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Epidemiology of Dental Caries in the World

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1. Introduction

The oral health of children 12 years old is the object of several epidemiological studies conducted around the world. According to the World Health Organization (WHO, 1997), the importance given to this age group is due to the fact that it is this age that children leave primary school. Thus, in many countries, is the last age at which data can be easily obtained through a reliable sample of the school system. Moreover, it is possible that at this age all the permanent teeth except third molars, have already erupted. Thus, the age of 12 was determined as the age of global monitoring of caries for international comparisons and monitoring of disease trends.

Even considering the large number of scientific evidence from several epidemiological studies in schoolchildren worldwide, the majority are regional studies. In addition, the information is too outdated for some countries, which does not make easy international comparison. The index that measures the number of permanent teeth decayed, missing and filled teeth (DMFT) is the common outcome for such studies.

Although there are differences in both the sampling plan and the types of individual attributes collected at different times in history, epidemiology has been developing epistemological and methodological tools that allow revisit both old and recent data in order to understand the influence of environmental characteristics on individual outcomes, seeking correct the effect of aggregate, also known as ecological fallacy (Moreira & Nico, 2010). At the same time, the use of Geographic Information Systems (GIS) and statistical methods have allowed a more sophisticated processing of data since the observations are given an adequate spatial analysis.

As for the health-disease process, perceiving it as a historical phenomenon, the health situation of a given society is the result of models of health care employees in the past.

The interest in developing appropriate methodologies for knowledge and monitoring of social inequalities health has grown around the world. Area until recently restricted to a few academic groups, now finds conditions of highest use by health system managers, as a powerful instrument for establishing priorities agendas and evaluate the impact of adopted policies.

The global oral health database is currently being developed as part of the WHO Global InfoBase and it provides for the outcome evaluation of national and community oral health promotion and disease prevention programmes. The data stimulate providers of oral health care in countries and health authorities to implement preventive oral care programmes by sharing experiences and ensures data for adjustment of ongoing programmes. Oral health

status of target population groups is monitored worldwide and linked with selected chronic diseases and common risk factors.

High quality health statistics are essential for planning and implementing health policy in all country settings. The Infobase assembles, for the first time in one place, non-communicable disease (NCD) risk factor data collected from WHO Member States. NCD risk factor data are crucial for predicting the future burden of chronic diseases in populations and also for identifying potential interventions to reduce the future burden.

The aim of this study is to describe the dental caries status of countries that are part of the WHO regions.

2. Methods

This research can be classified as an ecological study (Costa & Nadanovsky, 2005), as it takes to investigate aggregate data. Ecological studies are those using measured values for population groups rather than individuals. In them, a description and analysis are referred to the mean exposure and the prevalence in geopolitical units considered. They have a lower cost, simplicity and easy analytical process in relation of the ethical aspects. It is extremely useful for the evaluation of policies, programs and interventions in health (Peres & Antunes, 2006). The unit of analysis were the WHO member countries. Analyses were performed in each of the six WHO regions: the Americas (AMRO), Africa (AFRO), South East Asia (SEARO), Europe (EURO), Eastern Mediterranean (EMRO) and Western Pacific (WPRO). Figure 1 shows the spatial distribution of the six WHO regions in the world.

We used data of dental caries, expressed by the DMFT index at 12 years-old. These data were provided by WHO Oral Health Country / Area Profile Programme (CAPP). The "CAPP" was established at the WHO Collaborating Centre for Education, Training and Research at the Faculty of Odontology, Malmö, Sweden, in 1995. Before that, extensive consultations had taken place with the WHO Noncommunicable Diseases Cluster, Geneva, and with several WHO Collaborating Centres, organizations and individuals around the world. The objective is to present information on dental diseases and oral health services for various countries/areas. The data are publicly accessed at the site http://www.mah.se/CAPP.

Thus, thematic maps were constructed to show the spatial distribution of the dental caries in the world. Measures of association such as Relative Risk (RR) and Population Attributable Risk (PAR) were made. The main results were presented through charts and graphs.

Relative Risk (RR) consists of a ratio between rates of each class variable and an arbitrary reference value. In the analysis was taken as reference value the average of the WHO regions, thus evaluating how much each country is away from the mean (values above 1 showed an excess and values below 1 showed a lack in relation to the regional average).

Population Attributable Risk (PAR) is the relative difference between each of the proportional units of analysis and an arbitrary reference value, which in this study refers to the average of each region. It is intended to measure the impact it would have on the indicator considered the reduction of inequality between each value and the reference value. It can also be taken as a goal to guide interventions.
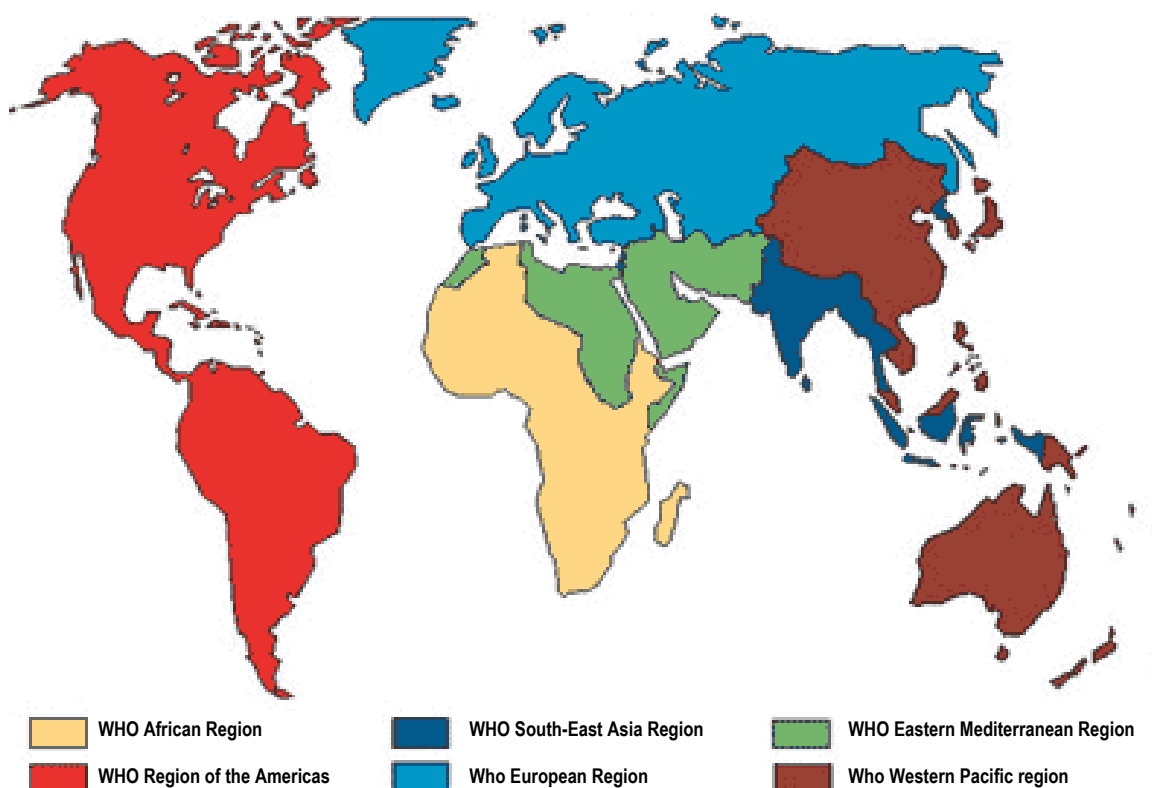
WHO regional offices

