

## Study Protocol

# National and Sub-national Burden of Oral Diseases in Iran: 1990 – 2013, Study Protocol

Shervan Shoaee DMD<sup>1,2,3</sup>, Anooosheh Ghasemian DDS<sup>2</sup>, Baharak Najafi MSc<sup>3</sup>, Amir Kasaeian MSc PhD Candidate<sup>2,4</sup>, Farshad Farzadfar MD MPH DSc<sup>•2,5</sup>, Hossein Hessari DDS PhD<sup>•6</sup>

## Abstract

**Background:** Non-communicable chronic diseases are the greatest preventable cause of death. One of the most prevalent groups of chronic diseases, are oro-facial diseases. The major burden of oral diseases is caused by dental caries, periodontal diseases, tooth loss, oral cancer and oral clefts. The aim of the study is to present data collection and methodology processes for estimating the prevalence of the mentioned oral diseases and their attributed burden at national and sub-national levels in Iran, from 1990 to 2013.

**Methods:** Systematic review of published literature will be conducted, as well as using unpublished and grey literature. Three international databases (PubMed, ISI and Scopus) and three local databases (IranMedex, SID and Irandoc) will be used to provide the most comprehensive epidemiologic data bank. The study will be included if it is population-based and has reported diseases data. The target population is representative healthy Iranian population. A comprehensive assessment form in Epi-Info 7 will be designed to assess the quality of selected articles. Other main sources of data are National Oral Health surveys, “National Health Survey”, in addition to “Death Registry System” and “Cancer Registry System”. Two statistical models, Spatio-temporal Bayesian hierarchical and Bayesian multilevel auto-regressive, will be applied to overcome the problem of data gaps in provinces, and in some age or sex groups or in urban and rural areas.

**Conclusion:** A national and sub-national oral diseases burden study needs a standardized protocol for systematic review, quality assessment of data, data extraction strategy, and an appropriate statistical analysis method.

**Keywords:** Disease burden, Iran, oral health, systematic review

**Cite this article as:** Shoaee Sh, Ghasemian A, Najafi B, Kasaeian A, Farzadfar F, Hessari H. National and sub-national burden of oral diseases in Iran: 1990 – 2013, Study Protocol. *Arch Iran Med.* 2014; **17**(3): 159 – 168.

## Introduction

About 35 million deaths occur yearly from non-communicable chronic diseases,<sup>1</sup> prevention and correction of risk factors for the four most prominent of them: cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes has been set as the goal.<sup>2</sup> Considering the epidemic of chronic diseases as neglected,<sup>3</sup> the chronic oro-facial diseases are the neglected global hidden epidemic.<sup>4</sup>

Oral diseases are prevalent globally. Nearly all adults have experienced dental caries, worldwide. In industrialized countries, dental diseases affect 60 % – 90 % of children and the vast majority

of adults.<sup>5</sup> In adulthood and older ages, tooth loss, because of pain and discomfort, represents the impact of dental diseases which is leading to reduced quality of life.<sup>6</sup> For other oral diseases such as periodontal diseases, oral cancer, cleft lip and palate, and temporomandibular joint disorders there is a lack of sound, comprehensive and updated data in many countries, especially in developing countries which oral diseases are more prevalent.

Burden of disease, injuries and risk factors is expressed in disability-adjusted life years (DALYs), a summary measurement of population health gap. DALYs for a disease or health condition are calculated as the sum of the years of life lost due to premature mortality (YLL) in the population and years of life lost due to disability (YLD) for incident cases.<sup>7,8</sup> The burden of diseases, injuries, and risk factors has been studied, mostly, at the global and national levels.<sup>8–16</sup> Sub-national studies are considered important when health policies are evaluated at the sub-national level.

In Global Burden of Disease (GBD, 2010) study, a combination of three selected oral diseases (dental caries, periodontal diseases, and edentulism) contributed to 15 million YLDs, with equal shares caused by each of them, and all ages DALYs for the three oral diseases increased 21 % from 1990 to 2010, at global level. All ages DALYs for dental caries, periodontal diseases and mouth cancer increased 35 %, 57 % and 45 % from 1990 to 2010, respectively. All ages DALYs for edentulism, and cleft lip and cleft palate decreased 12 % and 42 %, respectively, from 1990 to 2010.<sup>15,16</sup>

In 2003, the burden of diseases was estimated in Iran, based on nationally representative data.<sup>17</sup> The results of the study showed that 1 % of all diseases burden was attributed to oral diseases.<sup>18</sup> In

**Authors' affiliations:** <sup>1</sup>Kerman Oral and Dental Diseases Research Center, Kerman University of Medical Sciences, Kerman, Iran. <sup>2</sup>Non-communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran. <sup>3</sup>Mehregan Pajooh Research Institute, Tehran, Iran. <sup>4</sup>Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran. <sup>5</sup>Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Research Institute, Tehran University of Medical Sciences, Tehran, Iran. <sup>6</sup>Department of Community Oral Health, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.

**•Corresponding author and reprints:** Farshad Farzadfar MD, MPH, DSc, Non-communicable Diseases Research Center, Endocrinology and Metabolism Research Institute, Tehran University of Medical Sciences, Tehran, Iran. Address: 4th floor, No. 4, Ostad Nejatollahi St, Enghelab Ave, Tehran, Iran. Postal code: 1599666615, Tel: 98-21-88913543, Fax: 98-21-88913549; Email: f-farzadfar@tums.ac.ir.  
Hossein Hessari DDS, PhD, Department of Community Oral Health, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran. Address: School of Dentistry, End of Kargar Ave, Tehran, Iran. Postal code: 1439955991, Tel: 98-21-88015960, Fax: 98-21-88015961; Email: h-hessari@tums.ac.ir.  
Accepted for publication: 3 December 2013

that study, in order to quantify the burden of diseases in Iran, disease prevalence and injury incidence were used for the calculation of DALYs. WHO has developed two software tools for analyzing burden of disease in regional, national or sub-national populations: DISMOD II and MODMATCH. DISMOD II was used as the software tool to check the consistency of estimates of incidence, prevalence, duration and case fatality for diseases in 2003.

