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Renata da Paz Leal Pereira

**PREVALÊNCIA DE LÍNGUA GEOGRÁFICA EM ADULTOS: UMA REVISÃO  
SISTEMÁTICA E META-ANÁLISE**

Florianópolis

2023

Renata da Paz Leal Pereira

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SISTEMÁTICA E META-ANÁLISE**

Dissertação submetida ao Programa de Pós-Graduação em Odontologia da Universidade Federal de Santa Catarina para obtenção do Grau de Mestre em Odontologia.

Orientadora: Prof<sup>a</sup> Dr<sup>a</sup> Graziela De Luca Canto

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SISTEMÁTICA E META-ANÁLISE**

O presente trabalho em nível de Mestrado foi avaliado e aprovado por banca  
examinadora composta pelos seguintes membros:

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Certificamos que esta é a **versão original e final** do trabalho de conclusão que foi  
julgado adequado para obtenção do título de Mestre em Odontologia.

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Prof. Dr.<sup>a</sup> Mariane Cardoso Carvalho  
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Prof. Dr.<sup>a</sup> Graziela De Luca Canto  
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Florianópolis

2023

Aos 9 anos meu pai renunciou à sua infância em prol do sustento da família. Dedico este trabalho ao meu pai, de 9 anos, que acordava cedo para vender cigarro e fósforo “a retalho” nas ruas de Salvador. Meu pai que desde muito cedo luta com honra e merece todas as glórias. Deu certo, pai.

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## APRESENTAÇÃO

Esta Dissertação é constituída por um artigo científico desenvolvido durante o Curso de Mestrado em Odontologia, área de concentração em Diagnóstico Bucal, do Programa de Pós-Graduação em Odontologia da Universidade Federal de Santa Catarina. O artigo originalmente escrito na língua inglesa, foi publicado no periódico *Oral Diseases* conforme referência: PEREIRA, R. D. P.; DE OLIVEIRA, J. M. D.; PAULETTO, P.; MUNHOZ, E. D. A.; SILVA GUERRA, E. N., MASSIGNAN, C.; DE LUCA CANTO, G. Worldwide prevalence of geographic tongue in adults: A systematic review and meta-analysis. **Oral Diseases**, v. 0, n. 0, p 1-10, 2022. <https://doi.org/10.1111/odi.1439> (Apêndice A).

Nesta dissertação, o artigo é precedido por uma Introdução que reúne o conhecimento dos principais estudos publicados sobre língua geográfica no mundo. Ao final, são apresentadas as considerações finais, bem como a bibliografia.



## RESUMO

**Objetivos:** Identificar a prevalência de língua geográfica em adultos. **Métodos:** Foi realizada uma revisão sistemática da literatura em busca de estudos observacionais de base populacional. As buscas foram realizadas em cinco bases de dados principais: Embase, LILACS, PubMed, Scopus e Web of Science; e três fontes de literatura cinzenta: Google Scholar, ProQuest e OpenGrey. Dois revisores selecionaram de maneira independente os estudos, com base em critérios de elegibilidade pré-definidos. Adicionalmente, foram realizadas uma busca manual na lista de referências e consulta a especialistas no tópico estudado. A qualidade metodológica foi avaliada utilizando o checklist para estudos de prevalência do Instituto Joanna Briggs. Meta-análises de proporção foram realizadas separadamente para os diferentes tipos de prevalência descritas (prevalência pontual e de período), permitindo comparar estudos que avaliaram medidas de efeito semelhantes usando o software JAMOVI. **Resultados:** Inicialmente, foram identificados 3.046 estudos. Após uma seleção em duas fases, onze estudos foram incluídos para síntese quantitativa. Dois estudos foram classificados como tendo baixa qualidade metodológica, cinco estudos com qualidade moderada e quatro como de alta qualidade. Três estudos foram incluídos na meta-análise de prevalência por período, e a prevalência foi de 3% (IC: 0,4% a 5,5%, n = 9.813). Oito estudos foram incluídos na meta-análise de prevalência pontual, e a prevalência foi de 3% (IC: - 0,2% a 5,5%, n = 10.967). **Conclusão:** Embora existam fases de exacerbação e remissão na língua geográfica, a prevalência pontual e a prevalência do período foram semelhantes mostrando que aproximadamente um em cada 30 adultos apresenta língua geográfica.

**Palavras-chave:** Língua geográfica, prevalência, revisão sistemática.

## ABSTRACT

**Objectives:** To identify the prevalence of geographic tongue in adults. **Methods:** A systematic review of the literature was carried out in search of population-based observational studies. Searches were carried out in five main databases: Embase, LILACS, PubMed, Scopus and Web of Science; and three gray literature sources: Google Scholar, ProQuest, and OpenGrey. Two reviewers blindly selected studies based on predefined eligibility criteria. Additionally, a manual search was carried out in the list of references and consultation with specialists in the studied topic. Methodological quality was assessed using the Joanna Briggs Institute checklist for prevalence studies. Proportion meta-analyses were performed separately for the different types of prevalence described (point and period prevalence), allowing to compare studies that evaluated similar effect measures using the JAMOVI software. **Results:** Initially, 3,046 studies were identified. After a two-stage selection, eleven studies were included for quantitative synthesis. Two studies were classified as having low methodological quality, five studies as moderate quality and four as high quality. Two types of prevalence were analyzed: punctual and by period. Three studies were included in the meta-analysis of prevalence by period, and the prevalence was 3% (CI: 0.4% to 5.5%, n=9,813). Eight studies were included in the meta-analysis point prevalence, and the prevalence was 3% (CI: -0.2% to 5.5%, n=10,967). **Conclusion:** Although there are exacerbation and remission phases in geographic tongue, the point prevalence and the prevalence of the period were similar. Almost one in 30 adults has geographic tongue.

**Keywords:** Geographic tongue, evidence-based dentistry, systematic review.

## LISTA DE FIGURAS

**Do artigo em inglês:**

**Figure 1.** Flow Diagram of Literature Search and Selection Criteria (2022, January 4th)  
.....41

**Figure 2.** (A) Meta-analysis' graphs for Populational Sample Prevalence of geographic tongue - **Period Prevalence**. (B) Meta-analysis' graphs for Populational Sample Prevalence of geographic tongue - **Point Prevalence**. JAMOVI 1.6.15 (The Jamovi Project 2021 - Computer Software, Sydney, Australia)  
.....42

## LISTA DE TABELAS

**Do artigo em inglês:**

**Table 1.** Summary of descriptive characteristics of included articles (n=11) .....43

## LISTA DE APÊNDICES

<b>Apêndice A.</b> Artigo completo publicado em periódico <i>Oral Diseases</i> .....	51
--	----

### **Do artigo em inglês:**

<b>Appendix 1.</b> Database search strategy.....	61
--	----

<b>Appendix 2.</b> Articles excluded and the reasons for exclusion (n=120) .....	62
--	----

<b>Appendix 3.</b> Appendix 3. Worldwide distribution of affected Sample (n) and Prevalence (%) of included studies: Africa, Asia, Europe, and South America .....	75
--	----

<b>Appendix 4.</b> Methodological quality summary author's judgments for each included study, assessed by the Joanna Briggs Institute (JBI) (ref) Critical Appraisal Checklist for Prevalence studies and graphically represented by "Traffic-light" plot (A) and Weighted bar plot (B) (generated using the online tool robvis (Risk-Of-Bias VISualization) (National Institute for Health Research).....	75
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## LISTA DE ABREVIATURAS E SIGLAS

### **Do artigo em inglês:**

CI - Confidence interval

JBI – Joanna Briggs Institute

MA – Meta-analysis

N - No

NA - Not applicable

NI - Not informed

PRISMA - Preferred reporting items for systematic reviews and meta-analysis

PROSPERO - International Prospective Register of Systematic Reviews

SR - Systematic review

UFSC - Universidade Federal de Santa Catarina

Y – Yes

## SUMÁRIO

<b>1. INTRODUÇÃO .....</b>	<b>16</b>
<b>2. OBJETIVOS.....</b>	<b>21</b>
2.1. Objetivo Geral .....	21
2.2. Objetivo Específico .....	21
<b>3. JUSTIFICATIVA.....</b>	<b>22</b>
<b>4. ARTIGO.....</b>	<b>23</b>
<b>5. CONSIDERAÇÕES FINAIS .....</b>	<b>46</b>
<b>REFERÊNCIAS .....</b>	<b>47</b>
<b>APÊNDICES.....</b>	<b>51</b>

## 1. INTRODUÇÃO

A língua geográfica foi descrita pela primeira vez por Rayer em 1831 como erupção da língua (PRINZ, 1927). O padrão típico foi comparado a massas de terra e oceanos em um mapa, do qual derivou o termo “língua geográfica” (REDMAN; SHAPIRO; GORLIN, 1972). Também conhecida como glossite migratória benigna ou eritema migratório, a língua geográfica é uma doença benigna caracterizada por manchas múltiplas, eritematosas e despapiladas, bem demarcadas, circundadas por uma borda branco-amarelada levemente elevada e geralmente restrita a o dorso da língua, que regride espontaneamente e coalescem em proporções variadas. (PICCIANI *et al.*, 2021; OYETOLA; OLUW; AGHO, 2018; SHULMAN; CARPENTER, 2006). As lesões decorrentes da língua geográfica podem mudar drasticamente de localização, padrão e tamanho, frequentemente parecendo migrar pela superfície da língua (OYETOLA; OLUW; AGHO, 2018; PICCIANI *et al.*, 2020).

O paciente com língua geográfica pode ter comprometimento de outras áreas da mucosa oral como palato mole, mucosa bucal, assoalho da boca, gengiva e úvula, porém são raros (COOKE, 1955). Quando ocorre em outras áreas da mucosa oral é chamada de “língua geográfica ectópica” e foi descrita pela primeira vez por Cooke (1955) (COOKE, 1955).

Estudos epidemiológicos podem fornecer uma visão importante para entender a prevalência, extensão e gravidade das lesões bucais na população (PACK, 1998; KULAK *et al.*, 2001). A prevalência de lesões na mucosa bucal varia de 41,7–66,2% em países como Alemanha, Brasil, Eslovênia, Suécia e Turquia (SALONEN, AXELL; HELLDEN, 1990; KOVAC-KOVACIC; SKALERIC, 2000; REICHART, 2000; DOS SANTOS *et al.*, 2004; MUMCU *et al.*, 2005).

Outros estudos relataram prevalência abaixo de 30%, incluindo estudos na Alemanha, Austrália, Camboja, China, Estados Unidos, Irã, Japão, Malásia, Suécia (4,9–20,5%) (AXÉLL, 1987; DO *et al.*, 2014; FENG *et al.*, 2015; GHANAEI *et al.*, 2013; IKEDA *et al.*, 1995; ROBLEDO-SIERRA *et al.*, 2013; SPLIETH *et al.*, 2007; VILLA; GOHEL, 2014; ZAIN *et al.*, 1997).

Estudos epidemiológicos mostraram que as lesões da língua constituem uma proporção considerável das lesões da mucosa oral (BYAHATTI; INGAFU, 2010; SCUTARIU, SURDU, MACOVEI, 2015). Tradicionalmente, por serem vistas como um



importante indicador de saúde bucal e geral, as lesões de língua têm sido amplamente estudadas em todo o mundo (REDMAN, 1964; SHAREEF; ETTEFAGH, 2021). A língua é um órgão complexo que desempenha diferentes funções como degustação, deglutição, fonação e percepção de sensações, incluindo características do paladar, alterações térmicas, estímulos de dor e sensações gerais e tem um papel fundamental no desenvolvimento dos maxilares (PATIL *et al.*, 2013; SCUTARIU, SURDU; MACOVEI, 2015; SHAMLOO *et al.*, 2016). As lesões na língua podem ser de desenvolvimento, infecciosa, idiopática, maligna ou devido a doença sistêmica subjacente.