	WHO African Region		WHO South-East Asia Region		WHO Eastern Mediterranean Region
	WHO Region of the Americas		Who European Region		Who Western Pacific region

Fig. 1. Spatial distribution of the six WHO regions in the world.
Source: WHO (http://www.who.int/about/regions/en/index.html)

2.1 Measurement of the decay

To measure mouth disease in epidemiological studies, there is standardization of criteria according to WHO, using indexes. To diagnose coronary cavity (located at the crown of the tooth) in permanent teeth, the index used is the sum of the number of decayed teeth (component), missing (component) and restored / filled (component), called DMFT index. Subsequently we calculate the average population.

2.2 Caries

Dental caries is a complex disease caused by a physiological imbalance between fluid and mineral dental biofilm (microbial cells in a matrix, favoring the use of nutritional resources available, formerly known as plaque). It is recognized that microorganisms are not only sufficient to explain it, highlighting the important role of biofilm in its development (Fejerskov, 2004).

The mechanism of the cavity can be presented as follows: from the fermentation of carbohydrates, the bacteria produce organic acids such as lactic acid, the formic, acetic and propionic. These acids penetrate the dental tissues, dissolving the enamel (the outside of the tooth), dentin and cementum (tooth root). The dissolution may cause cavitation. In non-

cavitated lesions, demineralization can be reversed by calcium and phosphate, together with fluor, a result of new deposits on the remnants of crystals (tooth enamel). The new mineral crystal surface is much more resistant to acid when compared with the original hydroxyapatite (tooth enamel). The process of de-and remineralization cavitation occur daily, leading to cavitation, repair, reversal or maintaining the *status quo* (Featherstone, 2004).

3. Distribution of caries in the world

Was analyzed data on DMFT index in 190 countries that are part of WHO's regions. The year in which data were available showed that, on average, the studies were of 1997. Half of the studies was of 1998. Were seen studies ranging from the year 1973 until the year 2008.

With respect to the DMFT index, the average worldwide was 2.11 (± 1.32). Half the country had about 1.8 teeth decayed, missing or filled. Values ranged from 0.2 to 7.8. Figure 2 shows the distribution of countries according to the year of study and the DMFT index.

Figures 3 and 4 show, respectively, the RR and PAR according to the six WHO regions, with reference to the world average. It is observed that the American Region (AMRO) and the Europe Region (EURO) present a risk of 1.14 and 1.10 times higher than the average in the world, representing an average increase in PAR by 14% and 10%, respectively. AFRO region was with a 19% lower risk compared to the average of all countries surveyed.

Figure 5 shows the spatial distribution of caries at 12 years-old in the world according to quartiles. There were high DMFT indices in most countries of South America, Northern Europe and South Asia. Interestingly, a significant proportion of African countries have low rates of caries.
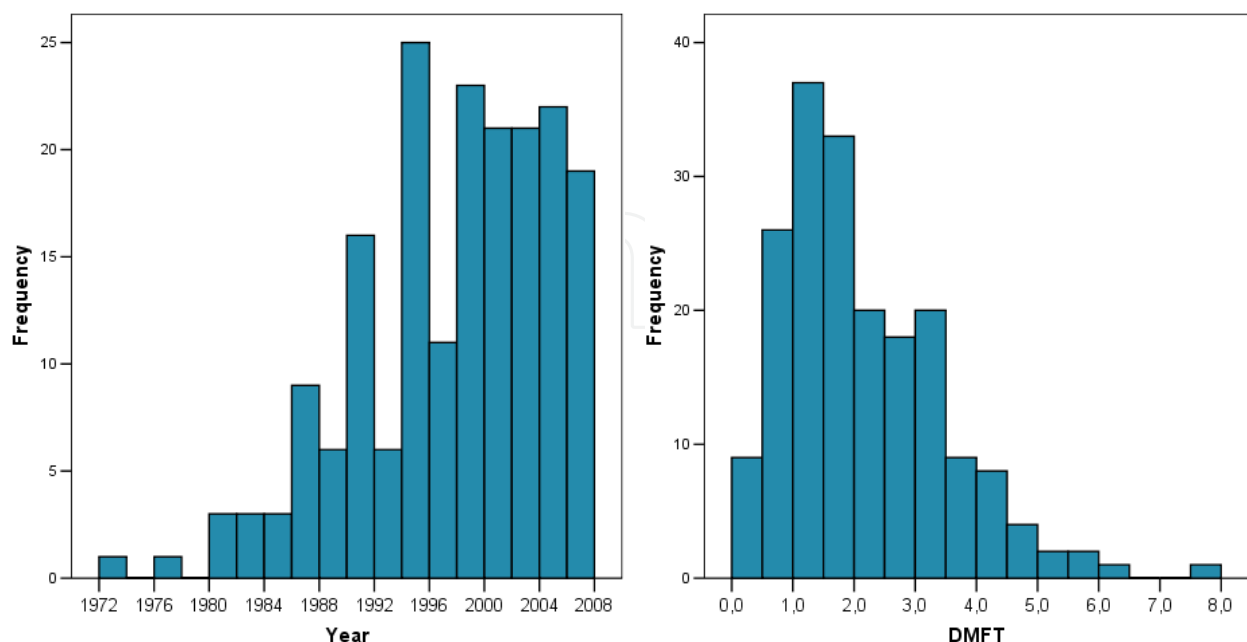

