

K. Tsiouli*, K. Karamesinis**, G.S. Antonarakis***, P. Christou****

*Department of Orthodontics, Aristotle University of Thessaloniki

**Department of Orthodontics, National and Kapodistrian University of Athens

***Department of Orthodontics, University of Geneva Dental School, Geneva, Switzerland

****Private Practice, Geneva, Switzerland

e-mail: p.christou@bluewin.ch

Prediction model of regional orthodontic workforce needs, using Greece as an example

ABSTRACT

Aim To develop a theoretical aepidemiological model for the prediction of orthodontic workforce needs, based on regional orthodontic treatment need.

Materials and methods Data were collected for the number of children between the ages of 8-11 years attending primary schools in Greece, within each regional division. Treatment need of the children was estimated using the Index of Orthodontic Treatment Need (IOTN). Demographics of practicing orthodontists in Greece were also collected. Based on the distribution of orthodontists and the number of children per region who would potentially receive orthodontic treatment (IOTN 3-5), the presence and distribution of orthodontic manpower was evaluated.

Results Overall orthodontic manpower is sufficient for Greece's needs with an excess of 55 orthodontists. Distribution however is not uniform, and this ranges from a large underrepresentation of orthodontists in the Ionian Islands (47% of those required) to an overrepresentation in the Attica region (183% of those required).

Conclusion Based on the present theoretical model, Greece has an adequate overall orthodontic workforce for coverage of the population needs, but with large regional variations indicating that some regions have a surplus while others a shortage of orthodontists. The present model seems suitable for the calculation of regional orthodontic workforce coverage of a population.

Keywords Health manpower; Index of orthodontic treatment need; Malocclusion.

Introduction

The high perception rate of malocclusions, the increasing understanding and awareness of occlusion, and the greater attention to aesthetics has brought a significant increase in orthodontic treatment demand over the past few decades [Chestnutt et al., 2003; Perillo et al., 2010]. Patients seeking orthodontic care fall into four categories: those who need orthodontic treatment and receive it; those who need orthodontic treatment and do not receive it; those who do not need orthodontic treatment and do not receive it; and those who do not need orthodontic treatment but receive it [Shaw et al., 2007]. The estimated number of patients that need and will actually receive orthodontic treatment - based on previous reports - amounts to 49.3% [Mandall et al., 2005]. Data available on treatment need of a population is not always representative of the objective treatment need, as a significant number of children are inappropriately referred for orthodontic treatment [Chew and Aw, 2002; Livas and Delli, 2013]. Therefore evaluation of the objective orthodontic treatment needs of a population is required. This can be done either by examining the entire population or by carrying out aepidemiological studies on population samples, and using aepidemiological indices such as the Index of Orthodontic Treatment Need (IOTN), the Dental Aesthetic Index (DAI), or the Risk of Malocclusion Assessment (ROMA) amongst others [Järvinen, 2001; Grippaudo et al., 2007]. Irrespective of the index employed in assessing treatment need, there are no statistically significant differences in the proportion of the population considered in need of treatment [Johnson et al., 2000].

Numerous aepidemiological surveys have been conducted in northern and central European countries [Alkhatib et al., 2005; Souames et al., 2006; Josefsson et al., 2007], but only a few are available concerning populations of Southern Europe [Ciuffolo et al., 2005; Nobile et al., 2007; Grippaudo et al., 2008a; Perillo et al., 2010]. In many European countries, it is not possible to register and evaluate the exact prevalence of malocclusion and orthodontic treatment needs of children, as no systematic and regular dental and orthodontic screening is carried out during their primary school years, as opposed to other European countries, such as in the United Kingdom [Milsom et al., 2008]. Conducting an aepidemiological survey can be a long and complicated process requiring thorough design, funds and adequate human resources, which under the current financial situation in many areas of Europe are impossible to allocate appropriately.

Responding to the treatment demand requires appropriate workforce planning, by private and public orthodontic service providers alike [Collins et al., 2009]. There are many constraints related to human resources for health, as orthodontic manpower planning is an often neglected component of national health systems development strategies. Although the needs of the population exist, this remains an area with insufficient scientific data for proper recommendations or long-term planning to ensure accessibility to orthodontic services [Shaw et al., 1996; Turpin, 2010]. Furthermore the conditions of orthodontic treatment provision vary greatly from country to country and data remain fragmented and inadequate for any prediction, especially in low- and middle-income countries.

