa [12], e a cárie coronária também estão diretamente relacionadas com a dieta, uma vez que os microrganismos responsáveis por iniciar a lesão metabolizam açúcares (carboidratos [CHO] fermentável) como fonte energética, assim dando início à disbiose. Durante o metabolismo microbiano dos biofilmes orais, há liberação de ácidos orgânicos que causam a queda do pH bucal. Assim como os CHO fermentáveis, os alimentos processados que contém adição de açúcar contribuem para a progressão e surgimento de novas lesões de cárie, bem como o aparecimento de doenças crônicas [13], especialmente a DM. Os CHO são as macromoléculas mais abundante no planeta, podendo ser catabolizada para a energia (ATP) ou usado para funções anabólicas, como a produção de ácidos graxos.

Microrganismos residentes da microbiota bucal utilizam esses CHO fermentáveis como fonte de energia, principalmente a sacarose, que serve de substrato para o metabolismo de polissacarídeos extracelulares (PEC), modificando o microambiente oral. Os PECs estão envolvidos com a estrutura e adesão do biofilme, causando canais de nutrientes e comunicação intracelular para todos microrganismos aderidos à estrutura dentária. O amido cru possui baixo potencial de ser utilizado para metabolismo microbiano nos biofilmes orais, o que pode mudar a partir da moagem e tratamento térmico. Além disso, a associação de sacorose e amido tem um alto potencial cariogênico, pois o amido se adere mais a estrutura dentária, tornando a sacarose disponível por mais tempo [14].

Uma orientação dietética quanto aos CHO fermentáveis e sua frequência é de suma importância, para reduzir o fator estressor da doença cárie e também para a prevenção das demais DCNT. Além disso, a OMS implementou diretrizes dietéticas, na qual aconselha uma redução na ingestão de açúcar adicionado para 5 a 10% de ingestão total de energia alimentar, para diminuir risco a doença

cárie [13].

Considerando o exposto, é fundamental prestar maior atenção à ingestão de macronutrientes em adultos, especialmente em idosos. Isso permite entender como a saúde bucal pode impactar negativamente a dieta desses indivíduos, além de estar associada ao agravamento de sua condição bucal e ao aumento do risco de DCNT. Esse conhecimento pode estimular discussões sobre a importância do cirurgião-dentista no controle dietético, não só entre pacientes odontopediátricos, mas também entre adultos e idosos, que são os mais afetados por problemas relacionados à dieta.

1.2 REVISÃO DA LITERATURA

A dieta diz respeito a quantidade total de alimentos consumidos pelos indivíduos e podem ser influenciados por vários fatores, como condições ambientais e disponibilidade de alimentos, crenças religiosas, status socioeconômico, dentre outros fatores [15]. A nutrição é o processo de utilização dos alimentos consumidos para crescimento, metabolismo e reparação dos tecidos e envolve ingestão, digestão, absorção, transporte, incorporação nas células e excreção [15]. Portanto, tanto a dieta quanto a nutrição são fundamentais na manutenção da saúde geral e oral das populações.

Há uma relação bidirecional entre dieta, nutrição e saúde. Ou seja, estado de saúde pode ser afetado pela deficiência de nutrientes, causada por uma dieta não equilibrada, e vice-versa, assim como qualquer problema de saúde, incluindo problemas de saúde bucal, pode afetar o estado nutricional [15,16]. Uma dieta nutritiva bem planejada consegue evitar muitas condições de saúde, como as DCNT, incluindo obesidade, DM, doenças cardiovasculares e doenças bucais [15].

Os principais nutrientes necessários para manter a saúde geral e bucal são os macronutrientes que são compostos por carboidratos, fibras, lipídeos e proteínas. Estes desempenham funções importantes, como fornecer energia e componentes essenciais para sustentar a vida. Além disso, uma combinação equilibrada desses macronutrientes é necessária em nossa dieta para mantes a longevidade e a saúdes dos indivíduos [17]. Abaixo, discutiremos os principais macronutrientes e seus papeis na nutrição e dieta humana.

1.2.2 Carboidratos

Os CHO são as macromoléculas mais abundantes em nosso planeta, compondo cerca da metade do total de calorias [11,13]. Os CHO são compostos de carbono, hidrogênio e oxigênio em uma proporção C:O:H2 [16].

Os CHO podem ser categorizados como: 1) monossacarídeos, que serve como componentes básicos de outros CHO e podem ter 3 a 7 átomos de carbono, porém os mais importantes é o carbono de seis hexoses: glicose,

frutose, galactose; 2) dissacarídeos e oligossacarídeos. Os dissacarídeos mais importantes na nutrição humana são: sacarose, lactose e maltose, os oligossacarídeos são pequenos com 3-10 unidade de monossacarídeos, facilmente hidrossolúveis e frequentemente doces; 3) polissacarídeos, que são carboidratos com mais de 10 unidades de monossacarídeos, tendo como exemplo o amido, de extrema abundância na dieta humana [16,18].

A recomendação para o consumo de CHO total tem uma variação de 55% a 75% da energia diária consumida. Para a OMS, 2003, a recomendação é de 55-75% [19], e para a Sociedade Brasileira de Obesidade (ABESO), em seu relatório em 2016, é de 55-60% [20].

Em 2023, a OMS atualizou sua diretriz para a ingestão de carboidratos, mantendo a recomendação do percentual de CHO total/dia. Recomenda-se para o adulto a ingestão de pelo menos 400 g de vegetais e frutas por dia, com a justificativa baseada em evidências de que um consumo maior de frutas e vegetais está associado à redução do risco de mortalidade por todas as causas, doenças cardiovasculares, DM tipo 2 e câncer [21]. Já para a saúde bucal, como citado anteriormente, a OMS aconselha ingestão máxima de 10% total/dia de CHO fermentáveis [13].

1.2.3 Fibras

As fibras dietéticas são um grupo complexo de CHO, podendo ser solúveis e insolúveis. A fibra solúvel diz respeito a parte comestível da planta que é resistente à digestão, porém pode ser parcialmente ou totalmente fermentada pelo microbioma em ácidos graxos de cadeia curta no intestino grosso. No entanto, a fibra insolúvel permanece intacta durante toda a digestão [22].

A fibra insolúvel inclui a celulose, hemicelulose e lignina. Suas fontes alimentares são: trigo integral, farelo, vegetais, grãos integrais, frutas e sementes comestíveis e tem como principais funções o aumento da capacidade de retenção de água aumentando, assim, o volume fecal e diminuindo o tempo de transito do intestino, além disso, a fermentação produz os ácidos graxos de cadeia curta associados com o risco diminuído da formação tumoral [16,22].

Já a fibra solúvel é composta pela pectina, gomas, psyllium, β-glucano, frutano, quitina, polissacarídeos de algas, polidextrose e polióis. Suas fontes

alimentares incluem aveia, legumes, maçãs, morangos e alguns sintetizados (como os polidextorse e poliói), suas principais funções para saúde em geral é a formação de gel, assim diminuindo o esvaziamento gástrico (digestão lenta), o tempo de trânsito do intestino e a absorção de glicose, além disso, traz benefícios como a diminuição da concentração do colesterol sérico e prebióticos que simulam o crescimento das bactérias benéficas no intestino [16,22]. Sendo assim, a ingestão de fibras solúveis contribui para a homestase intestinal, desempenhando suas funções corretamente e reduzindo o risco de doenças gastrointestinais e crônicas. As fibras, influenciam significativamente a abundância e a diversidade da microbiota intestinal humana, por meio da metabolização das fibras em produtos benéficos, principalmente ácidos graxos de cadeia curta, proporcionando várias vantagens para a saúde humana [23].

A recomendação para o consumo de fibras para adultos, segundo a OMS, é de pelo menos 25 gramas por dia. A recomendação é baseada em estudos mostraram que um consumo maior de fibras alimentares levou a melhorias favoráveis nos fatores de risco para obesidade e doenças crônicas não transmissíveis [21].

Estudos em humanos, mostram que o consumo de fibras alimentares diminuiu o risco de desenvolvimento de doenças cardiovasculares [24,25,26,27]. Um estudo randomizado demonstrou que pequenas modificações no estilo de vida, como a inclusão de fibras solúveis proveniente da aveia na dieta, podem ter um efeito significativo na redução dos níveis totais de colesterol [28]. As fibras também possuem outros fatores protetores contra doenças crônicas, como DM, síndrome metabólica, síndrome inflamatória intestinal, doença diverticular e obesidade [22] e até mesmo na homeostase do microbioma oral.

1.2.4 Gorduras e Lipídeos

A gordura dietética exerce um papel fundamental para a digestão, absorção e transporte de vitaminas lipossolúveis e fitoquímicos. Além disso, reduz as secreções gástricas, torna mais lento o esvaziamento gástrico e estimula o fluxo biliar e pancreático, facilitando o processo digestivo [16]. Ao contrário dos CHO, os lipídeos não são polímeros e são classificadas como pequenas moléculas extraídas dos tecidos animais e vegetais [16].

Os ácidos graxos são os principais constituintes dos lipídeos nos alimentos e no corpo e podem ser classificados como saturados, monoinsaturados e poli-insaturados, conforme com o número de carbonos, o número de ligações duplas e a posição das ligações duplas na cadeia. Os ácidos graxos também podem ser categorizados como essenciais e não essenciais, com base na necessidade nutricional [15,16].

O termo ácido graxo essencial pertence às famílias dos ácidos graxos ω-6 e ω-3, que não podem ser sintetizados no corpo, devendo ser obtido através da dieta. Os triglicerídeos são a forma mais prevalente de gordura na dieta e são compostos por três ácidos graxos e uma molécula de glicerol [16].

A recomendação de lipídeos total para adultos varia de 15% a 30% das calorias totais. Para a OMS, até 2003, a recomendação era de 15-30% [19]. Já para a ABESO, desde 2016 essa recomendação é muito similar, variando de 20 a 30% [20].

Em 2023, a OMS atualizou sua diretriz para a ingestão de lipídeos em adultos, a recomendação que os adultos limitem a ingestão total de gordura a 30% da ingestão total de energia ou menos. A recomendação é baseada em evidências, a partir de uma revisão sistemática, na qual observaram que o índice de massa corporal (IMC), circunferência de cintura (CC) e percentagem de gordura corporal foi menor em indivíduos que tinham uma ingestão menor de gordura [29].

1.2.5 Proteínas

As proteínas são componentes importantes para a estrutura corporal dos seres humanos e dos animais e diferem dos CHO e dos lipídeos, pois contêm nitrogênio. Os papeis primários das proteínas no organismo incluem proteínas estruturais, enzimas, hormônios, transporte e imunoproteínas [16].

A recomendação de proteínas total para adultos varia de 10% a 20% das calorias totais. Para a OMS, desde 2003, a recomendação é de 10-15% [19], enquanto para a ABESO, desde 2016, é de 15-20%, também muito similar [20].

A deficiência da proteína na dieta não só contribui para o crescimento deficiente, disfunção cardiovascular e alto risco de doenças infecciosas, mas também exacerba a deficiência de outros nutrientes e piora os perfis metabólicos

em humanos [30]. Uma alta ingestão de proteínas pode causar problemas para a saúde humana também, incluindo desconforto gastrointestinal, disfunção vascular e afeta a função renal [30].

1.2.6 Condições bucais que podem influenciar no consumo alimentar

A doença periodontal (DP) e a dieta atuam de forma simultânea equivalente uma sob à outra, ou seja, a dieta pode influenciar na DP, bem como, a DP pode afetar a ingestão da dieta e dos nutrientes necessários. Em estudo observacional prévio, pessoas que apresentam DP e perdas dentárias (<20 dentes) tiveram alteração alimentar, através do aumento da ingestão de CHO fermentáveis e uma baixa ingestão de fibras alimentares [31].

Uma pesquisa usando dados do National Health and Nutrition Examination Survery (NHANES) avaliou a associação entre número total de dentes naturais e dieta em uma população adulta. Os participantes da pesquisa foram divididos em três grupos: 1) dentição completa: 28 dentes; 2) dentição moderada: 21-27 dentes, 3) dentição inadequada: 20 dentes ou menos, excluindo terceiros molares. Ao analisar o recordatório alimentar de 24 horas, verificou-se que os participantes que tinham 20 dentes ou menos tiveram uma ingestão de energia significativamente menor, maior consumo de CHO e menor consumo de fibras e outros macronutrientes, em comparação aos demais grupos com dentição moderada e completa [5].

A DP e a cárie não tratadas podem levar à perda de elementos dentários, afetando a função mastigatória e influenciando nas escolhas alimentares e, consequentemente, no estado nutricional. Existe uma maior possibilidade de que indivíduos com perdas dentárias apresentem uma baixa ingestão de fibras, encontradas em alimentos mais duros, tais como frutas e cereais, e consomem uma dieta mais calórica, com alto teor de gordura, maior consumo de CHO refinados e açúcares, sendo mais suscetíveis a uma variedade de doenças sistêmicas e bucais [32].

O declínio na percepção do paladar também pode afetar o consumo da dieta, resultando em consequências negativas para a saúde [33]. O paladar é uma modalidade sensorial que permite os seres humanos reconhecer e distinguir os sabores básicos: doce, salgado, umami, amargo e azedo [34]. Acredita-se

que cada um desses sabores representa diferentes requisitos nutricionais ou fisiológicos ou podem apresentar riscos alimentares potenciais, como por exemplo, o sabor doce indica a presença de carboidratos e o sabor amargo pode proteger contra o consumo de venenos, sendo que muitos apresentam gosto amargo para os humanos [34].

A diminuição da percepção do paladar pode ocorrer em idosos e possui várias mudanças fisiológicas [33]. Além disso, indivíduos com DM podem também apresentar alterações no paladar e, na maioria das vezes, são descritas como uma sensação gustativa ácida, peculiar e alterada [35]. Geralmente essas alterações no paladar em indivíduos com DM estão associadas com a redução do fluxo salivar, em indivíduos diabéticos com mau controle metabólico, respiração bucal com ressecamento da mucosa, baixa taxa de produção de gustina, deficiência de zinco que ocasiona a diminuição da síntese de gustina e língua saburrosa, em razão da produção de compostos sulfetados que apresentam sabor ácido [35].