Fig. 2. Distribution of the world's countries according to the year of the study and the DMFT index
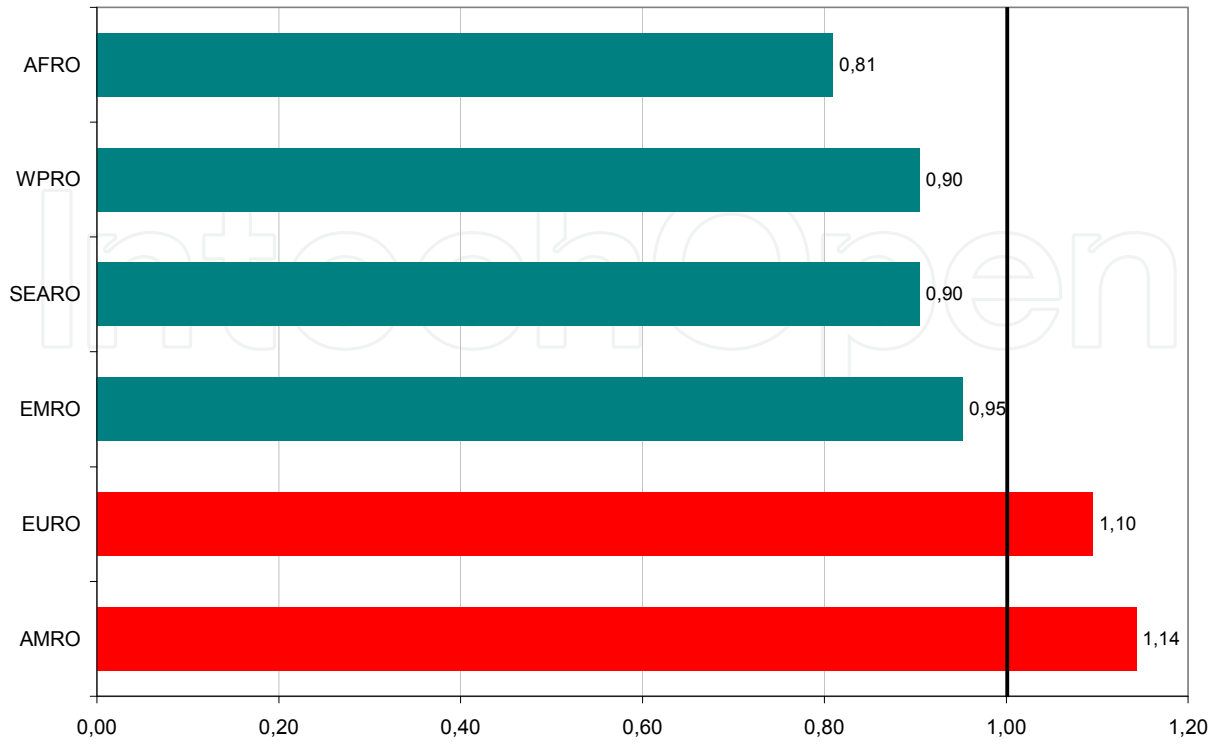
