

MARIA APARECIDA GONÇALVES DE MELO CUNHA

**TENDÊNCIA HISTÓRICA DAS EXODONTIAS DE DENTES PERMANENTES NO
BRASIL:
ANÁLISE DE UMA SÉRIE DE 15 ANOS**

**Faculdade de Odontologia
Universidade Federal de Minas Gerais
Belo Horizonte
2015**

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Dissertação apresentada ao Programa de Pós-Graduação em Odontologia da Faculdade de Odontologia da Universidade Federal de Minas Gerais, como requisito parcial para obtenção do título de Mestre em Odontologia.

Área de Concentração: Saúde Coletiva

Linha de pesquisa: Políticas, instituições e serviços de saúde bucal

Orientador: Prof. Dr. Mauro Henrique Nogueira Guimarães de Abreu

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**Faculdade de Odontologia
Universidade Federal de Minas Gerais
Belo Horizonte
2015**

FICHA CATALOGRÁFICA

C972t
2015
T

Cunha, Maria Aparecida Gonçalves de Melo
Tendência histórica da exodontia de dentes permanentes no
Brasil: análise de uma série de 15 anos / Maria Aparecida
Gonçalves de Melo Cunha – 2015.

56 f.: il.

Orientador: Mauro Henrique Nogueira Guimarães de Abreu
Coorientadoras: Simone Dutra Lucas
Mara Vasconcelos

Dissertação (Mestrado) – Universidade Federal de Minas
Gerais, Faculdade de Odontologia.

1. Acesso aos serviços de saúde. 2. Análise de séries
temporais interrompida. 3. Cirurgia bucal. I. Abreu, Mauro
Henrique Nogueira Guimarães de. II. Lucas, Simone Dutra.
III. Vasconcelos, Mara. IV. Universidade Federal de Minas
Gerais. Faculdade de Odontologia. V. Título.

BLACK D047

DEDICATÓRIA

Á todas as pessoas que, por vários motivos, encontraram na exodontia a solução mais viável para o problema de saúde bucal.

Á todas as pessoas que acreditam e lutam por um mundo melhor para todos.

AGRADECIMENTOS

À Deus por ser meu guia e sempre me apontar qual caminho trilhar.

Ao meu marido Fabiano e minhas filhas Elisa e Livia (sempre presente em mim) por sempre me apoiarem e entenderem ausências em momentos de ritmo intenso. Obrigada por serem minha vida...

Aos meus pais, exemplo a ser seguido em todo meu caminhar...

A toda minha grande família: irmãos, cunhados, sobrinhos, afilhados... Amo vocês!

Ao Orientador Mauro Henrique Nogueira Guimarães de Abreu que, além de brilhante professor, é um grande amigo. Pelo apoio, pela sabedoria transmitida em todos os momentos dessa caminhada e pela mão sempre estendida.

À Professora Simone Dutra Lucas pela dedicação, empenho e preocupação em sempre enriquecer esse estudo.

À Professora Mara Vasconcelos pelas leituras atentas e contribuições trazidas.

À Patrícia Azevedo Lino pela parceria e tempo dedicado na construção do banco de dados. Você é um anjo...

Ao Professor Thiago Rezende pelas ideias e contribuições trazidas com a análise estatística do trabalho.

A todos os Professores que participaram do meu percurso formativo. Os de anteontem, os de ontem e os de hoje.

Às minhas colegas de mestrado Andreza, Camilla, Mirna e Natália pelos conhecimentos partilhados e convivência harmoniosa.

Aos funcionários da Secretaria do Departamento de Odontologia Social e Preventiva/FOUFMG e do Colegiado de Pós-Graduação/FOUFMG pela disponibilidade, simpatia e gentileza.

Ao Davidson Silva, técnico da Secretaria Estadual de Saúde de Minas Gerais pela boa vontade na obtenção dos dados.

À Dani e Nenê pela amizade e por reconhecerem minha paixão pela saúde coletiva. Isso me levou a buscar mais... Obrigada pela oportunidade!!

À vida por me oferecer tanto...

*“Tudo é do Pai,
toda honra e toda glória...
É dele a vitória
Alcançada em minha vida.”*

CUNHA, Maria Aparecida Gonçalves de Melo. TENDÊNCIA HISTÓRICA DAS EXODONTIAS DE DENTES PERMANENTES NO BRASIL: ANÁLISE DE UMA SÉRIE DE 15 ANOS. Dissertação (Mestrado em Odontologia – área de concentração em Saúde Coletiva) – Programa de Pós-Graduação da Faculdade de Odontologia da Universidade Federal de Minas Gerais, Belo Horizonte, 2015.

RESUMO

Introdução: A perda dentária é considerada um problema de saúde pública. Estudos de série temporal que avaliam a influência das condições de desenvolvimento humano e do acesso a serviços de saúde sobre essas perdas dentárias são escassos. O estudo objetivou descrever a tendência das exodontias de dentes permanentes no Brasil entre 1998 e 2012, comparar essas tendências em municípios que apresentam Índice de Desenvolvimento Humano (IDH) diferentes; com acesso e cobertura de atenção primária e secundária distintos. **Metodologia:** Estudo de série temporal realizado entre 1998 e 2012, com dados do Sistema de Informação em Saúde do Sistema Único de Saúde. Foram calculadas duas taxas anuais de exodontias e analisadas de forma estratificada de acordo com três parâmetros: IDH, presença de Centro de Especialidade Odontológica (CEO) e cobertura das Equipes de Saúde Bucal (ESB). As séries temporais foram analisadas pelo modelo de regressão linear. **Resultados:** Observou-se, em geral, decréscimo nas tendências das perdas dentárias durante esse período, especialmente na taxa de exodontias em relação aos procedimentos da atenção primária. Em municípios brasileiros com IDH abaixo da mediana, as taxas médias são maiores do que municípios com IDH mais elevado, bem como, em municípios que não possuem o CEO em relação aos que o possuem. Municípios com menores índices de coberturas de ESB apresentaram taxas de exodontias mais baixas do que municípios com maiores índices de cobertura. **Conclusões:** O Brasil apresenta, em geral, um decréscimo na tendência das exodontias de dentes permanentes nesses 15 anos analisados. Desenvolvimento humano e acesso a serviços de saúde bucal, em geral, influenciam as taxas de exodontias.

Palavras-chave: Acesso a Serviços de Saúde; Análise de Séries Temporais; Exodontia.

CUNHA, Maria Aparecida Gonçalves de Melo. HISTORICAL TREND OF EXTRACTION LOSS IN BRAZIL: AN ANALYSIS OF 15 YEARS OF SERIES. Dissertation (Masters in Dentistry - specialization in Community Health) - Program Graduate School of Dentistry, Federal University of Minas Gerais, Belo Horizonte, 2015.