Indivíduos com DM não controlado podem apresentar uma resposta ao paladar prejudicada, essa alteração pode ser específica para glicose, e com a normalização da hiperglicemia pode melhorar essa alteração gustativa [35]. Tal alteração pode influenciar a escolha alimentares, pois com a necessidade de sentir o sabor salgado e doce em indivíduos com DM podem aumentar o consumo de sal e alimentos muito doces, o que pode levar a mais problemas de saúde como o aumento do risco de ter hipertensão ou agravamento da DM, elevando a hiperglicemia [35].

1.2 JUSTIFICATIVA

A nutrição é a base para o desenvolvimento humano. Quando se apresenta deficiente, pode influenciar o crescimento e o desenvolvimento dos componentes orofaciais e levar a doenças bucais. Da mesma maneira, a saúde bucal comprometida pode afetar a ingestão alimentar, causando danos ao estado nutricional. Portanto, é fundamental analisar o padrão e a frequência alimentar de indivíduos que possuem condições bucais que podem levar a uma alteração da dieta, visto que algumas condições levam a um alto consumo de carboidratos fermentáveis e baixo consumo de fibras alimentares. Além disso, indivíduos com DM e idosos são suscetíveis a problemas bucais, sendo que uma dieta desequilibrada traria piora da saúde sistêmica e bucal dessas pessoas.

1.3 OBJETIVOS

1.3.1 Objetivo geral:

Verificar como diferentes condições bucais e sistêmicas relacionadas ao DM, influenciam no consumo de macronutrientes em adultos e idosos.

1.3.2 Objetivos específicos:

1) Compreender se há mudanças significativas nas preferências alimentares em adultos e idosos, observando dados de percepção do paladar encontradas na literatura;
2) Verificar quais os impactos da saúde sistêmica sobre uma alimentação não equilibrada, comparando com indivíduos adultos e idosos, com e sem DM;
3) Associar quais os impactos da saúde bucal sobre uma alimentação não equilibrada, comparando com indivíduos adultos e idosos, com e sem DM;
4) Verificar se perda dentária e uso de próteses estão associados com alteração no consumo de macronutrientes;
5) Avaliar peso e circunferência abdominal e associar com ingestão macronutrientes.

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2. CAPÍTULO 2 – REVISÃO SISTEMÁTICA

Changes in taste perception in older adults and its potential impact on carbohydrate consumption: A systematic review and meta-analysis

2.1 ABSTRACT

Introduction: Gustatory function plays a fundamental role in various aspects related to nutrition and health, and the decline in taste perception can result in a series of adverse consequences. Alterations in taste perception are expected with aging due to a decrease in taste buds and other conditions, leading to systemic and oral diseases.

Objectives: We aimed to compare taste sensitivity in the elderly individuals and adults, as well as to evaluate carbohydrate preference among the aged.

Methods: This systematic review was reported according to PRISMA guidelines. The search was performed in four databases, as well as in grey literature. The risk of bias was assessed using the JBI's critical appraisal tools for observational studies. A meta-analysis with subgroups according to each flavor was conducted to obtain differences in means for adults vs. elderly (random-effects model).

Results: Out of the 5,660 studies retrieved, 18 observational studies were included, representing a total of 1,680 aged 18-59 years and 1,048 aged ≥ 60 years. Elderly individuals need higher concentrations to distinguish flavors compared to adults. In a qualitative analysis, all flavors showed differences between the groups, with sweet flavor being the easiest to recognize and the thresholds between the groups not being highly discrepant. However, in the meta-analysis, statistical differences were observed for sweet, salty, and umami flavors, while there were no statistical differences for sour and bitter flavors between the groups.

Conclusions: There are significant differences for distinguishing sweet, salty, and umami flavors between adults and elderly, indicating that elderly have impaired taste perception which need to be considered for their diet control.

2.2 INTRODUCTION

With the advancement of technology and science, life expectancy has been steadily increasing, and healthy aging is crucial for preserving an individual's quality of life. According to the WHO, in 2019 the global population aged 60 years or older was just over one billion people, representing 13.2% of the total world population of 7.7 billion. This number is 2.5 times higher than in 1980 (382 million), and projections suggest that, by 2050, it will reach nearly 2.1 billion aged people worldwide [1]. Decreased taste perception can be a characteristic of the aging process, impairing the dietary habits of elderly individuals [2]. The human gustatory system can recognize five basic tastes: sweet, sour, bitter, salty, and umami [3]. Gustatory function plays a fundamental role in various aspects of nutrition and health, and the decline in taste perception can result in a series of adverse consequences. These include decreased appetite, lower food intake, changes in dietary preferences, increased risk of malnutrition, and other potentially serious complications [4].

The most common causes of age-related decrease in gustatory function are physiological changes, such as decreased density of taste buds, reduced function of taste receptor cells responding to neural responses, difficulties in maintaining oral health, decline in olfactory function, chronic diseases, and related polypharmacy [5,6]. However, oral causes can also be associated with changes in people's diets and overall health, including reduced salivary flow and tooth loss, the latter being caused by advanced caries lesions and/or periodontal disease [7]. For instance, root caries is an incident condition, particularly in elderly individuals, as the prevalence of gingival recession increases with age, exposing root surfaces and increasing the chance of developing carious lesions [8]. Unhealthy dietary habits change due to decreased gustatory function increase the risk of diet-related disorders, creating a vicious cycle of diseases.

Physiological aging is also associated with the degeneration of functional tissue in salivary glands, resulting in a decrease in saliva production [9,10]. Saliva plays a fundamental role in oral functions, including both functional processes such as swallowing and speech, and the sensory perception of taste, acting in the preparation and transmission of gustatory stimuli [9,11]. Saliva characteristics vary widely among individuals throughout life, which may explain some of the

differences in taste perception. For example, studies show that the response to sucrose and the perception of sweetness depend on saliva pH [10,11].

It was previously observed that the recognition thresholds for the five basic tastes were significantly higher in elderly individuals compared to younger adults, indicating a decline in taste perception with aging [2]. A consequence of this decline in gustatory function is a shift towards unhealthy eating habits, which can have serious health implications. This increased risk of dietary disorders contributes to the development of conditions such as hypertension, diabetes mellitus, dyslipidemia, and malnutrition, among others. Additionally, high consumption of sugar-added foods leads to a greater risk of developing carious lesions, resulting in tooth loss, which affects chewing ability and alters the diet, creating a vicious cycle. Methven et al. (2012) conducted a systematic review with meta-analysis to investigate the worsening of taste perception in healthy aging and discuss the extent of change [12]. The study addressed very little about oral problems and their association with sensory perception. Additionally, it requires updating. It is still necessary a review more focused on oral health to understand how changes in macronutrient consumption directly affect oral health. Additionally, it is necessary to assess existing oral problems to determine if there is an association with changes in taste perception.

These factors mentioned above highlight the importance of addressing and managing the decline in taste perception in older adults, aiming to promote healthy eating habits and a better quality of life. In light of this, we investigated whether the taste perception is altered in elderly individuals compared to adults, especially the sweet taste. These changes could generate a higher carbohydrate consumption and consequent increased risk for caries, and potentially tooth loss, which in turn would lead to a worsened dietary intake. Therefore, this study aimed to analyze gustatory sensitivity in the elderly and adults.

2.3 METHODS

This systematic review protocol was registered at the PROSPERO International Prospective Register of Systematic Reviews platform under the number CRD42023463873. The acronym PECOS was used to design the following research question: “Do older adults experience alterations in taste perception when compared to adults?” where P= general population, E= aged people, C= adults, O= altered taste sensation, and S= observational and clinical studies.

Data Source and Search strategy

The following databases were searched: PubMed/MEDLINE, Embase, Web of Science, and Scopus. Also, the grey literature (ProQuest for dissertations and theses, Google Scholar, Livivo), and references lists of the included studies were searched. To assess alterations in taste perception in older adults compared to adults, the main terms added in the search strategy were "Old Age, Older adults, Aged", “Taste Disorders, Dysgeusia, Tasting, Distorted Taste, Altered Taste, Taste Perception, Gustatory Perception, Gustatory Response, sweet taste”. MESH terms were also included. The complete search strategy can be found in Appendix 1.

Inclusion criteria

Observational and clinical studies, without limitation of publication date and language, assessing taste perception and food preferences in at least one group of elderly individuals (≥60 years) compared to adults, using quantitative, qualitative, or hedonic scales as evaluation criteria, were included.

Exclusion criteria

Studies were excluded if: 1) the population included children and adolescents, edentulous individuals, participants with cancer and/or those who have undergone chemotherapy and radiation therapy, individuals with dementia or other neurological conditions, and studies that did not exclude participants who

are continuously using medication that may alter taste perception. 2) Articles with unavailable full text, preclinical studies (*in vitro* and animal studies), case reports or case series studies, randomized studies, systematic reviews and other reviews (narrative, scoping), letters, editorials, opinions, books and book chapters, and conference abstracts. 3) Studies without a control group (adults) or test group (elderly). 4) Studies that evaluated did not evaluate the sweet taste. 5) Studies that have not assessed taste perception using a quantitative/qualitative scale.

Studies selection

Two independent reviewers (LSMA and JMSM) selected the titles and abstracts for each study based on the eligibility criteria. Afterward, the same reviewers independently assessed the full text, confirming their eligibility. The discrepancies were resolved with the involvement of a third reviewer (MCOM). The Rayyan QCRI tool (Qatar Computer Research Institute, Qatar) was used in the both phases of study selection.

Data extraction

The data obtained for each study included the first author, year of publication, the sample size of tests and controls, proportions of male and female participants, age of the participants in each group, methods of taste evaluation (quantitative scale, qualitative scale, hedonic scale), unit of measurement for this evaluation (Likert scale, minimal concentration to have taste perception e threshold of recognition and detection), outcomes and findings for adults and elderly, main conclusions, and study type.

Qualitative Data Synthesis

Studies and their results were grouped and analyzed according to type of unit of measurement (Likert scale, minimal concentration to have taste perception, and threshold of recognition and detection) to identify the flavors sweet, salty, sour, bitter, and umami, age of participants in the control/test group, sample size, number of participants in each group, proportion of female and male

participants in each study, outcomes of each group, overall study conclusion, study type, and a field for observations to report missing data.

Quantitative Data Synthesis

A pair-wise meta-analysis was conducted, comparing the taste perception between aged people and adults, with subgroups according to basic tastes. The data analysis was conducted using the statistical program RevMan version 5.4.1 [13], and the statistical method used was the inverse variance with a random effects model. Due to substantial variability in methods in the included studies, the effect measured was the standardized mean difference with a 95% confidence interval. Heterogeneity among studies was estimated using Cochran's Q test, and inconsistency was assessed using the I^2 statistic.

Risk assessment of studies

The same reviewers (LSMA and JMSM) assessed the methodological quality of individual studies using the JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies [14]. All studies were evaluated using the same tool since only one design was found. This tool presents 8 items, of which 2 were considered very critical domain for this systematic review, including “Were the study subjects and the setting described in detail?” and “Were objective, standard criteria used for measurement of the condition?”. Another 2 questions were deemed critical domain, namely, “Were the criteria for inclusion in the sample clearly defined?” and “Was the exposure measured in a valid and reliable way?”. The criteria adopted in this systematic review for considering an article as of low methodological quality were answers of “no” or 1 “no” and 1 “unclear” or 2 “unclear” answers in critical domains, or 2 “unclear” answers and 1 or more “no” answers in non-critical domains. An article was considered to have high methodological quality if it received at most 1 “no” answer or 2 “unclear” answers in non-critical domains. Decisions regarding critical and non-critical domains and classification systems were discussed and agreed upon with the research team before applying the tool, as described in the JBI Reviewer Manual.

2.4 RESULTS

Study selection and qualitative synthesis

A total of 5,660 studies were identified through searching the main databases and grey literature. After excluding duplicates, 4,177 (main) and 545 (grey literature) studies were screened, of which 62 studies remained for full-text reading, and 18 were included in the final analysis [Figure 1]. Appendix 2 details the excluded studies with each reasons for exclusion.

Table 1 shows the characteristics of the 18 studies in a qualitative synthesis, including the number of participants in each group, the method used to assess taste perception, and the results. All studies were cross-sectional. A total of 2,728 individuals were included here, of which 1,680 were adults aged 18-59 years and 1,048 individuals aged ≥ 60 years. Similar numbers of female (n=1,412) and male (n=1,202) were reached. It was observed that 5 studies used Likert scales for taste sensation, 1 evaluated the minimum concentration for taste perception, and 15 assessed recognition/detection thresholds. The included studies were published from 1986 to 2022. A geographic analysis showed that most studies were conducted in the United States (6 studies reported in the USA, 3 in the Netherlands, 2 in Japan, 1 in England, 1 in Thailand, 1 in Spain, 1 in China, and 1 in South Korea).

Regarding the flavors analyzed in the studies, 18 assessed sweet taste, 14 assessed salty, bitter, and sour tastes, and 7 assessed umami taste. The flavors were diluted in distilled water or in other products, with most studies using sucrose solutions for sweet taste, sodium chloride (NaCl) for salty taste, caffeine or quinine hydrochloride (HCl) for bitter taste, citric acid for sour taste, and monosodium glutamate (MSG) for umami taste. Since recruiting aged individuals without dental prostheses was challenging, some studies allowed those who used partial dentures, but they were instructed not to use them during the tests. Some studies also instructed participants to avoid eating and drinking (except for water) and smoking for at least 1 hour before the tests.

Quantitative synthesis

In a qualitative analysis, all studies showed that elderly individuals required higher concentrations of solutions to perceive all flavors. Most studies indicated that the elderly individuals detected sweet taste as well as younger adults, suggesting that it might be a flavor that is easier to recognize; however, they still needed slightly higher concentrations to recognize it than younger adults.

Of the 6 studies included in the meta-analysis, 4 used the detection threshold method with the minimum concentration of the flavor perceived, where a lower value is better. The remaining 2 studies used the Likert scale with a numerical range, where the lowest value indicated no taste perception and the highest value indicated extreme taste perception, meaning that a higher value in this method was the positive outcome. For standardization purposes, the means of the studies using the Likert scale were converted to negative values since most of the studies included in the statistical analysis employed the method where a lower value was better for taste perception [15].

For standardization of the groups, we decided to maintain 2 groups (adults vs. elderly), as some studies included 3 groups with middle-aged adults, which were excluded from the analysis. Thus, there was one group of adults aged 18-40 years and one group of elderly individuals aged ≥ 60 years. Huang (2022) reported the mean (M) and standard deviation (SD) by sex in each group, and Weiffenbach (1986) provided the M and SD for elderly individuals in two different age groups. To standardize, the data was combined by sex in each group and the elderly groups were merged through the calculation of aggregated M and SD [15].

