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Time trends and determinants of acute odontogenic maxillofacial infections in Lithuania: a retrospective national 2009-2013 treatment data audit

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Objectives*:* To examine the distribution of treatment facilities accepting patients with acute odontogenic maxillofacial infections (AOMIs), time trends in incidence and relate these infections with a number of determinants. ***Methods***: A national Lithuanian retrospective study gathered data on all patients treated in outpatient/inpatient treatment facilities. Adjusted Incidence Ratios (AIRs) of AOMIs were calculated separately for each type of infection and for each year. Administrative districts (ADs) were grouped into low, medium, and high thirds based on the regional determinants: socio-economic index (R-SEI), access to basic (R-BDCI) or specialized dental care (R-SDCI) and index of systemic diseases (R-ISD). ***Results*:** There were no statistically significant geographical differences in the distribution of TFs providing care for patients with AOMIs. Numbers of treatment facilities consistently increased from 2009 to 2013, but there was no consistent increase/decrease in the incidence of AOMIs (~1%). Regions with the highest R-SEI tended to have a higher incidence of AOMIs as compared to regions with medium or low R-SEI. When controlled for other determinants, lower R-BDCИR-SDCI scores were associated with a higher incidence of AOMIs. ***Conclusions***: High annual incidences (~1% of a total population) were diagnosed and treated for AOMIs, but there was no consistent time trend for these infections.

Key words: *dental, acute, odontogenic infections, health care disparities, Lithuania*

Introduction

Acute odontogenic maxillofacial infections are frequently the outcome of untreated dental diseases (Bratton *et al.,* 2002). Such infections remain prevalent in many countries and urgent treatment of them is necessary because of their potentially fatal complications (Wang *et al.,* 2005) but their treatment in hospitals incurs substantial costs (Ahmad *et al.,* 2013). However, some of these infections may be successfully treated in outpatient treatment facilities (Seppanen *et al.,* 2010). Alternative health care delivery models have been recommended to meet the demand for, and improve access to, urgent primary care (Link *et al*., 2014). In the UK, the National Health Service provides comprehensive dental care funded mainly from taxation and supplemented with co-payments (Tickle, 2012). Another strategy for improving access to urgent primary care is distributing some treatments to local outpatient treatment facilities (Chestnutt *et al.,* 2009). This integrated shared professional responsibility may maximize capacity to provide urgent primary health care to all patients (Link *et al.,* 2014) while reducing the number of higher cost hospitalizations (Agee and Gates, 2014). Regional clinics and smaller local treatment facilities in less affluent areas providing this care may also better address the society's needs to manage acute infections (Christensen *et al.,* 2012).

Lithuania has a two-tier system including both private (fee for service) and public (free or partly subsidized) professional dental care. To improve access to primary care, the Lithuanian National Health Care Insurance Fund (NHCIF) has contracted multiple private and public treatment facilities to provide care for patients with acute odontogenic maxillofacial infections. This infrastructure allows patients with acute infections to receive free or partly subsidized primary medical care in a treatment facility of their choice and encourages individuals to seek professional help in a timely manner. In some other countries provision of urgent medical care is mainly centralized in hospitals and in comparison the Lithuanian urgent care model may reduce disparities in accessing professional medical care for patients with acute odontogenic infections.

The impact of health care models incorporating the shared medical professional responsibility in reducing inequalities in accessing urgent care has been poorly understood (Resnick, 2013). Having information from the National Medical Register System about patients with acute maxillofacial infections allows evaluation of the efficiency of the Primary Urgent Care Model where responsibility for treating patients with acute odontogenic infections is shared among different type of treatment facilities and different administrative districts.

Material and Methods

This retrospective national study was approved by the National Lithuanian Ethics Board. The data on treatments and institutions providing care for patients with acute odontogenic maxillofacial infections was obtained from the Lithuanian National Health Care Insurance Fund (NHCIF).