ABSTRACT

Background: Tooth loss is considered to be a public health problem. Time-series studies that assess the influence of social conditions and access to health services on tooth loss are scarce. **Objective:** This study aimed to examine the time series of permanent tooth extraction in Brazil between 1998 and 2012 and to compare these series in municipalities with different Human Development Index (HDI) scores and with different access to distinct primary and secondary care. **Research Design:** Time-series study was performed between 1998 and 2012. **Subjects:** Secondary data from the Brazilian National Health Information System. **Measures:** Two annual rates of tooth extraction were calculated and evaluated separately according to three parameters: the HDI, the presence of a Dental Specialty Center, and coverage by Oral Health Teams. The time series was analyzed using a linear regression model. **Results:** An overall decrease in the tooth-loss tendencies during this period was observed, particularly in the tooth extraction rate during primary care procedures. In the municipalities with an HDI that was lower than the median, the average tooth-loss rates were higher than in the municipalities with a higher HDI. The municipalities with lower rates of Oral Health Team coverage also showed lower extraction rates than the municipalities with higher coverage rates. **Conclusions:** In general, Brazil has shown a decrease in the trend to extract permanent teeth during these 15 years. Increased human development and access to dental services have influenced tooth extraction rates.

Key Words: Health Services Research; Time Series Analysis; Tooth Extraction

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LISTA DE ABREVIATURAS

CEO – Centro de Especialidades Odontológicas.

CPOD – Índice odontológico que contabiliza os dentes Cariados, Perdidos e Restaurados (Obturados).

ESB – Equipes de Saúde Bucal.

ESF – Equipe de Saúde da Família.

IDH – Índice de Desenvolvimento Humano.

OMS – Organização Mundial de Saúde.

PNSB – Política Nacional de Saúde Bucal.

PSF – Programa de Saúde da Família.

SIA – Sistema de Informação Ambulatorial.

SUS – Sistema Único de Saúde.

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1 CONSIDERAÇÕES INICIAIS

A perda dentária é um dos piores agravos decorrente das doenças bucais. Tem como consequência a diminuição da capacidade funcional da mastigação e da fonação, prejuízos nutricionais, psicológicos e estéticos, além de problemas nas relações sociais. No Brasil, a perda do órgão dental relacionada às exodontias provocadas por doenças evitáveis, entre elas, a cárie dentária e as doenças periodontais, é muito elevada (1).

O último estudo epidemiológico nacional de saúde bucal foi realizado pelo Ministério da Saúde em 2010, nas 26 capitais estaduais, no Distrito Federal e em 150 municípios de diferentes portes populacionais. Os resultados desta pesquisa, intitulada SB Brasil 2010, mostraram uma tendência de redução no número de dentes permanentes Cariados, Perdidos e Obturados (CPOD) dos adultos de 35 a 44 anos que passou de 20,1 em 2003, para 16,3. Esta redução também é confirmada pelo componente P (perdidos) que reduziu sua proporção de 65,72% em 2003 para 44,79% em 2010 (2). Apesar dessa queda, torna-se necessário o desenvolvimento de programas de atenção à saúde bucal, a fim de diminuir os danos causados e prevenir a continuidade da tendência à mutilação (3).

Diversos fatores estão associados a perdas dentárias, dentre os quais os socioeconômicos e o acesso a serviços de saúde bucal (4,5). No entanto, poucos estudos de séries temporais avaliaram o efeito destas condições sobre a perda dentária no Brasil.

As ações de Saúde Bucal no Sistema Único de Saúde (SUS) eram fragmentadas e ofertadas de forma paralela ao processo de organização dos demais serviços de saúde, com baixo poder de resolutividade, sendo incapazes de equacionar os principais problemas da população. A inclusão da saúde bucal na Equipe de Saúde da Família (ESF) ocorreu em 2001, após publicações de duas portarias. A portaria GM/MS 1.444, de 28 de dezembro de 2000 e a portaria GM/MS 267, de 6 de março de 2001, que estabeleceu incentivo financeiro para a reorganização da atenção à saúde bucal e aprovou as normas e diretrizes de inclusão da saúde bucal na

Estratégia de Saúde da Família, mediante o plano de Reorganização das Ações de Saúde Bucal na Atenção Básica. Estas portarias apresentaram a saúde bucal como parte integrante das ações desenvolvidas no SUS. Baseado no resultado do levantamento epidemiológico de 2003, no ano seguinte, o então Presidente Luiz Inácio Lula da Silva, por meio do Ministério da Saúde lançou a Política Nacional de Saúde Bucal (PNSB) – Brasil Sorridente em vigor desde 2004, como resposta aos problemas de saúde da população brasileira. As Diretrizes da Política Nacional de Saúde Bucal apresentam as ações do Ministério da Saúde para a organização da atenção à saúde bucal no âmbito do SUS. Estas diretrizes constituem o eixo político básico de proposição para a reorientação das concepções e práticas no campo da saúde bucal, capazes de propiciar um novo processo de trabalho tendo como meta à produção do cuidado. Houve a inserção de procedimentos mais complexos na Atenção Primária e a criação de uma rede de serviços de atenção em saúde bucal no SUS, resgatando a cidadania da população brasileira (2).

Nesse sentido, a observação e a descrição da tendência de exodontias de dentes permanentes nos últimos quinze anos, poderiam ser uma forma de avaliar se houve mudanças no modelo de atenção à saúde, subsidiando o planejamento, bem como monitoramento e avaliando a política nacional de atenção à saúde bucal.

2 OBJETIVOS

2.1 Objetivo Geral

Descrever a tendência das exodontias de dentes permanentes no Brasil entre os anos de 1998 a 2012.

2.2 Objetivos Específicos

- Descrever e comparar a tendência de exodontias de dentes permanentes de acordo com o Índice de Desenvolvimento Humano (IDH) dos municípios brasileiros;
- Descrever e comparar as tendências das exodontias de dentes permanentes em municípios com e sem Centros de Especialidades Odontológicas (CEO);
- Descrever e comparar as tendências de exodontias de dentes permanentes em municípios de acordo com indicadores de organização da atenção primária: cobertura de Equipes de Saúde Bucal (ESB).

3 REFERENCIAL TEÓRICO

3.1 Estudos sobre perda dentária no mundo e no Brasil

Alguns estudos que apresentam prevalências das perdas dentárias serão apresentados para conhecimento da situação no mundo e no Brasil.

No Reino Unido, Health RM (1992) (6) mostraram que a prevalência de edentulismo entre idosos com mais de 65 anos passou de 79% em 1968 para 74% em 1978 e para 57% em 1988.

Lin *et al.* (2001) (7) realizaram um estudo no Sul da China que apontou uma prevalência de edentulismo de 4,4% para os idosos de 65 a 74 anos residentes em área urbana e de 3,4% para os residentes na zona rural.

Estudo realizado com idosos acima de 60 anos na Índia, mostrou uma prevalência de edentulismo de 15% (8).