Em todo mundo, estudos epidemiológicos têm apresentado diferentes prevalências de lesões na língua. Em um estudo realizado por Cheruvathoor e colaboradores (2020) (CHERUVATHOOR *et al.*, 2020) com o objetivo de conhecer a prevalência, padrão e distribuição das lesões da mucosa oral em pacientes geriátricos, o local mais comum de lesão oral foi o dorso da língua, equivalente a 42% da população estudada. Em 2013, Ghanaei e colaboradores (GHANAEI *et al.*, 2013) realizaram um estudo a fim de avaliar a prevalência e os tipos de lesões orais em uma população geral do Irã, obtendo uma prevalência de 19,4%. Dentre as lesões mais comuns, a língua geográfica ganhou destaque representando 2,6% da população estudada.

É difícil precisar com exatidão os dados epidemiológicos de acometimento, pois porcentagens diferentes são mencionadas. Em estudo realizado por Henrique e colaboradores (2009) (HENRIQUE *et al.*, 2009) no qual determinaram a prevalência de alterações da mucosa oral em adultos brasileiros de Uberaba, Brasil, 1.006 pacientes acima de 20 anos foram avaliados e 27 foram diagnosticados com língua geográfica, o que representa uma prevalência de 2,7%. Salonen, Axéll e Hellden (1990) (SALONEN; AXÉLL; HELLDEN, 1990) estudaram uma amostra selecionada aleatoriamente de indivíduos adultos que viviam na Suécia e examinaram a presença de lesões na mucosa oral e 5,6% da amostra foi diagnosticada com língua geográfica. Em 2004, um estudo foi realizado em Israel para avaliar a prevalência de lesões benignas em adultos, e 12,8% da população foi diagnosticada com língua geográfica (YAROM; CANTONY; GORSKY, 2004).

A etiologia da língua geográfica permanece desconhecida (SHAREEF; ETTEFAGH, 2021). No entanto, pacientes relatam história familiar da doença, sugerindo então uma possível predisposição genética (REDMAN; SHAPIRO; GORLIN, 1972). Redman, Shapiro e Gorlin (1972) (REDMAN; SHAPIRO; GORLIN, 1972) relataram uma maior prevalência de glossite migratória benigna entre parentes de primeiro grau de alunos

afetados da Universidade de Minnesota do que entre os alunos de controle (14,1% vs 4%). Eidelman e colaboradores (EIDELMAN *et al.*, 1976) também sugeriram que a língua geográfica é uma condição hereditária. Em um estudo realizado por Liang e colaboradores (LIANG *et al.*, 2016) foi possível observar uma associação entre a língua geográfica e mutações da gene IL36RN em membros de uma mesma família.

Por outro lado, diferentes fatores e doenças têm sido descritas como relacionadas a esta condição, como alergias (MARKS *et al.*, 2005; MARKS; CZARNY, 1984), alterações hormonais (KULLAA-MIKKONEN; KOTILAINEN; ALAKUIJALA, 1986), gravidez, diabetes, psoríase (PICCIANI *et al.*, 2015), Síndrome de Down (DANESHPAZHOOH *et al.*, 2007; ERCIS; BALCI; ATAKAN, 1996), deficiências nutricionais (BANOCZY; SZABO; CSIBA, 1975), COVID-19 (SARRUF *et al.*, 2022) e também algumas drogas como anticoncepcionais orais (WALTIMO, 1991), lítio (ZARGARI, 2006; MARKS *et al.*, 2005) e anti-hipertensivos (DAFAR *et al.*, 2016). Uma relação inversa foi observada com o tabagismo (DAFAR *et al.*, 2016; MILOGLU *et al.*, 2009).

Como o diagnóstico da língua geográfica é essencialmente clínico, reconhecer uma lesão na língua é parte fundamental da prática profissional (OGUETA *et al.*, 2019). Por caracterizar-se como papilas filiformes atróficas com perda de queratina, áreas atróficas levemente deprimidas circundadas por bordas brancas levemente elevadas e degranulação da mucosa subjacente (PICCIANI *et al.*, 2015), o diagnóstico diferencial inclui candidíase, psoríase, língua fissurada, síndrome de Reiter, leucoplasia, líquen plano, lúpus eritematoso sistêmico, herpes simples e até mesmo alergia medicamentosa (OGUETA *et al.*, 2019; KOVAC-KAVCIC; SKALERIC, 2000).

Em termos gerais, a biópsia das lesões não é necessária devido à natureza benigna da doença (OGUETA *et al.*, 2019). Apesar disso, a biópsia pode ser indicada em casos atípicos, quando há suspeita de malignidade ou para auxiliar na tranquilização de pacientes com cancerofobia sobre a natureza benigna da doença (OGUETA *et al.*, 2019).

O exame histopatológico revela um infiltrado inflamatório agudo e crônico na submucosa com extravasamento epitelial, com infiltrados de neutrófilos (MARKS; RADDEN *et al.*, 1981). Nas áreas vermelhas da lesão, observa-se aumento no epitélio acantótico e ausência de diferenciação em papilas filiformes (PLACKOVA; SKACH, 1975). As células inflamatórias se acumulam nas camadas superiores do epitélio (PLACKOVA; SKACH, 1975). As áreas do meio das áreas eritematosas, mostram ausência completa das papilas filiformes e das camadas paraqueratóticas. Já as áreas

brancas elevadas das lesões incluem infiltrados subepiteliais de neutrófilos, invasão de leucócitos na camada epitelial, ruptura da junção celular, depósitos de glicogênio nas células epiteliais e esfoliação de células necróticas na camada superficial (PLACKOVA; SKACH, 1975).

Já na microscopia eletrônica de varredura, a superfície da língua geográfica contém dois tipos de mucosa: uma área atrófica das papilas filiformes e uma margem branca de células descamativas (KULLAA-MIKKONEN, 1986).

Devido ao seu caráter benigno e curso predominantemente assintomático, pacientes com língua geográfica geralmente não recebem tratamento. Em casos de sintomas como dor e/ou sensação de queimação, o uso de bochechos com corticosteroides tópicos é considerado (REDMAN; SHAPIRO; GORLIN, 1972). Em 1975, Helfman (HELFMAN, 1975) relatou resultados satisfatórios após o tratamento de três pacientes com ácido retinóico tópico. Abe e colaboradores (ABE *et al.*, 2007) relataram melhora acentuada em uma paciente de 54 anos, com língua geográfica persistente e dolorosa por de cinco anos, com administração sistêmica de ciclosporina (3 mg/kg/dia). Recomenda-se também evitar agentes irritantes que podem agravar as lesões, como alimentos condimentados e ácidos, e manter uma boa higiene (OGUETA *et al.*, 2019; KULLAA-MIKKONEN, 1986). Um estudo realizado por Saad (SAAD, 2020) sugere que a laserterapia de baixa potência pode ser usada para aliviar os desconfortos associados à língua geográfica, além de acelerar a cicatrização.

O cuidado multiprofissional combinado com uma abordagem baseada em evidências para diagnosticar e tratar (se necessário) são fundamentais, uma vez que quanto mais cedo os primeiros sinais e sintomas da língua geográfica são identificados, melhor é o resultado e a satisfação do paciente (SHAREEF; ETTEFAGH, 2021). O conhecimento da frequência dessas condições na população é um ponto essencial no estabelecimento do diagnóstico, pois se baseia principalmente nos aspectos clínicos da lesão (HENRIQUE *et al.*, 2009).

A saúde bucal é um reflexo da saúde geral, e qualquer doença que afete a condição de saúde bucal influenciará a saúde geral e a qualidade de vida de um indivíduo. Considerando que não há protocolo para avaliação clínica e tratamento validado na literatura, muitos casos são negligenciados e alguns pacientes apresentam sintomas de cancerofobia (PICCIANI *et al.*, 2020).

Devido às inúmeras variações acerca da prevalência da língua geográfica, esta dissertação buscou contribuir com evidências científicas sobre a temática acerca de

estudos de base populacional. Assim, os dados desta revisão sistemática de prevalência (RS) podem ser úteis para formular hipóteses sobre o desenvolvimento e progressão da língua geográfica, colaborar com tomadas decisões sobre políticas em saúde (MUNN *et al.*, 2020; MUNN, 2015), bem como facilitar o diagnóstico na prática clínica.

## **2. OBJETIVOS**

### **2.1 Objetivo Geral**

- Determinar a prevalência de língua geográfica em adultos

### **2.2 Objetivo Específico**

- Analisar a prevalência de língua geográfica de acordo com a idade, sexo e continente
- Identificar a prevalência por período e a prevalência pontual

### **3. JUSTIFICATIVA**

Estudos epidemiológicos podem fornecer informações importantes sobre a prevalência, extensão e gravidade das doenças bucais na população. Os dados obtidos nesta revisão sistemática (RS) de prevalência ajudarão na formulação de hipóteses sobre o desenvolvimento e progressão da língua geográfica, compreendendo os perfis dos pacientes e as regiões do mundo onde ocorrem, a fim de viabilizar o diagnóstico na rotina clínica. Assim, reunir dados de estudos transversais sobre a prevalência de língua geográfica ao redor do mundo, pode contribuir com as tomadas de decisões sobre políticas de saúde (Munn et al., 2020; Munn, 2015).

#### 4. ARTIGO

Artigo formatado conforme as normas da revista *Oral Diseases* (acessadas em: 30/03/2022).

### **Worldwide prevalence of geographic tongue in adults: a systematic review and meta-analysis**

**Keywords:** Geographic tongue, evidence-based dentistry, systematic review

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## **Conflict of interest**

Authors have no conflicts of interest to declare.

## **ABSTRACT**

**Objective:** To identify the prevalence of geographic tongue in patients > 18 years.

**Methods:** A systematic literature review was performed in search of population-based observational studies. Searches were performed in five main databases: Embase, LILACS, PubMed, Scopus and Web of Science; and three gray literature sources: Google Scholar, ProQuest, and OpenGrey. Additionally, a manual search in the reference list and consultation with experts on the topic studied were performed. Methodological quality was assessed using the Joanna Briggs Institute's checklist for prevalence studies. Ratio meta-analyses were performed using JAMOVI. **Results:** Initially, 3,046 studies were identified. After a two-phase selection, eleven studies were included for quantitative synthesis. Two study was classified as of low methodological quality, five studies as of moderate quality, and four as of high quality. Two types of prevalence were analyzed: by period and point. Three studies were included in the period prevalence meta-analysis, and the prevalence was 3% (Confidence interval (CI): 0.4%-5.5%, n=9,813). Eight studies were included in the point-prevalence meta-analysis, and the prevalence was 3% (CI: -0.2%-5.5%, n=10,967). **Conclusion:** Although there are phases of exacerbation and remission in geographic tongue, prevalence and period prevalence were similar. Approximately one in 30 adults has a geographic tongue.

**Keywords:** Geographic tongue, evidence-based dentistry, systematic review.



## INTRODUCTION

Epidemiological studies have shown that tongue lesions constitute a considerable proportion of oral mucosal lesions (Byahatti & Ingafou, 2010; Scutariu, Surdu, & Macovei, 2015). The prevalence rates of tongue lesions in different populations vary from 0.2% in China (Corbet, Holmgren & Philopsen, 1994) to 12.8% in Israel (Yarom, Cantony, & Gorsky, 2004).

Tongue lesions were classified into six categories: injuries (physical, chemical, and thermal), infections (bacterial, viral, fungal), nutritional deficiencies, premalignant disorders, immunological, and miscellaneous and developmental disturbances (geographic tongue, hairy tongue, fissured tongue, macroglossia) (Al-Wesabi et al., 2017). Continuous modifications in population lifestyle result in possible changes in disease patterns, therefore, conducting studies on the prevalence of oral lesions in different geographic regions is important and tongue lesions have been studied worldwide because the tongue is an important indicator of oral and general health. (Redman, 1964; Shareef & Etefagh, 2021).