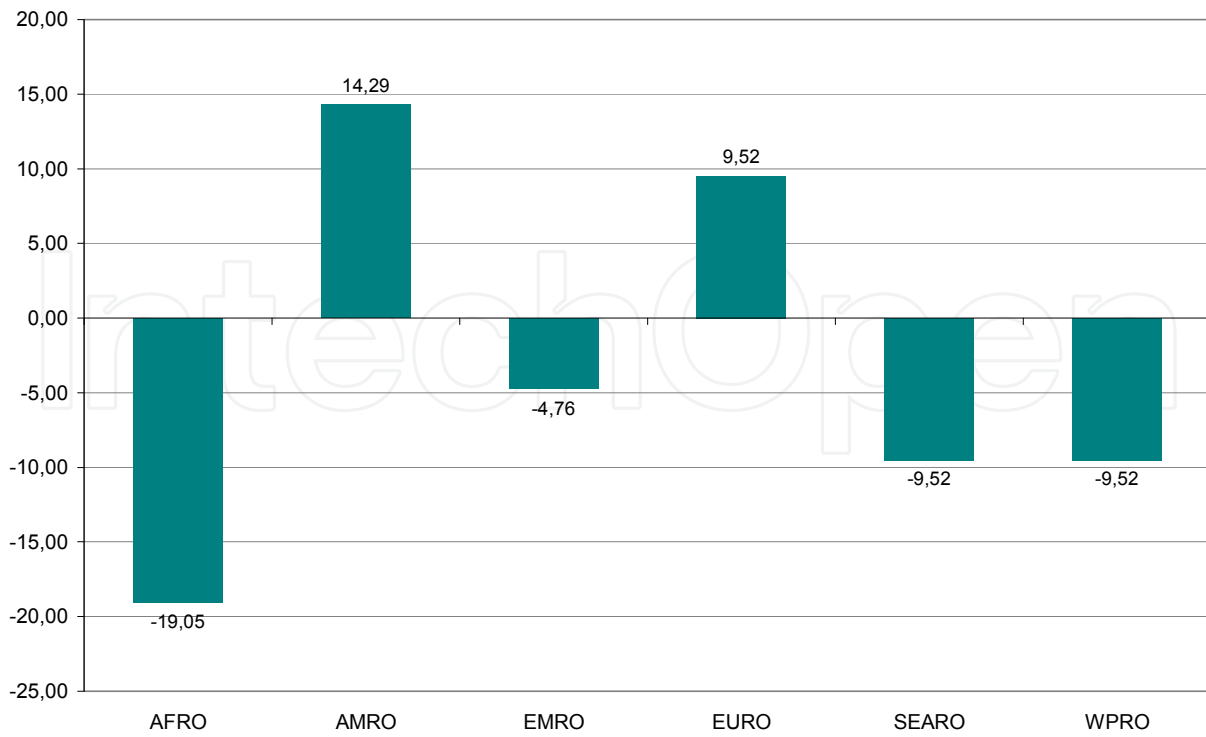Fig. 3. Relative risk for dental caries according to WHO regions
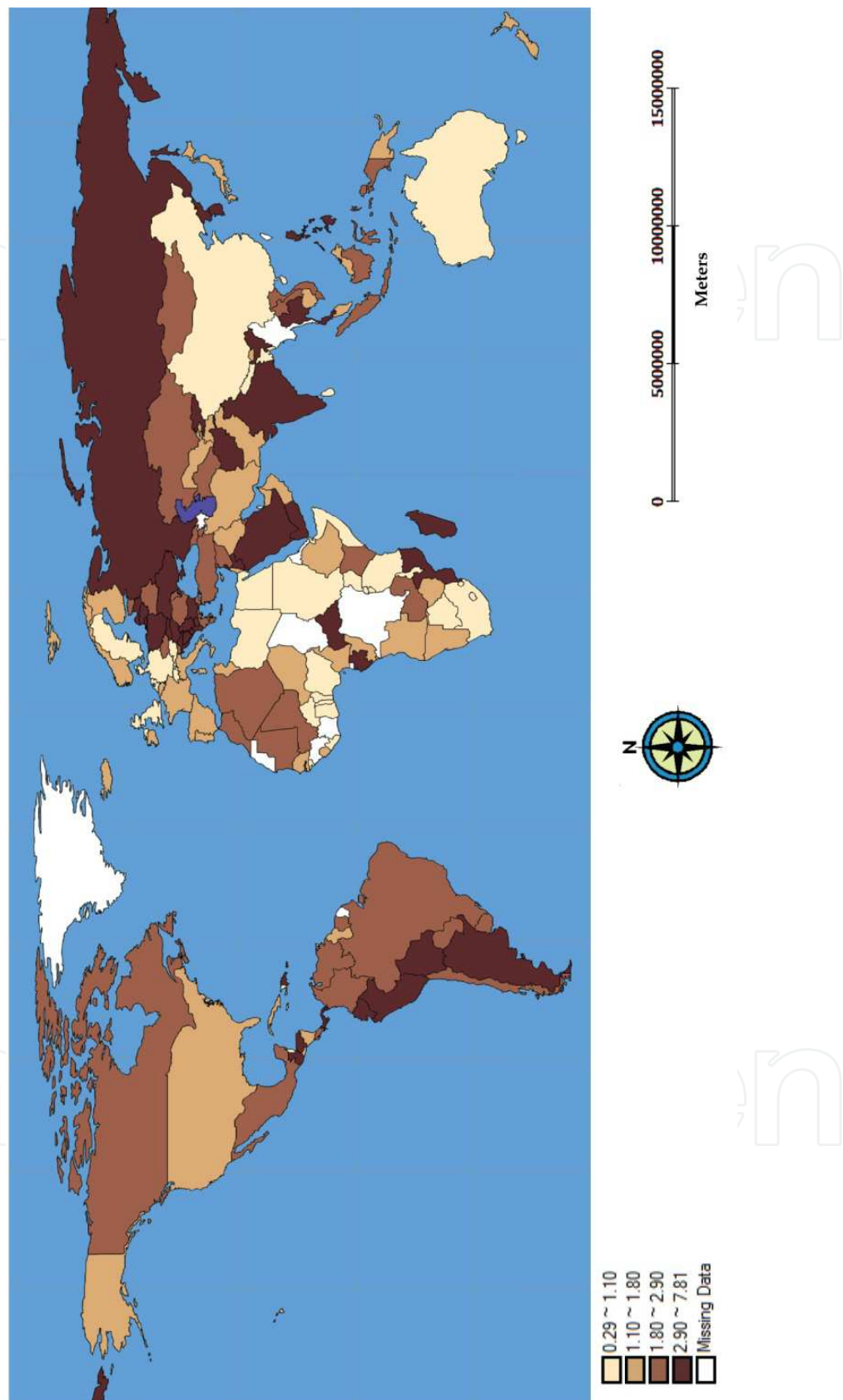