The meta-analysis comparing the mean taste perception for each flavor between adults and elderly individuals is presented in Figure 2. There was a statistical difference for sweet, salty, and umami flavors, while sour and bitter flavors did not show a statistical difference between the groups. The sweet taste had a SMD of -1.06 (95% confidence interval [95% CI] -1.70, -0.42), salty taste had a SMD of -1.98 (95% CI -3.19, -0.77), bitter taste had a SMD of -0.96 (95% CI -1.95, 0.04), sour taste had a SMD of -0.25 (95%CI -0.85, 0.35), and umami taste a SMD of -0.63 (95% CI -1.18, -0.09).

Methodological quality of individual studies

The assessment of the methodological quality of the selected studies was determined and detailed in Appendix 3. Applying the defined criteria resulted in 15 articles with low quality, and 4 with high quality. The item that most significantly impacted the evaluation of methodological quality were related to sample inclusion criteria, such as age, participants' health condition, and lifestyle.

2.5 DISCUSSION

There are several studies in the literature that assess taste perception in relation to genes, certain nutritional deficiencies, age, among other comparisons. Here, we conducted a rigorous systematic review to examine whether elderly individuals exhibit changes in taste perception compared to adults. Our main result was that elderly individuals presented altered taste sensation, requiring higher concentrations to identify sweet (large effect size), salty (large effect size), and umami (medium effect size) flavors compared to adults.

The meta-analysis showed a decrease in taste perception in elderly compared to adults. However, in the qualitative analysis, some studies reported that the recognition threshold for sweet taste was similar between the groups. One hypothesis for this result is that there may be a higher consumption of sweet foods by elderly individuals. This increase in the consumption of sweeter foods could be explained by the need to perceive the taste, considering a loss of taste perception, or because sweet flavor is easier to recognize. However, when the means were combined in the meta-analysis, only bitter and sour flavors did not show significant differences between the groups. Our results differ in two flavors from those reported in the systematic review by Methven et al. (2012). In their meta-analysis, 20 out of the 23 included studies revealed higher taste thresholds for the elderly across all flavors, indicating a decline in taste perception with aging. A possible explanation for this discrepancy in results may be the number of studies included in each meta-analysis. While Methven et al. (2012) considered 23 studies, our meta-analysis included only 6 studies. As our aim was to observe changes that could be associated with oral health, our eligibility criteria led to the differences in the number of included studies, with 3 studies included in this meta-analysis that were not included in the review by Methven et al. (2012).

Murphy and Withee (1986) reported that elderly individuals rated sucrose and NaCl solutions at higher concentrations as more pleasant compared to younger individuals, due to this decrease in sensory perception [16]. Our results confirm that the taste disorder may be related to the fact that elderly individuals reported finding high concentrations of sucrose and NaCl more pleasant. This could lead to an increase in the consumption of sugary and salty foods among the aged individuals. The increased consumption of sugary foods, in particular, can alter the oral microbiome, promoting the development of coronal and root

caries and exacerbating periodontal diseases [17]. In the case of dental caries, the microorganisms present benefit from the high frequency of sugar consumption, producing acid and resulting in an acidic pH that promotes the demineralization of the dental structure [18]. High consumption of added sugars is associated with periodontal disease, for example, regardless of other risk factors, suggesting that sugar and postprandial hyperglycemia contribute to systemic inflammation, affecting both periodontal diseases and other non-communicable diseases [17].

Among the factors that can impair taste perception in elderly individuals are the use of medications and hyposalivation [19]. The mechanisms responsible for the adverse effects of medication use on taste are not well understood; they are likely multiple and interactive. These effects can include changes in the taste of the medication itself, damage to taste receptors (such as from gastroesophageal reflux acid), influences from immunosuppression and related conditions like oral candidiasis, alterations in neurotransmitter function, drying of the oral mucosa, changes in the chemical composition of saliva and mucosal elements, among other adverse effects [20]. Foods contain taste substances such as inorganic ions, polysaccharides, and amino acids [21]. Some of these taste substances chemically interact with salivary components while accessing taste receptor sites. Additionally, certain salivary components continuously stimulate taste receptors and have a long-term effect, protecting the taste receptor site and/or taste buds [21]. Taste sensitivity can be affected in various ways by saliva, including the stimulation of taste receptors, chemical interaction with taste substances, and protection of taste receptors [22]. Sansano et al. 2015, observed that individuals with taste disorders had significantly lower stimulated salivary flow, as measured by the gingival test, compared to individuals without taste disorders [23].

The limitations of this study include the use of various sensory methods, which reduces the ability to compile and compare results more robustly in a statistical analysis. Additionally, only cross-sectional studies were found. One study was deemed to be case-control; however, since the categorization was based on the independent variable (and not the outcome), we treated this study as cross-sectional. We could not find any longitudinal studies, which means that any inference of "cause-effect" is impossible at this moment. However, the data found in the cross-sectional studies corroborate with the meta-analysis

conducted, indicating a decline in taste perception in elderly individuals compared to adults and this can be related to oral health impairment.

2.6 CONCLUSIONS

In conclusion, there is a decline in taste perception in elderly individuals compared to adults for sweet, salty, and umami flavors. Bitter and sour flavors did not exhibit differences in elderly.

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Figure and Table

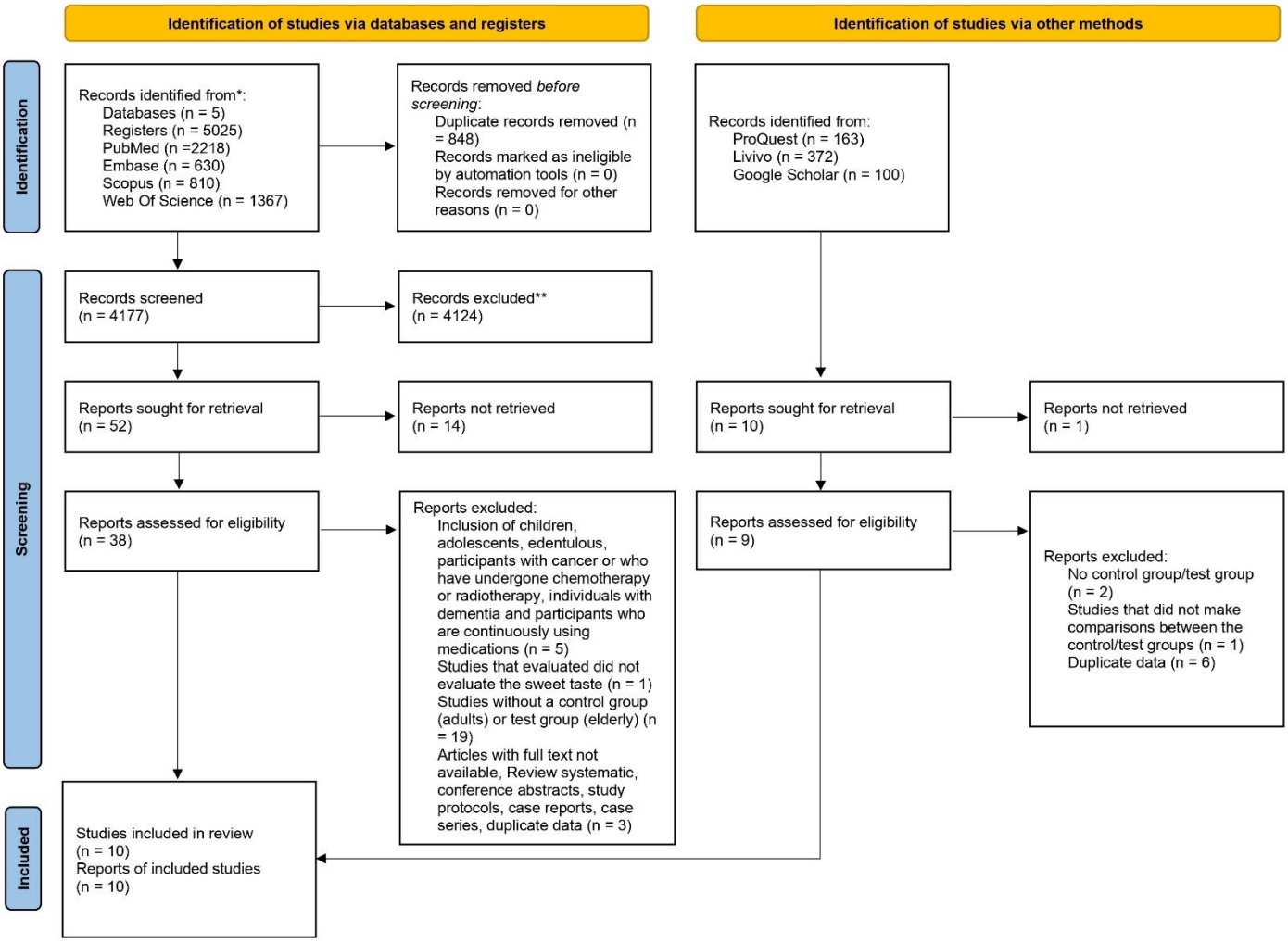

Figure 1: Flowchart of the study

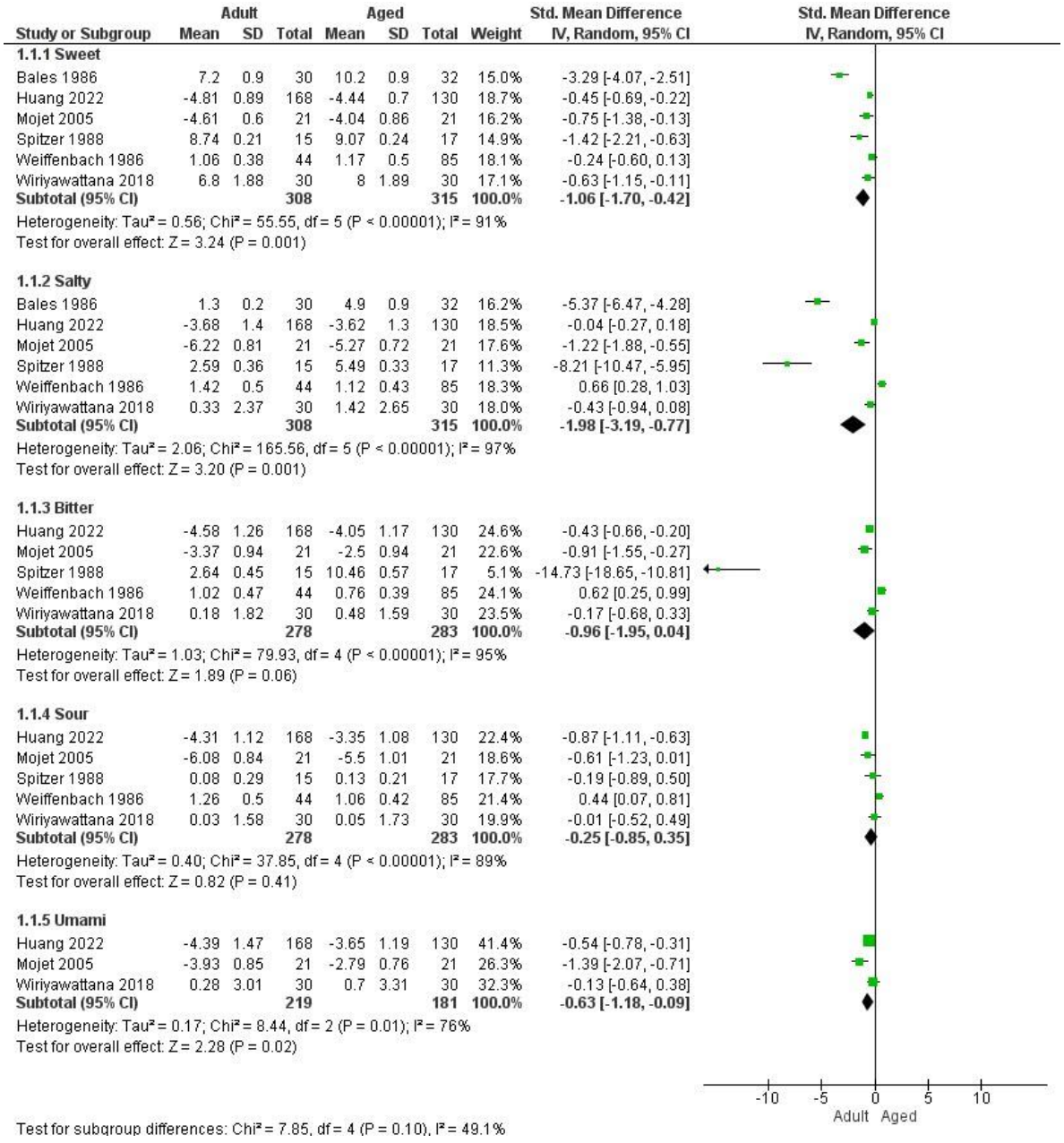

Figure 2. Forest plot of the 5 flavors (sweet, salty, bitter, sour, and umami) compared between adult and elderly (aged) groups.