Em uma pesquisa sobre a queda das taxas de edentulismo em três países europeus, Mojon *et al.* (2004) (9) apontaram que a prevalência de edentulismo na Suécia em 1997, foi igual a 0% no grupo etário de 35 a 44 anos, 15% entre idosos de 65 a 74 anos e 35% entre aqueles com mais de 75 anos. Já no grupo etário de 35 a 44 anos de residentes no Reino Unido, a prevalência foi de apenas 1%. Para a Finlândia, o inquérito nacional realizado em 1997 encontrou uma prevalência de 1% de edentulismo no grupo etário de 35 a 44 anos, 9% para indivíduos de 45 a 54 anos e 23% para aqueles com 55 a 64 anos.

Cunha-Cruz *et al.* (2007) (10) compararam os três inquéritos nacionais de saúde realizados nos Estados Unidos nos anos de 1972, 1991 e 2001. Os resultados mostraram que a prevalência de edentulismo para adultos de 25 a 74 anos reduziu de 20,3% (1972) para 16,7% (1991) e 13,9% (2001) entre os mais pobres. Entre os mais ricos, a redução foi de 9,8% para 4,5% e 2,5% nos respectivos

anos. No grupo etário de 35 a 44 anos, entre os mais pobres a prevalência de edentulismo foi de 7,2% para 6,1% e 4,9%, enquanto entre os mais ricos a redução foi de 1,6%, para 0,7% e 0,2%, considerando os três inquéritos. Entre os idosos (65 a 74 anos) a redução da prevalência foi de 58,4% para 44,6% e 43,4% entre os mais pobres e de 30,3% para 12,0% e 9,1% entre os mais ricos.

Na Hungria, Madlena *et al.* (2008) (11) avaliaram os resultados do inquérito nacional realizado em 2004 e encontraram uma prevalência de edentulismo no grupo etário de 35 a 44 anos de 1,9% e no grupo de 65 a 74 anos, 19,8%. A perda dentária de 17 dentes ou mais foi prevalente em 6,9% dos adultos e 39,7% dos idosos.

Um estudo de saúde bucal conduzido no México por Islas-Granillo *et al.* (2010) (12), em idosos com 60 anos ou mais encontrou uma prevalência de edentulismo de 36,7%.

Em um estudo de série temporal de 23 anos ocorrido entre os anos de 1980 a 2002 na Suécia, Österberg *et al.* (2010) (13) apontaram uma redução no edentulismo de 43% para 14%, considerando indivíduos de 55 a 84 anos.

Jung *et al.* (2011) (14) avaliaram os resultados do inquérito nacional de saúde da Coreia do Sul realizado em 2004 (KNHANES III), e mostraram que a prevalência de edentulismo entre coreanos com idades de 65 anos ou mais era igual a 29%.

Perera e Ekanayake (2011) (15), em estudo conduzido no Sri Lanka, encontraram uma prevalência global de perdas dentárias de 81,6%. Essa prevalência foi de 71% de perdas dentárias em adultos de 20 a 39 anos, de 93% entre os adultos de 40 a 59 anos e de 96% entre os idosos com 60 anos ou mais.

No Brasil, a epidemiologia das perdas dentárias é estudada baseada nos três estudos epidemiológicos de base nacional realizados nos anos de 1986, 2003 e 2010. O índice CPOD é utilizado nesses levantamentos epidemiológicos de saúde bucal. É um índice recomendado pela Organização Mundial da Saúde (OMS) para

medir e comparar a experiência de cárie dentária em populações e seu valor expressa a média de dentes cariados (C), perdidos (P) e obturados (O) em um grupo de indivíduos (16) por meio de cada um dos seus componentes.

A primeira pesquisa denominada Levantamento Epidemiológico em Saúde Bucal de 1986 se constituiu no primeiro estudo de abrangência nacional na área de saúde bucal, onde 16 capitais das cinco macrorregiões geográficas foram selecionadas como representativas da população urbana brasileira. Compuseram a amostra 15.480 escolares do ensino fundamental e médio e 6.480 domicílios. Foram examinados participantes com idades de 6 e 12 anos e nas faixas etárias de 15 a 19 anos, 35 a 44 anos e 50 a 59 anos (17). Os resultados mostraram que para os adolescentes (15-19 anos), o componente perdido (P) do CPO-D representou 15,2% do índice, enquanto para os adultos (35-44 anos) os dentes perdidos representaram 66,5% e para indivíduos de 50-59 anos o componente P representou 86,0% (18).

O segundo estudo epidemiológico denominado SB Brasil 2003 teve como objetivo produzir informações sobre as condições de saúde bucal da população brasileira e subsidiar o planejamento e avaliação de ações da área no SUS. Foram examinadas 108.921 pessoas nas idades índices de 5 e 12 anos e nas faixas etárias dos 18 a 36 meses, 15 a 19 anos, 35 a 44 anos e 65 a 74 anos. Compuseram a amostra 50 municípios de cada uma das macrorregiões brasileiras, estratificados segundo porte populacional (até 5.000 habitantes; 5.001-10.000 habitantes; 10.001-50.000 habitantes; 50.001-100.000 habitantes e mais de 100.000 habitantes), totalizando 250 municípios. Todas as capitais foram incluídas na amostra (17). Os resultados apontaram um percentual do componente P de 14,4% para os adolescentes, 65,7% para os adultos e 92,9% para os idosos. Nesse inquérito houve uma modificação da faixa etária representativa dos idosos que foi compreendida entre os 65 e 74 anos (19).

O SB Brasil 2010, nome dado à pesquisa nacional de saúde bucal, teve a finalidade de dar continuidade ao processo de realização de pesquisas epidemiológicas de base nacional, a fim de construir uma série histórica que

contribua para as estratégias de avaliação e planejamento dos serviços e consolidar um modelo metodológico. A amostra foi constituída de 32 domínios: 27 capitais e 5 domínios de interior, um para cada macrorregião. As unidades primárias de amostragem foram setores censitários (para os domínios capitais) e municípios (para os domínios do interior). As idades índices utilizadas foram 5 e 12 anos e os grupos etários foram 15 a 19 anos, 35 a 44 anos e 65 a 74 anos. Um total de 37.519 pessoas participou do inquérito, distribuídos entre as idades índice e grupos etários (17). Os resultados apresentaram um componente P do índice CPO-D de 9,0%, 44,4% e 92,0% para adolescentes, adultos e idosos (20).

O referencial teórico apresentado permite identificar que o edentulismo, ainda constitui um problema de saúde pública no Brasil e no mundo. Estudos que avaliam a produção de procedimentos odontológicos de exodontias ainda são pouco frequentes na literatura científica.

3.2 Utilização das séries temporais em estudos epidemiológicos

De acordo com Aquino *et al.* (2012) (21), o estudo ecológico ou de dados agregados é usado desde o início da epidemiologia para compreender a ocorrência e distribuição dos fenômenos de saúde e doença em populações. O estudo ecológico de tendência ou de série temporal tem por objetivo comparar, em populações geograficamente definidas, indicadores de saúde através do tempo e avaliar o impacto de ações, programas ou políticas de saúde, comparando as tendências temporais da ocorrência da doença antes e depois das intervenções. Os autores apontam como vantagens deste estudo a possibilidade de estudar grandes populações, a abrangência de grupos populacionais divergentes em relação à exposição, a facilidade na condução do estudo pela obtenção dos dados, baixo custo e utilização de dados secundários.