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Table 1. Operationalization of the study variables

Variable	*Operationalisation*
Types of Acute Odontogenic Maxillofacial Infections	Based on the codes (ICD-10)# acquired from the Lithuanian National Health Care Insurance Fund: Code K05.2: acute periodontitis Code K10.2: inflammatory conditions of jaws Code K10.3: alveolitis of jaws Code K12.2: cellulitis and abscess of mouth Code L03.2: cellulitis of face
Administrative Regions	Administrative regions based on geographical location (n=10).
Type of Treatment Facility	1=Private Dental Clinics (outpatient, local), 2=Central Polyclinics (outpatient, big cities), 3=Regional Hospitals (outpatient or hospital, big cities), 4=Local Public Clinics (outpatient, local).
Years	1=2009 year, 2=2010, 3=2011, 4=2012, 5=2013.
Hospitalisation	0= treatment of infections in an outpatient institution, 1= treatment of infections in a hospital.
Regional Socio-economic Index (R-SEI), social determinant.	A joint A-SES index was based on: natural population growth, averaged regional individual income, regional average level of migration (inside country), regional average level of emigration and regional level of serious crime. Low R-SEI=0, Medium R-SEI=1, High R-SEI=2.
Regional Basic Dental Care Index (R-BDCI), social determinant.	Based on the regional adjusted number of dentists per 1000 inhabitants. R-BDCI Lowest=0, R-BDCI medium=1, R-BDCI highest=2.
Regional Specialised Dental Care Index (R-SCDI), social determinant.	A regional adjusted number of specialists (oral surgeons and/or maxillofacial surgeons) per 1000 inhabitants. R-SDCI Lowest=0, R-SDCI medium=1, R-SDCI highest=2
Regional Index of Systemic Diseases (R-ISD), disease determinant.	Based on an adjusted regional number of systemic diseases/conditions per region (N of diseases per 1,000 inhabitants). R-ISD Lowest=0, R-ISD medium=1, R-ISD highest=2.

ICD-10 Codes# according International Statistical Classification of Diseases and Related Health Problems 10th Revision

Table 1 presents all study variables and their operationalization. All ten Lithuania Administrative Regions (ARs) had five years of annual data (2009 to 2013) available. In the NHCIF database, acute odontogenic maxillofacial infections are coded following the International Statistical Classification of Diseases and Related Health Problems 10th Revision classification system (ICD-10 Version: 2015) as: K12.2, cellulitis and abscess of mouth; K10.2, inflammatory conditions of jaws; K10.3, alveolitis of jaws; K05.2, acute periodontitis and L03.2, cellulitis of face (Table 1). The present study focused on time trends and determinants of acute maxillofacial infections at treatment institution and district levels without using individual-based data.

In preparation for bivariate and multivariate analyses, incidences of acute maxillofacial infections were adjusted per 10,000 inhabitants to produce Adjusted Incidence Ratios for each type of acute odontogenic maxillofacial infection and for each year adjusting for the number of cases treated in each type of treatment institution and adjusting for the size of a district. $AIR_{(type\ of\ institution\ in\ a\ region\ in\ a\ year)}$ = *number of infections treated in an institution that year* × *10,000* ÷ *number of inhabitants per region that year.*

Table 1 operationalizes the study variables. The following potential risk determinants for a higher incidence of acute odontogenic maxillofacial infections were considered: hospitalization (outpatient vs. inpatient care), regional socio-economic index (R-SEI), regional access to basic dental care (R-BDCI), regional access to specialized dental care (R-SDCI) and regional averaged number of systemic diseases (R-ISD). The R-SEI was a combined regional socio-economic index calculated considering several social deprivation aspects employing data from the National Statistics Register. The R-SEI was calculated based on five area-based social parameters and the ten administrative regions were allocated R-SEI scores (0, lowest third by R-SEI; 1, middle third; 2, highest third). Area-based groupings (lowest, middle and highest thirds) of ARs were also used to code the potential risk determinants related to regional access to both professional basic dental care (R-BDCI) and to specialized dental care (R-SDCI). The Regional Index of Systemic Diseases (R-ISD) likewise grouped the ten ARs into thirds on the averaged regional number of systemic diseases/conditions.