Epidemiological data are important and valuable to estimate the proportion and distribution of oral diseases. Estimating the trends of prevalence and burden of oral diseases from 1990 to 2013 at national and sub-national levels in Iran, is a sub-component of National and Sub-national Burden of Diseases, injuries and risk factors (NASBOD) study from 1990 to 2013.<sup>19</sup>

Burden of Oral Diseases (BOD) study aims to estimate the prevalence of oral diseases, from 1990 to 2013 at national and sub-national levels, and consequently to assess the burden and inequalities of oral diseases in Iran.

The current article aims to present motives, methodology of a systematic review of epidemiological literature for oral diseases, data collection based on clear definitions, and the methodology for calculating the burden of oral diseases in Iran.

## Methods and Materials

### Formation of technical team

In 2011, “National and Sub-national Burden of Diseases, injuries and risk factors” (NASBOD) study from 1990 to 2013 in Iran originated and was granted by “Endocrinology and Metabolism Research Institute” of Tehran University of Medical Sciences.

The Burden of Oral Disease (BOD) study was granted by Oral and Dental Diseases Research Center of Kerman University of Medical Sciences. Department of Community Oral Health, Dental school of Tehran University of Medical Sciences, Non-Communicable Diseases Research Center of Tehran University of Medical Sciences, and Mehregan Parto Pajooch Research Institute supported the present study. The technical team comprises dentists and experts in dental public health, epidemiology and health-care management.

### Diseases selection and definitions

According to Global Burden of Disease<sup>15,16</sup> and Iran Burden of Disease<sup>17</sup> studies, and through expert panels meetings, five diseases of dental caries, periodontal diseases, tooth loss, oral cancer and oral clefts were selected for the study. In addition, temporomandibular joint disorders was selected as the sixth disease. The definitions of diseases were adopted from definitions given by WHO (1997),<sup>20</sup> PubMed, and ICD-10 (Table 1).

### Data Sources

Various heterogeneous data sources will be used in the present study that could be categorized in two main groups:

- I. Generally, published, unpublished, and grey literature will be used as sources of data in the present study.
- II. National data will be utilized accordingly.

#### A) Published, Unpublished and Grey literature

Published literature in form of English and Persian articles will be searched in the selected databases including PubMed, ISI (Web of Science), and Scopus as international databases and IranMedex, SID (Scientific Information Database), and Irandoc as local search engines. To find unpublished data, key informants and authors will be contacted. Theses, reports of research projects, governmental reports, congress abstracts and presentations will be also evaluated and included in the study.

A standardized protocol will be used to conduct a systematic review of the published literature. Review of the literature will be done based on combination of the following search terms - prevalence, incidence, general mortality, cause specific mortality, remission rate, age of onset and disability weights - with names of the six diseases.

In the next step, related keywords for each disease will be searched; systematic review articles will be selected and evaluated to find the most appropriate search terms; and the terms will be searched in MeSH, to complete the list of keywords. MeSH and Entry terms will be checked in Hub to find the related Emtree or matching terms for searching any extra query in Scopus. Persian keywords will be direct translation and equivalent to the English keywords, and all probable combinations of Persian keywords will be considered. All keywords will be searched in above mentioned electronic databases.

Table 2 shows search activities in selected databases. All MeSH terms, Entry terms and Emtree for searching in PubMed, ISI and Scopus, and all Persian equivalents for searching in IranMedex, SID and Irandoc are presented in Appendix in detail.

### Selection criteria

*Type of Study:* includes all cross-sectional studies, results of baseline survey of cohort studies, control groups in case control studies and baseline data from community-based trials (if they are from general population). Moreover, all national, provincial, district and community studies reported prevalence or incidence of oral diseases will be included in the study. Case reports, case series, clinical trials with small sample size, and also non-population-based surveys will be excluded.

**Table 1.** Practical definitions of oral diseases, Burden of Oral Diseases (BOD) study

Disease	Definition
Dental caries	Diagnosis of caries in D3 area - dentinal exposure - enamel softening - unsupported enamel - discoloration in inter-dental area
Periodontal diseases	Gingivitis - shallow periodontal pocket - deep periodontal pocket - periodontal abscess
Tooth loss	Partial loss of teeth - complete edentulousness
Oral cancer	Any malignancy or cancer which is defined as oral cancer based on ICD-10 - any malignancy or cancer according to report of pathology laboratories based on national registry data
Oral clefts	Presence of lip and/or palate clefts via observation - or according to report of infant medical records
Temporo-mandibular joint disorders	Clicking - deviation in jaw movement path - limitation in mouth opening - pain in TMJ

**Table 2.** Search activity in selected databases, Burden of Oral Diseases (BOD) study

Databases	Search activity
PubMed	all MeSH terms will be searched in "All field"
ISI (Web of Science)	all MeSH terms and Entry terms will be searched in "Topic"
Scopus	all MeSH terms, Entry terms and Emtree terms will be searched in "Title, Abstract, Keyword"
IranMedex and SID (English)	all MeSH terms and Entry terms will be searched in "Title, Abstract, Keyword"
IranMedex and SID (Persian)	all Persian equivalents will be searched in "Title, Abstract, Keyword"
IranDoc (Persian)	all Persian equivalents will be searched in "All field"
All the key words will be combined by "OR" operator in the databases. Limitations of search: <ul style="list-style-type: none"> <li>• Geographical Limitation is defined by the following phrase: [Iran* OR Persia* OR "I.R.Iran" OR "IR.Iran"] in all databases and will be added to the search by "AND" operator.</li> <li>• Time Limitation is from 1985 to 2013 in PubMed and Scopus and from 1990 to 2013 in ISI.</li> <li>• Only the human studies are included in the study.</li> </ul>	

**Study Population:** is the representative Iranian population from wide age groups of infants, children, adolescents, adults and the elderly according to the type of disease. Population with special health condition who are not healthy, specific population groups based on their (un)employment, occupation or education status and also immigrants are excluded.