Segundo Almeida Filho e Rouquayrol (2003) (22), os estudos ecológicos sofreram, ao longo dos anos, um processo de desvalorização pela abordagem descritiva, com pequeno poder analítico. Mas, depois de uma reavaliação de suas bases lógicas e metodológicas, seu reconhecimento foi garantido de acordo com seu delineamento

empregado. Estes estudos abordam áreas geográficas bem delimitadas, analisando variáveis globais, referentes à população total, tomada como um agregado integral.

Os estudos ecológicos são aqueles que utilizam medidas aferidas para grupos de população e não para indivíduos. Neles, a descrição e a análise são referidas à média de exposição e à prevalência nas unidades geopolíticas consideradas e apresentam menor custo, simplicidade analítica e fácil condução do ponto de vista ético, sendo extremamente úteis para a avaliação de políticas, programas e intervenções em saúde (23).

As séries temporais são conjuntos de observações ordenadas no tempo. A sua análise estatística tem por objetivos: compreender o mecanismo gerador da série (descrevendo seu comportamento; encontrando periodicidade; tentando obter razões para seu comportamento através de variáveis auxiliares e controlando a trajetória da série) e prever o comportamento futuro da série (fazer planos a longo, médio e curto prazo e tomar decisões apropriadas). O modelo de regressão linear é usado para caracterizar o sinal que controla a série (24).

Viana *et al.* (2012) (25), afirmaram que esse tipo de estudo é útil quando se quer apresentar análises periódicas de situações de saúde para municípios, estados e regiões ou para revelar novas problemáticas que venham a demandar estudos mais específicos e precisos.

Nadanovsky e Sheiham (1995) (26) avaliaram através de um estudo ecológico a contribuição dos serviços odontológicos para as mudanças nos níveis de cárie de crianças de 12 anos de idade em 18 países industrializados na década de 1970 e início de 1980. As conclusões relevaram que a possível contribuição dos serviços odontológicos para as quedas nestes níveis de cárie foram devidas à mudança nos critérios de diagnóstico e no tratamento da cárie.

Fischer *et al.* (2010) (27) analisaram indicadores de saúde bucal do pacto de atenção primária, no sul do Brasil e associaram com algumas variáveis. Observaram que as extrações dentárias eram negativamente associadas ao Índice de Desenvolvimento

Humano (IDH) e positivamente associadas ao Índice Gini (IGini), usado para medir a desigualdade social. Por outro lado, medidas preventivas de cuidado em saúde bucal foram associadas negativamente ao IGini e positivamente associadas ao IDH.

Um estudo desenvolvido por Celeste *et al.* (2011) (28) teve por objetivos descrever o padrão temporal de taxas mensais de cinco procedimentos odontológicos dos serviços públicos do Brasil e avaliar mudanças nas tendências das taxas entre 1994 e 2007. Os dados foram obtidos no Sistema de Informação Ambulatorial (SIA-SUS). Foram calculadas as taxas mensais de procedimentos odontológicos coletivos, procedimentos preventivos, restauradores, exodontias e total de procedimentos odontológicos para o Brasil, e a taxa total de procedimentos odontológicos para cada macrorregião. Observou-se decréscimo nas tendências das taxas de restaurações e exodontias. As principais alterações foram observadas entre janeiro de 1998 e janeiro de 2000. Em outubro de 1999, a taxa total de procedimentos por mil habitantes aumentou em 30,5 procedimentos ou 55%, e após a inclusão das Equipes de Saúde Bucal (ESB) o aumento foi de 5,9 procedimentos ou 6,9%. Encontrou-se um forte padrão sazonal. Conclui-se que as principais alterações nas séries coincidem com o período tardio de municipalização da saúde, mas houve um aumento na taxa total de procedimentos com o incentivo a inclusão da ESB-PSF (Programa Saúde da Família).

4 ARTIGO

Submetido ao periódico *Medical Care* – Fator de Impacto 2,9 (Qualis Odontologia A1)

A 15-year time-series study of tooth extraction in Brazil

Abstract

Background: Tooth loss is considered to be a public health problem. Time-series studies that assess the influence of social conditions and access to health services on tooth loss are scarce.

Objective: This study aimed to examine the time series of permanent tooth extraction in Brazil between 1998 and 2012 and to compare these series in municipalities with different Human Development Index (HDI) scores and with different access to distinct primary and secondary care.

Research Design: Time-series study was performed between 1998 and 2012.

Subjects: Secondary data from the Brazilian National Health Information System.

Measures: Two annual rates of tooth extraction were calculated and evaluated separately according to three parameters: the HDI, the presence of a Dental Specialty Center, and coverage by Oral Health Teams. The time series was analyzed using a linear regression model.

Results: An overall decrease in the tooth-loss tendencies during this period was observed, particularly in the tooth extraction rate during primary care procedures. In the municipalities with an HDI that was lower than the median, the average tooth-loss rates were higher than in the municipalities with a higher HDI. The municipalities with lower rates of Oral Health Team coverage also showed lower extraction rates than the municipalities with higher coverage rates.

Conclusions: In general, Brazil has shown a decrease in the trend to extract permanent teeth during these 15 years. Increased human development and access to dental services have influenced tooth extraction rates.

Key Words: Health Services Research; Time Series Analysis; Tooth Extraction

Introduction

Oral health care is part of general health, and it is currently considered to be essential to an individual's quality of life.¹ Therefore, tooth loss is considered to be one of the worst health problems resulting from oral diseases. This condition results in decreased functional capacities for chewing and speech and nutritional, psychological and aesthetic damage, in addition to problems with social relations. In Brazil, the tooth loss via tooth extractions caused by preventable diseases, including dental caries and periodontal diseases, is very high.² The possibility of controlling this disease and the important impact on the lives of the affected individuals is a challenge to public health to minimize this problem.³

Earlier studies⁴⁻⁸ found that the level of education, place of residence, occupation, nutritional status, income and access to dental care are associated with tooth loss. However, time-series studies assessing the influence of these factors on tooth loss are scarce.

In this respect, we observed and described the trend to extract permanent teeth in the last fifteen years as a way of assessing whether there were changes in the health care model and as a means of supporting the planning, monitoring and evaluation of the National Oral Health Policy in Brazil. Therefore, the aim of the study was (i) to describe the time series of permanent tooth extraction in Brazil between 1998 and 2012 and (ii) to compare these series in municipalities with different Human Development Index (HDI) scores, in municipalities with and without access to secondary care via Dental Specialty Centers and in municipalities with distinct organizational indicator of primary care (Oral Health Team coverage).