Analyses were performed using SPSS v21.0 with the threshold for statistical significance set at $p<0.05$. Univariate statistics tested the data for normality in preparation for the inferential statistics. As most of the data were not normally distributed, nonparametric tests were chosen for all bivariate analyses.

Bivariate analyses compared proportions of patients with acute odontogenic maxillofacial infections treated in different types of treatment facilities (Kruskal Wallis test), to explore time trends concerning the incidence of different type of acute odontogenic maxillofacial infections (Friedman's test) and to associate potential risk determinants with the adjusted incidence ratios of acute odontogenic infections (Kruskal Wallis test/Mann Whitney U test). The multivariate linear regression analysis examined the joint effect of the following potential risk determinants: the type of treatment modality (outpatient vs. inpatient), the density of basic dental care (R-BDCI), the density of specialized dental care (R-SDCI), the regional socio-economic index (R-SEI) and the regional occurrence of systemic diseases (R-ISD).

Results

During the observation period, the Lithuanian NHCIF had contracts with 482 treatment facilities, of which 421 were outpatient and 61 were inpatient facilities. There were four types of these facilities providing either free or partly subsidized primary dental care for patients with acute odontogenic infections: 235 outpatient Private Dental Clinics across the country provided subsidized care, 27 outpatient Central Polyclinics in big cities provided free care, 61 Regional Hospitals (outpatient/inpatient) in big cities provided free care and 159 outpatient Local Polyclinics countrywide provided free dental care. Although more treatment facilities were in city areas there were many treatment facilities in the other areas.

Figure 1 illustrates the numbers of odontogenic infections treated per 10,000 inhabitants. Proportionally, the Central Polyclinics provided most of the primary care for patients with acute odontogenic infections followed by Local Polyclinics. However, there was substantial variation between institutions of the same type.

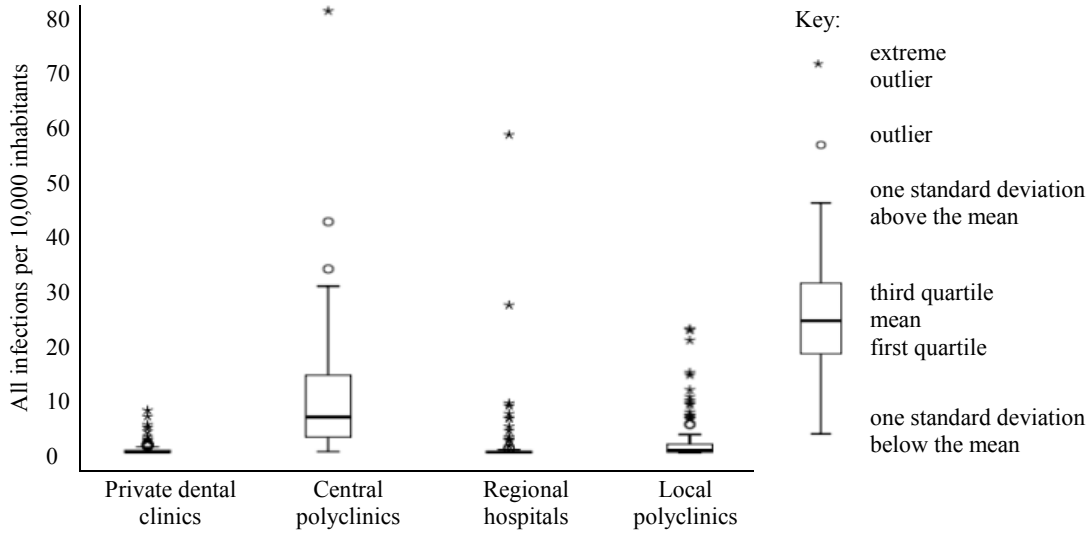

Figure 1. *Treatment of acute odontogenic infections in different Lithuanian treatment institutions*

Over the five years 150,254 cases (~1% of the Lithuanian population) were diagnosed and treated for acute odontogenic maxillofacial infections. The corresponding annual proportions were as follows: 29,362 cases in 2009 (0.9%), 27,937 in 2010 (0.9%), 30,390 in 2011 (1.0%), 30,058 in 2012 (1.0%) and 32,057 cases in 2013 (1.1%).