Table 1. Characteristics of the included studies (N=18)

Author; year	Country	Ref.	Metodological quality	N (C)	N (T)	Age (C)	Age (T)	sex	Taste measurement	Unit of measurement	Flavor	Outcome (C)	Outcome (T)
Bales et al. 1986	United States	[25]	+	30	32	18-30	≥ 60	Fem 69,4% Men 30,6 %	Qualitative Scale	Detection threshold	Sweet and salty	**Sweet** (mM)- 7.2 ±0.9 **Salty** (mM)- 1.3±0.2	**Sweet** (mM) 10.2 ± 0.9 **Salty** (mM) 4.9 ± 0.9
Weiffenbach et al. 1986	United States	[26]	+	85	85	<40-56	57->70	Fem 46,5% Men 53,5%	Qualitative Scale	Detection threshold	Sweet, salty, sour and bitter	<40 years: **Sweet** 1.06 ± .38 **Salty** 1.42 ± .50 **Sour** 1.26 ± .50 **Bitter** 1.02 ± .47 40-56 years: **Sweet** 1.05 ± .39 **Salty** 1.20 ± .41 **Sour** 0.99 ± .46 **Bitter** 0.99 ± .51	57-70 years: **Sweet** 1.22 ± .46 **Salty** 1.12 ± .46 **Sour** 1.11 ± .42 **Bitter** 0.81 ± .36. >70 years: **Sweet** 1.12 ± .54 **Salty** 1.12 ± .41 **Sour** 1.01 ± .41 **Bitter** 0.71 ± .41
Spitzer 1988	United States	[27]	+	15	17	18-25	63-88	Men 100%	Qualitative Scale	Detection threshold	Sweet, salty, sour and bitter	**Sweet** 8.74 ± 0.21 **Salty** 2.59 ±0.36 **Sour** 0.08 ± 0.29 **Bitter** 2.64 ± 0.45	**Sweet** 9.07 ± 0.24 **Salty** 5.49 ± 0.33 **Sour** 0.13 ± 0.21 **Bitter** 10.46 ± 0.57
Cowart 1989	United States	[28]	+	58	29	19-60	65-80	Fem 55,2% Men 44,8%	Qualitative Scale	Likert scale	Sweet, salty, sour and bitter	**Sweet**: very intense at high concentration **Salty**: extremely intense at high concentration **Sour**: moderate at low concentration **Bitter**: Very strong at high concentration for middle-aged individuals and extremely strong at high concentration for young individuals	**Sweet**: very intense at high concentration **Salty**: very intense at high concentration **Sour**: slightly strong at low concentration **Bitter**: very intense at high concentration
Gilmore et al. 1989	United States	[29]	+	12	12	18-25	67-77	Fem 100%	Qualitative Scale	Minimum concentration	Sweet, and bitter	**Sweet** e **Bitter**: identified at low concentrations	**Sweet**: identified at low concentrations **Bitter**: Identified at medium to high concentrations

Stevens 1995	United States	[30]	+	15	15	19-26	65-87	-	Qualitative Scale	Detection threshold	Sweet	**Sweet**: Detection at a concentration of 55:1 (dilution 55 times less than the most concentrated solution)	**Sweet**: Detected at a concentration of 100:1 (corresponding to a concentration range 100 times higher than the most concentrated solution)
Receputo et al. 1996	Italy	[31]	+	20	40	27.7 + 3.2	Idosos -71,3 + 5,5 Centenários-102.6 + 2.4	Fem 60% Men 40%	Qualitative Scala	Detection threshold	Sweet, salty, sour and bitter	Ability to identify the flavors **Sweet**: 97.5% **Salty**: 92,5% **Sour**: 92,5% **Bitter**: 87,5%	Ability to identify the flavors **Elderly** **Sweet**: 69% **Salty**: 68% **Sour**: 77% **Bitter**: 78% C**entenarians** **Sweet**: 46% **Salty**: 49% **Sour**: 56% **Bitter**: 63% .
Keneda et al. 2000	Japan	[32]	+	20	20	21-40	59-75	Fem 50% Men 50%	Qualititative Scale	Detection threshold	Sweet and sour	**Sweet**: higher thresholds **Sour**:lower thresholds Concentrations (sweet and sour) **High**: High percentage of correct identifications **Moderate**: High percentage of correct identifications **Low**: Low percentage of correct identifications	**Sweet**: higher thresholds **Sour**: higher thresholds Concentrations (sweet and sour) **High**: High percentage of correct identifications **Moderate**: Significantly lower percentage of correct identifications **Low**: Low percentage of correct identifications
Mojet et al. 2001	Netherlands	[33]	+++	21	21	19-33	60-75	Fem 50% Men 50%	Qualitative Scale	Detection threshold	Sweet, salty, sour, bitter and umami	**Sweet**, **salty**, **sour**, **bitter** e **umami**: Significantly lower detection thresholds	**Sweet**, **salty**, **sour**, **bitter** e **umami**: Significantly higher detection thresholds

Mojet et al. 2003	Netherlands	[34]	+++	21	21	19-33	60-75	Fem 50% Men 50%	Qualitative Scale	Detection threshold	Sweet, salty, sour, bitter and umami	**Sweet, salty, sour, bitter and umam**i: they perceived the flavors as significantly more intense when dissolved in water and in the product	**Sweet, salty, sour, bitter and umami**: they perceived the flavors as significantly less intense when dissolved in water and in the product
Fukunaga et al. 2005	Japan	[35]	+	30	30	18 -29	65-85	Fem 56,7% Men 43,3%	Qualitative Scale	Detection threshold	Sweet, salty, sour and bitter	**Sweet, salty, sour and bitter**: Lower threshold	**Sweet, salty, sour and bitter**: Higher threshold
Mojet et al. 2005	Netherlands	[36]	+++	21	21	19-33	60-75	Fem 50% Men 50%	Qualitative Scale	Detection threshold; Likert scale	Sweet, salty, sour, bitter and umami	Compounds: **Water** **Sweet** Sucrose 4.61 ± 0.60 Aspartame 4.64 ± 0.53 **Salty:** Sodium chloride 6.22 ± 0.81 **Sour:** Citric acid 6.08 ± 0.84 **Bitter:** Caffeine 3.45 ± 0.70 **Umami:** Monosodium glutamate 3.93 ± 0.85 **Products** **Sweet** Sucrose 6.24 ± 0.74 Aspartame 4.46 ± 0.69 **Salty**: Sodium chloride 14 ± 0.94 **Sour:** Citric acid 4.62 ± 1.06 **Bitter:** Caffeine 4.08 ± 1.24 **Umami:** Monosodium glutamate 4.84 ± 1.29	Compounds: **Water** **Sweet** Sucrose 4.04 ± 0.86 Aspartame 4.21 ± 1.03 **Salty:** Sodium chloride 5.27 ± 0.72 **Sour:** Citric acid 5.50 ± 1.01 **Bitter:** Caffeine 2.77 ± 1.09 **Umami:** Monosodium glutamate 2.79 ± 0.76 **Product** **Sweet** Sucrose 5.36 ± 1.18 Aspartame 3.80 ± 1.11 **Salty:** Sodium chloride 4.12 ± 0.97 **Sour:** Citric acid 4.06 ± 1.27 **Bitter:** Caffeine 4.40 ± 1.47 **Umami:** Monosodium glutamate 4.34 ± 1.19

Kennedy et al. 2010	England	[37]	+	36	48	18-33	63-85	-	Quantitative Scale/ Hedonic Scale	Detection threshold/recognition; Hedonic scale; Likert scale	Sweet	**Sweet**: More sensitive to taste; Hedonic test: chocolate more liked than the sucrose solution; Intensity: higher sweetness intensities of sucrose	**Sweet**: Less sensitive to taste; Hedonic test: chocolate more liked than the sucrose solution; Intensity: lower sweetness intensities of sucrose
Wiriyawattana et al. 2018	Thailand	[4]	+	60	30	20-59	60-85	Fem 70% Men 30%	Qualitative Scale;	Detection threshold/recognition	Sweet, salty, sour, bitter and umami	**Sweet, salty, sour, bitter and umami**: lower thresholds	**Sweet, salty, sour, bitter and umami**: higher thresholds
Barragán et al. 2018	Spain	[38]	+	671	349	18-50	51-80	Fem 64,2% Men 35,8%	Quantitative Scale	Likert scale	Sweet, salty, sour and bitter	**Sweet, salty, sour and bitter**: Perceived a stronger intensity with the same high concentration as the elderly	**Sweet, salty, sour and bitter**: Perceived weaker intensities at the same high concentration as the young **Sour and Bitter**: Lower flavor scores
Wang et al. 2020	Taiwan	[39]	+	160	80	20-59	≥ 60	Fem 50% Men 50%	Quantitative Scale; Quantitative Scale; Hedonic Scale	Detection threshold; Hedonic scale; Likert scale	Sweet, salty, sour and bitter	**Sweet, salty, sour and bitter**: Higher accuracy scores (age group 20 to 39 years); Intensity rating: higher scores (age range 20 to 39 years); Pleasantness: no differences between ages	**Sweet, salty, sour and bitter**: Lower accuracy scores; Intensity rating: lower scores; Pleasantness: no differences between ages
Jeon et al. 2021	South Korea	[2]	+	71	68	20-29	≥ 65	Men 100%	Qualitative Scale;	Recognition threshold	Sweet, salty, sour, bitter and umami	**Sweet, salty, sour, bitter and umami**: lower thresholds	**Sweet**: The same recognition threshold as adults. However, after analyzing the correlation with age, the threshold increased **Salty, sour, bitter and umami**: higher thresholds

Huang et al. 2022	China	[3]	+++	334	130	19-50	51-65	Fem 48,9% Men 51,1%	Hedonic Scale	Detection threshold/recognition; Likert scale	Sweet, salty, sour, bitter and umami	**Sweet, salty, sour, bitter and umami:** lower thresholds	**Sweet, sour, bitter and umami**: Significantly lower perception scores **Sour, bitter and umami**: Significantly lower recognition scores

C= Control (adults); T= Test (aged).

+++ = low risk of bias; ++ = moderate risk of bias; + = high risk of bias.

Appendix 1. Search strategies according to each database, performed on 16th July 2023

Pubmed	((("Old Age"[All Fields] OR "Old Aged"[All Fields] OR "Old Elder"[All Fields] OR "Old Elderly"[All Fields] OR "Ageing"[All Fields] OR "Older adults"[All Fields] OR "old adults"[All Fields] OR "Aged"[MeSH Terms]) AND ("Taste Disorders"[All Fields] OR "Dysgeusia"[All Fields] OR "Hedonic Scale"[All Fields] OR "Tasting"[All Fields] OR "Dysgeusias"[All Fields] OR "Distorted Taste"[All Fields] OR "Altered Taste"[All Fields] OR "Parageusia"[All Fields] OR "Parageusias"[All Fields] OR "taste sensation"[All Fields] OR "Taste Perception"[All Fields] OR "Gustatory Perception"[All Fields] OR "Gustatory Response"[All Fields] OR "sweet taste"[All Fields] OR "diet, carbohydrate restricted"[MeSH Terms] OR "Dietary Sugars"[MeSH Terms])) NOT "covid 19"[MeSH Terms]) NOT ("Review"[Publication Type] OR "systematic review"[Publication Type])	2218
Scopus	(ABS ("Old Age" OR "Old Aged" OR "Old Elder" OR "Old Elderly" OR "Ageing" OR "Older adults" OR "old adults" OR "Aged") AND ABS ("Taste Disorders" OR dysgeusia OR "Hedonic Scale" OR tasting OR "Dysgeusias" OR "Distorted Taste" OR "Altered Taste" OR parageusia OR parageusias OR "Taste sensation" OR "Taste Perception" OR "Gustatory Perception" OR "Gustatory Response" OR "diet, carbohydrate restricted" OR "sweet taste" OR "Dietary Sugars"))	810
ProQuest	noft((("Old Age" OR "Old Aged" OR "Old Elder" OR "Old Elderly" OR "Ageing" OR "Older adults" OR "old adults" OR "Aged") AND ("Taste Disorders" OR "Dysgeusia" OR "Hedonic Scale" OR "Tasting" OR "Dysgeusias" OR "Distorted Taste" OR "Altered Taste" OR "Parageusia" OR "Parageusias" OR "taste sensation" OR "Taste Perception" OR "Gustatory Perception" OR "Gustatory Response" OR "sweet taste" OR "diet, carbohydrate restricted" OR "Dietary Sugars")) NOT ("covid 19") NOT ("Review" OR "systematic review")))	163
Web of Science	"Old Age" OR "Old Aged" OR "Old Elder" OR "Old Elderly" OR "Ageing" OR "Older adults" OR "old adults" OR "Aged" (Abstract) and "Taste Disorders" OR "Dysgeusia" OR "Hedonic Scale" OR "Tasting" OR "dysgeusia" OR "Distorted Taste" OR "Altered Taste" OR "parageusie" OR "parageusie" OR "taste sensation" OR "Taste Perception" OR "Gustatory Perception" OR "Gustatory Response" OR "sweet taste" OR "diet, carbohydrate restricted" OR "Dietary Sugars" (Title)	1367
Embase	('old age':ti,ab,kw OR 'old aged':ti,ab,kw OR 'old elder':ti,ab,kw OR 'old elderly':ti,ab,kw OR 'ageing':ti,ab,kw OR 'older adults':ti,ab,kw OR 'old adults':ti,ab,kw OR 'aged':ti,ab,kw) AND ('taste disorders':ti,ab,kw OR 'dysgeusia':ti,ab,kw OR 'hedonic scale':ti,ab,kw OR 'tasting':ti,ab,kw OR 'dysgeusias':ti,ab,kw OR 'distorted taste':ti,ab,kw OR 'altered taste':ti,ab,kw OR 'parageusia':ti,ab,kw OR 'parageusias':ti,ab,kw OR 'taste sensation':ti,ab,kw OR 'taste perception':ti,ab,kw OR 'gustatory perception':ti,ab,kw OR 'gustatory response':ti,ab,kw OR 'sweet taste':ti,ab,kw) NOT 'covid 19':ti,ab,kw NOT ('review':ti,ab,kw OR 'systematic review':ti,ab,kw)	630
LIVIVO	((("Old Age" OR "Old Aged" OR "Old Elder" OR "Old Elderly" OR "Ageing" OR "Older adults" OR "old adults" OR "Aged") AND ("Taste Disorders" OR "Dysgeusia" OR "Hedonic Scale" OR "Tasting" OR "Dysgeusias" OR "Distorted Taste" OR "Altered Taste" OR "Parageusia" OR "Parageusias" OR "taste sensation" OR "Taste Perception" OR "Gustatory Perception" OR "Gustatory Response" OR "sweet taste" OR "diet, carbohydrate restricted" OR "Dietary Sugars")) NOT ("covid 19") NOT ("Review" OR "systematic review"))	372

Google Scholar	((“Old Age” OR “Older adults”) AND (“Taste Disorders” OR “Altered Taste” OR "diet, carbohydrate restricted")) -"Covid-19"	First 100 out of 2,670.