Geographic tongue, also known as benign migratory glossitis, erythema migrans, and annulus migrans, is a benign disorder of the tongue characterized by multiple, well-demarcated, erythematous, depapillated patches surrounded by a slightly elevated yellowish-white border, and usually restricted to the dorsum of the tongue, which regresses spontaneously, recurring and coalescing in varying proportions. (Picciani et al., 2021; Oyetola, Oluw & Agho, 2018; Shulman & Carpenter, 2006).

Geographic tongue was first described by Rayer in 1831 as wandering rash of the tongue (Prinz, 1927). The typical pattern has been likened to land masses and oceans on a map, from which the synonym "geographic tongue" was derived (Redman, Shapiro & Gorlin, 1972).

Since the diagnosis of geographic tongue is essentially clinical, recognize a tongue lesion is a fundamental part of professional practice. Therefore, knowledge of the frequency of these conditions in the population is an essential point in establishing the diagnosis, as it is mainly based on clinical aspects of the lesion (Henrique et al., 2009).

There is no protocol for clinical evaluation and treatment, many cases are neglected and some patients present symptoms of cancerphobia (Picciani et al., 2020). It is essential to know the prevalence of geographic tongue in adults to be helpful to identify this disease in the clinical routine, for therapeutic definition, follow-up, and scientific research.

Thus, data from a prevalence systematic review (SR) can therefore be useful in formulating hypotheses regarding geographic tongue development and progression and understanding how many people have it, who is getting it, and where is geographic tongue occurring. This kind of information is particularly valuable for governments when making decisions regarding health policy (Munn et al., 2020; Munn, 2015). For this reason, the aim of this (SR) was to identify the overall prevalence of geographic tongue in adults.

## **METHODS**

### **Eligibility criteria**

The PEO acronym (Population, Exposure, Outcomes) (Moola et al., 2015) was used to formulate the focused question and inclusion criteria in this systematic review, in which: P) Adults (>18 years) without comorbidities; E) Geographic tongue; O) Prevalence.

Cross-sectional studies were included if evaluated prevalence of geographic tongue, diagnosed through clinical examination in healthy adults. No restriction criteria regarding language and publication time were applied.

The exclusion criteria were studies that included patients with comorbid; studies in which samples were composed by children and adolescents; absence of data after contacting authors; studies in which samples were selected by convenience (dental clinical, hospital, faculty of dentistry); posters and guidelines; studies that did not include patients with geographic tongue; reviews, letters, books, conference abstracts, case report, opinion; studies that did not separate tongue lesions and studies that did not cite the age of participants.

### **Information sources and Search strategy**

An electronic literature search strategy was performed on January 4th, 2022, in five databases: Embase, PubMed/Medline, LILACS, Scopus, and Web of Science. Gray literature was conducted in the Google Scholar, ProQuest Dissertation and Theses, and OpenGrey (Appendix 1). Reference lists of included studies were manually searched and experts on the subject were contacted by e-mail to recommend additional studies to be included.

The reference manager software (EndNote X7, Thomson Reuters) was used to collect references and to exclude duplicates. After, the references were evaluated by the titles and abstracts according to the eligibility criteria using a computer software (Rayyan, Qatar Computing Research Institute).

### **Selection process**

Two independent reviewers (R.P.L.P. and J.M.D.O.) conducted a two-phase selection process. Firstly, on phase-1, the two reviewers evaluated the titles and abstracts according to the eligibility criteria; secondly on phase-2, the same two reviewers applied the eligibility criteria after reading the remaining full-text studies. Any discrepancies were resolved by a consensus discussion with a third reviewer (P.P.), before a final decision in both phases. If important data for the review was unclear or missing, the corresponding author was contacted to resolve or clarify the problem.

### **Data collection process and data items**

Two independent reviewers extracted pertinent data from the included studies (R.P.L.P. and J.M.D.O.) with a pre-tested extraction form developed by the authors and crosschecked in a consensus discussion to ensure the integrity of collected data. The following information were extracted regarding included studies: authors, country and year of publication, sample characteristics, sample size, age range and prevalence. Moreover, if prevalence rate was not expressed, it was calculated by using the definition of prevalence, once is frequency of actual cases of a condition in a population over a given period (Szklo & Nieto, 2014). In addition, the prevalence was divided per type defined by Szklo and Nieto (2014): Point prevalence, considering the number of cases at a point in time; period prevalence, considering the number cases in a specific period. When prevalence was not specified, it was taken to mean point prevalence (Szklo & Nieto, 2014).

### **Study methodological quality assessment**

The methodological quality in individual studies was assessed using the Joanna Briggs Institute Critical Appraisal Checklist for Studies Reporting Prevalence Data (2020) (Munn et al., 2020). The study that presents “yes” for all questions was rated as having good methodological quality, those that presents at least one answer “unclear” was rated as moderate methodological quality and at least one answer “no”, as low methodological quality (Oliveira et al., 2021).

### **Effect measures and synthesis methods**

A meta-analysis was performed using JAMOVI 1.6.15 (The JAMOVI Project 2021 - Computer Software, Sydney, Australia). The prevalence of populational sample of geographic tongue was calculated. Meta-analyses were carried out separately for the different types of prevalence rates described (point and period prevalence), making it possible to compare studies that evaluated similar measures of effect. Dichotomous data and the restricted maximum likelihood study model were used (Veroniki et al., 2016). The heterogeneity was assessed using the  $I^2$  statistics, prediction interval, Tau-squared and the Cochran Q test.  $I^2$  gives an estimate of the percentage of variability in results across studies that is due to real differences and not due to chance. The null hypothesis of the Q-statistic, based on a chi-square distribution, is that all studies share a common effect size and, if all studies shared the same effect size, the expected value of Q would be equal to the degrees of freedom, indicating larger variation across studies rather than within subjects within a study (Borenstein et al., 2010). Statistical analysis was performed considering random effects and the effect measure for outcome was proportion (Borenstein et al., 2010). The prediction intervals are graphically represented.

## **RESULTS**

## Study selection

From a total of 3,046 studies identified, 1,623 remained after duplicated removal records. After the first selection phase of reading of title and abstracts, 131 studies of full texts were read in the second phase. Thus, 120 studies were excluded (Appendix 2) and 11 studies were finally included for quantitative synthesis. From these, two studies were included from manual search and one study was included from experts' indications (Figure 1).

## Study characteristics

Eleven analytical cross-sectional studies were included. They were published between 1990 (Salonen, Axell & Hellden, 1990) and 2020 (Oivio et al., 2020), and conducted in Brazil (Henrique et al., 2009), Cambodia (Chher et al., 2018), China (Corbet, Holmgren & Philopsen, 1994), Finland (Oivio et al., 2020), Germany (Reichart, 2000), Hungary (Bánóczy, Rigó & Albrecht, 1993), Iran (Ghanaei et al., 2013), Israel (Yarom et al., 2004), Nigeria (Taiwo, Kolude & Akinmoladun, 2009), Sweden (Salonen, Axell & Hellden, 1990) and Turkey (Mumcu et al, 2005) (Appendix 3).

The sample sizes ranged from 496 (Mumcu et al, 2005) to 6,932 (Bánóczy, Rigó & Albrecht, 1993). The borderlines ages were 18 years (Yarom et al., 2004) to 106 years (Henrique et al., 2009). All these studies embraced a total size of 20,243 individuals. The type of prevalence measured were period prevalence (Bánóczy, Rigó & Albrecht, 1993; Oivio et al., 2020; Salonen, Axell & Hellden, 1990) and point prevalence (Corbet, Holmgren & Philopsen, 1994; Chher et al., 2018; Ghanaei et al., 2013; Henrique et al., 2009; Mumcu et al, 2005; Reichart, 2000; Taiwo, Kolude, & Akinmoladun, 2009; Yarom et al., 2004).

All studies diagnosed geographic tongue using oral examination.

A detailing individual studies characteristic is presented on Table 1.

### **Study methodological quality assessment**

Among included studies, two was rated as having low methodological quality (Bánóczy, Rigó & Albrecht, 1993; Chher et al., 2018), five studies were rated as moderate methodological quality (Ghanaei et al., 2013; Henrique et al., 2009; Reichart, 2000; Taiwo, Kolude, & Akinmoladun, 2009; Yarom et al., 2004) and four studies as high methodological quality (Corbet, Holmgren & Philopsen, 1994; Oivio et al., 2020; Mumcu et al, 2005; Salonen, Axell & Hellden, 1990) (Appendix 4).

### **Results of individual studies**

Bánóczy, Rigó and Albrecht (1993) assessed the prevalence of tongue lesions in Budapest, Hungary. All 6,932 patients were over 20 years of age, and 190 were diagnosed with geographic tongue, resulting in a prevalence rate of 2.74%.

Chher et al. (2018) determined the prevalence of oral cancer, oral potentially malignant disorders and other oral mucosal lesions in Cambodia. Of 1,634 individuals aged over 18 years, 7 people had geographic tongue, which represents a prevalence of 0.43%.

Corbet, Holmgren and Philopsen (1994) investigated the prevalence of oral mucosal lesions among 65-74 years old living in Hong Kong, China. A total of 537 patients were analyzed, and one was diagnosed with geographic tongue, representing a prevalence of 0.2%.

Ghanaei et al. (2013) assessed the prevalence and types of oral lesions in a general population in Rasht, Iran. Of 1,581 individuals aged over 30 years, 41 people had geographic tongue, resulting in a prevalence rate of 2.6%.

Henrique et al. (2009) determined the prevalence of oral mucosal alterations among Brazilian adults of the Uberaba, Brazil. A total of 1,006 patients over 20 years were analyzed, and 27 were diagnosed with geographic tongue, which represents a prevalence of 2.7%.

Mumcu et al. (2005) researched the prevalence of oral lesions in Turkey population. Of 496 patients over 18 years, seven people had geographic tongue, which represents a prevalence of 1.41%.

Oivio et al. (2020) investigated the oral mucosal changes in a middle-aged Finnish population. Their age ranged from 45 to 47 years. Of 1,961 sample, 18 individuals were diagnosed with geographic tongue, which represents a prevalence of 0.9%.

Reichart (2000) determined the prevalence of oral mucosal lesions in a cross-sectional study among Germans. Of 2,022 individuals, 45 people had geographic tongue, which represents a prevalence of 2.24%.

Salonen, Axéll and Hellden (1990) study a randomly selected sample of adult subjects living in a Swedish country was examined for the presence of oral mucosal lesions. A total of 920 patients were analyzed, and 50 were diagnosed with geographic tongue, resulting in a prevalence rate of 5.6%.

Taiwo, Kolude and Akinmoladun (2008) determined the prevalence of oral mucosal lesions in the elderly people in Ibadan, Nigeria. A randomly selected sample of 690 was examined and two were diagnosed with geographic tongue, which represents a prevalence of 0.29%.

Yarom, Cantony and Gorsky (2004) researched the prevalence of benign tongue lesions among adult Israeli. The overall population of the database was 2,464. Among them, 315 were diagnosed with geographic tongue, representing a prevalence of 12.8%.



## Results of syntheses

Once the included studies presented high heterogeneity among each other, statistical analysis was performed considering random effects. For general populations period prevalence meta-analysis, three studies participated on the sum of 9,813 patients for the statistics and the prevalence rate was 3.00% (CI: 0.4%-5.5%) ( $I^2$ : 98.4%; Q test: 60.554;  $Tau^2$ : 0.0005 (SE= 0.0005)). For general populations point prevalence meta-analysis, eight studies participated on the sum of 10,967 patients for the statistics and the prevalence rate was 3.00% (CI: -0.2%-5.5%) ( $I^2$ : 99.57%; Q test: 375.959;  $Tau^2$ : 0.0017 (SE= 0.0009) (Figure 2B).

## DISCUSSION

The meta-analysis results showed the period prevalence of geographic tongue in the general population was 3.00% (CI: 0.4%-5.5%) and the point prevalence of geographic tongue was 3.00% (CI: -0.2%-5.5%).