Workforce planning should include a projection of whether the existing workforce can cover the orthodontic treatment needs of the population. Therefore a simple model based on readily available data both on the population and the rate of malocclusion can allow a prediction of regional orthodontic workforce requirements. The aim of the present study was to develop a theoretical model for the prediction of regional orthodontic workforce needs, using the population in Greece as an example.

Materials and methods

Population

The number and age distribution of children attending primary schools in Greece during the school year 2010-2011 were collected, by contacting the Directorates of Primary Education of all administrative divisions of the country, during the period of October 2010 to February 2011. It should be noted that the Peloponnese region could not provide official data. Data for children between the ages of 8 and 11 years (from the day of their 8th birthday to the day before their 12th birthday) was collected. The recorded age was the age of each child on the first day of classes in 2010 (September 13, 2010).

Treatment need

Treatment need was estimated using previously published data on the IOTN [Brook and Shaw, 1980] for 8-11 year old Caucasian children. The data collected were namely percentages of no treatment need (IOTN 1), minimal treatment need (IOTN 2), moderate treatment need (IOTN 3), and definite treatment need (IOTN 4-5). This data was used as previous studies on the prevalence of malocclusion in the whole Greek territory using the DAI found that there are no statistically significant differences between malocclusion in Greek pupils and American Caucasian pupils of the same age [Jenny et al., 1993; Hatzopoulos, 1999].

Thereafter, the percentages were applied to the population of primary school children in each region

of Greece and thus the theoretical needs of children aged 8-11 years were calculated. The number of patients requiring orthodontic treatment (IOTN 3-5) was calculated, and the estimated number of patients that will actually receive orthodontic treatment, based on previous data [Mandall et al., 2005] was calculated at 49.3%.

Manpower

The Greek Association for Orthodontic Study and Research provided demographics of practicing orthodontists in the country, the number and their distribution by region, as of November 2010. Based on the number of orthodontists per region and the number of children per region who are expected to receive orthodontic treatment, the presence and distribution of orthodontic manpower in the country was evaluated. On the basis that on average an orthodontist can potentially commence treatment of approximately 246 patients yearly [Health Wellbeing and Local Government Committee, 2010], an estimation could be made on whether there was a shortage or surplus of orthodontists in each region.

Results

The number of children aged 8-11 years in each region of Greece, as well as the estimated number of children with an IOTN of 1, 2, 3, and 4-5 is shown in Table 1. The

Region	Total children	IOTN 1	IOTN 2	IOTN 3	IOTN 4-5
East Macedonia and Thrace	20153	7376	4454	8323	2056
Attica	122621	44879	27099	50642	12507
North Aegean	7570	2771	1673	3126	772
West Greece	26448	9680	5845	10923	2698
West Macedonia	11392	4169	2518	4705	1162
Epirus	11025	4035	2437	4553	1125
Thessaly	28088	10280	6207	11600	2865
Ionian Islands	8308	3041	1836	3431	847
Central Macedonia	74147	27138	16386	30623	7563
Crete	27383	10022	6052	11309	2793
South Aegean	13686	5009	3025	5652	1396
Central Greece	20069	7345	4435	8288	2047
Total	370890	135745	81967	153175	37831

TABLE 1 Number of children per region and estimated treatment need.



FIG. 1 'Traffic light' map [Boulos and Phillipps, 2004] of Greece showing the administrative regional divisions and the current percentage of estimated required orthodontic manpower per region. Green = adequate coverage. Yellow = somewhat inadequate coverage. Red = largely inadequate coverage. White = no data provided.

percentages of treatment need that resulted from the NHANES III survey [Proffit et al., 1998] for Caucasian 8 to 11 year old children are the following: IOTN 1 = 36.6%; IOTN 2 = 22.1%; IOTN 3 = 41.3%; IOTN 4-5 = 10.2%.

The number of orthodontists in each region of Greece in comparison to the orthodontic needs is shown in Table 2. Orthodontists are present in all regions of Greece. In total the orthodontic manpower is sufficient for adequate coverage of the population's orthodontics treatment needs. In total Greece has an excess of 55 specialist orthodontists for its potential orthodontic needs of patients 8-11 years old. A variation in the distribution is observed however. The lowest orthodontic presence was observed in the Ionian Islands, East Macedonia and Thrace, and Crete, whereas there is an overrepresentation in Attica, Epirus, and the North Aegean (Fig. 1). Excluding the orthodontic workforce coverage in the two major metropolitan centers of Athens (Attica) and Thessaloniki (Central Macedonia) where the majority of orthodontists are located, the mean orthodontic coverage in the periphery is 79%.