Appendix 2. Excluded articles in phase 2 and reasons for exclusion (n= 46)

	Author, year	Reason for exclusion
After full-text reading		
(1)	(Alia et al. 2021)	3
(2)	(Allen et al. 2011)	2
(3)	(Appleton et al. 2016)	1
(4)	(Bartoshuk et al. 1986)	1
(5)	(Boesveldt et al. 2011)	3
(6)	(Cao et al. 2015)	2
(7)	(Cohen et al. 1959)	1
(8)	(Coltell et al. 2019)	3
(9)	(Dias et al. 2015)	3
(10)	(Dikmen et al. 2017)	2
(11)	(Drewnowski et al. 2001)	2
(12)	(Fikentscher et al. 1977)	3
(13)	(Gervis et al. 2020)	2
(14)	(Gervis et al. 2021)	3
(15)	(Guido et al. 2016)	3
(16)	(Habberstad et al. 2017)	3
(17)	(Hasan et al. 2022)	3
(18)	(Hyde R. J., Feller R. P. 1981)	2
(19)	(Jacquot et al. 2020)	1
(20)	(Jayasinghe et al. 2017)	3
(21)	(Jayasinghe et al. 2017)	2
(22)	(Kanjirath et al. 2018)	2
(23)	(Klimacka-Nawrot et al.2005)	2

(24)	(Lampuré et al. 2015)	3
(25)	(Magdalena et al. 2017)	2
(26)	(Martelli et al. 2020)	3
(27)	(Mattos et al. 2022)	3
(28)	(Methven et al. 2012)	2
(29)	(Miotti et al. 1989)	2
(30)	(Mondon et al. 2014)	2
(31)	(Fatemeh et al. 2021)	3
(32)	(Nagy et al. 2014)	3
(33)	(Ogawa et al. 2016)	3
(34)	(Ogawa et al. 2017)	3
(35)	(Ozturk et al. 2022)	3
(36)	(Pfrimer et al. 2023)	2
(37)	(Plattig et al. 1980)	2
(38)	(Richter et al. 2017)	2
(39)	(Rivers et al. 2017)	2
(40)	(Robino et al. 2015)	3
(41)	(Sergi et al. 2017)	2
(42)	(Silva et al. 2021)	3
(43)	(Stevens et al. 1993)	4
(44)	(Trachootham et al. 2018)	3
(45)	(Uota et al. 2016)	3
(46)	(Yoshinaka et al. 2016)	1

1- Studies including children and adolescents, edentulous individuals, participants with cancer or those who have undergone chemotherapy and radiation therapy, individuals with dementia or other neurological conditions, and participants who are continuously using medications.

2 = Articles with full text not available, Reviews, Review systematic, Book chapters, opinions, letters, conference abstracts, study protocols, case reports, case series, duplicate data.

3 = Studies without a control group (adults) or test group (elderly).

4 = Studies that evaluated did not evaluate the sweet taste.

5 = Studies that have not assessed taste perception using a quantitative/qualitative scale.

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Appendix 3. Assessment of methodological quality of individual studies using the JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies (Moola et al. 2020).

Author	1. Were the criteria for inclusion in the sample clearly defined?	2. Were the study subjects and the setting described in detail?	3. Was the exposure measured in a valid and reliable way?	4. Were objective, standard criteria used for measurement of the condition?	5. Were confounding factors identified?	6. Were strategies to deal with confounding factors stated?	7. Were the outcomes measured in a valid and reliable way?	8. Was appropriate statistical analysis used?	**Overall appraisal:** LOW, MODERATE, OR HIGH QUALITY
Barragán, 2018	U	U	Y	Y	N	N	Y	Y	**LOW**
Bales, 1986	U	U	Y	Y	N	N	U	Y	**LOW**
Cowart, 1989	U	U	Y	U	N	N	U	Y	**LOW**
Fukunaga, 2005	U	U	Y	Y	N	N	U	Y	**LOW**
Gilmore, 1989	U	U	U	Y	N	N	Y	Y	**LOW**
Huang, 2022	Y	Y	Y	Y	Y	Y	Y	Y	**HIGH**
Jeon, 2021	U	Y	Y	U	U	N	Y	Y	**LOW**
Keneda, 2000	N	U	U	U	N	N	N	N	**LOW**
Kennedy, 2010	N	U	Y	N	N	N	U	Y	**LOW**
Mojet, 2001	Y	U	Y	Y	Y	Y	Y	Y	**HIGH**
Mojet, 2003	Y	U	Y	Y	Y	Y	Y	Y	**HIGH**
Mojet, 2005	Y	U	Y	Y	Y	Y	Y	Y	**HIGH**
Receputo, 1996	N	N	U	N	N	N	U	N	**LOW**
Spitz, 1988	N	U	Y	Y	N	N	Y	Y	**LOW**
Stevens, 1995	N	U	Y	U	N	N	Y	Y	**LOW**
Wang, 2020	Y	N	Y	Y	N	N	Y	Y	**LOW**
Weiffenbach, 1986	N	U	Y	U	N	N	U	Y	**LOW**
Wiriyawattana, 2018	U	U	Y	Y	Y	N	Y	Y	**LOW**

Y: Yes; N: No; U: Unclear; NA: Not applicable.

1. 1. Were the criteria for inclusion in the sample clearly defined? **CRITICAL DOMAIN**
2. 2. Were the study subjects and the setting described in detail? **VERY CRITICAL DOMAIN**
3. 3. Was the exposure measured in a valid and reliable way? **CRITICAL DOMAIN**
4. 4. Were objective, standard criteria used for measurement of the condition? **VERY CRITICAL DOMAIN**
5. 5. Were confounding factors identified? **NON-CRITICAL DOMAIN**
6. 6. Were strategies to deal with confounding factors stated? **NON-CRITICAL DOMAIN**
7. 7. Were the outcomes measured in a valid and reliable way? **NON-CRITICAL DOMAIN**
8. 8. Was appropriate statistical analysis used? **NON-CRITICAL DOMAIN**

3. CAPÍTULO 3 – ESTUDO TRANSVERSAL

Macronutrient consumption in adults and relationship with oral and systemic parameters: a cross-sectional study

3.1 ABSTRACT

Introduction: A balanced diet with appropriate combinations of macronutrients is essential for maintaining general health, as these nutrients provide energy and essential elements for the proper functioning of the body. Dietary changes may be associated with the emergence of systemic and oral diseases. However, oral conditions, such as tooth loss and change in taste perception, can also affect the consumption of these macronutrients.

Objectives: To study systemic and oral alterations associated with inadequate consumption of macronutrients in adults and elderly with and without type 2 diabetes mellitus (T2D).

Methods: This is a cross-sectional study that included 170 individuals, of whom 120 were adults ≥ 35 years-old and 50 were ≥ 60 years-old. Sociodemographic variables (sex, age and educational level) were collected using a questionnaire. Clinical parameters examined included weight status, waist circumference risk, T2D (HbA1c >6.5%), presence of inflammation (C-reactive protein>0.5 mg/L), smoking history, functional dentition (≥20 natural teeth), presence of removable prostheses, worsened taste, discomfort while eating, and salivary flow rate. The study outcomes were high carbohydrate intake, high lipid intake, low fiber intake, and inadequate protein intake. Unadjusted and adjusted Poisson regressions models were performed for each macronutrient. Prevalence ratios (PR) and the 95% confidence intervals (IC) were estimated.

Results: Individuals with high-risk waist circumference (PR=0.23; 95%CI: 0.11-0.50) and those with functional dentition (PR=0.27; 95%CI: 0.10-0.75) were less likely to have high carbohydrate consumption. However, individuals reporting worsened taste perception were almost 4 times more likely to have high carbohydrate intake (PR=3.84; 95%CI: 1.36-10.83). Salivary flow rate was significantly associated with increased lipid intake (PR=0.21; 95%CI: 0.05-0.89). Male individuals were less likely to have adequate fiber intake (PR = 0.72; 95%CI:

0.54-0.96), while the presence of removable prostheses in both arches (P =1.40; 95% CI: 1.07-1.81) and high cardiovascular risk (as per waist circumference) (PR=1.86; 95%CI: 1.06-3.26) were associated with higher likelihood of having low fiber intake. These associations with fiber were affected by the salivary flow rate. Individuals ≥60 years-old (PR=1.12; 95%CI: 1.00-1.24), using removable prosthesis in one arch (PR=1.23; 95% CI: 1.04-1.46), or in both arches (PR=1.22; 95% CI: 1.04-1.45) had higher likelihood of having inadequate protein intake. In contrast, individuals with functional dentition (PR=0.78; 95%CI: 0.64-0.94) were less likely to report inadequate protein consumption.

Conclusions: Demographic factors, such as sex and age, and systemic and oral conditions, such as functional dentition, use of removable prostheses and taste perception, were significantly associated with inadequate macronutrient intake.

3.2 INTRODUCTION

A fundamental basis to maintain general health is a balanced diet that includes an adequate combination of macronutrients, comprising carbohydrates, fibers, lipids, and proteins. These nutrients are crucial for providing energy and supplying the essential elements for the body's proper functioning [1]. Among the methods for assessing food consumption, nutrient intake, and energy intake, Food Frequency Questionnaires (FFQ) are tools widely used in epidemiological studies. FFQs are based on the frequency of consumption of each item on a determined food list over a specific period (ranging from months to a year), allowing for a detailed analysis of dietary patterns and nutrient intake [2,3].

Diet and nutrition play fundamental roles in the prevention of non-communicable chronic diseases (NCDs) [4]. An inadequate dietary pattern, combined with lifestyle factors, can contribute to an increase in these conditions [4]. To assess the risk of developing NCDs, anthropometric data such as body mass index (BMI) and waist circumference (WC) can be used. BMI is a relevant tool for identifying the risk of obesity, which is a global concern due to associated health problems, such as diabetes mellitus (DM), hypertension, coronary artery disease, and dyslipidemia [5,6]. Additionally, WC helps assess the risk of developing cardiovascular diseases and other comorbidities, with classifications based on sex and risk level, which can be categorized as increased or very increased [5,6].

NCDs are currently a main public health issue globally, with a particular emphasis on DM [7]. Prolonged hyperglycemia associated with DM can lead to a range of oral changes, including dry mouth [8], dental caries [9], periodontal disease [10], burning mouth syndrome [11], taste disturbances [12] and increased susceptibility to oral infections [13].

Oral manifestations of T2D can directly influence dietary habits and the intake of various nutrients due to decreased masticatory function. This fact, in turn, can lead to dietary restrictions and impaired food bolus formation [14,15], which will be associated with worsened levels of blood glycemia. Some studies have already demonstrated that edentulous individuals have lower fiber consumption and higher fat and carbohydrates intake, and healthy edentulous elderly individuals have higher BMIs and a greater tendency towards weight gain [16,17]. Additionally, dietary patterns in individuals with T2D can be linked to

increased risk of both coronal and root dental caries [9] due to high frequency of fermentable carbohydrate consumption. This not only compromises oral health but can also lead to greater tooth loss, further impairing nutrition and perpetuating a harmful cycle [18].

Research on dietary composition associated with oral and general health is of utmost relevance, as these factors are interconnected and simultaneously impact general health and quality of life. Therefore, this study aimed to investigate systemic and oral alterations associated with inadequate macronutrient consumption in adults and elderly individuals with or without Type 2 DM (T2D).

3.3 METHODS

Study design and ethics

This is a cross-sectional study reported according the STROBE checklist. It was approved by the Ethics Committee of the School of Health Sciences (No. 87962818.4.0000.0030). After understanding all the information about the research and agreeing to participate in the study, all participants signed an informed consent form.

Participants

The study sample consisted of participants who attended dental clinics of the University Hospital of Brasília (HUB/EBSERH). Recruitment and examinations were conducted between March 2023 and December 2023. Inclusion criteria were adults (≥35 years) who were dentate (at least one tooth in their mouth). Exclusion criteria were individuals with type 1 DM, those with severe systemic complications and comorbidities, pregnant or postpartum women, transplant recipients, individuals with a history of epilepsy, or those with systemic conditions that might affect salivary gland physiology, such as Sjögren's syndrome, or those who had undergone head and neck radiotherapy or chemotherapy within the past 3 months. Additionally, individuals with physical disabilities preventing the measurement of height/weight and waist circumference while standing, such as cerebral palsy, paraplegia, and tetraplegia, were excluded.

Variables

Sociodemographic parameters

Sociodemographic parameters were analyzed according to the guidelines of Patient-Centered Outcomes for Adult Oral Health [19] and included information on sex and age, classified as "adults" (≥ 35 years and < 60 years) and "elderly individuals" (≥ 60 years). Educational level was recorded according to the Brazilian Institute of Geography and Statistics (IBGE) for individuals with ≥ 25 years, based on the Continuous National Household Sample Survey 2012-2019.

Individuals were classified according to the number of years of study, as follows: "≤ 8 years" (no schooling, incomplete primary education, complete primary education), "9-11 years" (incomplete secondary education, complete secondary education), and "≥ 12 years" (higher education).

General health

Body Mass Index (BMI)

Information on general health included anthropometric data collected by a nutritionist (LSMA) and nurse trainees supervised by a specialized nurse (SB). To calculate BMI, weight (kg) was divided by height (m^2). Height was measured with a tape measure, and weight was recorded using a digital scale from Original Line® with a maximum capacity of 180 kg. Both procedures followed the Anthropometry Manual of the National Health Survey 2013 [20]. BMI classification was performed according to the categories established by the WHO, 2000 [6], with individuals categorized as “normal” (normal weight and underweight) and “overweight/obese” (overweight and the three degrees of obesity).

Waist circumference (WC)

For the measurement of WC, an anthropometric tape from FitMetria, made of flexible and inelastic fiberglass with a measuring range up to 200 cm was used, following the Anthropometry Manual of the National Health Survey 2013 [19]. WC classification was based on the WHO, 2000 [6] criteria, according to sex and risk of metabolic complications. Individuals were categorized as: “normal” (no risk) and “at risk” (increased and very increased risk of cardiovascular diseases).

Diabetes e C-reactive protein

For the diagnosis of T2D and the assessment of inflammation markers, tests for glycated hemoglobin (HbA1c; %) and C-reactive protein (CRP; mg/L) were performed at the university hospital’s specialized clinical analysis laboratory. Individuals were classified based on glycemic control levels into two groups: “no” (normoglycemic - HbA1c ≤ 6.5%) and “yes” (hyperglycemic - HbA1c > 6.5%), according to the Guidelines of the Brazilian Diabetes Society [21]. For evaluating inflammation presence, CRP was classified as “normal” (< 0.5 mg/L)

and “increased” (≥ 0.5 mg/L), based on the reference values established by the laboratory.

Smoking

The history of cigarette use was analyzed according to the guidelines of Patient-Centered Outcomes for Adult Oral Health [19]. Individuals were classified into the following categories: “never” (non-smoker), “former” (former smoker), and “current” (active smoker).

Oral health

Calibrated examiners for the dental examination assessed the number of natural teeth in the mouth, including third molars, as well as the presence of removable prostheses. Individuals were classified regarding the use of removable prostheses as “no” (no removable prosthesis), “one arch” (removable prosthesis in one arch, either total or partial prosthesis), or “two arches” (removable prostheses in both arches, either total or partial). Regarding functional dentition, individuals were classified as “yes” (≥ 20 teeth) or “no” (< 20 teeth).