Knowing the prevalence of geographic tongue is an important clinical implication for different health care professionals and could be helpful in clinical practice and future research (Henrique et al., 2009; Taiwo, Kolude, & Akinmoladun, 2009). Epidemiological studies have shown a high frequency of geographic tongue with variable prevalence in different parts of the world. Such genetic variations are due to the differences in ethnic groups, sex, and age of the studied samples and the use of different diagnostic criteria, methodology, and procedures.

Regarding sex, Shulman and Carpenter (2006) found no relationship between geographic tongue and sex. In this systematic review, Bánóczy, Rigó and Albrecht (1993) shows that 64.21% who presented geographic language were women. In Mumcu et al's

(2005) results, 57.14% were women. Oivio et al.'s (2020) results the prevalence of geographic tongue is higher in women (66.67%). Reichart's (2000) study indicated that 62.8% were women. Salonen, Axéll and Hellden's (1990) study shows that 52% of patients with geographic tongue were women.

Regarding age, authors report that geographic tongue occurs more often in young adults and that the occurrence of lesions decreases with age (Picciani et al., 2020). There is a higher frequency of geographic tongue in the 20–29-year age group (Bánóczy, Rigó & Albrecht, 1993) when compared with a 45- 47-year age group, 0.9% (Oivio et al, 2020) or 65-74-year age group, 0.2% (Corbet, Holmgren & Philopsen, 1994).

Geographic tongue constitutes a remarkable proportion of oral mucosal lesions and prevalence rates vary in different parts of the world. The distribution of included studies covers four continents around the world: Africa, America, Asia, and Europe. The sample of included studies was larger in the European continent (n = 11,835), then in the Asian continent (n = 6,216), followed by South American continent (n = 1,006) and finally the African continent (n = 690). In Mumcu et al.'s (2005) study, Turkey is a transcontinental country spanning across Europe and Asia and the sample was 496. The results show that the geographic tongue prevalence was different between various continents. The prevalence was 1.29% in Nigeria (Taiwo, Kolude & Akinmoladun, 2009), the only African country in the selected studies. In Asia the prevalence rates from 0.2% in China (Corbet, Holmgren & Philopsen, 1994) to 12.8% in Israel (Yarom et al., 2004). In Brazil was 2.7%, the only American country included (Henrique et al., 2009). The prevalence in European countries varies from 0.9% in Finland (Oivio et al., 2020) to 5.43% in Sweden (Salonen, Axéll and Hellden, 1990). In Turkey, the prevalence was 1.41% (Mumcu et al., 2005).

Even though some conditions which affect the oral mucosa are acquired and can be prevented, in the case of geographic tongue, it is possible to observe that the use of tobacco is inverse to the appearance of the condition. Oivio et al. (2015) show that geographic tongue was significantly more frequently in non-smokers (1.5%) than in current smokers (0.6%), similar to that seen in a Swedish study where 6.8% of non-smokers and 1.7% of smokers had a geographic tongue (Salonen, Axell & Hellden, 1990).

The etiology of geographic tongue remains largely unknown; however, a few theories have been proposed. Psychosomatic and hereditary factors have been suggested to have a role in the etiology of geographic tongue. In Liang et al.'s (2019) study, biopsies revealed similarities among geographic tongue patients with different genotypes with the neutrophils prominently infiltrating the epidermis and the expression ratio of IL-36Ra/IL-36 $\gamma$  in lesioned tongues with individuals harboring different genotypes decreased significantly compared to controls.

In the other hand, Morger et al. (2010) found geographic tongue in 46.43% out of 28 recruits in whom a fissured tongue was also demonstrated. In Yarom, Cantony and Gorsky's (2004) study the occurrence of FT and GT simultaneously in the same individuals was recorded in 8.5% of participants. The simultaneous and frequent prevalence of geographic tongue and fissured tongue based on a genetic predisposition had previously been described in the literature (Salonen, Axell & Hellden, 1990; Shulman, 2015).

There are several comorbidities known in the literature to be associated with geographic tongue as psoriasis and asthma, for example (Picciani et al., 2015; Lesan et al., 2021). Some authors indicate that this lesion may represent an early oral manifestation of psoriasis, and correct diagnosis and continuous treatment of these patients is crucial, because with psoriasis we are treating a chronic disease (Oyetola,

Oluw, & Agho, 2018; Picciani et al., 2015). In most investigations the comorbidity approach with specific diseases predominated, which was an exclusion criterion adopted in this study, lacking studies related to with symptomatology and therapy. It is certain that some comorbidities increase the chances of geographic tongue prevalence and would therefore be a confounding factor. All articles that made it clear that the patients had comorbidities were excluded. However, we cannot be certain that all the subjects in each of the retained studies did not present with any comorbidities. Such possibility could lead to uncontrolled biases that cannot be estimated.

Some reports of geographic among adults were based on convenience samples such as Darwazeh et al.'s (1993) a dental outpatient's study, that the prevalence of geographic tongue was 6.8%. Or Marks and Czarny's (1984) a specialty clinic referrals study that the prevalence of geographic tongue rates at 14%. Once prevalence is the rate of affected individuals calculated over a population total with a common characteristic (Szklo & Nieto, 2014), studies in hospital, medical and dentistry centers where cases are identified cater to patients having characteristics related to the exposure being evaluated and cannot express the real prevalence of geographic tongue in the population (Szklo & Nieto, 2014). For This is the reason the convenience samples studies were excluded.

## **LIMITATIONS**

These lesions may change drastically in location, pattern, and size, often appearing to migrate across the surface of the tongue (Oyetola, Oluw & Agho, 2018; Picciani et al., 2020; Redman, 1964). They present periods of exacerbation and remission, without complications or sequelae, that regresses spontaneously, which makes it difficult to provide objective prevalence data. Nevertheless, any comparison between epidemiological surveys is difficult, as they vary in the methodology, sample size, and

diagnostic criteria, diversity of examiners and the inter-examiner variability causes further confusion, which partially explains the high heterogeneity observed across the studies (period prevalence:  $I^2$ : 98.40%; and point prevalence:  $I^2$ : 99.57%).

Another limitation is that although all the articles used oral examination to diagnose the geographic tongue, it cannot be guaranteed that all of them used the same parameters, since there is no protocol for clinical evaluation.

On the other hand, the search strategy is limited to certain keywords that may not find some important articles, despite the search being done systematically in different databases in addition to the search in the gray literature. Trying to overcome this limitation, a reading of the reference list of the included articles was carried out and experts on the subject were consulted.

## **CONCLUSION**

The proportion of geographic tongue in adults varied widely around the world. However, the results demonstrated that approximately one in 30 adults has geographic tongue.

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## OTHER INFORMATION

### Registration and protocol

This SR was reported following the PRISMA checklist (PRISMA). For previous registration, a SR protocol based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) was developed and registered at Prospective Register of Systematic Reviews (PROSPERO; Center for Reviews and Dissemination, University of York; and the National Institute for Health Research). The registration number is CRD42021265461.

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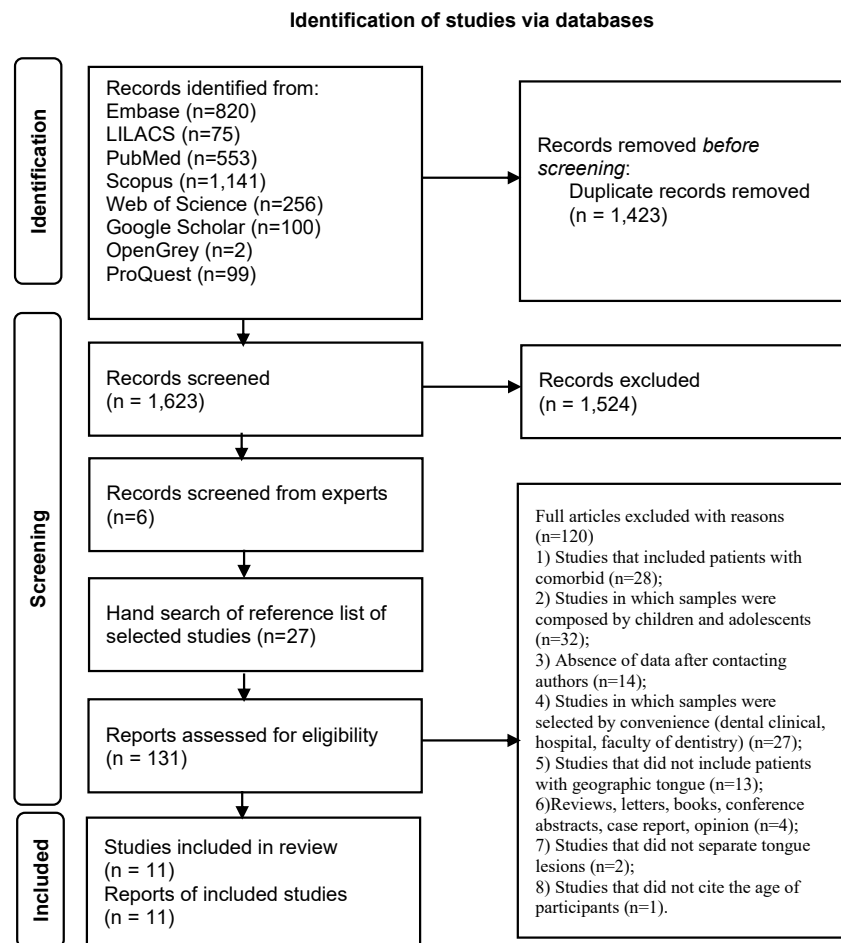
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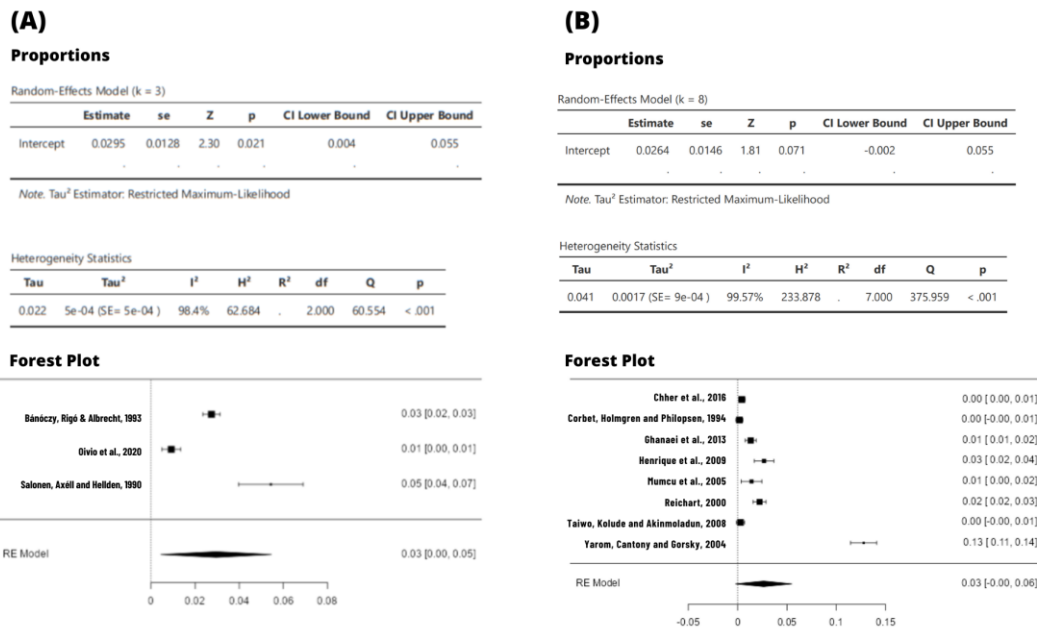
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## FIGURES





**FIGURES LEGENDS**

**Figure 1.** Flow Diagram of Literature Search and Selection Criteria (2022, January 4th).

**Figure 2.** (A) Meta-analysis' graphs for Populational Sample Prevalence of geographic tongue - **Period Prevalence**. (B) Meta-analysis' graphs for Populational Sample Prevalence of geographic tongue - **Point Prevalence**. JAMOVI 1.6.15 (The Jamovi Project 2021 - Computer Software, Sydney, Australia).