Fig. 4. PAR caries according to WHO regions

Fig. 5. Spatial distribution of the dental caries (12-years-old) in the world according to quartiles

4. Distribution of dental caries according to WHO regions

4.1 WHO African Region (AFRO)

The WHO African region have 46 countries. However, it was possible to find oral health data for 40 countries. Analyzing the available studies regarding the year, there was a downgrade of the data. Half of the information was stemmed by the year 1992, also representing the average year of the surveys. The data ranged from 1977 to 2004.

Figure 6 shows the distribution of countries according to the year of study and the DMFT index. With respect to the DMFT index, there was an average of 1.7 (± 1.3). Considering the goals set by WHO and the Fedération Dentaire Internacionale (FDI, 1982) of a DMFT of three for the year 2000, it is observed that the African region achieved these results even before the deadline. In this way, at least with respect to decay, the region does not present a precarious scenario. The index ranged from 0.3 to 5.5. Half of the countries had a index of 1.3. Figure 7 shows the values of DMFT according to the countries of the African region.

Figure 8 shows the spatial distribution of Relative Risk of each country in relation to the regional average. Analyzing the RR, it was found that Mozambique had a risk 3.2 times higher than the average for the region. Tongo and Tanzania already had PAR 82.5% lower than the regional average.
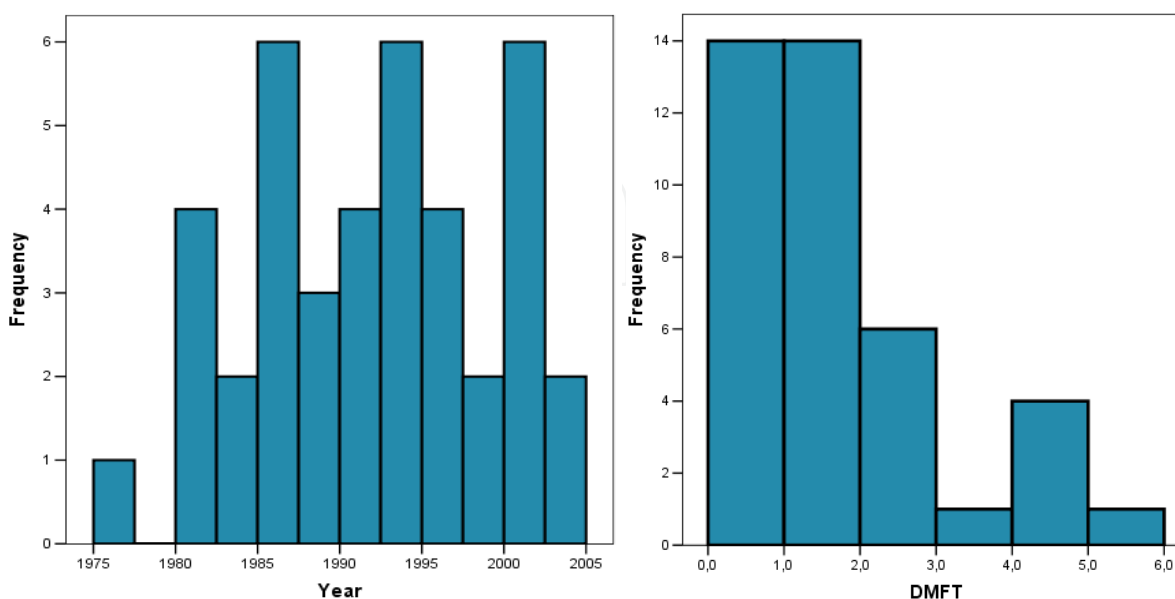

Fig. 6. Distribution of the AFRO countries according to the year of the study and the DMFT index
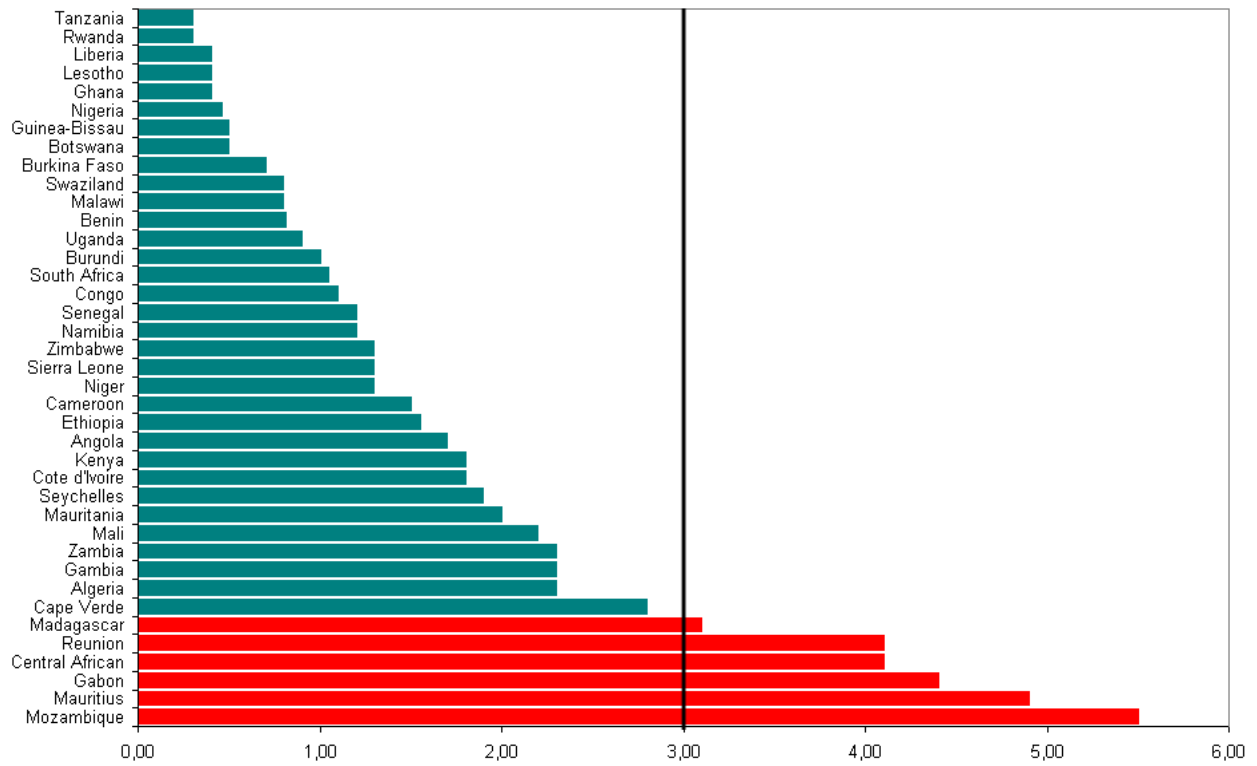
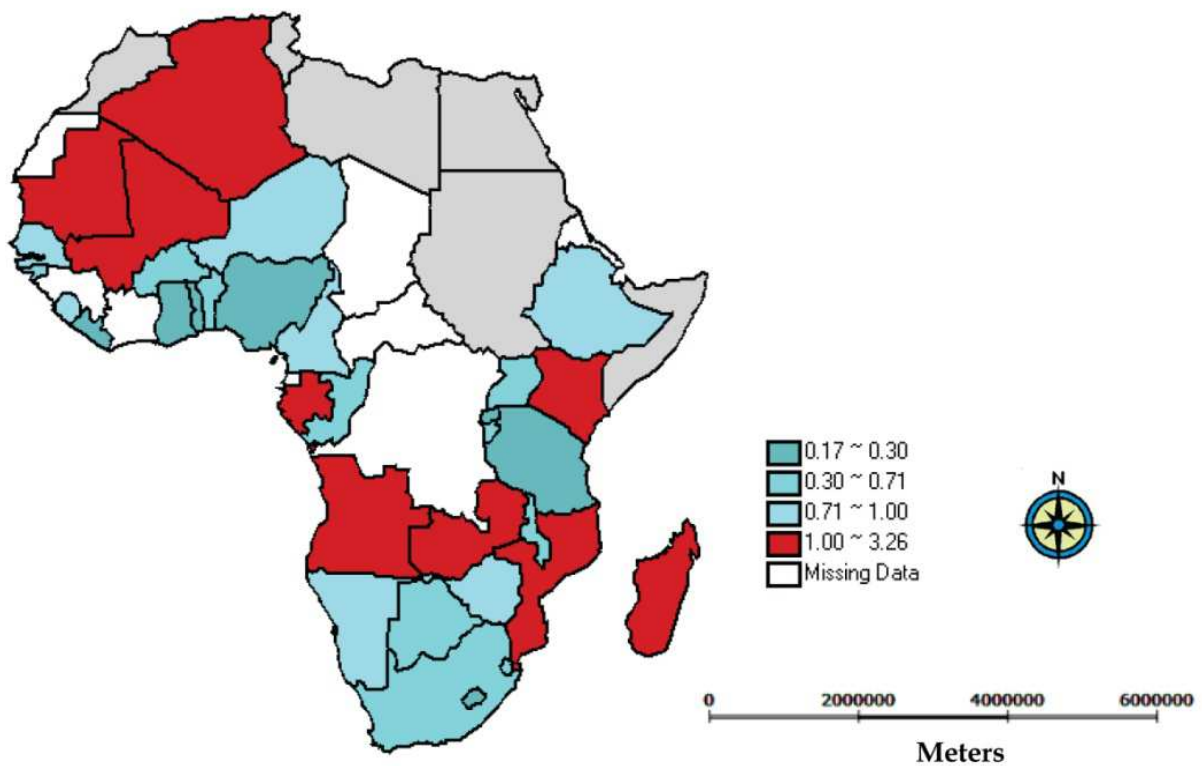Fig. 7. Distribution of DMFT according to the countries of the African region