**Sampling Method:** Studies that did not report the sampling method or did not use random sampling methods will be excluded.

#### Selection of searched articles

Following the search in selected databases, articles will be selected according to the inclusion and exclusion criteria in three phases. In case of disagreement, reviewers discuss the doubtful articles to reach an agreement and select them.

#### Title phase

Reviewers scan all the titles according to the inclusion criteria, and the titles in doubt will be included.

#### Abstract phase

Reviewers scan all the abstracts according to the inclusion criteria, and the articles with unclear methods will be included.

#### Full-text phase

To finalize the selection phase, reviewers evaluate all remaining articles to find out if they are eligible.

Full texts will be obtained via referring to digital library of Tehran University of Medical Sciences, contacting with corresponding authors or accessing to the journal in which the article is published.

#### Quality assessment and data extraction

To assess the quality of articles with different sampling and measuring methods, based on the criteria of study characteristic sheet, a new comprehensive quality assessment form with defined ranking scores for the systematic review, will be used through four steps.

- First, a quality assessment form will be developed based on the study characteristic sheet with defined criteria (Table 3, A) such as study ID, citation, corresponding author's characteristics, study year, study sources, study design, scope of study, level of study, sample weight, sampling quality and measurement quality. The quality assessment form will include the following criteria: ID, disease group, study scope, study level, study type, power of study, sampling method, gender, province, location, sample size, sample weight, practical disease definition, disease exploration,

validity, intra-observer reliability, inter-observer reliability, examiner level and number of examiners (Table 4).

- Next, each criterion will be defined and explained precisely. The form will be designed in Epi-Info 7 in Access format and ranking scores will be given to the articles to assess their qualities.

- To validate the face and content of the form, the focus group discussion method will be used, and the form will be finalized.

- Then, in calibration step, two members of research team will complete the quality assessment form for ten selected articles; and accordingly, the disagreements will be assessed, the differences will be discussed, and the level of agreement will be obtained (Intra-class Correlation Coefficient).

Finally, data extraction sheet will be used to abstract study data based on sex, age, and sample size in related age and sex groups, prevalence, incidence, mean, standard deviation, standard error and confidence interval (Table 3, B).

#### B) National data

**National Oral Health surveys:** These surveys were designed to collect national and provincial data about the oral health and their risk factors in Iran through oral health examinations. Data of national oral health surveys in years 1995, 1998, 1999, 2001 and 2004 will be used.

**National Health Survey:** This survey is a repeated multipurpose national survey covering all Iranian households. The survey is repeated each ten years to evaluate indicators of health and illness. In 1990 and 1999, the survey included oral health data for different age groups of Iranian population.

For oral cancer and oral clefts the following data registry system will be used:

**Death Registry System:** National death data reported by Ministry of Health will be included in this study to measure the oral cancer and oral clefts mortality based on age group, sex, and cause of death.

**Cancer Registry System:** Oral cancer reported by the population-based cancer registry system will be used to measure the rate of oral cancer.

#### Statistical methods and analysis plans

To overcome the gap caused by lack of representative data in provincial level, in some age or sex groups, and in urban or rural areas, two distinct statistical models (including Spatio-temporal model and multilevel autoregressive model) will be used to estimate mean and its confidence interval. The data of a specific age, year, and province as well as that of other ages, years, and provinces will be entered to the models. The problem of misalignment

**Table 3.** The defined criteria of study characteristic sheet and data extraction sheet

<b>A. Study characteristic information</b>	
<b>General information</b>	<ul style="list-style-type: none"> <li>• ID (abbreviation of disease, province code and a number for each article)</li> <li>• Study name (special name of national and sub-national study)</li> <li>• Citation</li> <li>• Corresponding author's characteristics</li> <li>• Article code (PMID or DOI)</li> <li>• Publication year</li> <li>• Study year</li> <li>• Practical definition (description of diseases in each article)</li> <li>• Sub group (ethnicity of the study population)</li> <li>• Study Included/Excluded by, and Study Cross-checked by (name of people)</li> </ul>
<b>Study source</b>	<ol style="list-style-type: none"> <li>1. Iranian databases</li> <li>2. Foreign databases</li> <li>3. Non-indexed Iranian journals</li> <li>4. Health surveys</li> <li>5. Abstract of congress</li> <li>6. Theses</li> <li>7. Other un-published reports</li> </ol>
<b>Study design</b>	<ol style="list-style-type: none"> <li>1. Cross-sectional</li> <li>2. Case-Control</li> <li>3. Cohort</li> <li>4. Others</li> </ol>
<b>Scope of study</b>	<ol style="list-style-type: none"> <li>1. Rural</li> <li>2. Urban</li> <li>3. Both</li> </ol>
<b>Level of study</b>	<ol style="list-style-type: none"> <li>1. National</li> <li>2. Provincial</li> <li>3. District</li> <li>4. Community</li> <li>5. Sub-region (two or more provinces with similar ethnicity and race)</li> <li>6. Two or more sub-regions</li> </ol>
<b>Sample weight</b>	<ol style="list-style-type: none"> <li>0. No</li> <li>1. Yes</li> </ol>
<b>Sampling quality assessment</b>	
<b>Sampling method</b>	<ol style="list-style-type: none"> <li>1. Multi-level clustering random sampling</li> <li>2. One-level clustering random sampling</li> <li>3. Simple random sampling</li> <li>4. Others</li> </ol>
<b>Sample size</b>	<ol style="list-style-type: none"> <li>0. Less than 250</li> <li>1. 250 to 500</li> <li>2. 500 to 1000</li> <li>3. More than 1000</li> </ol>
<b>Response rate</b>	<ol style="list-style-type: none"> <li>0. Less than 59 %</li> <li>2. 60 to 74 %</li> <li>4. 75 to 89 %</li> <li>6. More than 90 %</li> </ol>
<b>Measurement quality assessment</b>	
<b>Measurement</b>	<ul style="list-style-type: none"> <li>• Type of measurement tools</li> <li>• Calibration of tools</li> <li>• Validity and reliability of questionnaires or examiners or instruments</li> </ul>
<b>B. Data extraction information</b>	
<b>Sex</b>	<ul style="list-style-type: none"> <li>• Male</li> <li>• Female</li> <li>• Both</li> </ul>
<b>Age</b>	<ul style="list-style-type: none"> <li>• Age start</li> <li>• Age end</li> <li>• Median age range</li> </ul>
<b>Sample size</b>	The sample size in each sex and age group of the study population
<b>Point prevalence or incidence</b>	The point estimate, mean, SD, SE, lower level and upper level of confidence interval are extracted from the included articles
<b>Data extracted by, and data cross-checked by</b>	The name of people who will extract and cross- check the data