Methods

Ethical clearance

Ethical clearance was not required, as the data obtained from the Brazilian National Health Information System of the Ministry of Health were public, aggregated and anonymous. Written consent was not obtained because the data was public and aggregated at the municipal level. Patient information was anonymized and de-identified prior to analysis.

Place of study

A time-series study was held in Brazil, a country in South America, which has a land area of 8,514,876 square kilometers and a total population of

approximately 203-million people.⁹ It consists of 26 states and one federal district that include 5,564 municipalities containing great diversity and socioeconomic inequality.

The Brazilian Health System is based on the constitutional principle that all citizens have the right of access to healthcare, and it is governed by the Brazilian Health System (SUS in Portuguese). In terms of primary care, the health care model adopted by the SUS is the Family Health Strategy. Dentistry has been included in the Family Health Strategy since 2000, and the National Oral Health Policy has incorporated secondary care via Dental Specialty Centers since 2004. At the primary level, the collective and individual actions on the territory/area of coverage are standard, in addition to preventive, surgical and restorative dental procedures. The Dental Specialty Center primarily includes endodontics, periodontics, oral medicine and oral surgery.¹⁰

Variables analyzed

All of the analyzed data, including the outpatient treatment, presence of a Dental Specialty Center, and coverage by oral health teams Oral Health Team in the Family Health Strategy, were obtained from secondary and public sources from the Brazilian National Health Information System of the Ministry of Health. The HDI for 1998, 2003 and 2010 was proposed by the United Nations Development Programme¹¹, and the HDI estimates and population counts from 1998 to 2012⁹ were analyzed. The data were extracted and exported in December 2013, and the tabulation was performed using Excel for Windows. The data were extracted from the health systems by a single researcher with 8 years of experience in these web environments. The database was evaluated for inconsistencies by a senior epidemiologist for quality control. The data from all 5,564 Brazilian municipalities were analyzed.

All of the preventive, restorative and surgical oral health procedures (permanent tooth extractions) in each of the Brazilian municipalities were recorded. The preventive procedures included the topical application of fluoride, sealant application, cariostatic application and the control of dental plaque and supra- and subgingival scaling. The restorative procedures included direct restorations of the permanent and primary teeth, direct pulp capping and

pulpotomies. The number of permanent-tooth extractions was also recorded for each Brazilian municipality. The extractions of primary teeth, impacted or unerupted teeth were excluded.

Two extraction rates were calculated. The first is the ratio of the extractions of permanent teeth in relation to the total number of individual dental procedures that were performed (surgical, restorative, and preventive procedures).¹² The second is the ratio of the number of extractions of permanent teeth divided by the total population.¹³

The two rates were calculated separately based on three covariates: the HDI (high and low), the presence of a Dental Specialty Center (with and without), and the Oral Health Team coverage (high and low). According to the covariate, the extraction rates represent the mean of the rates for two subgroups of municipalities (high and low or with and without).

The two tooth-extraction rates were computed separately according to the median of the HDI. For the period between 1998 and 1999, the 1998 HDI was used (estimated from the census data from 1970, 1980, and 1991). For the period from 2000 to 2009, the 2003 HDI was used (estimated from the 2000 census data). Finally, for the period from 2010 to 2012, the 2010 HDI was used (estimated from the 2010 census data).¹¹

The presence of a Dental Specialty Center was recorded dichotomously (with or without). The Oral Health Teams coverage is calculated by adding up the total number of oral health teams (Oral Health Team) per year for each municipality and multiplying by 3,450.^{14,15} The result is then divided by the population for each respective year.

To compare the extraction rates between municipalities that had a Dental Specialty Center with those that did not, we analyzed the period from 2004 to 2012, as 2004 marked the beginning of the current National Oral Health Policy in Brazil.¹⁰

Both rates were also compared between municipalities with an Oral Health Teams less than or equal to the median or above the median for each of the years. We analyzed the period from 2000 to 2012, as 2000 marked the commencement of the implementation of Oral Health Teams in the Family Health Strategy in Brazil.¹⁶

So the two extraction rates for each year were calculated considering the two groups of municipalities (for example, one rate for those with a Dental Specialty Center and another for those without a Dental Specialty Center).

Statistical methods

The statistical analysis of the time series was performed using a linear regression model. This technique is used when you want to relate or explain a variable of interest (dependent) via other variables (independent or covariates). In other words, the model aims to find the regression equation that best describes the relationship between the independent variables (X) and the dependent variable (Y). The multiple linear regression model is defined as follows:¹⁷

$$Y_t = X_t\beta + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma^2),$$

for $t = 1, \dots, n$, where Y_t is the dependent variable, X_t the covariate matrix, ε_t is the associated error and β is the vector of the regression parameters. The model errors have mean of zero, are not correlated and have a constant variance. An additional requirement for the error terms is that they are normally distributed.

The two dependent variables that were modeled were the two extraction rates described above. The explanatory variables in these rates were the presence of a Dental Specialty Center, the HDI, and the Oral Health Teams and the time (the order of the observations).

As the data are time series, the time covariate was included in the regression models to incorporate the correlation structure of the data. For example, a linear regression model with the intercept and the time variable is a non-stationary ARIMA model. An autoregressive component with an order of 1 was included in the models of the tooth extraction rates by population based on the Oral Health Team coverage to meet the independent assumptions of the model residuals.¹⁸ A logarithmic transformation of all of the tooth extraction rates was applied to stabilize the variance and make the data closer to a probability normal distribution.

Therefore, as the rates were calculated separately by each covariate, eight models were analyzed:

Model 1 – the tooth extraction rate via primary care in Brazil (15-year time-series)

Model 2 – the tooth extraction rate for the Brazilian population (15-year time-series)

Model 3 (a) – the tooth extraction rate via primary care calculated for the municipalities according to the HDI (15-year time-series)

Model 3 (b) – the tooth extraction rate via primary care calculated for the municipalities according to the Dental Specialty Center (9-year time-series)

Model 3 (c) – the tooth extraction rate via primary care calculated for the municipalities according to the Oral Health Teams (13-year time-series)