Discussion

The present study attempts to create a model for predicting regional national orthodontic workforce needs in response to potential orthodontic treatment needs of the pupil population independent of any financial constraints. The population data represent the entire pupil population as primary school participation in Greece is obligatory and has an enrolment ratio of 100%, for both boys and girls [UNICEF, 2008-2012]. These data are readily available in all countries and are not affected by sociodental indicators.

Our model attempts to take into account the overall number of patients seeking orthodontic treatment as we base our calculations on individuals with actual

need of treatment in the population as reflected by IOTN grades 3, 4 and 5. Due to factors such as the influence of patient perception and aesthetics, maternal level of education, family social status, and income and supplementary insurance, the number of patients seeking treatment is expected to be only 49.3% of the abovementioned population. Dentists may also influence orthodontic treatment uptake as they encourage patients to seek orthodontic treatment. The general dentist-to-population ratio in Greece is generally favourable and thus may counteract any influence of social deprivation on the uptake of orthodontic services [Koletsis-Kounari et al., 2011].

The age range of our patients represents the population of patients most frequently starting orthodontic treatment [Tulloch et al., 2004]. Orthodontic treatment need was not based on the individual perception of malocclusion of each treating orthodontist, which reduces bias. It is known that despite any previous calibration there is always a possibility of bias in evaluating the need of orthodontic treatment as differences between clinicians in evaluating the severity of malocclusion may exist [Luke et al., 1998]. The few existing studies that profile the orthodontic workforce and forecast population needs use different data sources and approaches usually are limited to a specific region [Al-Azemi and Artun, 2010; Soma et al., 2012]. Those studies draw data directly from examination of a limited sample of children which can lead to bias since not all schoolchildren are examined.

One of the caveats inherent in the proposed model is the reference to epidemiological data based on another population. The ideal approach would be a nationwide examination of all pupils, however a previous study [Hatzopoulos, 1999] on samples from the whole of the Greek territory using the DAI has evidenced that there is no statistically significant difference in malocclusion between Greek pupils and American Caucasians of the same age. Indices such

as the DAI and IOTN have been adapted for reporting malocclusion, and both result in the same number of children with malocclusions requiring orthodontic treatment [Younis et al., 1997; Johnson et al., 2000]. The NHANES III data can therefore be applied to a pupil population in the present age range under study. One may argue on the appropriateness of using Greece as a data source given the current financial situation. However, previous experience has shown that despite the existing economic restraints the demand and uptake of orthodontic treatment for children under such conditions is expected to remain stable [Josefsson and Halling, 2000].

Another approach could have been to perform an original epidemiological study using a quick, reproducible, reliable, and sensitive index to assess malocclusion such as the ROMA. This index seems to be particularly suitable for Southern European populations [Grippaudo et al., 2007; 2008a; 2008b; 2013; Deli et al., 2012].

Prediction of human resources for orthodontic services is a complex task as there is no commonly adopted 'gold standard' and no corresponding monitoring authority. The present approach assumes a quantitative homogeneity of the services provided by the orthodontists (all are equally productive) and of the population (all populations have similar needs). The number of orthodontists not providing full-time orthodontic services is not known, thus the present model provides only an estimation and not an exact calculation of workforce needs. Additionally in any healthcare system, different categories of healthcare workers may provide different forms of health services. For orthodontics, treatment is provided in a number of settings, and general dental practitioners may provide simple interceptive treatments. Rarely, the provision of more complicated treatments may also be carried out by some general dental practitioners and this is not monitored. Moreover, some orthodontists may not be registered with the Greek Association for Orthodontic Study and Research. These possibilities suggest a small underestimation of the orthodontic workforce in the present study. A further factor not considered in the present study is that adults may also represent a potential pool of orthodontic patients. In a time of economic crisis however, their number is expected to decrease as adults have different treatment uptake than children.