Variables related to worsened sense of taste and discomfort when eating were measured using adaptation of the OHIP-14 [22]. To assess worsened sense of taste, the following question was asked: “Have you felt that the taste of food has become worse because of problems with your teeth, mouth, or dentures?” To assess discomfort when eating, the question was: “Have you felt uncomfortable eating any food because of problems with your teeth, mouth, or dentures?” Individuals were classified based on their responses to both questions into the categories: “never,” “rarely/occasionally,” and “often/very often.” Additionally, for salivary flow rate, stimulated saliva samples were collected and sialometry (ml/min) was evaluated, following the protocol established by Vieira Lima et al, 2023 (23).

Macronutrients

For the analysis of macronutrient consumption, participants completed a quantitative Food Frequency Questionnaire (FFQ), validated for the population of

Porto Alegre, South Brazil, and adapted for the population of Brasília, Federal District, Brazil [2]. The FFQ consisted of 29 food items that reflect the local diet. Carbohydrates were represented by foods such as white/whole wheat bread, cakes, savory snacks, biscuits, roots, white/whole grain rice, sweets, and sugary beverages. Lipids were represented by foods like fried snacks, fast food sandwiches, cheese, milk, and others. Proteins were primarily represented by foods such as meats, milk, and cheese. Finally, fibers were represented by foods such as fruits, leguminous vegetables (such as beans), whole grains, nuts, and others. Information on food intake was converted into daily intake (grams [g] or milliliters [ml]) using an Excel spreadsheet that automatically converted the data reported in the FFQ. To estimate the daily consumption of macronutrients, the Brazilian Table for the Evaluation of Food Consumption in Household Measures [24] and the Brazilian Food Composition Table (TACO) [25] were used. All data conversion from the FFQ was performed by a nutritionist (LSMA).

The average recommendations for adequate daily macronutrient intake are: 55% to 60% of daily energy in carbohydrates, 20% to 30% lipids, and 15% to 20% proteins [26]. For fibers, the daily recommendation is at least 25 g/day [27]. For this study, negative outcomes were: 1) high carbohydrate intake, categorized as > 60%; 2) high lipid intake, categorized as over 30%; 3) inadequate protein intake, categorized as less than 15% and more than 20%; and 4) low fiber intake, categorized as less than 25 g/day.

Sample size

A general sample size calculation was performed using the OpenEpi software (version 3.0 opensource calculator - SSMean) for the main study, based on a 15% difference in outcome prevalence between individuals with and without T2D from a previous study [23], with a study power of 80%, an alpha of 5%, a ratio of 2:1 (two individuals with T2D for each individual without T2D), and a 30% loss rate, resulting in a total of 170 individuals to be examined.

Statistical analysis

The outcomes of the study were high carbohydrate intake (>60%), high lipid intake (>30%), inadequate protein intake (<15% or >20%), and low fiber intake (<25 g/day). The explanatory variables were socio-demographics (sex, age, education), general health (weight status, waist circumference, glycemic control, C-reactive protein, smoking), and oral health (removable prosthesis, functional dentition, worsened sense of taste, discomfort when eating).

Data analysis was conducted using STATA software (Stata 14.2 for Windows; Stata Corporation, College Station, TX, USA), and the research commands considered the study design, including robust variance estimates. Poisson regression was carried out using unadjusted models, and variables that showed associations with $P < 0.2$ or those that were considered plausible were selected for the adjusted models. Age and glycemic control were included in the adjusted models irrespective of their p-values based on the previous literature. Removable prosthesis and functional dentition were also included in the adjusted models irrespective of their p-values since they are considered the main oral health variables. Prevalence ratios (PR) and the 95% confidence intervals (IC) were estimated. The statistical significance level was set at 5%.

3.4 RESULTS

A total of 187 individuals were recruited, of whom 17 did not meet the inclusion criteria (Figure 1). The final sample comprised 170 individuals, including 109 females and 61 males. Among the participants, 71% were adults and 29% were elderly individuals. Additionally, 57 individuals were in hyperglycemia, 76% were overweight and/or obese, and 83% had a high risk of cardiovascular diseases associated with waist circumference. The prevalence of high carbohydrate intake and high lipids intake was low in the studied sample (18% and 9%, respectively). Low fiber intake was observed in 68% of the individuals, being 60% among those using prosthesis in one arch and 89% among those with prostheses in both arches. The prevalence of inadequate protein intake was also high (92%).

Table 1 shows the high carbohydrate consumption according to the explanatory variables. After adjusting for other factors, individuals with high-risk of cardiovascular diseases as per their waist circumference (PR = 0.23; CI: 0.11-0.50) and those with functional dentition (PR = 0.27; CI: 0.10-0.75) were less likely to have high carbohydrate consumption. In contrast, individuals who reported a worsened sense of taste (often/very often) in relation to their food consumption due to their teeth, mouth, or prosthesis were about 4 times more likely to have high carbohydrate consumption (PR = 3.84; CI: 1.36-10.83).

Table 2 shows the association between explanatory variables and high lipid consumption. In the unadjusted analysis, salivary flow rate showed a borderline association with increased lipid consumption. After adjusting for other factors, it reached statistical significance. For every increase of 1 ml/min in stimulated saliva flow rate, there was a 79% reduction in the likelihood of having high lipid intake (PR = 0.21; CI: 0.05-0.89).

Low fiber consumption results can be found in Table 3. After adjusting for other factors, including salivary flow rate, it was observed that male individuals were less likely to have how fiber consumption (PR = 0.72; CI: 0.54-0.96) , while the presence of prostheses in both arches was associated with a 40% higher likelihood of having low fiber consumption (PR = 1.40; CI: 1.07-1.81). In the adjusted analysis excluding salivary flow rate, the same factors remained associated, but an additional association was observed: people with high

cardiovascular risk as per waist circumference had an 86% higher likelihood of having low fiber consumption (PR = 1.86; CI: 1.06-3.26).

Table 4 shows the association between explanatory variables and inadequate protein consumption. After adjusting for other factors, elderly individuals (PR = 1.12; CI: 1.00-1.24), and those using prosthesis in one arch (PR = 1.23; CI: 1.04-1.46) or in both arches (PR = 1.22; CI: 1.04-1.45) were more likely to consume protein inadequately, by 12%, 23%, and 22%, respectively. In contrast, individuals without functional dentition (PR = 0.78; CI: 0.64-0.94) had lower likelihood of inadequate protein consumption.

3.5 DISCUSSION

In the present study, the consumption of carbohydrates, lipids, fibers, and proteins was evaluated. The objective of the study was to investigate whether inadequate intake of macronutrients is associated with age, as well as with systemic and oral conditions, especially the ones associated with T2D. We confirmed that systemic and oral conditions, as well as age, were associated with inadequate patterns of macronutrient consumption, increasing their risk for NCDs.

A high carbohydrate intake was associated with a worsening in taste perception related to teeth, mouth, or prosthesis (OHIP-14), confirming literature findings that individuals with altered taste may seek or consume more intense sweet-tasting foods to compensate for this weakened perception [28,29]. In contrast, individuals with no functional dentition and those at risk to cardiovascular diseases due to waist circumference had a lower likelihood of consuming high amounts of carbohydrates (Table 1). These results differ from those found in the literature, where edentulous individuals are reported to have higher carbohydrates intake and higher-calorie foods, leading to increased body weight [16,17,30]. We believe that our result can be explained by the fact that most individuals in the sample with a previous diagnosis of T2D had controlled blood glucose levels, suggesting effective medical and/or nutritional monitoring for diet management.

Interestingly, salivary flow rate was associated with lipid intake, as shown in Table 2. This suggests that higher saliva production may be inversely related to high lipid intake, possibly indicating that good salivary function can positively influence eating habits and reduce lipid consumption. Saliva plays essential roles in chewing and swallowing, primarily through the lubrication of food [31]. A study by Brudevold et al. (1990) investigated how specific food ingredients affect salivation and oral retention. The researchers observed that fat-free cookies were much harder and more difficult to chew compared to cookies containing fat. Adding fat to the cookies not only softened the texture, making chewing easier and reducing the time needed to chew, but also significantly increased the volume of saliva produced [32]. These results are consistent with our finding that food preparations with fat can soften foods and facilitate grinding, especially in

individuals with reduced salivary flow rate, which may lead to an increased consumption of lipids.

In the adjusted Poisson regression model for fiber consumption, it was observed that male individuals are less likely to have low fiber intake, while aged individuals did not show a significant association with low fiber intake. This finding contrasts with the literature, which indicates that elderly individuals typically have lower amounts of fiber in their diet [33]. Additionally, individuals who use dentures on both arches were more likely to have less fiber intake. This result is consistent with the literature, which suggests that denture use is associated with lower intake of fruits and vegetables [34]. This may be explained by the fact that dentures can reduce biting force and chewing efficiency, especially if they are not well-fitted or are unstable, making it difficult to chew harder foods [35]. In the adjusted model excluding salivary flow rate, individuals with high cardiovascular risk due to waist circumference showed a higher likelihood of having low fiber consumption (Table 3). This result aligns with the literature, which suggests that adequate fiber intake helps with weight control and reduces the risk of cardiovascular diseases [27,36]. Fibrous foods, such as fruits and vegetables, can be a good stimulus for salivary flow [31,37]. However, these foods can also be tougher and, therefore, require adequate salivary flow to facilitate chewing and swallowing.

Inadequate protein consumption was associated with aged individuals and those using removable prostheses, whether in one arch or both, corroborating the literature. Elderly individuals often have reduced protein intake, which can lead to health issues such as sarcopenia, characterized by the loss of muscle mass and strength [38,39]. Additionally, the use of removable prostheses can make it more difficult to consume harder foods, such as meats [35]. Individuals without functional dentition were less likely to consume inadequate protein, a finding that contrasts with some studies in the literature. Ervin and Dye (2009) indicated that having functional dentition, defined as 21 or more teeth, does not significantly contribute to better scores on the healthy eating index or nutrient intake among the elderly individuals, compared to individuals with 20 or fewer teeth [34]. Their result differs from the findings of Zhu and Hollis (2014), who demonstrated that adults with functional dentition, defined as 21 or more teeth, tend to have more adequate energy and macronutrient intake compared to individuals with 20 or fewer teeth [17]. It is important to emphasize that functional

dentition depends not only on the number of teeth present but also on their distribution and occlusion capacity in the dental arches [40].

The strengths of the study include an adequate and calculated sample size. HbA1c was used to assess the glycemic status instead of presence of self-reported diagnosis of T2D. Even though a diagnosis of T2D is relevant, a person with T2D who has well-controlled HbA1c levels may have a reduced risk of complications associated with the disease. Another strength of our study is that all examiners were calibrated for clinical data collection, and the study encompasses a range of variables including socioeconomic aspects, general and oral health. Additionally, the examiner team is multidisciplinary, including dental and nursing teams, and a nutritionist, adding more reliability to the data. The limitations of the study include a self-selected on-demand population attended in a dental clinic of a hospital, which tends to be more health-conscious than individuals that do not seek for dental treatment. This may have influenced some results, as around one third of the participants were well-controlled diabetics. Furthermore, during the FFQ interview, some participants reported having recently changed their diet. The FFQ used was validated for the population of Southern Brazil, and the adaptation for the Brazilian Midwest adult population based on slightly differences in dietary habits has yet to be validated. Additionally, some participants found the FFQ questionnaire lengthy and tiring. Another aspect to be mentioned is the low prevalence of high lipids consumption (9%) observed in this sample, which may have affected the study power for this outcome. Finally, as this is a cross-sectional study assessing the population at a specific point in time, longitudinal studies are needed to validate the findings, observing direction of the associations, as well as potential cause-effect relationship.

3.6 CONCLUSION

In conclusion, demographic factors, such as sex and age, and systemic and oral conditions, such as functional dentition, use of removable prosthesis, salivary flow rate and taste perception were significantly associated with inadequate macronutrient consumption. However, it is not yet clear whether it is the existing condition that leads to changes in diet, or if dietary changes increase the risk of oral problems, further altering the diet. Therefore, these associations should now be investigated in longitudinal studies to investigate cause-effect relationships.

3.7 REFERENCES

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Figure and Tables

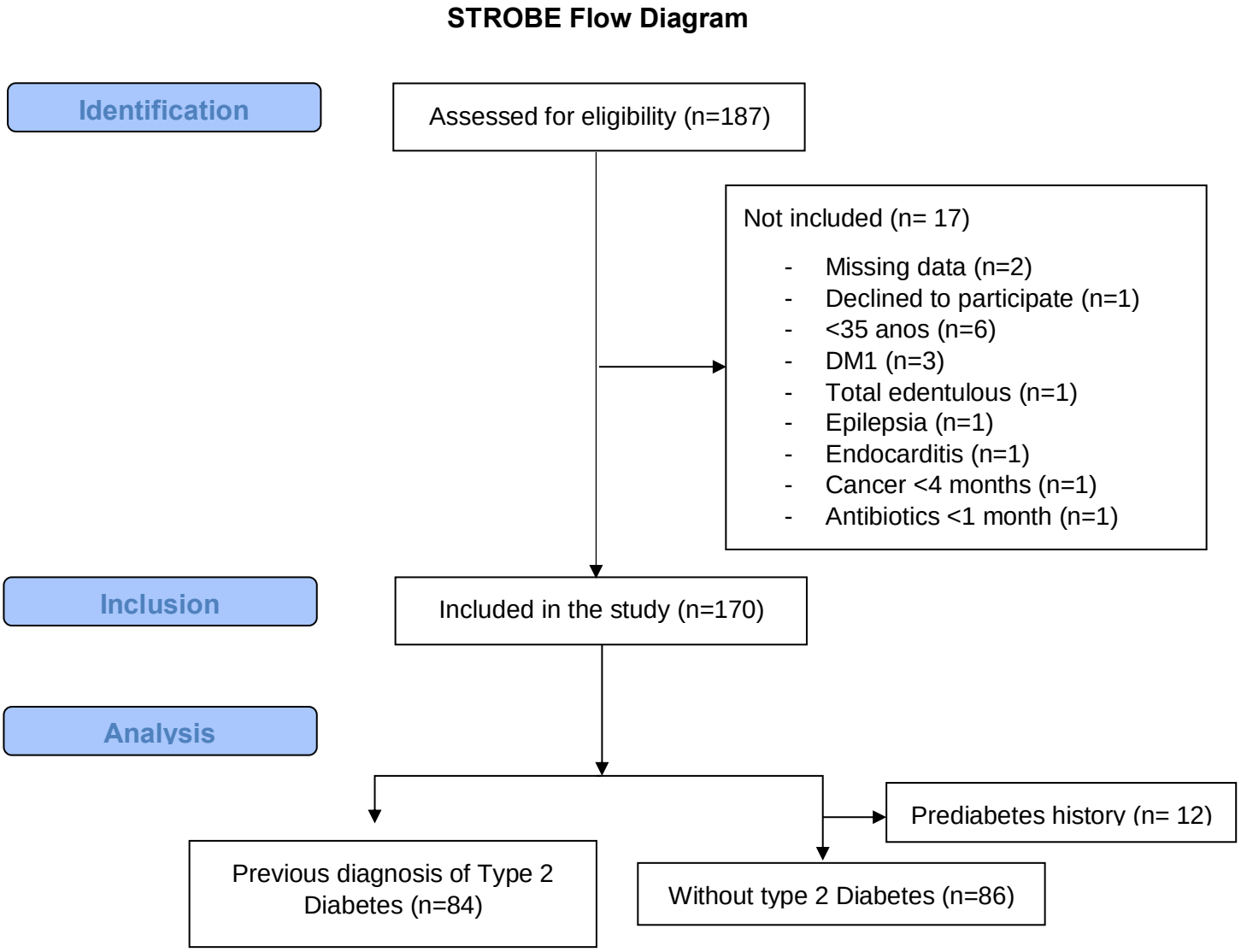

Figure 1. Flowchart of the study recruitment.