Table 2 presents time trends separately for each type of acute odontogenic maxillofacial infection and for each type of treatment facility. Among private clinics AIRs did not differ by year. There was an overall trend for fewer infections to be treated in private clinics than in other types of institutions with central clinics treating most of the acute odontogenic maxillofacial infections. Although there were some differences by year, there was no consistent trend in incidence rates across the five years. Table 2 also presents the increasing numbers of regional hospitals and local public clinics providing AOMIs care.

When adjusted, summative incidence ratios (all years combined) were compared across the country's 10 administrative regions, only one administrative region treated significantly more infections as compared to the other nine administrative regions ($p<0.040$)

Relationships between potential risk determinants and the dependent outcome AIR per 10,000 inhabitants are presented in Table 3 when identified from bivariate testing and in Table 4 from multivariate testing. Table 3 presents horizontally time trends for different population subgroups and time trends for the within group differences are presented vertically. Overall the total number of dental treatment facilities increased from 2009 to 2013 (Table 3, horizontal comparison) though there were differences between ARs. There were statistically significant differences in AIRs among the lowest and medium socio-economic regions across the five years, but not those with the highest socio-economic index.

Regarding access to professional dental care, a small decrease in AIRs coincided with increasing numbers of treatment facilities, with highest AIRs in areas with the least dental specialists (oral and maxillofacial surgeons) per capita. For density of basic dental care, an opposite trend has been observed, i.e. a statistically significant increase in AIRs occurred in areas with most of the dental specialists.

There were some differences in regional occurrences of systemic diseases between years though no trends were observed. Similarly, no clear trends could be identified regarding treatment provision by different types of facilities or as outpatient/inpatient.

Table 2. Time trends in the incidence of acute odontogenic infections in Lithuania (2009-2013) in various services