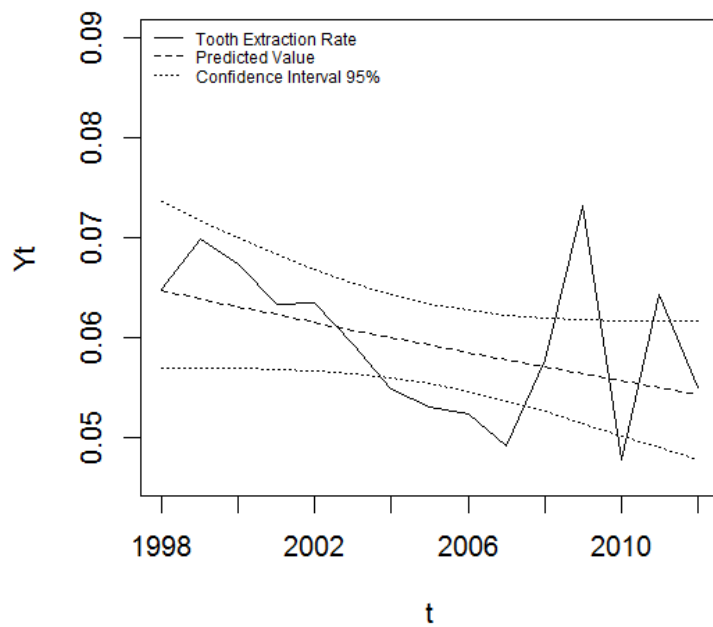
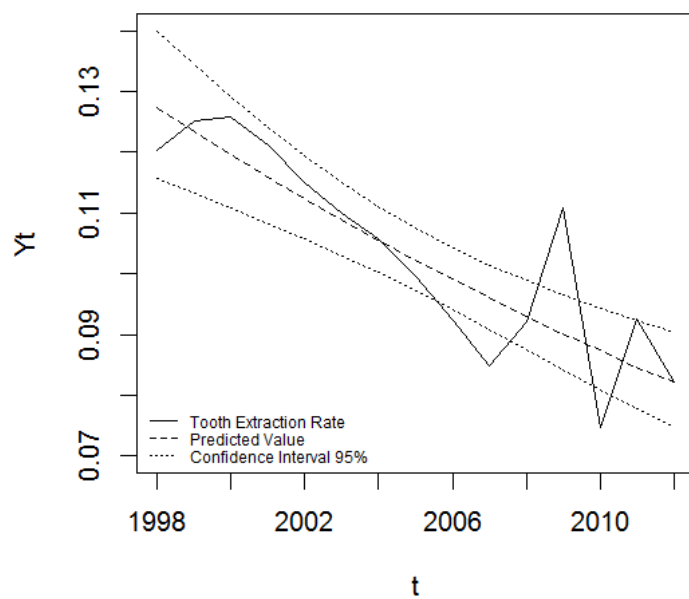
Model 4 (a) – the tooth extraction rate by population calculated for the municipalities according to the HDI (15-year time-series)

Model 4 (b) – the tooth extraction rate by population calculated for the municipalities according to the presence of a Dental Specialty Center (9-year time-series).

Model 4 (c) – the tooth extraction rate by population calculated for the municipalities according to the Oral Health Teams (13-year time-series).

The covariate time was common in all of the models and the trend is the same for the two groups in the same model. The assumptions of the regression techniques were checked via an analysis of the model residuals, and hypothesis tests were performed for the regression coefficients. For each of the eight final models, the set values or estimates of the average number were calculated, in addition to the 95% confidence intervals for the average rate. Finally, eight charts were constructed. To verify if the coefficients of the covariates in the regression model were significant, Student's t test was used, with $p < 0.05$ considered statistically significant. The analysis of the rates was performed using a logarithmic scale, as described previously. However, to aid in the understanding of the graphics, the dependent variables are presented using the original scale for the data. R¹⁹ (R Foundation, Vienna, Austria) was used for the statistical analyses.

Results



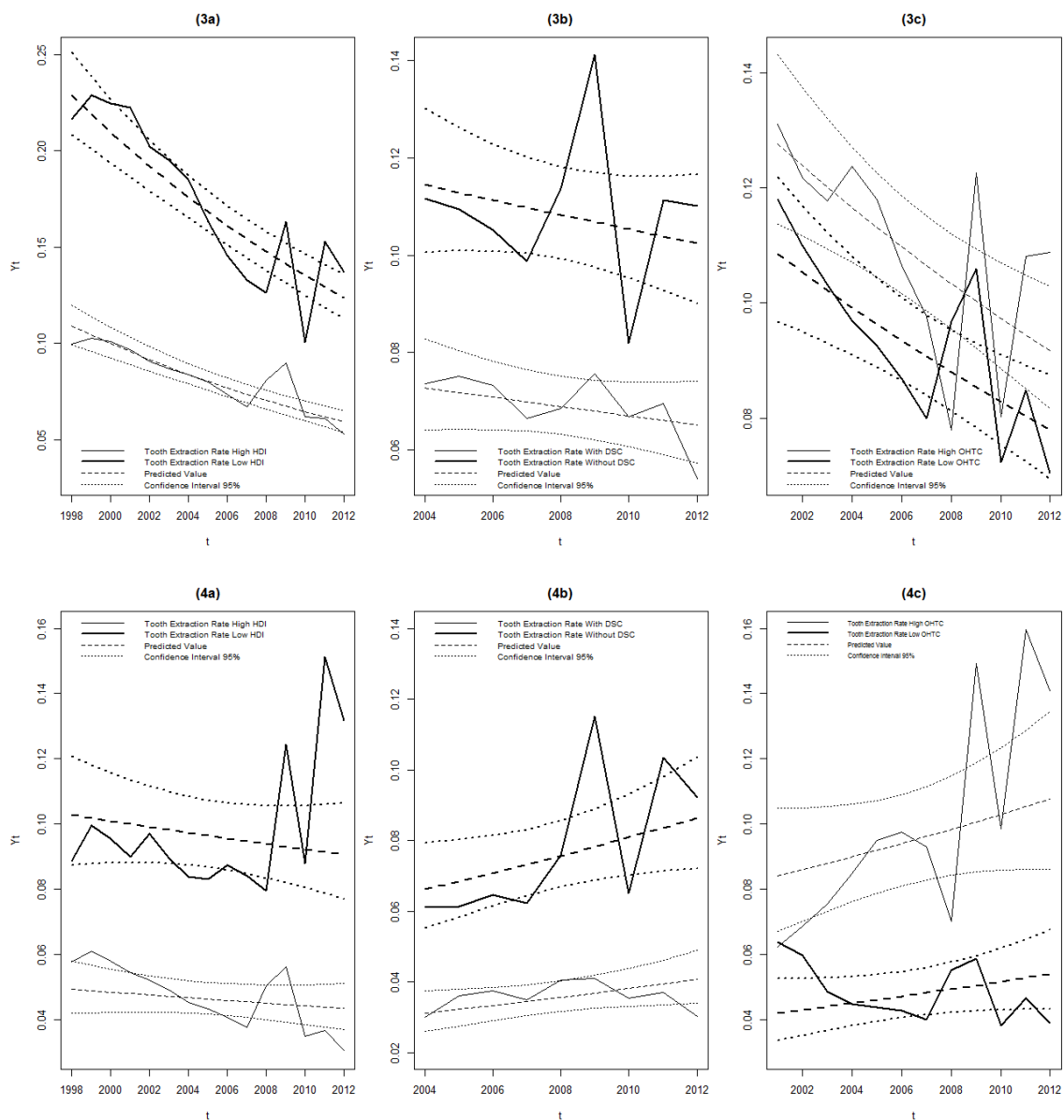


Figure Legends

Figure 1. The time series of the tooth extraction rates via primary care procedures in Brazil from 1998-2012.