**TABLE****Table 1.** Summary of descriptive characteristics of included articles (n=11).

Author, Year (Country)	Setting and type of sample	n Sample (F)	Range age (mean $\pm$ SD)	Oral examiner	Geographic tongue definition (References, year)	Type of prevalence measured / assessed	N/% Prevalence (F)
Bánóczy, Rigó and Albrecht, 1993 (Hungary)	Living in Budapest, Hungary/populational	6,932 (NR+)	20-29y (NR)	Five dentists	“The occurrence of one or more smooth areas on the dorsum and lateral borders of the tongue, in the smooth areas with all absence of filiform papillae” (Van Der Waal and Pindborg, 1986)	Period prevalence	190/2.74%(122)
Chher et al., 2018 (Cambodia)	Living in Cambodia/populational	1634	18-60y (43.8 $\pm$ 16.2)	Seven dentists	NR (NR)	Point prevalence	7/0.43%*(NR)
Corbet, Holmgren and Philopsen, 1994 (China)	Living in Hong Kong, China/populational	537(NR)	65-74y (NR)	Three examiners	Referenced by the authors (Axéll et al., 1990)	Point prevalence	1/0.2%(NR)
Ghanaei et al, 2013 (Iran)	Living in Rasht, Iran/populational	1,581 (NR+)	> 30y (NR)	Two trained health specialists	Referenced by the authors (World Health Organisation (WHO), NR)	Point prevalence	41/2.6%(NR)

Henrique et al, 2009 (Brazil)	Living in Uberaba (MG), Brazil/populational	1,006(648)	20-106y (49y ± NR)	One examiner	Referenced by the authors (Marcucci, 2005)	Point prevalence	27*/2.7%(NR)
Mumcu et al, 2005 (Turkey)	Living in Turkey/populational	496(195)	18-95y (NR)	One dentist specialist on oral medicine	Referenced by the authors (WHO, 1980; WHO, 1997)	Point prevalence	7/1.41%*(4)
Oivio et al, 2020 (Finland)	Living in the longitudinal Northern, Finland/populational	1,961(1050)	45- 47y (NR)	Seven general dentists and oral pathologist	Referenced by the authors (Regezi, Sciubba and Jordan, 2016)	Period prevalence	18/0.9%(12)
Reichart, 2000 (Germany)	Living in Germany/populational	2022(1115)	35-44y and 65-74y (NR)	A dentist, a dental nurse and a recording assistant	Referenced by the authors (Kramer et al., 1980)	Point prevalence	45.29*/2.24%*(28.26*)
Salonen, Axéll and Hellden, 1990 (Sweden)	Living in Sweden/populational	920(471)	20->79y (NR)	One of the authors	Referenced by the authors (Axéll,1976; Axéll, 1990)	Period prevalence	50/5.6%(26)

Taiwo, Kolude and Akinmoladun, 2008 (Nigeria)	Living in Ibadan, Nigeria/population	690(283)	65-90y (69.7y± 7.6y)	Two examiners	Referenced by the authors (WHO, 1986)	Point prevalence	2/0.29%(1)
Yarom, Cantony and Gorsky, 2004 (Israel)	Living in Jewish, Israel/population	2,464(1422)	18-90y (41.5y ± NR)	Three clinicians	“A common, usually asymptomatic, benign condition, which primarily affects the dorsal surface of the tongue. Local loss of filiform papillae leads to annular or circulate limited atrophic erosive-like lesions usually accompanied by white raised borders” (Assimakopoulos, Patrikakos and Elisaf, 2002)	Point prevalence	315*/12.8%(NR)

NR: Not reported; SD: Standard Deviation; F: female sample; y: years; (\*) data calculated by the authors; (+) The article brings the data but was not considered because it involved an excluded group.

## CONSIDERAÇÕES FINAIS

Esta revisão sistemática avaliou a prevalência mundial de língua geográfica em adultos e os resultados da análise qualitativa mostraram que a prevalência de língua geográfica em adultos por período foi 3% (IC: 0,4% - 5,5%) e a prevalência pontual foi 3% (IC: -0,7% - 6,9 %).

Nesta revisão sistemática estudos realizados em hospitais, centros médicos e odontológicos com amostras de conveniência foram excluídos, pois poderiam não expressar a prevalência real da língua geográfica na população mundial.

A distribuição dos estudos incluídos abrangeu quatro continentes: África, América, Ásia e Europa e os resultados demonstraram que as prevalências de língua geográfica variaram em diferentes partes do mundo. Tais variações podem ser atribuídas às diferenças nos grupos étnicos, sexo e idade das amostras estudadas, bem como ao uso de diferentes critérios de diagnóstico.

Quanto ao sexo dos pacientes, nos estudos incluídos nesta revisão sistemática que apresentam este dado, houve uma ligeira predileção por mulheres. Em relação à idade, os autores relatam que a língua geográfica ocorre mais frequentemente em adultos jovens.

Cabe destacar que uma importante limitação que pode dificultar os dados de estudos de prevalência de língua geográfica é a mudança drástica de localização, padrão e tamanho dessas lesões, sem complicações ou sequelas, regredindo espontaneamente. Além disso, houve alta heterogeneidade entre os estudos (prevalência de período:  $I^2$ : 98,40% e prevalência pontual:  $I^2$ : 99,57%), o que revela que comparações entre estudos epidemiológicos devem ser cautelosas, uma vez que variam na metodologia, no tamanho da amostra e nos critérios diagnósticos e entre examinadores. Outro obstáculo é a falta de um protocolo padronizado para diagnóstico clínico da língua geográfica, então não se pode garantir que todos os estudos tenham utilizado os mesmos parâmetros, o que evidencia a necessidade da construção de um protocolo para diagnóstico da lesão.

Dessa forma, mostra-se a necessidade de mais estudos primários populacionais para complementar a análise da prevalência de língua geográfica, afim de beneficiar pacientes, bem como profissionais da área médica e odontológica no diagnóstico e tratamento desta lesão.

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## APÊNDICES

Apêndice A. Artigo completo publicado em periódico *Oral Diseases*

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REVIEW ARTICLE

ORAL DISEASES  
WILEY

## Worldwide prevalence of geographic tongue in adults: A systematic review and meta-analysis

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## Abstract

To identify the prevalence of geographic tongue in patients >18 years. A systematic literature review was performed in search of population-based observational studies. Searches were performed using five main databases: Embase, LILACS, PubMed, Scopus and Web of Science; and three gray literature sources: Google Scholar, ProQuest, and OpenGrey. In addition, a manual search in the reference list and consultation with experts on the topic studied were performed. Methodological quality was assessed using the Joanna Briggs Institute's checklist for prevalence studies. Ratio meta-analyses were performed using JAMOVI. Initially, 3046 studies were identified. After a two-phase selection, 11 studies were included for quantitative synthesis. Two studies were classified as of low methodological quality, five studies as of moderate quality, and four as of high quality. Two types of prevalence were analyzed: by period and point. Three studies were included in the period prevalence meta-analysis, and the prevalence was 3% (Confidence interval [CI]: 0.4%–5.5%,  $n = 9813$ ). Eight studies were included in the point-prevalence meta-analysis, and the prevalence was 3% (CI: –0.2% to 5.5%,  $n = 10,967$ ). Although there are phases of exacerbation and remission in geographic tongue, prevalence and period prevalence were similar. Approximately one in 30 adults has a geographic tongue.

## KEYWORDS

evidence-based dentistry, geographic tongue, systematic review

## 1 | INTRODUCTION

Epidemiological studies have shown that tongue lesions constitute a considerable proportion of oral mucosal lesions (Byahatti & Ingafou, 2010; Scutariu et al., 2015). The prevalence rates of tongue

lesions in different populations vary from 0.2% in China (Corbet et al., 1994) to 12.8% in Israel (Yarom et al., 2004).

Tongue lesions were classified into six categories: injuries (physical, chemical, and thermal), infections (bacterial, viral, fungal), nutritional deficiencies, premalignant disorders, immunological, and

miscellaneous and developmental disturbances (geographic tongue, hairy tongue, fissured tongue, macroglossia) (Al-Wesabi et al., 2017). Continuous modifications in population lifestyle result in possible changes in disease patterns, therefore, conducting studies on the prevalence of oral lesions in different geographic regions is important and tongue lesions have been studied worldwide because the tongue is an important indicator of oral and general health (Redman, 1964; Shareef & Etefagh, 2021).

Geographic tongue, also known as benign migratory glossitis, erythema migrans, and annulus migrans, is a benign disorder of the tongue characterized by multiple, well-demarcated, erythematous, and depapillated patches surrounded by a slightly elevated yellowish-white border, and usually restricted to the dorsum of the tongue, which regresses spontaneously, recurring and coalescing in varying proportions (Oyetola et al., 2018; Picciani et al., 2021; Shulman & Carpenter, 2006).

Geographic tongue was first described by Rayer in 1831 as wandering rash of the tongue (Prinz, 1927). The typical pattern has been likened to land masses and oceans on a map, from which the synonym "geographic tongue" was derived (Redman et al., 1972).

As the diagnosis of geographic tongue is essentially clinical, recognizing a tongue lesion is a fundamental part of professional practice. Therefore, knowledge of the frequency of these conditions in the population is an essential point in establishing the diagnosis, as it is mainly based on clinical aspects of the lesion (Henrique et al., 2009).

There is no protocol for clinical evaluation and treatment, many cases are neglected and some patients present symptoms of cancer-phobia (Picciani et al., 2020). It is essential to know the prevalence of geographic tongue in adults to be helpful to identify this disease in the clinical routine, for therapeutic definition, follow-up, and scientific research.

Thus, data from a prevalence systematic review (SR) can therefore be useful in formulating hypotheses regarding geographic tongue development and progression and understanding how many people have it, who is getting it, and where is geographic tongue occurring. This kind of information is particularly valuable for governments when making decisions regarding health policy (Munn et al., 2015, 2020). For this reason, the aim of this SR was to identify the overall prevalence of geographic tongue in adults.

## 2 | METHODS

### 2.1 | Eligibility criteria

The PEO acronym (Population, Exposure, Outcomes) (Moola et al., 2015) was used to formulate the focused question and inclusion criteria in this SR, in which: (P) Adults (>18 years) without comorbidities; (E) Geographic tongue; (O) Prevalence.

Cross-sectional studies were included if evaluated prevalence of geographic tongue, diagnosed through clinical examination in healthy adults. No restriction criteria regarding language and publication time were applied.

The exclusion criteria were studies that included patients with comorbid; studies in which samples were composed by children and adolescents; absence of data after contacting authors; studies in which samples were selected by convenience (dental clinical, hospital, faculty of dentistry); posters and guidelines; studies that did not include patients with geographic tongue; reviews, letters, books, conference abstracts, case report, opinion; studies that did not separate tongue lesions and studies that did not cite the age of participants.

### 2.2 | Information sources and search strategy

An electronic literature search strategy was performed on January 4, 2022, in five databases: Embase, PubMed/Medline, LILACS, Scopus, and Web of Science. Gray literature was conducted in the Google Scholar, ProQuest Dissertation and Theses, and OpenGrey (Appendix S1). Reference lists of included studies were manually searched and experts on the subject were contacted by e-mail to recommend additional studies to be included.

The reference manager software (EndNote X7, Thomson Reuters) was used to collect references and to exclude duplicates. After the references were evaluated by the titles and abstracts according to the eligibility criteria using a computer software (Rayyan, Qatar Computing Research Institute).

### 2.3 | Selection process

Two independent reviewers (R.P.L.P. and J.M.D.O.) conducted a two-phase selection process. Firstly, on phase-1, the two reviewers evaluated the titles and abstracts according to the eligibility criteria; secondly on phase-2, the same two reviewers applied the eligibility criteria after reading the remaining full-text studies. Any discrepancies were resolved by a consensus discussion with a third reviewer (P.P.), before reaching a final decision in both phases. If important data for the review was unclear or missing, the corresponding author was contacted to resolve or clarify the problem.