	ICD-10 Codes #	*Adjusted Incidence Ratios per 10,000 inhabitants*															
		2009			*2010*			*2011*			*2012*			*2013*			*^ P values*
Service context		*mean*	*95%CI*	*n*	*mean*	*95%CI*	*n*	*mean*	*95%CI*	*n*	*mean*	*95%CI*	*n*	*mean*	*I95%CI*	*n*	
Private Dental Clinics (Outpatient, countrywide)	K10.2	3.1	1.8,4.3	111	2.6	1.6,3.5	118	2.9	1.9,3.9	122	3.0	1.9,4.1	131	3.3	2.2,4.5	127	0.217
	K12.2	0.5	0.4,0.7	51	1.7	1.0,2.4	52	0.7	0.4,1.0	67	0.9	0.4,1.3	57	0.7	0.4,0.9	71	0.053
	K10.3	1.5	0.7,2.3	57	2.0	0.8,3.2	45	1.7	1.0,2.4	58	1.9	1.2,2.6	70	2.5	1.4,3.7	73	0.437
	K05.2	2.4	1.7,3.1	104	3.1	1.9,4.2	106	3.3	1.4,5.1	112	2.9	1.6,4.2	123	2.6	1.5,3.6	123	0.613
	L03.2	0.6	0.3,0.9	29	0.7	0.5,0.9	34	0.6	0.4,0.8	46	0.5	0.4,0.7	39	0.6	0.5,0.8	59	0.592
Central Polyclinics (Outpatient, big cities)	K10.2	83.1	18.0,148.3	5	80.9	17.7,144.1	24	87.2	18.3,156.1	25	92.3	22.5,162.1	26	93.1	27.8,158.4	25	**0.002**
	K12.2	3.2	0.9,5.5	26	3.4	1.1,5.6	23	3.1	0.9,5.3	24	3.2	0.8,5.6	23	3.5	0.6,6.3	22	0.296
	K10.3	25.2	10.8,39,6	25	24.6	10.3,38.8	24	27.6	12.8,42.4	23	28.3	13.9,42.6	23	22.2	13.4,31.0	25	**0.036**
	K05.2	22.0	10.3,33.8	26	22.8	10.9,13.6	24	24.7	8.5,40.9	26	32.7	6.1,59.4	26	29.3	9.1,49.5	25	0.739
	L03.2	0.5	0.1,1.0	13	0.9	0.3,1.5	16	1.1	0.5,1.7	14	0.7	0.3,1.2	28	1.3	0.7,1.9	18	0.509
Regional Hospitals (Outpatient/Inpatient, Big cities)	K10.2	13.4	4.1,22.7	37	17.0	7.3,26.8	27	20.1	4.2,36.0	25	16.2	3.2,29.2	27	17.4	-1.0,35.9	37	0.517
	K12.2	6.5	2.8,10.3	32	7.3	3.0,11.6	28	6.2	2.1,10.4	32	7.5	2.6,12.5	25	4.3	1.7,7.0	54	0.335
	K10.3	4.9	0.1,9.6	10	3.5	1.3,5.8	10	4.0	0.8,7.3	8	1.9	-1.2,3.9	10	2.5	-1.5,6.5	15	0.663
	K05.2	33.6	-23.7,90.8	22	49.2	-39.3,137.8	17	55.6	-44.7,156.0	16	35.8	-26.5,98.0	14	5.9	-1.2,13.2	26	0.663
	L03.2	1.3	0.7,1.8	54	1.1	0.6,1.7	49	1.5	0.9,2.1	51	1.5	1.1,2.0	50	2.2	1.5,2.9	66	**0.001**
Local Polyclinics (Outpatient, across the country)	K10.2	10.8	7.0,14.7	126	10.0	6.4,13.6	124	11.6	7.4,15.8	124	11.8	7.3,16.3	126	12.8	8.4,17.2	127	**0.030**
	K12.2	0.9	0.7,1.2	67	1.5	1.0,1.9	67	1.1	0.8,1.4	68	1.0	0.8,1.3	67	1.2	0.9,1.5	74	0.186
	K10.3	5.8	3.6,8.1	83	5.1	3.4,6.8	83	5.8	4.1,7.5	81	6.4	4.3,8.5	81	7.0	4.3,9.7	90	0.195
	K05.2	9.7	4.3,15.0	92	9.1	3.6,14.6	96	8.1	3.8,12.4	102	8.5	4.0,13.0	104	7.3	4.2,10.4	114	0.974
	L03.2	0.6	0.4,0.8	43	0.7	0.4,1.0	35	0.8	0.5,1.1	39	1.0	0.6,1.3	41	1.0	0.7,1.4	52	**0.010**

ICD-10 Codes: International Statistical Classification of Diseases and Related Health Problems 10th Revision: K12.2- cellulitis and abscess of mouth; K10.2- inflammatory conditions of jaws; K10.3- alveolitis of jaws; K05.2- acute periodontitis; L03.2- cellulitis of face. ^ Friedman's Test; n=number of treatment institutions.