Table 1. Sample distribution and the association between explanatory variables and high carbohydrates intake (Poisson regression analysis).

	n (%)	Prevalence	Unadjusted		Adjusted
			PR (95% CI)	p	PR (95% CI)
Socio-demographics					
Sex					
Female	109 (64)	17 (16)	1.00		-
Male	61 (36)	13 (21)	1.37 (0.71-2.62)	0.35	-
Age					
Adult	120 (71)	23 (19)	1.00		1.00
Elderly	50 (29)	7 (14)	0.73 (0.33-1.60)	0.43	1.20 (0.50-2.86)
Education					
≤ 8 years	50 (29)	10 (20)	1.00		-
9-11 years	66 (39)	11 (17)	0.83 (0.38-1.81)	0.65	-
≥ 12 years	54 (32)	9 (17)	0.83 (0.37-1.89)	0.66	-
General health					
Weight status[£]					
Normal BMI	40 (24)	10 (25)	1.00		-
Overweight/Obese	126 (76)	16 (12)	0.51 (0.25-1.03)	0.06	-
Waist Circumference[£]					
Normal	29 (17)	10 (34)	1.00		1.00
At risk for cardiovascular diseases	137 (83)	16 (12)	0.34 (0.17-0.67)	0.002	**0.23 (0.11-0.50)***
Glycemic control (HbA1c)[£]					
Normoglycemic	100 (64)	17 (17)	1.00		1.00
Hyperglycemic	57 (36)	9 (16)	0.93 (0.44-1.95)	0.85	1.03 (0.47-2.24)
C-reactive protein[£]					
Normal	118 (69)	21 (18)	1.00		-
Increased	52 (31)	9 (17)	0.97 (0.48-1.98)	0.94	-
Smoking					
Never	111 (65)	17 (15)	1.00		1.00
Former	44 (26)	8 (18)	1.19 (0.55-2.56)	0.66	1.12 (0.50-2.51)
Current	15 (9)	5 (33)	2.18 (0.94-5.05)	0.07	1.79 (0.61-5.23)
Oral health					
Removable prosthesis					
No	112 (66)	20 (18)	1.00		1.00
One arch	30 (18)	6 (20)	1.12 (0.49-2.55)	0.79	1.32 (0.47-3.71)
Two arches	28 (16)	4 (14)	0.8 (0.30-2.16)	0.66	1.99 (0.57-7.00)
Functional dentition[£]					
Yes (≥20 teeth)	53 (32)	5 (9)	1.00		1.00
No (<20 teeth)	114 (68)	22 (19)	2.05 (0.04-0.22)	0.13	**0.27 (0.10-0.75)***
Worsened sense of taste*					
Never	123 (72)	19 (15)	1.00		1.00
Rarely/occasionally	29 (17)	5 (17)	1.12 (0.45-2.75)	0.81	1.43 (0.54-3.81)
Often/very often	18 (11)	6 (33)	2.16 (0.99-4.69)	0.05	**3.84 (1.36-10.83)***
Discomfort when eating**					
Never	67 (39)	13 (19)	1.00		-
Rarely/occasionally	45 (26)	7 (16)	0.80 (0.35-1.86)	0.60	-
Often/very often	58 (34)	10 (17)	0.89 (0.42-1.88)	0.76	-
Salivary flow rate	-	-	1.75 (0.80-3.82)	0.16	1.43 (0.56-3.65)
Total	170 (100)	30 (18)			

[£] Missing data.
BMI, body mass index; PR, prevalence ratio; CI, confidence interval.
* p<0.05.

Table 2. Association between explanatory variables and high lipids intake (Poisson regression analysis).

	Prevalence	Unadjusted		Adjusted
		PR (95% CI)	p	PR (95% CI)
Socio-demographics				
Sex				
Female	10 (9)	1.00		-
Male	6 (10)	1.07 (0.41-2.81)	0.89	-
Age				
Adult	13 (11)	1.00		1.00
Elderly	3 (6)	0.55 (0.16-1.87)	0.34	0.42 (0.12-1.45)
Education				
≤ 8 years	7 (14)	1.00		-
9-11 years	3 (5)	0.32 (0.09-1.20)	0.09	-
≥ 12 years	6 (11)	0.79 (0.29-2.21)	0.66	-
General health				
Weight status				
Normal BMI	2 (5)	1.00		-
Overweight/Obese	10 (8)	1.16 (0.36-7.0)	0.54	-
Waist				
Normal	2 (7)	1.00		1.00
At risk for cardiovascular diseases	10 (7)	1.06 (0.24-4.60)	0.94	1.16 (0.30-4.54)
Glycemic control (HbA1c)				
Normoglycemic	10 (10)	1.00		1.00
Hyperglycemic	3 (5)	0.53 (0.15-1.84)	0.31	0.20 (0.03-1.53)
C-reactive protein				
Normal	13 (11)	1.00		-
Increased	3 (6)	0.52 (0.16-1.77)	0.30	-
Smoking				
Never	9 (8)	1.00		
Former	6 (14)	1.68 (0.63-4.46)	0.30	-
Current	1 (7)	0.82 (1.11-6.08)	0.84	-
Oral health				
Removable prosthesis				
No	10 (9)	1.00		1.00
One arch	4 (13)	1.49 (0.50-4.44)	0.47	1.65 (0.36-7.69)
Two arches	2 (7)	0.8 (0.18-3.46)	0.77	1.40 (0.31-6.23)
Functional dentition				
Yes (≥20 teeth)	3 (6)	1.00		1.00
No (<20 teeth)	13 (8)	1.55 (0.44-5.42)	0.49	0.97 (0.31-3.00)
Worsened sense of taste*				
Never	10 (8)	1.00		-
Rarely/occasionally	3 (10)	1.27 (0.37-4.35)	0.70	-
Often/very often	3 (17)	2.05 (0.62-6.77)	0.24	-
Discomfort when eating**				
Never	9 (13)	1.00		-
Rarely/occasionally	3 (7)	0.50 (0.14-1.74)	0.27	-
Often/very often	4 (7)	0.51 (0.17-1.59)	0.25	-
Salivary flow rate	-	0.21 (0.04-1.01)	0.05	**0.21 (0.05-0.89)***
Total	16 (9)			

BMI, body mass index; PR, prevalence ratio; CI, confidence interval.
* $p<0.05$.

Table 3. Association between explanatory variables and low fiber intake (Poisson regression analysis).

	Prevalence	Unadjusted		Adjusted[a]	Adjusted[b]
		PR (95% CI)	p	PR (95% CI)	PR (95% CI)
Socio-demographics					
Sex					
Female	84 (77)	1.00		1.00	1.00
Male	32 (52)	0.68 (0.52-0.88)	0.004	**0.72 (0.54-0.96)***	**0.76 (0.58-0.99)***
Age					
Adult	77 (64)	1.00		1.00	1.00
Elderly	39 (78)	1.22 (1.0-1.48)	0.055	1.21 (0.96-1.52)	1.21 (0.99-1.48)
Education					
≤ 8 years	32 (64)	1.00		-	-
9-11 years	44 (67)	1.04 (0.80-1.36)	0.77	-	-
≥ 12 years	40 (74)	1.16 (0.89-1.50)	0.27	-	-
General health					
Weight status					
Normal BMI	29 (73)	1.00		-	-
Overweight/Obese	87 (69)	0.95 (0.76-1.19)	0.67	-	-
Waist					
Normal	11 (38)	1.00		1.00	1.00
At risk for cardiovascular diseases	105 (77)	2.02 (1.26-3.25)	0.004	1.72 (0.98-3.01)	**1.86 (1.06-3.26)***
Glycemic control (HbA1c)					
Normoglycemic	70 (70)	1.00		1.00	1.00
Hyperglycemic	37 (65)	0.93 (0.74-1.17)	0.52	0.98 (0.78-1.24)	0.94 (0.76-1.17)
C-reactive protein					
Normal	78 (66)	1.00		-	-
Increased	38 (73)	1.11 (0.90-1.36)	0.35	-	-
Smoking					
Never	81 (73)	1.00		-	-
Former	26 (59)	0.81 (0.62-1.06)	0.13	-	-
Current	9 (60)	0.82 (0.54-1.26)	0.37	-	-
Oral health					
Removable prosthesis					
No	73 (65)	1.00		1.00	1.00
One arch	18 (60)	0.92 (0.67-1.27)	0.62	1.06 (0.75-1.49)	1.06 (0.78-1.44)
Two arches	25 (89)	1.37 (1.14-1.65)	0.001	**1.40 (1.07-1.81)***	**1.37 (1.07-1.75)***
Functional dentition					
Yes (≥20 teeth)	39 (74)	1.00		1.00	1.00
No (<20 teeth)	77 (68)	0.92 (0.75-1.13)	0.42	0.89 (0.68-1.15)	0.89 (0.70-1.15)
Worsened sense of taste*					
Never	83 (67)	1.00		-	-
Rarely/occasionally	21 (72)	1.07 (0.83-1.39)	0.59	-	-
Often/very often	12 (67)	0.99 (0.70-1.40)	0.95	-	-
Discomfort when eating**					
Never	45 (67)	1.00		-	-
Rarely/occasionally	32 (71)	1.05 (0.82-1.36)	0.66	-	-
Often/very often	39 (67)	1.00 (0.78-1.28)	0.99	-	-
Salivary flow rate	-	0.86 (0.59-1.26)	0.44	1.03 (0.75-1.42)	-
Total	116 (68)				

BMI, body mass index; PR, prevalence ratio; CI, confidence interval.
[a] Adjusted model including salivary flow rate; [b] Adjusted model not including salivary flow rate.
* $p<0.05$.

Table 4. Association between explanatory variables and inadequate protein intake (Poisson regression analysis).

	Prevalence	Unadjusted		Adjusted
		PR (95% CI)	p	PR (95% CI)
Socio-demographics				
Sex				
Female	101 (93)	1.00		-
Male	55 (90)	0.97 (0.88-1.07)	0.59	-
Age				
Adult	109 (91)	1.00		1.00
Elderly	47 (94)	1.03 (0.95-1.13)	0.46	**1.12 (1.00-1.24)***
Education				
≤ 8 years	46 (92)	1.00		-
9-11 years	58 (88)	0.96 (0.85-1.08)	0.46	-
≥ 12 years	52 (96)	1.05 (0.95-1.15)	0.36	-
General health				
Weight status				
Normal BMI	36 (90)	1.00		-
Overweight/Obese	116 (92)	1.02 (0.91-1.14)	0.70	-
Waist				
Normal	24 (83)	1.00		1.00
At risk for cardiovascular diseases	128 (93)	1.13 (0.95-1.34)	0.17	1.06 (0.90-1.25)
Glycemic control (HbA1c)				
Normoglycemic	89 (89)	1.00		1.00
Hyperglycemic	55 (96)	1.08 (1.0-1.18)	0.06	1.07 (0.98-1.17)
C-reactive protein				
Normal	107 (91)	1.00		-
Increased	49 (94)	1.04 (0.95-1.14)	0.40	-
Smoking				
Never	101 (91)	1.00		1.00
Former	42 (95)	1.05 (0.96-1.14)	0.28	1.02 (0.92-1.14)
Current	13 (87)	0.95 (0.77-1.17)	0.65	0.99 (0.90-1.25)
Oral health				
Removable prosthesis				
No	101 (90)	1.00		1.00
One arch	28 (93)	1.03 (0.92-1.16)	0.55	**1.23 (1.04-1.46)***
Two arches	27 (96)	1.07 (0.97-1.17)	0.16	**1.22 (1.04-1.45)***
Functional dentition				
Yes (≥20 teeth)	46 (87)	1.00		1.00
No (<20 teeth)	107 (94)	1.08 (0.96-1.21)	0.18	**0.78 (0.64-0.94)***
Worsened sense of taste*				
Never	112 (91)	1.00		-
Rarely/occasionally	27 (93)	1.02 (0.91-1.15)	0.70	-
Often/very often	17 (94)	1.04 (0.92-1.18)	0.57	-
Discomfort when eating**				
Never	63 (94)	1.00		-
Rarely/occasionally	42 (93)	0.99 (0.90-1.10)	0.88	-
Often/very often	51 (88)	0.94 (0.84-1.05)	0.25	-
Salivary flow rate	-	1.05 (0.96-1.15)	0.25	1.09 (0.97-1.22)
Total	156 (92)			

BMI, body mass index; PR, prevalence ratio; CI, confidence interval.
* $p<0.05$.