### 2.4 | Data collection process and data items

Two independent reviewers extracted pertinent data from the included studies (R.P.L.P. and J.M.D.O.) with a pre-tested extraction form developed by the authors and crosschecked in a consensus discussion to ensure the integrity of collected data. The following information were extracted regarding included studies: authors, country and year of publication, sample characteristics, sample size, age range and prevalence. Moreover, if prevalence rate was not expressed, it was calculated using the definition of prevalence, once is frequency of actual cases of a condition in a population over a given period (Szklo & Nieto, 2014). In addition, the prevalence was divided per type defined by Szklo and Nieto (2014): Point prevalence,

considering the number of cases at a point in time; period prevalence, considering the number of cases in a specific period. When prevalence was not specified, it was taken to mean point prevalence (Szklo & Nieto, 2014).

## 2.5 | Study methodological quality assessment

The methodological quality in individual studies was assessed using the Joanna Briggs Institute Critical Appraisal Checklist for Studies Reporting Prevalence Data (2020) (Munn et al., 2020). The study that presents "yes" for all questions was rated as having good methodological quality, those that presents at least one answer "unclear" was rated as moderate methodological quality and at least one answer "no", as low methodological quality (Oliveira et al., 2021).

## 2.6 | Effect measures and synthesis methods

A meta-analysis was performed using JAMOMI 1.6.15 (The JAMOMI Project 2021—Computer Software, Sydney, Australia). The prevalence of populational sample of geographic tongue was calculated. Meta-analyses were carried out separately for the different types of prevalence rates described (point and period prevalence), making it possible to compare studies that evaluated similar measures of effect. Dichotomous data and the restricted maximum likelihood study model were used (Veroniki et al., 2016). The heterogeneity was assessed using the  $I^2$  statistics, prediction interval, Tau-squared and the Cochran Q test.  $I^2$  gives an estimate of the percentage of variability in results across studies that is due to real differences and not due to chance. The null hypothesis of the Q-statistic, based on a chi-square distribution, is that all studies share a common effect size and, if all studies shared the same effect size, the expected value of Q would be equal to the degrees of freedom, indicating larger variation across studies rather than within subjects within a study (Borenstein et al., 2010). Statistical analysis was performed considering random effects and the effect measure for outcome was in proportion (Borenstein et al., 2010). The prediction intervals are graphically represented.

## 3 | RESULTS

### 3.1 | Study selection

From a total of 3046 studies identified, 1623 remained after removing duplicate records. After the first selection phase of reading of title and abstracts, 131 studies of full texts were read in the second phase. Thus, 120 studies were excluded (Appendix S2) and 11 studies were finally included for quantitative synthesis. From these, two studies were included from manual search and one study was included from experts' indications (Figure 1).

### 3.2 | Study characteristics

Eleven analytical cross-sectional studies were included. They were published between 1990 (Salonen et al., 1990) and 2020 (Oivio et al., 2020), and conducted in Brazil (Henrique et al., 2009), Cambodia (Chher et al., 2018), China (Corbet et al., 1994), Finland (Oivio et al., 2020), Germany (Reichart, 2000), Hungary (Bánóczy et al., 1993), Iran (Ghanaei et al., 2013), Israel (Yarom et al., 2004), Nigeria (Taiwo et al., 2009), Sweden (Salonen et al., 1990) and Turkey (Mumcu et al., 2005) (Appendix S3).

The sample sizes ranged from 496 (Mumcu et al., 2005) to 6932 (Bánóczy et al., 1993). The borderlines ages were 18 years (Yarom et al., 2004) to 106 years (Henrique et al., 2009). All these studies embraced a total size of 20,243 individuals. The type of prevalence measured were period prevalence (Bánóczy et al., 1993; Oivio et al., 2020; Salonen et al., 1990) and point prevalence (Chher et al., 2018; Corbet et al., 1994; Ghanaei et al., 2013; Henrique et al., 2009; Mumcu et al., 2005; Reichart, 2000; Taiwo et al., 2009; Yarom et al., 2004).

All studies diagnosed geographic tongue using oral examination.

A detailed individual study characteristic is presented in Table 1.

### 3.3 | Study methodological quality assessment

Among included studies, two were rated as having low methodological quality (Bánóczy et al., 1993; Chher et al., 2018), five studies were rated as moderate methodological quality (Ghanaei et al., 2013; Henrique et al., 2009; Reichart, 2000; Taiwo et al., 2009; Yarom et al., 2004) and four studies as high methodological quality (Corbet et al., 1994; Mumcu et al., 2005; Oivio et al., 2020; Salonen et al., 1990) (Appendix S4).

### 3.4 | Results of individual studies

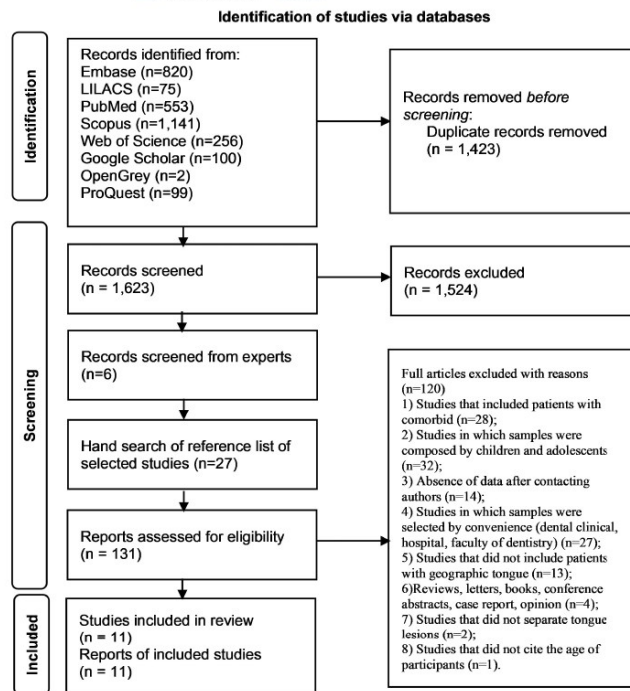
Bánóczy et al. (1993) assessed the prevalence of tongue lesions in Budapest, Hungary. All 6932 patients were over 20 years of age, and 190 were diagnosed with geographic tongue, resulting in a prevalence rate of 2.74%.

Chher et al. (2018) determined the prevalence of oral cancer, oral potentially malignant disorders and other oral mucosal lesions in Cambodia. Of 1634 individuals aged over 18 years, 7 people had geographic tongue, which represents a prevalence of 0.43%.

Corbet et al. (1994) investigated the prevalence of oral mucosal lesions among 65–74 years old living in Hong Kong, China. A total of 537 patients were analyzed, and one was diagnosed with geographic tongue, representing a prevalence of 0.2%.

Ghanaei et al. (2013) assessed the prevalence and types of oral lesions in a general population in Rasht, Iran. Of 1581 individuals aged over 30 years, 41 people had geographic tongue, resulting in a prevalence rate of 2.6%.

Henrique et al. (2009) determined the prevalence of oral mucosal alterations among Brazilian adults of the Uberaba, Brazil. A total of



**FIGURE 1** Flow diagram of literature search and selection criteria (January 4, 2022)

1006 patients over 20 years were analyzed, and 27 were diagnosed with geographic tongue, which represents a prevalence of 2.7%.

Mumcu et al. (2005) researched the prevalence of oral lesions in Turkey population. Of 496 patients over 18 years, seven people had geographic tongue, which represents a prevalence of 1.41%.

Ovio et al. (2020) investigated the oral mucosal changes in a middle-aged Finnish population. Their age ranged from 45 to 47 years. Of 1961 sample, 18 individuals were diagnosed with geographic tongue, which represents a prevalence of 0.9%.

Reichart (2000) determined the prevalence of oral mucosal lesions in a cross-sectional study among Germans. Of 2022 individuals, 45 people had geographic tongue, which represents a prevalence of 2.24%.

In a study by Salonen et al. (1990), a randomly selected sample of adult subjects living in a Swedish country was examined for the presence of oral mucosal lesions. A total of 920 patients were analyzed, and 50 were diagnosed with geographic tongue, resulting in a prevalence rate of 5.6%.

Taiwo et al. (2009) determined the prevalence of oral mucosal lesions in elderly people in Ibadan, Nigeria. A randomly selected sample of 690 was examined and two were diagnosed with geographic tongue, which represents a prevalence of 0.29%.

Yarom et al. (2004) researched the prevalence of benign tongue lesions among adult Israelis. The overall population of the database

was 2464. Among them, 315 were diagnosed with geographic tongue, representing a prevalence of 12.8%.

### 3.5 | Results of syntheses

Once the included studies presented high heterogeneity among each other, statistical analysis was performed considering random effects. For general populations period prevalence meta-analysis, three studies were conducted on 9813 patients participated and the statistics and the prevalence rate was 3.00% (CI: 0.4%–5.5%) ( $I^2$ : 98.4%; Q test: 60.554; Tau<sup>2</sup>: 0.0005 [SE = 0.0005]). For general populations point prevalence meta-analysis, eight studies were conducted on 10,967 patients and the statistics and the prevalence rate was 3.00% (CI: -0.2%–5.5%) ( $I^2$ : 99.57%; Q test: 375.959; Tau<sup>2</sup>: 0.0017 [SE = 0.0009]) (Figure 2b).

## 4 | DISCUSSION

The meta-analysis results showed the period prevalence of geographic tongue in the general population was 3.00% (CI: 0.4%–5.5%) and the point prevalence of geographic tongue was 3.00% (CI: -0.2% to 5.5%).

TABLE 1 Summary of descriptive characteristics of included articles (n = 11)

Author, year (country)	Setting and type of sample	n Sample (F)	Range age (mean $\pm$ SD)	Oral examiner	Geographic tongue definition (references, year)	Type of prevalence measured/assessed	N/% prevalence (F)
Bánóczy et al. (1993) (Hungary)	Living in Budapest, Hungary/ populational	6932 (NR <sup>a</sup> )	20–29y (NR)	Five dentists	"The occurrence of one or more smooth areas on the dorsum and lateral borders of the tongue, in the smooth areas with all absence of filiform papillae" (Van der Waal & Pindborg, 1986)	Period prevalence	190/2.74% (122)
Chher et al. (2018) (Cambodia)	Living in Cambodia/ populational	1634	18–60y (43.8 $\pm$ 16.2)	Seven dentists	NR (NR)	Point prevalence	7/0.43% <sup>b</sup> (NR)
Corbet et al. (1994) (China)	Living in Hong Kong, China/ populational	537 (NR)	65–74y (NR)	Three examiners	Referenced by the authors (Axell et al., 1990)	Point prevalence	1/0.2% (NR)
Ghanaei et al. (2013) (Iran)	Living in Rasht, Iran/ populational	1581 (NR <sup>a</sup> )	>30y (NR)	Two trained health specialists	Referenced by the authors (World Health Organisation [WHO], NR)	Point prevalence	41/2.6% (NR)
Henrique et al. (2009) (Brazil)	Living in Uberaba (MG), Brazil/ populational	1006 (648)	20–106y (49y $\pm$ NR)	One examiner	Referenced by the authors (Marucci, 2005)	Point prevalence	27 <sup>b</sup> /2.7% (NR)
Mumcu et al. (2005) (Turkey)	Living in Turkey/ populational	496 (195)	18–95y (NR)	One dentist specialist on oral medicine	Referenced by the authors (WHO, 1980; 1997)	Point prevalence	7/1.41% <sup>b</sup> (4)
Olvio et al. (2020) (Finland)	Living in the longitudinal Northern, Finland/ populational	1961 (1050)	45–47y (NR)	Seven general dentists and oral pathologist	Referenced by the authors (Regezi et al., 2016)	Period prevalence	18/0.9% (12)
Reichert (2000) (Germany)	Living in Germany/ populational	2022 (1115)	35–44y and 65–74y (NR)	A dentist, a dental nurse and a recording assistant	Referenced by the authors (Kramer et al., 1980)	Point prevalence	45.29 <sup>b</sup> /2.24% <sup>b</sup> (28,26 <sup>b</sup> )
Salonen et al. (1990) (Sweden)	Living in Sweden/ populational	920 (471)	20–>79y (NR)	One of the authors	Referenced by the authors (Axell, 1976; Axell et al., 1990)	Period prevalence	50/5.6% (26)
Taiwo et al. (2009) (Nigeria)	Living in Ibadan, Nigeria/ populational	690 (283)	65–90y (69.7y $\pm$ 7.6y)	Two examiners	Referenced by the authors (WHO, 1986)	Point prevalence	2/0.29% (1)

(Continues)

TABLE 1 (Continued)

Author, year (country)	Setting and type of sample	n Sample (F)	Range age (mean $\pm$ SD)	Oral examiner	Geographic tongue definition (references, year)	Type of prevalence measured/assessed	N/% prevalence (F)
Yarom et al. (2004) (Israel)	Living in Jewish, Israel/ populational	2464 (1422)	18-70y (41.5y $\pm$ NR)	Three clinicians	<sup>a</sup> A common, usually asymptomatic, benign condition, which primarily affects the dorsal surface of the tongue. Local loss of filiform papillae leads to annular or circulate limited atrophic erosive-like lesions usually accompanied by white raised borders <sup>b</sup> (Assimakopoulos et al., 2002)	Point prevalence	315 <sup>c</sup> /12.8% (NR)

Abbreviations: F, female sample; NR, not reported; SD, standard deviation; y, years.