Our study proposes an integral model for forecasting population needs and workforce capacity needs based on previously published data. Its output depicts that in Greece the distribution of orthodontists is not uniform, following similar patterns to other countries such as France [Germa et al., 2010], the UK [Morris and Landes, 2006], and the USA [Waldman et al., 2009]. There is a surplus of orthodontists for the needs of the population in some regions, and a shortage in other regions of

the country. Consequently, there is an uneven regional potential for treatment, which is strongly related to the distribution of orthodontic manpower. An apparent need to decentralise the orthodontic workforce is necessary to increase the orthodontic coverage outside of the capital and decrease the workforce in areas where there is a surplus. The present model overcomes inaccuracies of the overly simplistic orthodontist-to-population ratio [Dreesch et al., 2005], which seems to ignore the estimation of treatment need and takes into account factors such as the small number of adults seeking treatment in countries such as Greece under the current economic situation. It can be useful for workforce planning especially in areas most in need of orthodontic coverage, and the development of health policies in the management of orthodontic manpower. It also represents an attempt to overcome the poor availability of epidemiological data needed for specific workforce monitoring.

Conclusions

The proposed model provides a simple theoretical method to estimate the regional orthodontic workforce needs, based on published data and treatment need. As an application of this model, Greece has a general surplus of orthodontists for the needs of the population, but variable regional workforce coverage. This model appears suitable for the simple and immediate calculation of orthodontic workforce coverage of a population with readily available data.

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References

- › Al-Azemi R, Artun J. Orthodontic treatment need in adolescent Kuwaitis: prevalence, severity and manpower requirements. *Med Princ Pract* 2010;19:348-354.
- › Alkhatib MN, Bedi R, Foster C, Jopanputra P, Allan S. Ethnic variations in orthodontic treatment need in London schoolchildren. *BMC Oral Health* 2005;5:8.
- › Boulos MN, Phillipps GP. Is NHS dentistry in crisis? 'Traffic light' maps of dentists distribution in England and Wales. *Int J Health Geogr* 2004;3:10.
- › Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. *Eur J Orthod* 1980;11:309-320.
- › Chestnutt IG, Burden DJ, Steele JG, Pitts NS, Nuttall NM, Morris AJ. The orthodontic condition of children in the United Kingdom, 2003. *Br Dent J* 2006;200:609-612.
- › Chew MT, Aw AK. Appropriateness of orthodontic referrals: self-perceived and normative treatment needs of patients referred for orthodontic consultation. *Community Dent Oral Epidemiol* 2002;30:449-454.
- › Ciuffolo F, Manzoli L, D'Attilio M, Tecco S, Muratore F, Festa F, Romano F. Prevalence and distribution by gender of occlusal characteristics in a sample of Italian secondary school students: a cross-sectional study. *Eur J Orthod* 2005;27:601-606.