4. CAPÍTULO 4 – DISCUSSÃO GERAL E CONCLUSÕES DA DISSERTAÇÃO

4.1 DISCUSSÃO GERAL

Nutrição, saúde geral e bucal exercem uma relação de multidirecionalidade. O consumo alimentar pode ser influenciado por condições bucais e sistêmicas. Uma dieta inadequada afeta o consumo de macronutrientes, aumentando o risco de problemas bucais e sistêmicos, resultando no que aqui denominamos como "Ciclo Vicioso da má Nutrição e Doenças Orais". Com o envelhecimento da população, o número de casos de DCNT tem aumentado, e essa alteração da dieta pode aumentar o risco para essas doenças. Nesta dissertação, destacamos a DM que, além de ter consequências em diversos sistemas no corpo humano, também tem diversas manifestações bucais, como doenças periodontais, cárie, redução do fluxo salivar e alteração do paladar [1,2,3,4,5].

A diminuição da função do paladar pode ter várias causas, dentre as quais a idade avançada e as doenças crônicas estão entre as mais comuns [6,7]. No capítulo 2 desta dissertação, observamos que, de maneira geral, os idosos apresentam uma percepção gustativa reduza em comparação com os adultos. Observamos que houve diferença estatística para os sabores doce, salgado e umami comparando idosos com adultos, enquanto os sabores azedo e amargo não apresentaram diferenças significativas entre os grupos.

Indivíduos com paladar alterado podem consumir alimentos mais doces para compensar essa percepção enfraquecida [5,8]. Em relação às preferências dos idosos por carboidratos e à alteração da dieta causada pela distorção do paladar, não conseguimos obter uma resposta a essa pergunta na revisão sistemática (capítulo 2). Porém, no capítulo 3, que trata do estudo transversal realizado, observamos que indivíduos que relataram piora no sabor dos alimentos devido a problemas dentários, na boca ou em próteses dentárias apresentavam 4 vezes mais chance de ter um alto consumo de carboidratos, independentemente da idade. Um alto consumo de carboidratos ou alimentos açucarados pode aumentar o risco de desenvolvimento ou piora de algumas condições bucais. Na doença cárie, por exemplo, os microrganismos se

beneficiam da alta frequência de açúcar, o que leva a um pH ácido devido à produção de ácidos, resultando na desmineralização da estrutura dental. Além disso, o alto consumo de açúcares adicionados está associado a doença periodontal, contribuindo para a inflamação sistêmica [9,10]. Ainda, quando se tem um consumo controlado de carboidratos o risco de desenvolver DM e outras comorbidades pode ser reduzido [11].

A doença periodontal e a doença cárie podem levar à perda de elementos dentários [12,13,14], podendo apresentar alterações no consumo alimentar como o aumento da ingestão de carboidratos e um menor consumo de fibras [15,16]. Nas análises do estudo transversal, observamos que indivíduos com dentição funcional (≥20 dentes) apresentaram menores chances de consumir grandes quantidades de carboidratos. Além disso, indivíduos com DM não apresentaram associação direta com consumo elevado de carboidratos, nem com uma ingestão inadequada dos demais macronutrientes. Uma hipótese para esses resultados é de que os indivíduos da amostra apresentaram níveis de glicemia e marcadores de inflamação controlados, sugerindo o acompanhamento com um médico e/ou nutricionista para o manejo da doença e planejamento adequado da dieta. Em relação ao consumo baixo de fibras, não encontramos associação com a dentição funcional nos nossos achados. Além disso, indivíduos com dentição funcional apresentaram menores chances de consumo inadequado de proteínas. Vale ressaltar que a distribuição dos dentes na arcada é importante para função mastigatória, não só apenas o número de dentes presentes [17].

Os indivíduos idosos e aqueles com prótese em uma arcada apresentaram maiores chances de consumir proteínas de forma inadequada. Além disso, indivíduos que usavam próteses em ambas as arcadas mostraram maior probabilidade de consumir proteínas de forma inadequada e de consumir fibras abaixo do recomendado. É relatado que indivíduos idosos frequentemente apresentam ingestão reduzida de proteínas, o que pode levar a problemas de saúde como a sarcopenia [18,19]. Em relação a presença de prótese, isso pode ser explicado pela redução da força de mordida e pela eficiência da mastigação em indivíduos que utilizam próteses dentárias, principalmente se estas estiverem desajustadas, dificultando a mastigação de alimentos duros [20].

O fluxo salivar mostrou que, a cada aumento de ml/min na taxa do fluxo salivar estimulado, há uma redução na chance de alto consumo de lipídeos. Isso pode ser explicado pelo fato de que a gordura pode deixar os alimentos mais moles e, portanto, facilitar a mastigação. Em contrapartida, alimentos sem gordura tendem a ser mais duro e necessitam de mais saliva para lubrificação auxiliando na mastigação [21].

A circunferência de cintura com alto risco apresentou menores chances de consumir grandes quantidades de carboidratos e maiores chances de baixo consumo de fibras, sem a presença de saliva no modelo ajustado. Por se tratar de uma população de livre demanda, pode-se inferir que são pessoas que já apresentam um cuidado com a saúde, o que pode incluir o consumo alimentar mais controlado. Alimentos fibrosos podem estimular o fluxo salivar, auxiliar no controle do peso e reduzir o risco de doenças cardiovasculares [11,22]. Por outro lado, alimentos fibrosos são mais duros e necessitam de um fluxo salivar adequado para facilitar a mastigação e deglutição. Não se sabe ao certo se é o aumento do consumo de fibra que melhora o fluxo salivar ou se é a presença do fluxo salivar normal que promove um aumento no consumo de fibras.

Por todo o exposto, acreditamos que os cirurgiões-dentistas são essenciais para romper esse Ciclo vicioso da má Nutrição e Doenças Orais, sendo necessários na equipe multiprofissional no cuidado do idoso e das pessoas com DCNT, em especial a DM.

4.2 CONCLUSÕES

Em conclusão, a percepção do paladar pode se apresentar alterada com o avanço da idade, o que pode levar a uma modificação na dieta, como um aumento no consumo de carboidratos ou alimentos açucarados. Essas mudanças podem elevar o risco de problemas bucais, como as doenças cárie e periodontal, além de doenças sistêmicas, incluindo DM, doenças cardiovasculares e obesidade. Algumas condições bucais, como a taxa de fluxo salivar reduzida e o uso de próteses, podem interferir no consumo adequado de macronutrientes. Por outro lado, a dentição funcional está associada a uma menor probabilidade de consumo inadequado de carboidratos e proteínas. A circunferência da cintura, quando indicativa de alto risco de desenvolvimento de doenças cardiovasculares, foi associada a apenas dois macronutrientes: menores chances de consumo elevado de carboidratos e menores chances de consumo baixo de fibras. Esses achados são importantes para entender a inter-relação entre nutrição, saúde bucal e geral, destacando a necessidade de atenção ao cuidado desses indivíduos no ambiente odontológico de forma integral.

4.3 REFERÊNCIAS

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5. CAPÍTULO 5 – PRESS RELEASE

A nutrição desempenha um papel fundamental na saúde, sendo uma dieta adequada aquela que fornece nutrientes essenciais, em equilíbrio, para um bom funcionamento do organismo. Com o aumento da expectativa de vida, também cresceram os casos de doenças sistêmicas, condições bucais e uso de diversas medicações pela mesma pessoa. Além disso, pessoas idosas e indivíduos com Diabetes Mellitus (DM) podem apresentar uma piora na alimentação, afetando o seu estado nutricional, saúde geral e bucal. Por isso, o consumo alimentar passou a ser motivo de estudo, para melhorar a qualidade de vida dessa população. Indivíduos com DM frequentemente enfrentam problemas bucais como a perda de dentes, cárie, redução de saliva e perda do paladar, enquanto pessoas idosas mostram maior prevalência de cárie radicular e sensibilidade gustativa prejudicada. Este estudo avaliou a associação entre diferentes condições bucais e sistêmicas relacionadas ao DM e seu impacto no consumo de nutrientes em adultos e idosos. O primeiro estudo desta dissertação, analisou estudos publicados em diversas bases de dados, nacionais e internacionais e revelou que a percepção do paladar diminui em pessoas idosas em comparação com adultos, o que pode afetar negativamente o consumo alimentar. O segundo estudo foi realizado no Hospital Universitário de Brasília, com o objetivo de coletar dados sobre a associação entre o consumo de nutrientes, saúde geral e problemas bucais. Este estudo mostrou que a diabetes não teve associação direta com o consumo de nutrientes, mas o consumo inadequado desses nutrientes esteve associado a uma piora do sentido do sabor, presença de prótese, risco cardiovascular aumentado/muito aumentado e a idade avançada. Avaliar a dieta das pessoas idosas e com doenças crônicas também deve ser parte dos cuidados do dentista, para que se promova saúde e qualidade de vida como um todo ao garantir o consumo adequado de nutrientes. A nutrição vai além do simples ato de se alimentar e nutrir; ela envolve interações sociais e conexões que fazem partes fundamentais da vida humana. Assim, como profissionais da saúde, devemos nos empenhar em promover uma vida com qualidade, sem comprometer outros aspectos da saúde.

Material Suplementar

Medidas antropométricas

Altura (de acordo com Manual de Antropometria da Pesquisa Nacional de Saúde 2023)

Material: Fita métrica flexível, fixada na parede com a ajuda de fita adesiva.

Instruções antes da medição

Peça ao indivíduo para:

- Remover os sapatos.
- Retirar roupas pesadas (casacos, jaquetas, suéteres grossos).
- Remover acessórios e presilhas de cabelo (fivelas, tiaras, lenços, clipes, laços, elásticos, etc.).
- Desfazer qualquer penteado (rabo de cavalo, coque, trança, etc.).
- Passos para medir a altura:
- O indivíduo deve ficar em pé com as pernas e pés paralelos, peso distribuído igualmente em ambos os pés, braços relaxados ao longo do corpo e palmas voltadas para o corpo.
- As costas do indivíduo devem estar voltadas para a parede, com os calcanhares, panturrilhas, nádegas, costas e a parte de trás da cabeça tocando a parede.
- A cabeça do indivíduo deve estar posicionada no plano de Frankfurt.
- Usando uma régua rígida, posicione-a contra a cabeça do indivíduo com pressão suficiente para comprimir o cabelo, se necessário.
- Complete a medição lendo e registrando a medida.

Peso Corporal (de acordo com Manual de Antropometria da Pesquisa Nacional de Saúde 2023)

Equipamento: Balança digital Original Line® com capacidade máxima de 180 quilos (kg), colocada em uma superfície plana e firme. A balança liga automaticamente quando o indivíduo sobe nela; espere o visor mostrar "zero" antes de pedir para o indivíduo subir.

Calibração da balança:

- Verifique as baterias e as condições do equipamento.
- Utilize 5 garrafas PET de dois litros com rótulos removidos.
- Adicione água a cada garrafa até exatamente 2 kg.
- Após completar o passo anterior para cada garrafa, coloque-as na balança e leia o peso total exibido na tela.
- O peso final das 5 garrafas deve ser 10 kg, com uma variação aceitável de 9,9 a 10,1 kg.

Instruções antes da aferição

Peça ao indivíduo para:

- Remover os sapatos.
- Remover roupas pesadas (casacos, jaquetas, suéteres grossos).
- Remover acessórios (cintos, óculos, colares).
- Retirar itens dos bolsos de calças, saias ou camisas (celular, caneta, moedas, carteira).
- Passos para medir o peso corporal:
- Peça ao indivíduo para subir na balança com ambos os pés na plataforma e o peso distribuído igualmente entre os dois pés.
- O indivíduo não deve olhar para o visor da balança, mas sim para o horizonte.
- O examinador lê e registra o peso.
- Complete o procedimento pedindo ao indivíduo para sair da balança.

Circunferência da Cintura (CC) (de acordo com Manual de Antropometria da Pesquisa Nacional de Saúde 2023)

Material: Fita antropométrica FitMetria feita de fibra de vidro flexível e não elástica, com uma faixa de medição de até 200 cm.

Instruções antes da medição

Peça ao indivíduo para:

- Deixar a área da cintura livre.
- Remover os sapatos.

Passos para medir a circunferência da cintura (CC):

- O indivíduo deve ficar descalço, com os braços flexionados e cruzados na frente do peito, pés afastados, abdômen relaxado e respirando normalmente.
- Identifique a linha axilar média: O examinador fica de frente para o indivíduo, coloca as mãos atrás das costelas formando um círculo, e lentamente traz as mãos para a frente. Quando os dedos estiverem claramente visíveis, marque a linha axilar média neste ponto.
- O examinador deve localizar a costela mais baixa (10ª costela) e a crista ilíaca, o ponto mais alto do osso ilíaco. Marque o ponto médio entre a 10ª costela e a crista ilíaca.
- A fita deve ser passada ao redor do corpo do indivíduo no nível do ponto médio.
- A fita deve ser ajustada e verificada para garantir que esteja paralela ao chão.
- Pergunte ao indivíduo para respirar profundamente e exalar completamente, segurando a respiração até que a medição seja realizada.

Questionário de Frequência Alimentar (QFA)

Alimentos avaliados no QFA-DF (modificado de Henn et al. 2010)

1. Pão (francês/forma/leite/bisnaguinha/batata)
2. Pão Integral (centeio /aveia)
3. Bolo/pão doce/ bolo de mandioca
4. Salgados (pão de queijo/ biscoito assado/ pizza)
5. Salgados fritos (pastel/biscoito de queijo frito/coxinha/quibe)
6. Sanduíches “fast food” – (Mc Donald’s e hamburguer em geral”)
7. Bolacha (salgada/doce/recheada)
8. Achocolatados (Nescau/Toddy) ou outros
9. Embutidos (salsicha/mortadela/presunto)
10. Batata/mandioca/polenta - frito
11. Batata/mandioca - cozido
12. Legumes in natura (cenoura/beterraba)
13. Legumes cozido (cenoura/beterraba/brócolis/abóbora)
14. Verduras (tomate/alface/rúcula)
15. Arroz branco/macarrão
16. Arroz integral/macarrão integral
17. Leguminosas (feijão/lentilha/grão de bico)
18. Amendoim/nozes/castanha do Pará/castanha de caju/aveia/granola
19. Frutas (laranja/maçã/mamão/morango/abacaxi)
20. Suco da fruta adoçado com açúcar
21. Refrigerante
22. Refrigerante diet
23. Café com açúcar
24. Guloseimas (paçoquinha/maria-mole/rapadura/balas/chiclete)
25. Doces (brigadeiro/doce de leite/arroz doce)
26. Leite integral
27. Queijo (muçarela/branco/minas/ricota)
28. Carnes (frango/suíno/bovino/peixe) – Cozido/desfiado
29. Churrasco