<sup>a</sup>The article brings the data but was not considered because it involved an excluded group.

<sup>b</sup>Data calculated by the authors.

Knowing the prevalence of geographic tongue is an important clinical implication for different health care professionals and could be helpful in clinical practice and future research (Henrique et al., 2009; Taiwo et al., 2009). Epidemiological studies have shown a high frequency of geographic tongue with variable prevalence in different parts of the world. Such genetic variations are due to the differences in ethnic groups, sex, and age of the studied samples and the use of different diagnostic criteria, methodology, and procedures.

Regarding sex, Shulman and Carpenter (2006) found no relationship between geographic tongue and sex. In this SR, Bánóczy et al. (1993) shows that 64.21% who presented geographic tongue were women. The results by Mumcu et al. (2005) showed that 57.14% were women. The results of Oivio et al. (2020) showed that the prevalence of geographic tongue is higher in women (66.67%). Reichart (2000) study indicated that 62.8% were women. Salonen et al.'s (1990) study shows that 52% of patients with geographic tongue were women.

Regarding age, authors report that geographic tongue occurs more often in young adults and that the occurrence of lesions decreases with age (Picciani et al., 2020). There is a higher frequency of geographic tongue in 20-29-year age group (Bánóczy et al., 1993) when compared with a 45-47-year age group, 0.9% (Oivio et al., 2020) or 65-74-year age group, 0.2% (Corbet et al., 1994).

Geographic tongue constitutes a remarkable proportion of oral mucosal lesions and prevalence rates vary in different parts of the world. The distribution of included studies covers four continents around the world: Africa, America, Asia, and Europe. The sample of included studies was larger in the European continent ( $n = 11,835$ ), than in the Asian continent ( $n = 6216$ ), followed by South American continent ( $n = 1006$ ) and finally the African continent ( $n = 690$ ). In the study by Mumcu et al. (2005), Turkey is a transcontinental country spanning across Europe and Asia and the sample was 496. The results show that the geographic tongue prevalence was different among various continents. The prevalence was 1.29% in Nigeria (Taiwo et al., 2009), the only African country in the selected studies. In Asia, the prevalence rates range from 0.2% in China (Corbet et al., 1994) to 12.8% in Israel (Yarom et al., 2004). In Brazil it was 2.7%, the only American country included (Henrique et al., 2009). The prevalence in European countries varies from 0.9% in Finland (Oivio et al., 2020) to 5.43% in Sweden (Salonen et al., 1990). In Turkey, the prevalence was 1.41% (Mumcu et al., 2005).

Even though some conditions which affect the oral mucosa are acquired and can be prevented, in the case of geographic tongue, it is possible to observe that the use of tobacco is inverse to the appearance of the condition. Oivio et al. (2020) show that geographic tongue was significantly more frequent in non-smokers (1.5%) than in current smokers (0.6%), similar to that seen in a Swedish study where 6.8% of non-smokers and 1.7% of smokers had a geographic tongue (Salonen et al., 1990).

The etiology of geographic tongue remains largely unknown, however, a few theories have been proposed. Psychosomatic and hereditary factors have been suggested to have a role in the etiology



## (a) Proportions

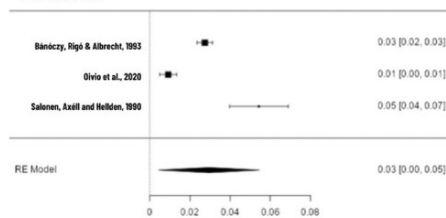
Random-Effects Model (k = 3)						
	Estimate	se	Z	p	CI Lower Bound	CI Upper Bound
Intercept	0.0295	0.0128	2.30	0.021	0.004	0.055

Note. Tau<sup>2</sup> Estimator: Restricted Maximum-Likelihood

## Heterogeneity Statistics

Tau	Tau <sup>2</sup>	I <sup>2</sup>	H <sup>2</sup>	R <sup>2</sup>	df	Q	p
0.022	5e-04 (SE= 5e-04)	98.4%	62.684	.	2.000	60.554	< .001

## Forest Plot



## (b) Proportions

Random-Effects Model (k = 8)						
	Estimate	se	Z	p	CI Lower Bound	CI Upper Bound
Intercept	0.0264	0.0146	1.81	0.071	-0.002	0.055

Note. Tau<sup>2</sup> Estimator: Restricted Maximum-Likelihood

## Heterogeneity Statistics

Tau	Tau <sup>2</sup>	I <sup>2</sup>	H <sup>2</sup>	R <sup>2</sup>	df	Q	p
0.041	0.0017 (SE= 9e-04)	99.57%	233.878	.	7.000	375.959	< .001

## Forest Plot

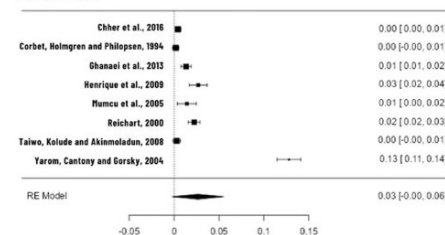


FIGURE 2 (a) Meta-analysis' graphs for populational sample prevalence of geographic tongue—*period prevalence*. (b) Meta-analysis' graphs for populational sample prevalence of geographic tongue—*point prevalence*. JAMOVI 1.6.15 (the Jamovi project 2021—computer software, Sydney, Australia)

of geographic tongue. Liang et al. (2019) reported that biopsies revealed similarities among geographic tongue patients with different genotypes with the neutrophils prominently infiltrating the epidermis and the expression ratio of IL-36Ra/IL-36 $\gamma$  in lesioned tongues with individuals harboring different genotypes decreased significantly compared with controls.

On the other hand, Morger et al. (2010) found geographic tongue in 46.43% out of 28 recruits in whom a fissured tongue was also demonstrated. In the study by Yarom et al. (2004), the occurrence of FT and GT simultaneously in the same individuals was recorded in 8.5% of participants. The simultaneous and frequent prevalence of geographic tongue and fissured tongue based on a genetic predisposition had previously been described in the literature (Salonen et al., 1990; Shulman, 2015).

There are several comorbidities known in the literature to be associated with geographic tongue as psoriasis and asthma, for example (Lesan et al., 2021; Picciani et al., 2015). Some authors indicate that this lesion may represent an early oral manifestation of psoriasis, and correct diagnosis and continuous treatment of these patients are crucial, because with psoriasis we are treating a chronic disease (Oyetola et al., 2018; Picciani et al., 2015). In most investigations the comorbidity approach with specific diseases predominated, which was an exclusion criterion adopted in this study, lacking studies related to symptomatology and therapy. It is certain that some comorbidities increase the chances of geographic tongue prevalence and would therefore be a confounding factor. All articles made it clear that the patients had comorbidities were excluded. However, we

cannot be certain that all the subjects in each of the retained studies were not presented with any comorbidities. Such possibility could lead to uncontrolled biases that cannot be estimated.

Some reports of geographic among adults were based on convenience samples, such as Darwazeh and Pillai (1993) a dental outpatient's study, that the prevalence of geographic tongue was 6.8%. On a specialty clinic referral study by Marks and Czarny (1984) the prevalence of geographic tongue rates at 14%. Once prevalence is the rate of affected individuals calculated over a population total with a common characteristic (Szklo & Nieto, 2014), studies in hospital, medical and dentistry centers where cases are identified cater to patients having characteristics related to the exposure being evaluated and cannot express the real prevalence of geographic tongue in the population (Szklo & Nieto, 2014). For this is the reason the convenience sample studies were excluded.

## 5 | LIMITATIONS

These lesions may change drastically in location, pattern, and size, often appearing to migrate across the surface of the tongue (Oyetola et al., 2018; Picciani et al., 2020; Redman, 1964). They present periods of exacerbation and remission, without complications or sequelae that regress spontaneously, which makes it difficult to provide objective prevalence data. Nevertheless, any comparison between epidemiological surveys is difficult, as they vary in the methodology, sample size, and diagnostic criteria, diversity of examiners and the

inter-examiner variability causes further confusion, which partially explains the high heterogeneity observed across the studies (period prevalence:  $I^2$ : 98.40%; and point prevalence:  $I^2$ : 99.57%).

Another limitation is that although all the articles used oral examination to diagnose the geographic tongue, it cannot be guaranteed that all of them used the same parameters, as there is no protocol for clinical evaluation.

On the other hand, the search strategy is limited to certain keywords that may not be found in some important articles despite the search being done systematically in different databases in addition to the search in the gray literature. Trying to overcome this limitation, a reading of the reference list of the included articles was carried out and experts on the subject were consulted.

## 6 | OTHER INFORMATION

**Registration and protocol:** This SR was reported following the Preferred Reporting Items for Systematic Reviews and Meta-analyses checklist (PRISMA). For previous registration, a SR protocol based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) was developed and registered at Prospective Register of Systematic Reviews (PROSPERO; Center for Reviews and Dissemination, University of York; and the National Institute for Health Research). The registration number is CRD42021265461.

## 7 | CONCLUSIONS

The proportion of geographic tongue in adults varied widely around the world. However, the results demonstrated that approximately one in 30 adults has geographic tongue.

### AUTHOR CONTRIBUTIONS

**Júlia Meller Dias de Oliveira:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; supervision; validation; visualization. **Patrícia Pauletto:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; supervision. **Etiene de Andrade Munhoz:** Conceptualization; investigation; methodology; project administration; supervision; validation; writing – review and editing. **Eliete Neves Silva Guerra:** Conceptualization; formal analysis; methodology; supervision; validation; writing – review and editing. **Carla Massignan:** Conceptualization; data curation; formal analysis; methodology; project administration; resources; supervision; writing – review and editing. **Graziela De Luca Canto:** Methodology; project administration; supervision; validation; visualization; writing – review and editing.

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### CONFLICT OF INTEREST

Authors have no conflicts of interest to declare.

### PEER REVIEW

The peer review history for this article is available at <https://publons.com/publon/10.1111/odi.14397>.

### DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the supplementary material of this article.

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#### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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## DO ARTIGO EM INGLÊS

### Appendix 1. Database search strategy.

Database	Database Search query 2022 January 4th
EMBASE	'benign migratory glossitis'/exp OR 'benign migratory glossitis' OR 'geographic tongue'/exp OR 'geographic tongue' OR 'geographical tongue' OR 'glossitis areata exfoliativa' OR 'lingual erythema migrans'
LILACS	"Benign Migratory Glossitis" OR "Geographic Tongue" OR "geographical tongue" OR "Glossitis Areata Exfoliativa" OR "Lingual Erythema Migrans" OR "Glossite Migratória Benigna" OR "Glositis Migratoria Benigna" OR "Glositis Areata Exfoliativa" OR "Lengua Geográfica" OR "Glossite Esfoliativa Circunscrita" OR "Língua Geográfica"
PUBMED	"glossitis, benign migratory"[MeSH Terms] OR "Benign Migratory Glossitis"[All Fields] OR "Geographic Tongue"[All Fields] OR "geographical tongue"[All Fields]
SCOPUS	"Benign Migratory Glossitis" OR "Geographic Tongue" OR "geographical tongue" OR "Glossitis Areata Exfoliativa" OR "Lingual Erythema Migrans"
Web of Science	"Benign Migratory Glossitis" OR "Geographic Tongue" OR "geographical tongue" OR "Glossitis Areata Exfoliativa" OR "Lingual Erythema Migrans"
Google scholar	"Benign Migratory Glossitis" OR "Geographic Tongue" OR "geographical tongue" OR "Glossitis Areata Exfoliativa" OR "Lingual Erythema Migrans"
Proquest	"Benign Migratory Glossitis" OR "Geographic Tongue" OR "geographical tongue" OR "Glossitis Areata Exfoliativa" OR "Lingual Erythema Migrans"
Open Grey	"Benign Migratory Glossitis" OR "Geographic Tongue" OR "geographical tongue" OR "Glossitis Areata Exfoliativa" OR "Lingual Erythema Migrans"

Search strategies were performed for each database by using specific words combinations and truncations with support of an experienced librarian, Msc Karyn Munky Lehmkuhl.

**Appendix 2.** Articles excluded and the reasons for exclusion (n=120)

<b>References</b>	<b>Author</b>	<b>Reasons for Exclusion*</b>
1	Aboyans & Ghaenmaghami, 1973	1
2	Alaeddini et al., 2014	2
3	Al-Maweri et al., 2013	3
4	Al-Maweri et al., 2015	1
5	Al-Qahtani et al., 2019	1
6	Al-Wesabi et al., 2017	2
7	Araújo et al., 2015	1
8	Avcu and Kanli, 2003	4
9	Axéll et al., 1990	4
10	Baharv et al., 2017	1
11	Bánóczy et al., 1975	1
12	Bastos et al., 2011	3
13	Benevides Dos Santos et al., 2014	2
14	Birman, Silveira and Sampaio, 1991	1
15	Bomfim et al., 2008	3
16	Bornstein et al., 2006	4
17	Bouquot and Gundlach, 1986	5
18	Bouquot, 1986	2
19	Byahatti, Mohammed and Ingafou, 2010	1
20	Campisi and Margiotta, 2001	5
21	Cardoso et al., 2018	6
22	Cebeci et al., 2009	4
23	Chaudhary, 2021	2
24	Chosack, Zadik and Eildeman, 1974	2
25	Cornejo et al., 2007	4
26	Costa et al., 2009	2
27	Crivelli et al., 1990	4
28	Cury et al., 2014	1
29	Dabic et al., 2015	2
30	Darwazeh et al., 1993	3
31	Darwazeh et al., 2012	2
32	Dhanuthai et al., 2020	2
33	Dick et al., 2020	2
34	Dirschnabel et al., 2010	2
35	Do et al., 2014	5

36	Donohue et al., 2007	4
37	Dos Santos et al., 2004	4
38	Dundar and Kal, 2007	2
39	Eidelman et al., 1976	2
40	El Mostehy and Stallard, 1968	2
41	Epinoza et al., 2003	5
42	Feng et al., 2015	2
43	Garcia, 2020	2
44	Garcia-Pola et al., 2002	5
45	Garhammer et al., 2001	2
46	Gavrilovic et al., 2012	6
47	Germi et al., 2012	1
48	Ghadiri-Anari et al., 2019	1
49	Glowacka and Konopka, 2018	1
50	Gonzaga et al., 2014	2
51	Guzmán and Suárez, 2004	2
52	Guzmán Marín and Calero, 2005	2
53	Halperin et al., 1953	4
54	Harini and Don, 2018	3
55	Harsha and Brundha, 2017	3
56	Hashemipour et al., 2008	1
57	Hernández-Pérez et al., 2008	2
58	Hoff, Silva and De Carli, 2015	4
59	Ikeda et al., 1991	4
60	Ikeda et al., 1995	5
61	Jainkittivong, Aneksuk, and Langlais, 2002	4
62	Jarvis and Golin, 1972	2
63	Jhugroo et al., 2019	3
64	Jorge et al., 2017	2
65	Kansky et al., 2018	4
66	Koay, Lim and Siar, 2011	1
67	Konopka et al., 2015	5
68	Kovac-Kovacic and Skaleric, 2000	4
69	Kullaa-Mikkonen et al., 1982	2
70	Kutscher et al., 1966	2
71	Laronde et al., 2014 (A)	7
72	Laronde et al., 2014 (B) – Decision-making	3
73	Lin, Cobert and Lo, 2001	5
74	López-Jornet et al., 2021	1
75	Marks and Czarny, 1984	1

76	Marks et al., 2005	1
77	Martinez and Garcia-Pola, 2002	4
78	Mathew et al., 2008	4
79	Meskin et al., 1963	6
80	Miloglu et al., 2009	4
81	Mittermüller et al., 2018	3
82	Monshi et al., 2021	1
83	Morger et al., 2010	4
84	Motallebnejab et al., 2008	4
85	Mozafari et al., 2012	1
86	Mushatat et al., 2018	3
87	Muzyka et al., 2001	1
88	Olejniak et al., 2020	1
89	Oyetola et al., 2018	3
90	Patil et al., 2012	4
91	Pentenero et al., 2008	5
92	Picciani et al., 2011	1
93	Picciani et al., 2018	1
94	Pinheiro et al., 2019	5
95	Rabiei et al., 2010	1
96	Ramírez, Mosqueda and Hernández, 1986	4
97	Rampi et al., 2019	4
98	Redman et al., 1964	1
99	Redman et al., 1972	8
100	Saini et al., 2010	3
101	Samaranayake et al., 1995	4
102	Schaumann, Peagler and Gorlin, 1970	4
103	Scott and Cheah, 1989	4
104	Shamloo et al., 2016	2
105	Shayeb et al., 2020	3
106	Shet et al., 2013	5
107	Shulman and Carpenter, 2006	4
108	Shulman, Beach and Rivera-Hidalgo, 2004	2
109	Singh, Nivash and Mann, 2013	3
110	Tajmirriahi et al., 2014	7
111	Tomb et al., 2010	1
112	Tortorici et al., 2016	1
113	Triantos, 2005	1
114	Ugar-Cankal, Denizci and Hocaoglu, 2005	2
115	Vieira et al., 2009	2



<b>116</b>	Viera et al., 2011	2
<b>117</b>	Zahed et al., 2020	5
<b>118</b>	Zain et al., 1997	5
<b>119</b>	Zlotogorski Hurvitz et al., 2020	2
<b>120</b>	Zunt et al., 1989	6

\*

- 1) Studies that included patients with comorbid;
- 2) Studies in which samples were composed by children and adolescents;
- 3) Absence of data after contacting authors.
- 4) Studies in which samples were selected by convenience (dental clinical, hospital, faculty of dentistry) posters and guidelines;
- 5) Studies that did not include patients with geographic tongue;
- 6) Reviews, letters, books, conference abstracts, case report, opinion
- 7) Studies that did not separate tongue lesions
- 8) Studies that did not cite the age of participants.

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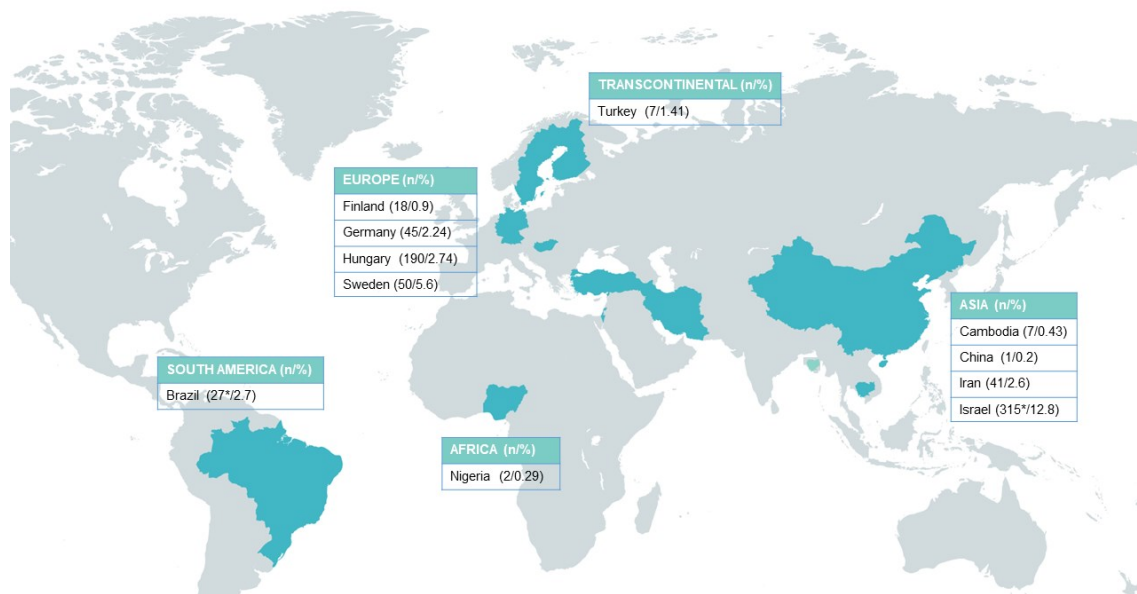
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**Appendix 3.** Worldwide distribution of affected Sample (n) and Prevalence (%) of included studies: Africa, Asia, Europe, and South America



**Appendix 4.** Methodological quality summary author's judgments for each included study, assessed by the Joanna Briggs Institute (JBI) (ref) Critical Appraisal Checklist for Prevalence studies and graphically represented by "Traffic-light" plot (A) and Weighted bar plot (B) (generated using the online tool robvis (Risk-Of-Bias VISualization) (National Institute for Health Research)

(A)

Study	D1	D2	D3	D4	D5	D6	D7	D8	D9
Bánóczy et al., 1993	+	×	+	+	+	+	+	+	+
Chher et al., 2018	+	+	+	-	+	×	+	+	+
Corbet, Holmgren and Philipsen, 1994	+	+	+	+	+	+	+	+	+
Ghanaei et al., 2013	+	-	+	+	+	+	+	+	+
Henrique et al., 2009	+	-	+	+	+	+	+	+	-
Mumcu et al., 2005	+	+	+	+	+	+	+	+	+
Olvio et al., 2020	+	+	+	+	+	+	+	+	+
Reichart, 2000	+	+	+	+	+	-	+	-	+
Salonen, Axéll and Hellden, 1990	+	+	+	+	+	+	+	+	+
Taiwo, Kolude and Akinmoladun, 2008	+	+	+	+	+	+	+	+	-
Yarom, Cantory and Gorsky, 2004	+	-	+	+	+	+	+	+	-

D1: 1 Was the sample frame appropriate to address the target population?  
 D2: 2 Were study participants sampled in an appropriate way?  
 D3: 3 Was the sample size adequate?  
 D4: 4 Were the study subjects and the setting described in detail?  
 D5: 5 Was the data analysis conducted with sufficient coverage of the identified sample?  
 D6: 6 Were valid methods used for the identification of the condition?  
 D7: 7 Was the condition measured in a standard, reliable way for all participants?  
 D8: 8 Was there appropriate statistical analysis?  
 D9: 9 Was the response rate adequate, and if not, was the low response rate managed appropriately?

**Judgement**  
 High (Red X)  
 Unclear (Yellow -)  
 Low (Green +)

(B)