Fig. 8. Spatial distribution of Relative Risk of DMFT in relation to the average for the African region

4.2 WHO Region of the Americas (AMRO)

The regional of the Americas have 47 countries. However, only 40 countries had data on caries at 12 years-old.

Just as the average, half of the studies was available in 2000. Although more recent data than Africa, the results are given with more than 10 years, making it difficult to capture a more current data. The studies ranged from 1987 to 2008. Figure 9 shows the distribution of studies according to the year in which they were made and according to the DMFT index.

The DMFT index showed an average of 2.4 (± 1.4). Half of the countries had DMFT equal to 2.1. Figure 10 shows the ranking of countries according to the DMFT of the Americas. With the highest levels found in Ecuador and Martinique (6.3 and 5.2, respectively). Belize and Haiti had low (0.60 and 0.65 respectively). Figure 11 shows the spatial distribution of the countries of the Americas according to relative risk, with reference to the regional average.
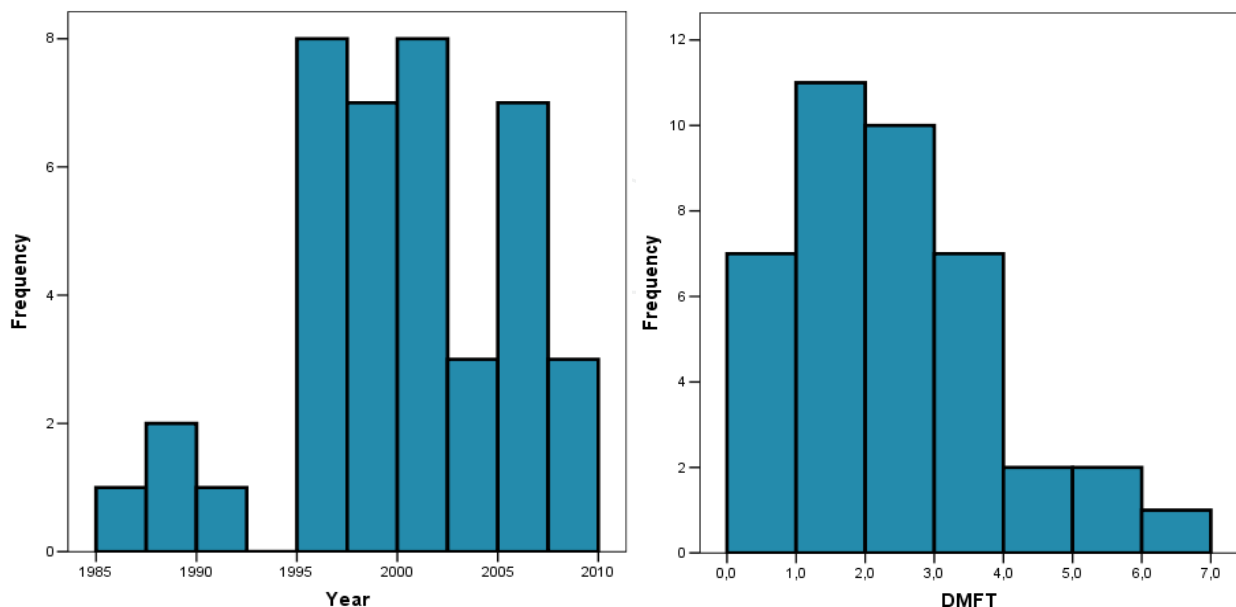