Table 3. Bivariate analyses of the determinants of acute odontogenic infections

	Adjusted Incidence Ratios per 10,000 inhabitants															^ *P values*
	2009			*2010*			*2011*			*2012*			*2013*			
	mean	*95%CI*	*n*	*mean*	*95%CI*	*n*	*mean*	*95%CI*	*n*	*mean*	*95%CI*	*n*	*mean*	*95%CI*	*n*	
Regional Socio-Economic Index																
Lowest third	20.9	5.2,36.6	63	19.3	6.7,31.8	63	21.9	7.7,36.1	66	23.4	5.7,41.2	63	22.7	11.3,34.1	65	**0.002**
Middle third	13.4	8.3,18.4	195	14.9	8.8,19.3	187	14.4	8.9,19.9	185	13.5	8.2,18.6	199	14.1	9.3,19.0	197	**0.021**
Highest third	31.6	13.7,49.4	144	30.8	12.5,49.1	143	31.8	12.6,50.9	153	30.7	12.9,48.6	163	28.7	13.3,44.1	171	0.159
*P value			**0.03**			0.257			0.096			**0.001**			**<0.001**	
Regional Basic Dental Care Index																
Lowest third per capita	23.9	12.7,35.1	166	24.1	12.2,36.0	158	26.3	13.4,39.1	159	23.6	13.4,33.8	169	22.9	15.5,30.1	168	0.097
Middle third per capita	35.5	5.7,65.4	72	35.8	7.0,64.7	73	36.4	4.5,68.3	75	38.9	5.1,72.7	79	35.5	6.2,64.8	80	0.097
Highest third per capita	11.8	7.4,16.2	164	11.3	7.0,15.5	162	12.2	7.3,17.1	170	11.9	6.9,16.9	177	13.4	6.9,19.9	185	**0.032**
*P value			**<0.001**			**<0.001**			**<0.001**			**<0.001**			**<0.001**	
Regional Specialized Dental Care Index																
Lowest third per capita	31.6	12.9,50.3	85	31.8	11.2,52.4	84	34.5	12.4,56.5	84	31.5	15.9,47.1	86	26.7	15.7,37.6	94	**0.020**
Middle third per capita	15.6	7.0,24.6	125	16.5	8.3,24.7	119	16.3	7.9,24.8	121	14.9	6.2,23.6	133	16.5	10.2,22.7	123	0.065
Highest third per capita	19.8	8.4,31.3	192	19.0	7.8,30.2	190	20.6	8.2,33.0	199	21.7	8.3,35.1	206	21.5	9.4,33.5	216	**0.020**
*P value			**<0.001**			**<0.001**			**<0.001**			**<0.001**			**<0.001**	
Regional Index of Systemic Diseases																
Lowest third	26.2	13.4,38.9	99	24.7	13.4,36.0	96	28.9	15.8,42.0	96	30.1	15.2,45.1	98	28.9	17.5,40.3	104	**0.039**
Medium third	13.7	8.9,18.6	163	14.4	9.1,19.7	160	14.2	8.8,19.6	166	13.2	8.2,18.1	184	15.1	8.7,21.5	180	0.113
Highest third	26.0	8.0,44.0	140	26.0	7.3,44.8	137	27.1	7.0,47.2	142	26.5	6.9,46.1	143	23.1	7.1,39.1	149	0.070
*P value			**<0.001**			**0.003**			**<0.001**			**<0.001**			**<0.001**	
Type of Treatment Facilities																
Private dental clinics	4.7	3.2,6.1	154	5.2	3.7,6,8	158	5.3	3.5,7.1	167	5.3	3.6,6.9	182	5.5	3.9,7.2	181	**0.030**
Central Polyclinics	129.7	44.8,214.5	26	122.0	41.8,202.1	26	136.4	43.2,229.5	26	147.7	45.4,250.0	27	148.6	57.6,239.5	25	**<0.001**
Regional Hospitals	20.2	1.7,38.7	77	23.5	-0.3,47.1	68	25.0	-0.5,50.5	68	17.2	2.6,31.8	71	14.5	2.5,26.6	84	**<0.001**
Local Policlinics	19.5	13.1,25.9	145	18.8	12.4,25.3	141	19.9	13.5,26.3	143	20.7	13.8,27.6	145	22.6	15.6,29.6	143	0.413
*P value			**<0.001**			**<0.001**			**<0.001**			**<0.001**			**<0.001**	
Hospitalisation																
Outpatient care	22.5	14.6,30.5	364	22.1	14.1,30.1	360	23,1	14.5,31.6	377	22.8	14.3,31.1	390	22.3	15.1,29.5	398	**0.010**
Hospital care	7.1	1.1,13.1	38	8.4	0.8,15.9	33	10.4	1.2,19.7	27	7.8	0.9,14.8	35	8.0	1.2,15.0	35	0.096
**P value			**<0.001**			**0.001**			**0.014**			**0.003**			**<0.001**	