**Table 4.** The defined criteria developed within quality assessment form

Name of criteria	Definition
<b>ID</b>	Disease group Number Title Article code Language (English, Persian) Locality (Iranian, Non-Iranian)
<b>Disease group</b>	Dental caries Periodontal diseases Tooth loss Oral cancer Oral clefts Temporo-mandibular joint disorders
<b>Study scope</b>	Urban Rural Urban-rural Urban-rural-suburb Urban suburb
<b>Study level</b>	Local District Provincial National
<b>Study type</b>	Cross-sectional Survey Cohort Only case series
<b>Power of study</b>	Representative By weight By stratification Referral data None
<b>Sampling method</b>	Simple random Cluster Multistage Other
<b>Gender</b>	Male Female Both
<b>Province</b>	Name and code of province
<b>Location</b>	The place of study implementation
<b>Sample size</b>	< 250 250 – 500 500 – 1000 > 1000
<b>Sample weight</b>	Yes No
<b>Practical disease definition</b>	Yes No
<b>Disease exploration</b>	Standard Method Invalid Method Other accepted Method Unexplained
<b>Validity</b>	High Moderate Low
<b>Intra-observer reliability</b>	Coefficient Explained but incorrect unexplained
<b>Inter-observer reliability</b>	Coefficient Explained but incorrect Not need (one examiner) unexplained



<b>Examiner level</b>	Specialist General dentist/hygienist Student unexplained
<b>Number of examiners</b>	One Two or more Unexplained

due to changes in provincial map is going to be addressed in both models. Using two different models reduces model dependency in the results.

#### Spatio-temporal Bayesian Hierarchical model

One of the commonly used frameworks to overcome the above-mentioned limitations is Spatio-temporal Bayesian hierarchical modeling with Conditional Auto Regression (CAR) prior to spatial random effects.<sup>21</sup> In spatial framework, observations that are closer in space are assumed to be more correlated than observations farther away. The structure enables model to “borrow information” from neighboring areal units to improve estimates for areas with missing values and/or small number of observations. In addition, we will employ Spatio-temporal misalignment modeling to combine incompatible areal units between data sources and/or over the years. The model includes covariates effects, non-linear age trend, and study quality and source of data variations.

#### Bayesian Multilevel Autoregressive model

Another advanced method to handle the challenges is Bayesian multi-level autoregressive model.<sup>22</sup> In this framework, observations are hierarchically nested in districts, provinces, sub-regions, regions, and national levels, respectively. In this hierarchical model, higher levels borrow information to the lower levels and units of each level borrow information to each other depending on the degree of data availability. The model considers several different components including linear time trends, nonlinear change over time, covariate effects, non-linearity associated with age, heterogeneity of data sources, and age-by-study variability. Time-varying covariates at district-level or province-level covariates inform the estimates if practical.

In both modeling frameworks, the MCMC methods for their general applicability and ease of implementation will be used to perform Bayesian inference. All programs will be written in R-statistical packages (version 3.0.1).

Beside these challenges, the other problem is about summary statistics that have been reported in different classification. Using regression models, we will do cross walk between continuous and categorical measures of interest variables.

#### Ethical considerations

The present work is a study based on secondary data, and there are no specific ethical considerations.

## Discussion

The objective of the present study is to elaborate the methodology of a national and sub-national survey aims to estimate the trends and values of burden of oral diseases, in 1990-2013. Most studies on the burden of disease, injuries and risk factors were at the national or global level.<sup>8-16</sup> However, there are a few sub-national analyses of the burden of disease<sup>23,24</sup> and some sub-national

analyses of mortality are available.<sup>25,26</sup> The burden of oral diseases has been evaluated at the global level, and those of national and sub-national levels are scarce or alongside overall burden of diseases.<sup>5,6,27-32</sup>

Six selected oral diseases in this study are dental caries, periodontal diseases, tooth loss, oral cancer, oral clefts and temporomandibular joint disorders. The diseases were included based on global and national burden studies, major causes of death and disability, leading causes of disease burden, availability of data on disease distributions, and policy implications. Parallel with other burden studies, the most useful sources of data are National Oral Health surveys, registry systems and population-based epidemiological studies, based on systematic review of published and unpublished surveys (Table 5).