Figure 2. The time series of the tooth extraction rates based on the population in Brazil from 1998-2012.

Figure 3. The time series of the tooth extraction rates via primary care procedures according to the HDI (3a), the presence of a Dental Specialty Centers (3b), and the Oral Health Teams (3c) in Brazil from 1998-2012.

Figure 4. The time series of the tooth extraction rates based on the population according to the HDI (4a), the presence of a Dental Specialty Centers (4b), and the Oral Health Teams (4c) in Brazil from 1998-2012.

The total number of primary dental care procedures performed by the SUS during the 15 years was 1,590,103,988 procedures. Of these, there were 161,812,852 tooth extractions, which ranged from 10,490,997 extractions in 1998 to 10,674,084 extractions in 2012. In 1998, 87,205,727 primary dental care procedures were performed, and this number increased to 129,964,282 in 2012. A total of 360,175,189 first dental visits were performed from 1998 to 2012. In 1998, 50% of the municipalities performed up to 971 first dental visits. In 2012, the median increased to 1,264. The Oral Health Teams coverage in each municipality ranged from 0.00 to 3.74% in 2001 (median, 0.00) and from 0.00 to 7.25% in 2012 (median, 0.83%).

There has been an overall reduction in the tooth extraction rate via primary care procedures ($p < 0.001$) (Model 1) (Fig. 1), but there has been no significant change in the overall tooth extraction rate in the Brazilian population ($p = 0.106$) (Model 2) (Fig. 2).

Fig. 3 presents the models of the tooth extraction rates via primary care procedures calculated separately according to the HDI, the presence of a Dental Specialty Center, and the Oral Health Teams. The analysis of the model 3 (a) data showed that the effect of time was negative and was statistically significant ($p < 0.001$). Each year, there was a decrease of 0.044 in the average log of the tooth extraction rate in the municipalities with HDIs above and below the median, and the effect of the HDI was significant ($p < 0.001$). The municipalities with a lower HDI (below or equal to the median) had a log of the extractions rates that were 0.738 higher, on average, than those municipalities with higher HDIs (above the median).

In model 3 (b), the analysis showed that the effect of time was negative and was not statistically significant ($p = 0.234$). Each year, there was an average decrease of 0.014 from the log of the tooth extraction rate in the municipalities both with and without a Dental Specialty Center, and the effect of a Dental Specialty Center was significant ($p < 0.001$). The municipalities without a Dental

Specialty Center had a log of the tooth extractions rates that were 0.452 higher, on average, than those municipalities with Dental Specialty Centers. Therefore, the average tooth extraction rates in the municipalities with and without Dental Specialty Centers were different at the 5% significance level for all of the analyzed time periods because the confidence intervals do not intersect.

Model 3 (c) showed the same statistical effect of time ($p < 0.001$). Each year, there was a decrease of 0.030 in the average log of the tooth extraction rate in the municipalities with Oral Health Teams coverage that were greater or less than the median, and the effect of the Oral Health Teams was significant ($p = 0.005$). The municipalities with lower coverage (below or equal to the median) had a log of tooth extractions rates that were 0.162 lower, on average, than those municipalities with greater coverage. The means of the tooth extraction rates in the municipalities with the lowest and highest Oral Health Teams coverage were different at the 5% significance level from 2000 to 2012.

Fig. 4 presents the different models of the tooth extraction rates by population and calculated separately according to the HDI, the presence of a Dental Specialty Center and the Oral Health Teams. The analysis of the model 4 (a) data showed that the effect of time was negative but was not statistically significant ($p = 0.295$), and each year, there was a decrease of 0.009 in the average log of the tooth extraction rate in the municipalities with an HDI below or above the median. The effect of the HDI was important and significant ($p < 0.001$). The municipalities with a lower HDI (below or equal to the median) had a log of the extractions rates that were 0.733 higher, on average, than those municipalities with higher HDIs (above the median). The means of the tooth extraction rates in the municipalities with HDIs that were lower or higher than the median were different at the 5% significance level for all of the analyzed time periods.

In model 4 (b), the analysis showed that the effect of time was statistically positive and significant ($p = 0.047$). Each year, there was an increase of 0.033 in the average log of the tooth extraction rate in the municipalities with or without a Dental Specialty Center, and the effect of a Dental Specialty Center was significant ($p < 0.001$). The municipalities without a Dental Specialty Center had a log of the tooth extractions rates that were 0.752 higher, on average, than those municipalities with Dental Specialty Centers. The mean extraction rates in the

municipalities with and without a Dental Specialty Center were different at the 5% significance level for all of the analyzed time periods.

The model 4 (c) analysis showed that the effect of time was positive, but it was not statistically significant ($p=0.588$), but the effect of the Oral Health Teams coverage was significant ($p<0.001$). The municipalities with lower coverage (below or equal to the median) had a log of tooth extractions rates that were 0.554 lower, on average, than those municipalities with greater coverage. The average extraction rates in the municipalities with the lowest and highest coverage were the same until 2001, and then they were different at the 5% significance level from 2002 to 2008.

Discussion

In this 15-year time-series study on tooth extraction in Brazil, the trend towards a reduction in tooth extraction during the overall time period was observed, especially when considering the tooth extraction rate via primary care procedures. The rates are, on average, lower in municipalities with better HDI values and access to secondary care. On the converse, the rates are, on average, higher in the municipalities with higher Oral Health Team coverage.

Over the 15-year period that was analyzed, Brazil went through several social and health changes that may explain the reduction in tooth extractions. Public policies for oral health¹⁰ and social inclusion²⁰ have been implemented, which have made access to dental care easier, in addition to improved income and living conditions in the population. However, the reduction in the tooth extraction rate in the overall population was less evident than the reduction observed when analyzing the tooth extraction rate during other primary care procedures. This shows that the tooth extraction rates in the general population have been relatively constant. The maintenance of the tooth extraction rates in the population as a whole is likely due to the low levels of dental care coverage in the public sector, which changed from 12.6% in 1998 to 13.8% in 2012.²¹ Despite the creation of the SUS, which is a universal and free system from a legal point of view, there is still limited coverage in the Brazilian population.²² Nevertheless, among the SUS users, there has been a change in the care profile. This aspect is interesting because it is aligned to the National Oral Health Policy that aims to meet the

needs of primary care, improve the oral health status of the population and overcome the current socio-demographic inequalities.¹⁰

While the HDI measures the progress of a nation from three dimensions (income, health and education¹¹), the impact of this index on the tooth extraction rates can be explained by the influence of the existing social and economic factors on oral health^{7,23,24} and specifically on tooth extraction.^{3,6,25,26} The locations with poorer social and economic conditions generally have a greater need for restorative and surgical interventions.^{4-8,27} Moreover, the lack of access to treatments that help to prevent the need for tooth extractions in these populations may also be present. The progress in reducing social inequality is extremely relevant to the improvement of the health conditions in these human populations.^{28,29}