* Kruskal-Wallis Test, ** Mann-Whitney U Test, ^ Friedman Test

Table 4. Predictors of acute odontogenic infections – Linear Multiple Regression #

Model number and Summary	*Predictors*	*β coeff. **	*P value*	*Unstandardized coefficients (95%CI)*
1st Outcome: Adjusted Incidence Ratio for inflammatory conditions of jaws (K10.2) *P*=0.750, R^2 =0.004.	Constant		**0.024**	12.4 (17.0; 23.2)
	Hospitalisation	-0.033	0.492	-6.4 (-24.8; 11.9)
	Regional Specialized Dental Care Index	0.018	0.751	-4.5 (-15.1; 6.2)
	Regional Index of Systemic Diseases	0.042	0.405	4.0 (-5.4; 13.4)
	Regional Socio-economic Index	0.019	0.707	2.4 (-10.2; 15.0)
2nd Outcome: Adjusted Incidence Ratio for alveolitis of jaws (K10.3) *P*=0.186, R^2=0.020	Constant		**<0.001**	31.2 (19.0; 43.5)
	Regional Basic Dental Care Index	-0.125	0.145	-15.4 (-31.0; 0.2)
	Regional Index of Systemic Diseases	-0.038	0.545	-4.9 (-20.7; 11.0)
	Regional Socio-economic Index	0.123	0.075	-3.4 (-25.3; 18.6)
Outcome: Adjusted Incidence Ratio for cellulitis/abscess of mouth (K12.2) *P*<**0.001**, R^2=0.059	Constant		0.076	0.9 (-0.1; 1.9)
	Hospitalisation	0.242	**<0.001**	3.7 (2.1; 5.2)
	Regional Specialized Dental Care Index	0.168	**0.006**	0.1 (-0.9; 1.1)
	Regional Index of Systemic Diseases	-0.018	0.213	-0.2 (-1.0; 0.7)
	Regional Socio-economic Index	0.116	**0.046**	-0.1 (-1.3; 1.1)
4th Outcome: Adjusted Incidence Ratio for acute periodontitis (K05.2) *P*=**0.044**, R^2=0.021	Constant		**0.001**	45.0 (18.6; 71.3)
	Regional Basic Dental Care Index	-0.143	**0.010**	-43.4 (-76.5; -10.4)
	Regional Index of Systemic Diseases	0.083	0.125	26.2 (-7.3; 59.6)
	Regional Socio-economic Index	0.094	0.099	-19.7 (-66.4; 27.0)
5th Outcome: Adjusted Incidence Ratio for cellulitis of face (L03.2) *P*<**0.001**, R^2=0.085	Constant		**<0.001**	3.2 (2.1; 4.4)
	Hospitalisation	0.189	**0.001**	2.4 (1.0; 3.8)
	Regional Specialized Dental Care Index	0.177	**0.009**	-1.4 (-2.6; -0.3)
	Regional Index of Systemic Diseases	0.013	0.849	-0.4 (-1.4; 0.7)
	Regional Socio-economic Index	0.023	0.678	1.7 (0.2; 3.2)

All predictors were dichotomized. Colinearity diagnostics showed that Tolerance values in all models exceeded 0.6 indicating that assumption for the independence among predictors was fulfilled. * Standardizes β coefficients

Comparing AIRs time trends between population groups showed that in 2009, 2011, 2012 and 2013 but not in 2010 there were differences in numbers of patients and types of infections treated in the different types of facilities. In terms of access to specialized dental care, there was an obvious trend of higher statistically significant incidence rates in areas where there were fewer practicing specialists. There was a substantial variation in incidence ratios in areas by different densities of specialists per capita. Regarding the provision of urgent care by general dentists, most patients with acute maxillofacial infections were treated in regions with a medium density of dentists.

There was some variation but no trend in the incidence of AOMIs when comparing areas with different proportions of people with systemic diseases. More outpatients than hospital inpatients were treated for AOMIs.