In GBD 2010 study, the cause of disease list for oral conditions included dental caries, periodontal diseases, edentulism, mouth cancer, and cleft lip and cleft palate. Dental caries, periodontal diseases and edentulism remained highly prevalent, and all ranked among the top 100 causes of DALYs.<sup>33</sup> Data for entering models came from systematic reviews of population-based studies. Prevalence estimates were calculated for all age-gender-country-year groups, by DisMod-MR, a Bayesian meta-regression tool developed for the GBD 2010 Study.<sup>34</sup>

The main oral conditions for estimating the burden of oral diseases were tooth decay, gum disease, edentulism, oral cancer and oral trauma, in a national report on oral health in Australia.<sup>32</sup> Disability weights for the burden of oral diseases were measured, in another study in South Australia, and the distribution of dental caries, periodontal diseases and some other common dental conditions were examined.<sup>28</sup>

The sources utilized for a study in South Africa on the burden of various diseases, including oral diseases, were the National Health Information System, epidemiological research studies and GBD 1990 study.<sup>29</sup> In UK, oral cavity cancer was the only oral disease which its burden was estimated based on data extracted from national statistics and cancer registration system.<sup>31</sup> First Year of Life Mortality among infants with oral clefts was assessed in New York using Congenital Malformation Registry system.<sup>30</sup>

As an advantage, our study covers major oral diseases; and the availability of various nationally representative sources of data facilitates the estimation of YLD, YLL, and consequently DALYs of oral diseases in Iranian population. In addition, a quality assessment form will be designed in Epi-Info in Access format with defined ranking scores to assess the quality of articles selected through systematic review of published and unpublished studies. Furthermore, analyses of trends and burden of the selected oral diseases will be extended to both national and sub-national levels for a 20-year period, not evaluated before. Moreover, the uncertainty of the resulted estimates will be quantified using new statistical methods which have been developed for the first time in the country, and analysis of heterogeneity can be used to reduce the uncertainty of the results. Finally, the results of the study will help

**Table 5.** Characteristics of studies on burden of oral diseases in selected countries

Country	Year of study	Data source	Type of diseases										Methodology	Data collection
			DC	PD	TL	OC	Tr	OCL	TMJ	Others				
Australia	2003 – 2006	<ul style="list-style-type: none"> <li>All national surveys</li> </ul>	+	+	+	+	+	-	-	-	-	-	<ul style="list-style-type: none"> <li>WHO methodology for DALY</li> </ul>	Literature review
South Australia	2001 – 2002	<ul style="list-style-type: none"> <li>Self-complete questionnaire</li> <li>Dentist questionnaire (Dentist's Practice Activity)</li> </ul>	+	+	-	-	-	-	-	-	-	<ul style="list-style-type: none"> <li>Recall/maintenance, failed restorations, pulp infections, denture problems, hygiene, tooth wear, dental sensitivity and aesthetic</li> <li>DALY (based on EuroQol instrument, UK)</li> </ul>	Random sampling	
Zimbabwe	1997	<ul style="list-style-type: none"> <li>National Health Information System</li> <li>Global Burden of Disease (GBD) study</li> </ul>	NA	NA	NA	NA	NA	NA	NA	NA	NA	<ul style="list-style-type: none"> <li>In form of a general term of Oral Condition</li> </ul>	<ul style="list-style-type: none"> <li>YLD</li> </ul>	Literature review
England, Scotland, Wales and Northern Ireland	2004 – 2005	<ul style="list-style-type: none"> <li>WHO data</li> <li>National Surveys</li> <li>Cancer registration data</li> </ul>	-	-	-	+	-	-	-	-	-	<ul style="list-style-type: none"> <li>Mortality Rate</li> <li>Potential Years of Life Lost (PYLL)</li> <li>Working Years of Life Lost (WYLL)</li> <li>DALY</li> </ul>	Literature review	
USA, New York	1983 – 1990	<ul style="list-style-type: none"> <li>Congenital Malformation Registry (CMR)</li> <li>Hospital Records</li> </ul>	-	-	-	-	-	-	+	-	-	<ul style="list-style-type: none"> <li>Mortality Rate</li> </ul>	Literature review	

Type of disease: DC = Dental Caries, PD = Periodontal Diseases, TL = Tooth Loss, OC = Oral Cancer, Tr = Trauma, OCL = Oral Cleft Lip and palate, TMJD = Temporomandibular Joint Disorders. NA = Not Assessed.

us to determine inequalities between regions, ages, and genders to develop oral health policies.

The limitations of this study are as follows: First, we will use various sources of data, and there may be heterogeneity between data sources, which will be managed by methodological strategies. Second, access to the full texts of certain published or unpublished epidemiological studies, as one of the main data sources, may be limited. Third, due to absence of a surveillance system for oral diseases there are not sufficient data about all oral diseases, especially temporo-mandibular joint disorders. Since annual data are not available for every sub-national level, many province-years and district-years do not have any data or representative data. Furthermore, some sources of data only cover some age or sex groups, or just urban or rural populations. In addition, the patterns of data scarcity persist for older ages. Fourth, disability weights are not calculated for the country and are adopted from global studies.

Results of this study will provide a broad framework for planning oral health intervention strategies and formulating policy approaches. School based and community programs for promoting oral health information, developing oral hygiene skills, reducing associated risk factors of oral health such as sugar intake, tobacco and alcohol, establishing water fluoridation, improving access to fissure sealant and regular dental care, promoting dental health services toward maximum preventive and minimum treatment strategies, and proposing affordable treatment cost are some potential interventions to decrease levels of oral diseases in the population.

In conclusion, the present study is the first comprehensive systematic study assessing the prevalence and burden of oral diseases for the Iranian population at national and sub-national levels. Since the findings will be used to identify distributions and inequalities of the oral diseases across different parts of the country, they can have an important role in directing future policy decisions and planning cost-effective strategies. The diversity in patterns of oral diseases indicates that the risk profiles can help to establish and strengthen preventive oral health care programmes through the implementation of effective measures.