The lowest tooth extraction rates that were observed in municipalities with access to secondary care via a Dental Specialty Center can be explained by the ability to perform clinical procedures that prevent tooth extraction. The implantation of Dental Specialty Centers has been the current national oral health strategy to ensure access to secondary care in Brazil. It is important to understand that primary care is linked to secondary care because both are essential for comprehensive oral health care.^{10,30} The Dental Specialty Centers promote the secondary and tertiary prevention of health issues through early diagnosis and prompt treatment, in addition to limiting the damage and rehabilitation of cases³¹, which contributes to the reduction of tooth extraction. The procedures performed by Dental Specialty Centers include surgery, periodontics, endodontics and prosthesis. As these procedures are not offered in primary care, it is assumed that in municipalities that do not have Dental Specialty Centers, the problems that are related to this level of care are being addressed via tooth extractions.³²

The highest rates in municipalities with higher Oral Health Teams can be explained by the recent implementation of Oral Health Teams with the accumulation of needs over the years³³, the availability of visits without planning and programming of activities³⁴, the profile and attitudes of the dental professionals^{3,32} and the type of dental emergencies that are deemed as a priority targets for direct resources are not sufficient to meet all of the needs of the population.¹⁶

Ecological studies show limitations that are inherent to the fact that they are observational studies of aggregate data. A limitation of this study is the use of secondary data from health information systems. The data for each variable were collected by different public health providers, and the reproducibility cannot be accessed. The big jumps/falls in observed rates between 2008 and 2010 could be due changes in the registration of tooth extraction in the National Health Information System. In addition, we did not evaluate the private dental practices in Brazil. Other variables that could be associated to the oral health conditions, such as sanitation and access to food, were also not evaluated because the information was not available in the databases that were used. Besides, the trends identified in our study should not be extrapolated to individual level.

This study presents results that are particularly important for the planning health care. Investments in individual and collective actions aimed at the promotion, prevention and treatment of health problems enables health care professionals to pay attention to an individual's health, thus reducing the level of tooth extraction.

In general, Brazil has shown a decrease in the trend to extract permanent teeth over the 15 years that were analyzed in this study. Human development and access to oral health services have both influenced the tooth extraction rates.

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5 CONSIDERAÇÕES FINAIS

Os resultados desse trabalho mostram que a tendência de exodontia no Brasil, durante esses 15 anos, está em decréscimo. O modelo assistencial prestado pelo SUS parece ter ajudado na redução dessa taxa de exodontia, pois, a saúde bucal tem sido incorporada às ESF por diversos municípios e cada vez mais usuários são beneficiados por essa assistência. O impacto da queda da taxa de exodontias, só pode ser afirmado, em relação aos usuários do SUS, pois, os dados analisados são pertencentes a esse sistema público de saúde. A queda na taxa da exodontia é influenciada por todos os fatores analisados. As condições socioeconômicas da população oportunizam outras escolhas além da exodontia. A oferta da atenção secundária por meio do CEO aumenta a oferta de procedimentos especializados mostrando-se essencial para que o serviço seja menos mutilador. O número de ESB aumentou a taxa de exodontia pela demanda reprimida da população. Esse estudo torna-se útil, pois, nos mostra que determinantes da condição de vida (IDH) e de saúde (oferta da atenção primária e secundária) das pessoas interferem nas perdas dentárias. Pode-se afirmar assim, que políticas públicas que reduzam as desigualdades socioeconômicas e que possibilitem o acesso aos serviços de atenção primária e de atenção secundária à saúde bucal tendem a modificar o quadro das perdas dentárias no Brasil. Estudos futuros para investigar fatores correlacionados que possam avaliar a tendência dessas perdas dentárias tornam-se importantes para melhorar o entendimento da determinação social das perdas dentárias.

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ANEXOS

Medical Care Online Submission and Review System

SCOPE

Medical Care, the official publication of the Medical Care Section of the American Public Health Association, serves as an international medium for publication of worthy articles in the broad field of medical care and thereby encourages progress in the research, planning, organization, financing, provision, and evaluation of health services.

Original contributions are welcomed in the form of both full-length articles and brief reports that describe current developments in the field. Additionally, submission is encouraged of review articles summarizing prior research, manuscripts describing research methods relevant to health services research, and letters to the editor. Selection of manuscripts for publication is based on their timeliness, originality, soundness of methods, significance of findings, appropriateness of conclusions, and quality of presentation. Manuscripts are subject to editorial modification and revisions necessary to bring them into conformity with *Medical Care* style.

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ANNALS OF HEALTH SERVICES RESEARCH

The goal of the Annals section is to present papers that offer perspectives on how ideas, theories, empirical research, organizations, policies and people evolved and influenced the field of health services research. Appropriate topics for Annals papers include the evolution and impact of an idea, a theory or conceptual framework, a thorny problem in US health care, a landmark study, a body of empirical work to which many have contributed, a health policy, an organization, or the career of a single person.

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Journal article

1. Mathews WC, McCutchan JA, Asch S, et al. National estimates of HIV related symptom prevalence from the HIV Cost and Services Utilization Study. *Med Care* 2000;38:750-762.

Book chapter

2. Todd VR. Visual information analysis: frame of reference for visual perception. In: Kramer P, Hinojosa J, eds. *Frames of Reference for Pediatric Occupational Therapy*. Philadelphia: Lippincott Williams & Wilkins; 1999:205- 256.

Entire book

3. Kassirer JP, Kopelman RI. *Learning Clinical Reasoning*. Baltimore: Lippincott Williams & Wilkins; 1991.

Software

4. Epi Info [computer program]. Version 6. Atlanta: Centers for Disease Control and Prevention; 1994.

Online journals

5. Friedman SA. Preeclampsia: a review of the role of prostaglandins. *Obstet Gynecol* [serial online]. January 1988;71:22 -37. Available from: BRS Information Technologies, McLean, VA. Accessed December 15, 1990.

Database

6. CANCERNET PDQ [database online]. Bethesda, MD: National Cancer Institute; 1996. Updated March 29, 1996.

World Wide Web

7. Gostin LO. Drug use and HIV/AIDS [JAMA HIV/AIDS web site]. June 1, 1996. Available at: <http://www.ama-assn.org/special/hiv/ethics>. Accessed June 26, 1997.

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Figure Legends

Figure 1. The time series of the tooth extraction rates via primary care procedures in Brazil from 1998-2012.

Figure 2. The time series of the tooth extraction rates based on the population in Brazil from 1998-2012.

Figure 3. The time series of the tooth extraction rates via primary care procedures according to the HDI (3a), the presence of a Dental Specialty Centers (3b), and the Oral Health Teams (3c) in Brazil from 1998-2012.

Figure 4. The time series of the tooth extraction rates based on the population according to the HDI (4a), the presence of a Dental Specialty Centers (4b), and the Oral Health Teams (4c) in Brazil from 1998-2012.

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