Fig. 9. Distribution of the AMRO countries according to the year of the study and the DMFT index
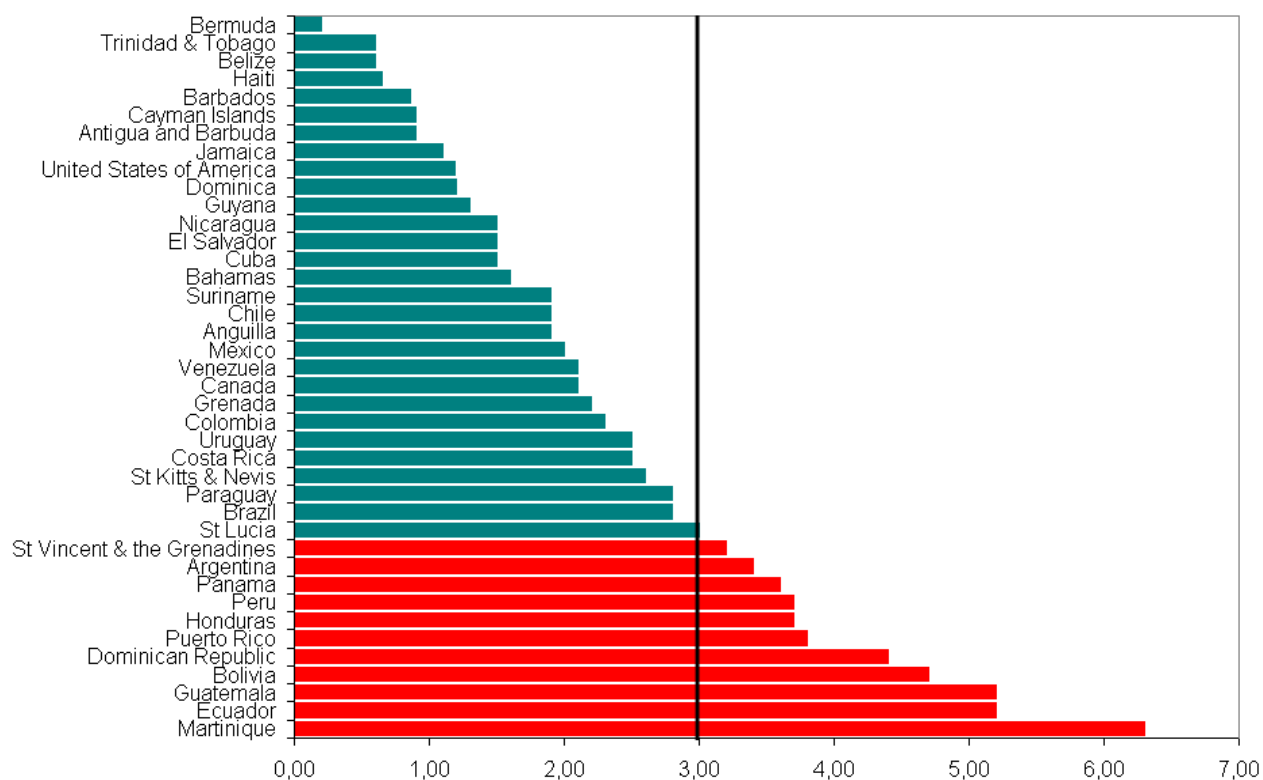
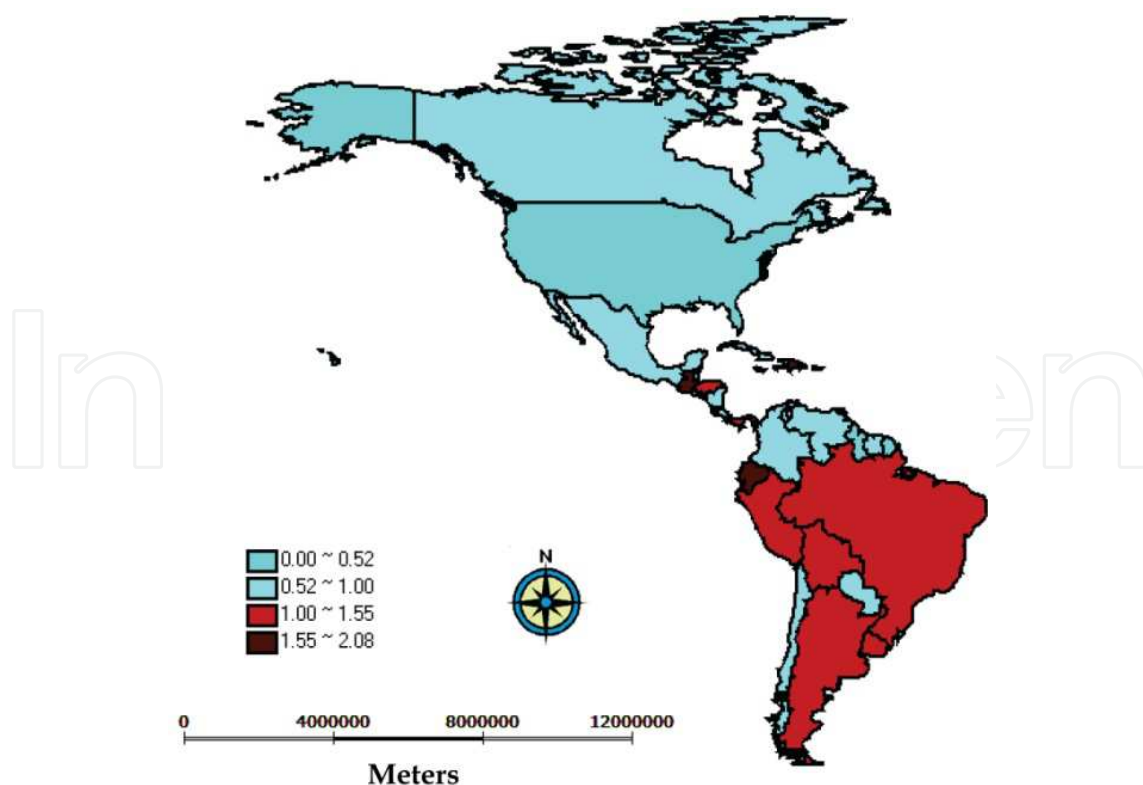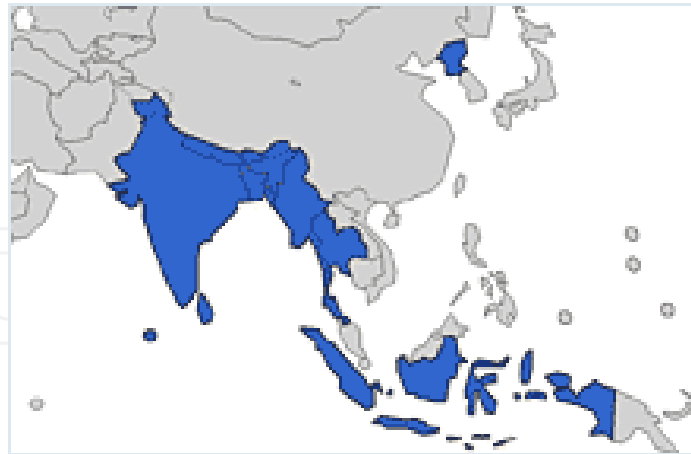Fig. 10. Distribution of DMFT according to the countries of the Americas

Fig. 11. Spatial distribution of relative risk of DMFT in relation to the average for the Americas

4.3 WHO Region of South East Asia (SEARO)

The Southeast Asian region consists of 11 countries. Only one country (East Timor) had no data on dental caries at 12 years-old.