## Abbreviations

*BOD: Burden of Oral Diseases; DALY: Disability-Adjusted Life Years; GBD: Global Burden of Disease; NASBOD: National and Sub-national Burden of Disease; YLL: Years of Life Lost due to premature mortality; YLD: Years of Life Lost due to Disability.*

## Competing Interests

*The authors declare that they have no competing interests.*

## Author's Contributions

**General designing of paper:** Shervan Shoaee, Hossein Hessari, Farshad Farzadfar

**Designing of models:** Amir Kasaeian, Farshad Farzadfar

**Designing of systematic review:** Anoosheh Ghasemian, Baharak Najafi, Farshad Farzadfar

**Writing primary draft:** Anoosheh Ghasemian

**Manuscript revision:** Hossein Hessari, Anoosheh Ghasemian, Shervan Shoaee, Farshad Farzadfar

## Acknowledgments

*The study is granted by Ministry of Health and Medical Education of Islamic Republic of Iran; Setad-e-Ejraie Farmane Imam, and Oral and Dental Diseases Research Center of Kerman University of Medical Sciences. We would also like to express thanks to Dr.Masoud Moradi for his precise editing of the text and Ms Rosa HaghShenas for her efforts on managing coordinative and administrative processes.*

## References

- Strong K, Mathers C, Leeder S, Beaglehole R. Preventing chronic diseases: how many lives can we save? *LANCET*. 2005; **366**: 1578 – 1582.
- Fuster V, Voute J. MDGS: chronic diseases are not on the agenda. *LANCET*. 2005; **366**: 1512 – 1514.
- Horton R. The neglected epidemic of chronic disease. *LANCET*. 2005; **366**: 1514.
- Mignogna M, Fedele S. The neglected global burden of chronic oral disease. *J Dent Res*. 2006; **85**: 390 – 391.
- Petersen PE, Bourgeois D, Ogawa H, Saska, Ndiaye Ch. The global burden of oral diseases and risks to oral health. *Bulletin of the World Health Organization*. 2005; **83**: 661 – 669.
- Petersen P, Ogawa H. The global burden of periodontal disease: towards integration with chronic disease prevention and control. *Periodontology*. 2000; **60**: 15039.
- Murray C. Quantifying the burden of disease: the technical basis for disability-adjusted life years. *Bull World Health Organ*. 1994; **72**: 429 – 445.
- Murray CJL, Lopez AD. The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020. *Harvard School of Public Health*. 1996.
- Ezzati M, Hoorn SV, Rodgers A, Lopez AD, Mathers CD, Murray CJ. Comparative Risk Assessment Collaborating Group. Estimates of global and regional potential health gains from reducing multiple major risk factors. *LANCET*. 2003; **362**: 271 – 280.
- Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ. Comparative Risk Assessment Collaborating Group. Selected major AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *LANCET*. 2012; **380**: 2224 – 2260.
- Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions 1990–2010: A systematic analysis for the global burden of disease study 2010. *LANCET*. 2012; **380**: 2224 – 2260.
- Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. *LANCET*. 2006; **367**: 1747 – 1757.
- Lozano R, Murray CJL, Frenk J, Bobadilla JL. Burden of disease assessment and health system reform: results of a study in Mexico. *J Int Dev*. 1995; **7**: 555 – 563.
- Michaud CM, McKenna MT, Begg S, Tomijima N, Majmudar M, et al. The burden of disease and injury in the United States 1996. *Popul Health Metr*. 2006; **4**.
- Murray Ch, Vos T, Lozano R, Naghavi M, Flaxman A, Michaud C, Ezzati M, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *LANCET*. 2012; **380**: 2197 – 2223.
- Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *LANCET*. 2012; **380**: 2163 – 2196.
- Naghavi M, Abolhassani F, Pourmalek F, Moradi Lakeh M, Jafari N, Vaseghi S, Mahdavi Hezaveh N, Kazemeini H. The burden of disease and injury in Iran 2003. *Population Health Metrics*. 2009; **7**.
- National burden of diseases and injuries in Islamic Republic of Iran. *Ministry of Health and Medical Education*. 2007; 230 – 240.
- Farzadfar F, Delavari A, Malekzadeh R, Mesdaghinia A, Jamshidi



- HR, Sayyari A, et al. NASBOD 2013: Design, definitions, and metrics. *Arch Iran Med.* 2014; **17(1)**: 7 – 15.
20. World Health Organization (WHO). Oral Health Surveys: Basic Methods. Geneva: WHO. 1997.
21. Parsaeian M, Farzadfar F, Zeraati H, Mahmoudi M, Rahimighazikalayeh G, Navidi I, et al. Application of spatio-temporal model to estimate burden of disease, injuries and risk factors in Iran 1990 – 2013. *Arch Iran Med.* 2014; **17(1)**: 28 – 33.
22. Kasaeian A, Eshraghia MR, Rahimi A, NiakanKalhori SR, Mohammad K, Farzadfar F. Bayesian autoregressive multilevel modeling of burden of diseases, injuries and risk factors in Iran 1990 – 2013. *Arch Iran Med.* 2014; **17(1)**: 22– 27.
23. Begg S, Vos T, Barker B, Stevenson C, Stanley L, et al. The burden of disease and injury Australia 2003. Canberra: Australian Institute of Health and Welfare. 2007.
24. Stevens G, Dias RH, Thomas KJ, Rivera JA, Carvalho N, Barquera S, Hill K, Ezzati M. Characterizing the epidemiological transition in Mexico: national and subnational burden of diseases, injuries, and riskfactors. *PLoS Med.* 2008; **5**: e125.
25. Bradshaw D, Nannan N, Groenewald P, Joubert J, Laubscher R, et al. Provincial mortality in South Africa, 2000–priority-setting for now and a benchmark for the future. *S Afr Med J.* 2005; **95**: 496 – 503.
26. Murray CJ, Kulkarni SC, Michaud C, Tomijima N, Bulzacchelli MT, Iandiorio TJ, Ezzati M. Eight Americas: investigating mortality disparities across races, counties, and race-counties in the United States. *PLoS Med.* 2006; **3**: e260.
27. Baelum V, Van Palenstein Helderman W, Hugoson A, Yee R, Fejerskov O. A global perspective on changes in the burden of caries and periodontitis: implications for dentistry. *Journal of Oral Rehabilitation.* 2007; **34**: 872 – 906.
28. Brennan D, Spencer A. Disability weights for the burden of oral disease in South Australia. *Population Health Metrics.* 2004; **2**.
29. Chapman G, Hansen KS, Jelsma J, Ndhlovu Ch, Piotti B, Byskov J. The burden of disease in Zimbabwe in 1997 as measured by disability-adjusted life years lost. *Tropical Medicine and International Health.* 2006; **11**: 660 – 667.
30. Druschel CM, Hughes JP, Olsen CL. First year-of-life mortality among infants with oral clefts: New York State, 1983-1990. *Cleft Palate-Craniofacial Journal.* 1996; **33**: 400 – 405.
31. Green S, Miles R. The Burden of Disease and Illness in the UK. 2007.
32. Richardson B, Richardson J. The cost of poor dental health and what should be done about it. 2011.
33. Marcenés W, Kassebaum NJ, Bernabe E, Flaxman A, Naghavi M, Lopez A, Murray CJL. Global Burden of Oral Conditions in 1990 – 2010: A Systematic Analysis. *J Dent Res.* 2013.
34. Flaxman A, Vos T, Murray C. The meta-regression of descriptive epidemiology model. Seattle: WA: University of Washington Press. 2012.