Five linear multiple regression models were tested and four potential risk determinants for higher incidence rates of acute odontogenic infections were considered: treatment mode (outpatient vs. hospital), density of basic dental care (access to basic dental care), density of specialized dental care (access to specialized dental care), regional socio-economic index (social) and regional distribution of systemic diseases (disease determinant) (Table 4).

A multivariate model was tested for each of the five coded types of odontogenic infection. When controlled/adjusted for other determinants, the two most significant determinants for higher incidence ratios of AOMIs were: regional lower density of basic dental care and lower density of specialized dental care.

Discussion

The present national retrospective study examined the country's distribution of treatment facilities and urgent care provision for patients with acute odontogenic maxillofacial infections, explored time trends of incidence of these infections from 2009 to 2013 and related incidences of these infections with several potential regional risk determinants.

This study evaluated the Lithuanian Primary Care Model, where urgent care for patients with acute odontogenic maxillofacial infections was delivered both locally and centrally by contracting with dentists or specialists in multiple locations countrywide so patients were able to be treated in the facility of their choice. These contracts cover all treatment for AOIs in the country so this study's findings are nationally representative. This care model with both free and partially subsidized medical urgent care provides all patients (including the non-working uninsured) with access to timely care for their AOMIs. Hence we did not expect to find substantial regional differences in the incidence of AOMIs.

Between 2009 and 2013 a consistent increase in numbers of all types of treatment facilities providing AOMIs care was observed, but there was no associated trend in the incidence of AOMIs. From the population health perspective, an incidence of acute odontogenic infections amounting to around 1% of the total population is alarming. Unfortunately, due to the limited evidence available from heterogeneous studies, direct comparisons of the incidence rates or time trends of Lithuania to those of other countries was not feasible. The recent review reported that it is difficult to predict the spread of an odontogenic infection (Moghimi *et al.,* 2013).

Consequently, timely professional care of these infections is important. Access to such care should not be difficult for Lithuanian patients as multiple treatment facilities in multiple locations across the county provide urgent care. In Lithuania, the most severe acute odontogenic infections are determined as acute life-threatening conditions requiring urgent medical care (Health Ministry of Lithuania, 2004).

Social vulnerability and limited access to health care have been suggested as risks for poorer health (Baker *et al.,* 2002). To test if area-based social deprivation associates with a higher incidence of acute odontogenic infections, we tested area-based potential risk determinants. There were no area-based socio-economic disparities in AOMIs incidence rates. It has been suggested that there is an added value to population dental health when resources are concentrated on people with low-socio-economic status residing in socially deprived areas (Jamieson and Thomson, 2006). In many countries, dentists and dental specialists tend to establish their practices in more affluent and city areas (Hanibuchi *et al.,* 2011) and new dental graduates generally locate their practices near where they were trained (McFarland *et al*. 2010). A lower density of dental practitioners has been associated with poor access to dental services (Lupi-Pegurier *et al.,* 2011). We also observed more dental treatment facilities near two dental schools. Unsurprisingly, a lower density of either basic dental care or a lower density of specialized dental care was associated with slightly higher incidences of acute maxillofacial infections.

We did not find regional differences regarding the distribution of systemic diseases (area-based indicator only) to be associated with a higher incidence of AOMIs. Possibly, the area-based indicators of systemic health we employed were insufficient sensitive to variations in individuals' general health. Timely management of acute odontogenic maxillofacial infections is necessary not only to avoid complications but also to reduce potential for co-morbidities (Cachovan *et al.,* 2013). The Lithuanian Health Care System infrastructure allows patients with AOIs to seek timely professional help; this has several benefits: a reduction in the overall costs related to treatment of acute infections or their complications (economical benefit), a decrease in overall morbidity (population gains) and an improvement in each patient's well-being and quality of life (individual gains).

Further research is needed to determine which state policies lead to both an improvement in individual oral health and a reduction in oral health-related disparities (Mandal *et al.,* 2014).

Conclusions

Annual incidence rates were around 900 to 1,000 acute odontogenic maxillofacial infections per 10,000 Lithuanian residents. Though the number of treatment facilities increased there was no change in the incidence of these infections from 2009 to 2013.

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