- › Collins JM, Cunningham SJ, Moles DR, Galloway J, Hunt NP. Factors which influence working patterns of orthodontists in the United Kingdom. *Br Dent J* 2009;207:30-31.
- › Deli R, Macrì LA, Radico P, Pantanali F, Grieco DL, Gualano MR, La Torre G. Orthodontic treatment attitude versus orthodontic treatment need: differences by gender, age, socioeconomic status and geographical context. *Community Dent Oral Epidemiol* 2012;40 Suppl 1:71-76.
- › Dreesch N, Dolea C, Dal Poz MR, Goubarev A, Adams O, Aregawi M, Vergstrom K, Fogstad H, Sheratt D, Linkins J, Scherpbier R, Youssef-Fox M. An approach to estimating human resource requirements to achieve the Millennium Development Goals. *Health Policy Plan* 2005;20:267-276.
- › Germa A, Kaminski M, Nabet C. Impact of social and economic characteristics on orthodontic treatment among children and teenagers in France. *Community Dent Oral Epidemiol* 2010;38:171-179.
- › Grippaudo C, Paolantonio EG, Deli R, La Torre G. Validation of the Risk Of Malocclusion Assessment (ROMA) index. *Eur J Paediatr Dent* 2007;8:136-142.
- › Grippaudo C, Paolantonio EG, Deli R, La Torre G. Orthodontic treatment need in the Italian child population. *Eur J Paediatr Dent* 2008a;9:71-75.
- › Grippaudo C, Paolantonio EG, La Torre G, Gualano MR, Oliva B, Deli R. Comparing orthodontic treatment need indexes. *Ital J Public Health Dent* 2008b;5:181-186.
- › Grippaudo C, Pantanali F, Paolantonio EG, Saule R, Latorre G, Deli R. Orthodontic treatment timing in growing patients. *Eur J Paediatr Dent* 2013;14:231-236.
- › Hatzopoulos PG. Prevalence of malocclusion in 14-year old Greek schoolchildren using the Dental Aesthetic Index (DAI). *Helv Orthod Rev* 1999;2:99-117.
- › Health, Wellbeing and Local Government Committee HWLG(3);17-10(p2):3 November 2010.
- › Järvinen S. Indexes of orthodontic treatment need. *Am J Orthod Dentofacial Orthop* 2001;120:237-239.
- › Jenny J, Cons NC, Kohout FJ, Jakobsen J. Predicting handicapping malocclusion using the Dental Aesthetic Index (DAI). *Int Dent J* 1993;43:128-132.
- › Johnson M, Harkness M, Crowther P, Herbison P. A comparison of two methods of assessing orthodontic treatment need in the mixed dentition: DAI and IOTN. *Aust Orthod J* 2000;16:82-87.
- › Josefsson E, Halling A. Influence of economic restraints and reduced specialist resources on delivery and quality of orthodontic care. *Swed Dent J* 2000;24:165-172.
- › Josefsson E, Bjerklind K, Lindsten R. Malocclusion frequency in Swedish and immigrant adolescents - influence of origin on orthodontic treatment need. *Eur J Orthod* 2007;29:79-87.
- › Koletsis-Kounari H, Papaioannou W, Stefaniotis T. Greece's high dentist to population ratio: comparisons, causes, and effects. *J Dent Educ* 2011;75:1507-1515.
- › Livas C, Delli K. Subjective and objective perception of orthodontic treatment need: a systematic review. *Eur J Orthod* 2013;35:347-353.
- › Luke LS, Atchison KA, White SC. Consistency of patient classification in orthodontic diagnosis and treatment planning. *Angle Orthod* 1998;68:513-520.
- › Mandall NA, Wright J, Conboy F, Kay E, Harvey L, O'Brien KD. Index of orthodontic treatment need as a predictor of orthodontic treatment uptake. *Am J Orthod Dentofacial Orthop* 2005;128:703-707.
- › Milsom KM, Tickle M, Blinkhorn AS. Is school dental screening a political or a scientific intervention? *J Dent Res* 2008;87:896-899.
- › Morris E, Landes D. The equity of access to orthodontic dental care for children in the North East of England. *Public Health* 2006;120:359-363.
- › Nobile CG, Pavia M, Fortunato L, Angelillo IF. Prevalence and factors related to malocclusion and orthodontic treatment need in children and adolescents in Italy. *Eur J Public Health* 2007;17:637-641.
- › Perillo L, Masucci C, Ferro F, Apicella D, Baccetti T. Prevalence of orthodontic treatment need in southern Italian schoolchildren. *Eur J Orthod* 2010;32:49-53.
- › Proffit WR, Fields HW Jr, Moray LJ. Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey. *Int J Adult Orthodon Orthognath Surg* 1998;13:97-106.
- › Shaw WC, Richmond S, O'Brien KD. The use of occlusal indices: a European perspective. *Am J Orthod Dentofacial Orthop* 1995;107:1-10.
- › Shaw WC, Richmond S, Kenealy PM, Kingdon A, Worthington H. 20-year cohort study of health gain from orthodontic treatment: psychological outcome. *Am J Orthod Dentofacial Orthop* 2007;132:146-157.
- › Soma KJ, Thomson WM, Morgaine KC, Harding WJ. A qualitative investigation of specialist orthodontists in New Zealand. Part 1. Orthodontists and orthodontic practice. *Aust Orthod J* 2012;28:2-16.
- › Souames M, Bassigny F, Zenati N, Riordan PJ, Boy-Lefevre ML. Orthodontic treatment need in French schoolchildren: an epidemiological study using the Index of Orthodontic Treatment Need. *Eur J Orthod* 2006;28:605-609.
- › Tulloch JF, Proffit WR, Phillips C. Outcomes in a 2-phase randomized clinical trial of early Class II treatment. *Am J Orthod Dentofacial Orthop* 2004;125:657-667.
- › Turpin DL. Need and demand for orthodontic services: The final report. *Am J Orthod Dentofacial Orthop* 2010;137:151-152.
- › UNICEF global education statistics - primary school participation - http://www.unicef.org/infobycountry/greece_statistics.html 2008-2012.
- › Younis JW, Vig KW, Rinchuse DJ, Weyant RJ. A validation study of three indexes of orthodontic treatment need in the United States. *Community Dent Oral Epidemiol* 1997;25:358-362.
- › Waldman HB, Perlman SP, Schindel R. Update on the imbalanced distribution of orthodontists, 1995-2006. *Am J Orthod Dentofacial Orthop* 2009;135:704-708.