## Appendix

Search terms in International databases
<p>■ <b>Dental Caries</b></p> <p>● <b>PubMed</b></p> <p>"Dental Caries"[Mesh] OR "DMF Index"[Mesh] OR "Dental Restoration, Permanent"[Mesh] OR "Tooth Diseases"[Mesh] OR "Dental Health Surveys"[Mesh]</p> <p>● <b>ISI OR Scopus</b></p> <p>"Dental Caries" OR "dental decay" OR "dental white spot" OR "DMF Index" OR "decayed, missing and filled teeth" OR "Dental Restoration, Permanent" OR "dental filling, permanent" OR "Tooth Diseases" OR "Dental Health Surveys"</p>
<p>○ <b>Periodontal Diseases</b></p> <p>● <b>PubMed</b></p> <p>"Periodontitis"[Mesh] OR "Periodontal Diseases"[Mesh] OR "Periodontal Index"[Mesh] OR "Periodontal Pocket"[Mesh] OR "Periodontal Attachment Loss"[Mesh] OR "Alveolar Bone Loss"[Mesh] OR "Dental Calculus"[Mesh] OR "Gingivitis"[Mesh] OR "Gingival Diseases"[Mesh] OR "Gingival Pocket"[Mesh]</p> <p>● <b>ISI OR Scopus</b></p> <p>Periodontitis OR "Periodontal Diseases" OR parodontosis OR parodontoses OR "Periodontal Index" OR CPITN OR CPI OR "bleeding on probing" OR "Periodontal Pocket" OR "Periodontal Attachment Loss" OR "Alveolar Bone Loss" OR "alveolar resorption" OR "Dental Calculus" OR Gingivitis OR "Gingival Diseases" OR "Gingival Pocket"</p>
<p>○ <b>Tooth Loss</b></p> <p>● <b>PubMed</b></p> <p>"Tooth Loss"[Mesh] OR "Mouth, Edentulous"[Mesh] OR "Tooth Mobility"[Mesh]</p> <p>● <b>ISI OR Scopus</b></p> <p>"Tooth Loss" OR "Mouth, Edentulous" OR edentulousness OR edentulism OR "Tooth Mobility"</p>
<p>○ <b>Oral Cancer</b></p> <p>● <b>PubMed</b></p> <p>"Carcinoma, Squamous Cell"[Mesh] OR "Mouth Neoplasms"[Mesh] OR "Gingival Neoplasms"[Mesh] OR "Palatal Neoplasms"[Mesh] OR "Lip Neoplasms"[Mesh] OR "Tongue Neoplasms"[Mesh] OR "Salivary Gland Neoplasms"[Mesh]</p> <p>● <b>ISI OR Scopus</b></p> <p>"Carcinoma, Squamous Cell" OR SCC OR "epidermoid carcinoma" OR "Mouth Neoplasms" OR "oral neoplasms" OR "mouth cancer" OR "oral cancer" OR "Gingival Neoplasms" OR "Palatal Neoplasms" OR "Lip Neoplasms" OR "Tongue Neoplasms" OR "Salivary Gland Neoplasms" OR "salivary gland cancer"</p>
<p>○ <b>Oral Clefts</b></p> <p>● <b>PubMed</b></p> <p>"Cleft Lip"[Mesh] OR "Cleft Palate"[Mesh] OR "Maxillofacial Abnormalities"[Mesh] OR "Craniofacial Abnormalities"[Mesh]</p> <p>● <b>ISI OR Scopus</b></p> <p>"Cleft Lip" OR "Cleft Palate" OR "Maxillofacial Abnormalities" OR "Craniofacial Abnormalities"</p>
<p>○ <b>Temporomandibular Joint Disorders</b></p> <p>● <b>PubMed</b></p> <p>"Temporomandibular Joint Disorders"[Mesh] OR "Temporomandibular Joint Dysfunction Syndrome"[Mesh] OR "Myofascial Pain Syndromes"[Mesh] OR "Craniomandibular Disorders"[Mesh]</p> <p>● <b>ISI OR Scopus</b></p> <p>"Temporomandibular Joint Disorders" OR "TMJ disorders" OR "TMJ diseases" OR "Temporomandibular Joint Dysfunction Syndrome" OR "myofascial pain dysfunction syndrome" OR "Myofascial Pain Syndromes" OR "Craniomandibular Disorders"</p>

Search terms in National databases
<p>○ <b>Dental Caries</b></p> <p>● <b>IranMedex, SID and Irandoc</b></p> <p>■ <b>English key words</b></p> <p>“Dental Caries”, “DMF Index”, “Dental Restoration, Permanent”, “Tooth Diseases”, “Dental Health Survey”, “DMF”</p> <p>■ <b>Persian key words:</b></p> <p>“Pousidegi-ye Dandan”, “Pousidegiha-ye Dandan”, “Shakhes-e Dandanha-ye Pousideh Oftadeh va Por Shodeh”, “Shakhes-e Dandanha-ye Pousideh Keshideh va Por Shodeh”, “Shakhes-e Dandanha-ye Pousideh Az Dast Raftah va Por Shodeh”, “Dandanha-ye Pousideh Oftadeh va Por Shodeh”, “Dandanha-ye Pousideh Keshideh va Por Shodeh”, “Dandanha-ye Pousideh Az Dast Raftah va Por shodeh”, “Shakhes-e Di Em Ef”, “Di Em Ef”, “Shakhes-e DMF”, “Tarmim-e Dandani”, “Tarmim-e Daemi-e Dandan”, “Bimariha-ye Dandan”, “Motaleat-e Behdasht-e Dandan”</p>
<p>○ <b>Periodontal Diseases</b></p> <p>● <b>IranMedex, SID and Irandoc</b></p> <p>■ <b>English key words</b></p> <p>“Periodontitis”, “Periodontal Diseases”, “Periodontal Index”, “Periodontal Pocket”, “Periodontal Attachment Loss”, “Alveolar Bone Loss”, “Dental Calculus”, “Gingivitis”, “Gingival Diseases”, “Gingival Pocket”, “CPI”, “CPITN”</p> <p>■ <b>Persian key words</b></p> <p>“Periodontit”, “Periodontaitis”, “Bimari-ye Periodontal”, “Bimariha-ye Periodontal”, “Zayeat-e Periodontal”, “Shakhes-e Periodontal”, “Shakhes-e Niaza-ye Darmani-ye Periodontal”, “Khounrizi Hengam-e Prob Kardan”, “Khounrizi-ye Laseh”, “Paket-e Periodontal”, “Az Dast Raftan-e Chasbandegi-e Periodontal”, “Az Dast Dadan-e Ostokhan-e Alveol”, “Tahlil-e Ostokhan-e Alveol”, “Germ-e Dandani”, “Janjivit”, “Janjivitis”, “Eltehab-e Laseh”, “Afzayesh-e Hajm-e Laseh”, “Bimari-ye Janjival”, “Bimari-ye Laseh”, “Bimariha-ye Laseh”, “Paket-e Laseh-i”</p>
<p>○ <b>Tooth Loss</b></p> <p>● <b>IranMedex, SID and Irandoc</b></p> <p>■ <b>English key words</b></p> <p>“Tooth Loss”, “Mouth, Edentulous”, “Tooth Mobility”</p> <p>■ <b>Persian key words</b></p> <p>“Bi Dandani”, “Az Dast Dadan-e Dandan”, “Adam-e Hozour-e Dandan”, “Feghdan-e Dandan”, “Laghi-ye Dandan”</p>
<p>○ <b>Oral Cancer</b></p> <p>● <b>IranMedex, SID and Irandoc</b></p> <p>■ <b>English key words</b></p> <p>“Carcinoma, Squamous Cell”, “Mouth Neoplasms”, “Gingival Neoplasms”, “Palatal Neoplasms”, “Lip Neoplasms”, “Tongue Neoplasms”, “Salivary Gland Neoplasms”, “SCC”</p> <p>■ <b>Persian key words</b></p> <p>“Eskoamous sel Karsinoma”, “Karsinom-e Seloul-e Sangfarshi”, “Karsinom-e Seloul-e Sangfarshi-e Dahan”, “Saratan-e Seloul-e Sangfarshi”, “Saratan-e Seloul-e Sangfarshi-e Dahan”, “Karsinom-e Epidermoeid”, “Neopelasm-e Dahan”, “Neopelazi-e Dahan”, “Toumorha-ye Badkhim-e Dahan”, “Zayeat-e Badkhim-e Dahan”, “Saratan-e Dahan”, “Saratanha-ye Dahan”, “Kanser-e Dahan”, “Neopelasm-e Laseh”, “Saratan-e Laseh”, “Neopelasm-e Kam”, “Saratan-e Kam”, “Neopelasm-e Lab”, “Saratan-e Lab”, “Neopelasm-e Zaban”, “Saratan-e Zaban”, “Neopelasm-e Ghodad-e Bozaghi”, “Saratan-e Ghodad-e Bozaghi”</p>
<p>○ <b>Oral Clefts</b></p> <p>● <b>IranMedex, SID and Irandoc</b></p> <p>■ <b>English key words</b></p> <p>“Cleft Lip”, “Cleft Palate”, “Maxillofacial Abnormalities”, “Craniofacial Abnormalities”</p> <p>■ <b>Persian key words</b></p> <p>“Shekaf-e Lab va Kam”, “Shekaf-e Lab”, “Lab Shekari”, “Shekaf-e Kam”, “Nahanjariha-ye Keraniofasial”, “Nahanjariha-ye Maxilofasial”, “Nahanjariha-ye Faki Sourati”</p>
<p>○ <b>Temporomandibular Joint Disorders</b></p> <p>● <b>IranMedex, SID and Irandoc</b></p> <p>■ <b>English key words</b></p> <p>“Temporomandibular Joint Disorders”, “Temporomandibular Joint Dysfunction Syndrome”, “Myofascial Pain Syndromes”, “Craniofacial Disorders”</p> <p>■ <b>Persian key words</b></p> <p>■ “Ekhtelalat-e Mafsal-e Gijgahi Faki”, “Moshkelat-e Mafsal-e Gijgahi Faki”, “Bimariha-ye Mafsal-e Gijgahi Faki”, “Sandrom-e Badkari-e Mafsal-e Gijgahi Faki”, “Sandrom-e Mafsal-e Gijgahi Faki”, “Ekhtelalat-e TMJ”, “Bimariha-ye TMJ”, “Moshkelat-e Keranio Mandiboular”, “Moshkelat-e Gijgahi Faki”, “Sandrom-e Dard-e Azolani Sourati”, “Sandrom-e Dard-e Azolani Niemi”</p>