The average years of studies completed was 1999. But half of the studies were of 2001. The studies ranged from 1984 to 2008. Figure 12 shows the distribution of studies according to the year in which they were made and according to the DMFT index.

The DMFT index showed an average of 1.95 (± 1.24) and a median of 1.65. The minimum and maximum values were 0.50 to 3.94, respectively.

Figure 13 shows the PAR of caries, with reference to the regional average. It was observed that India and Thailand respectively show a PAR of 101.84% and 89.55% more caries compared to the reference value. Nepal and Sri Lanka had the lowest risk being about 74% and 54% less in relation to the regional average, respectively.

Figure 14 shows the map with the RR of the region. It was observed that India, Thailand, Indonesia and Korea are in the categories of risk (RR> 1.00) for the highest DMFT.
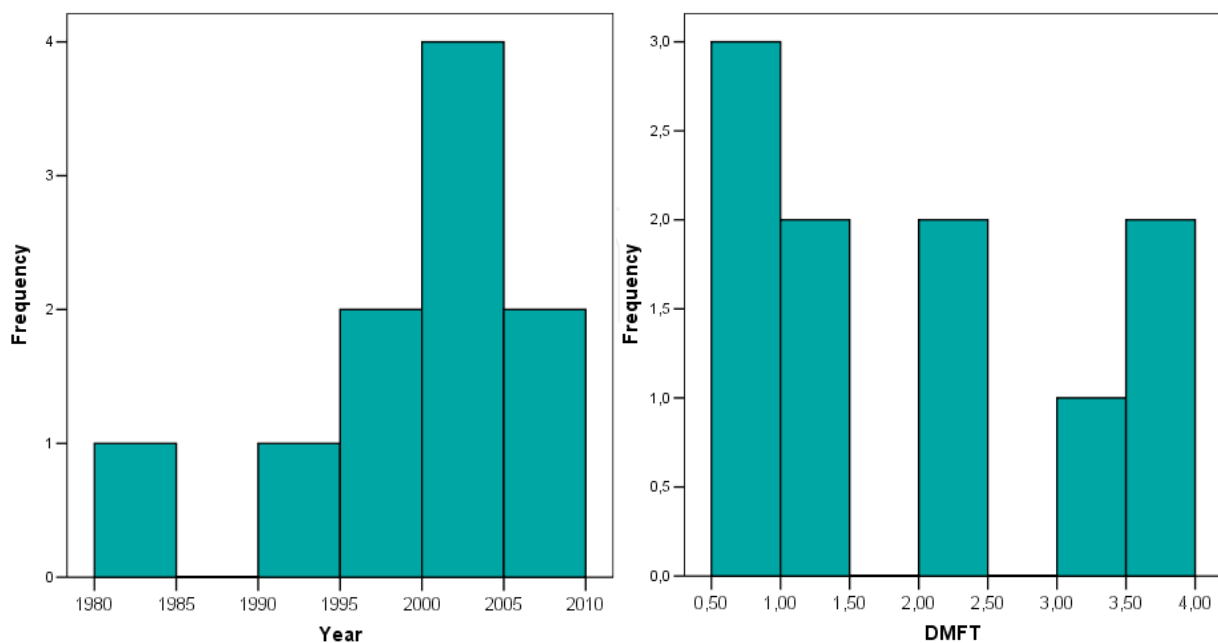

Fig. 12. Distribution of the SEARO countries according to the year of the study and the DMFT index
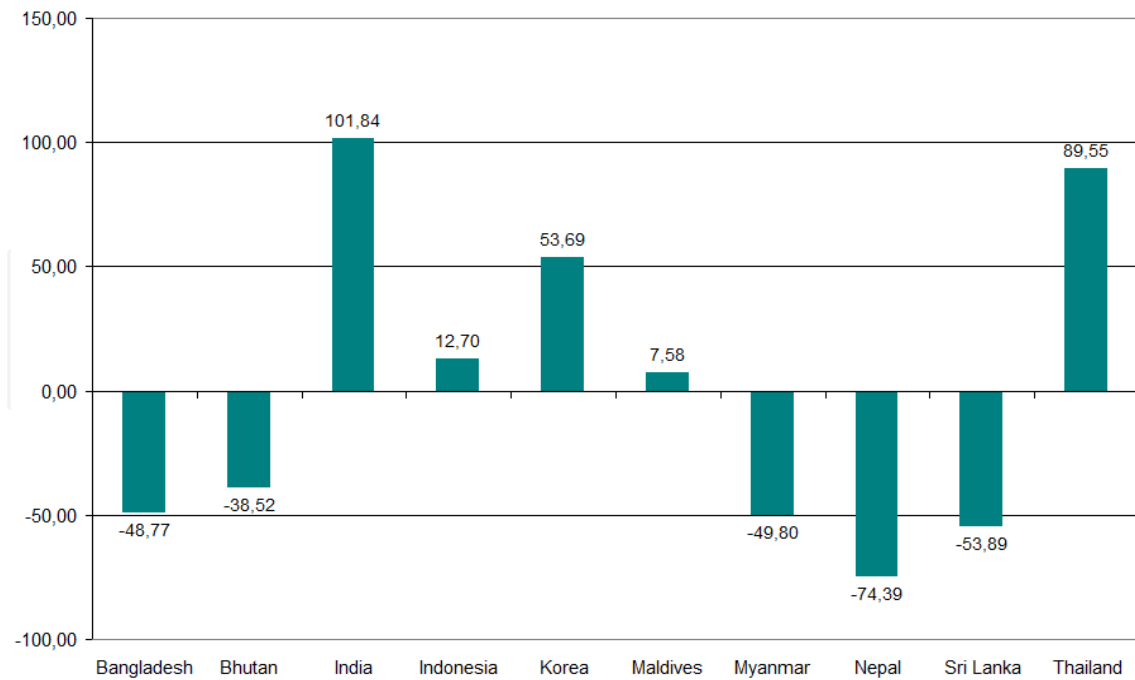
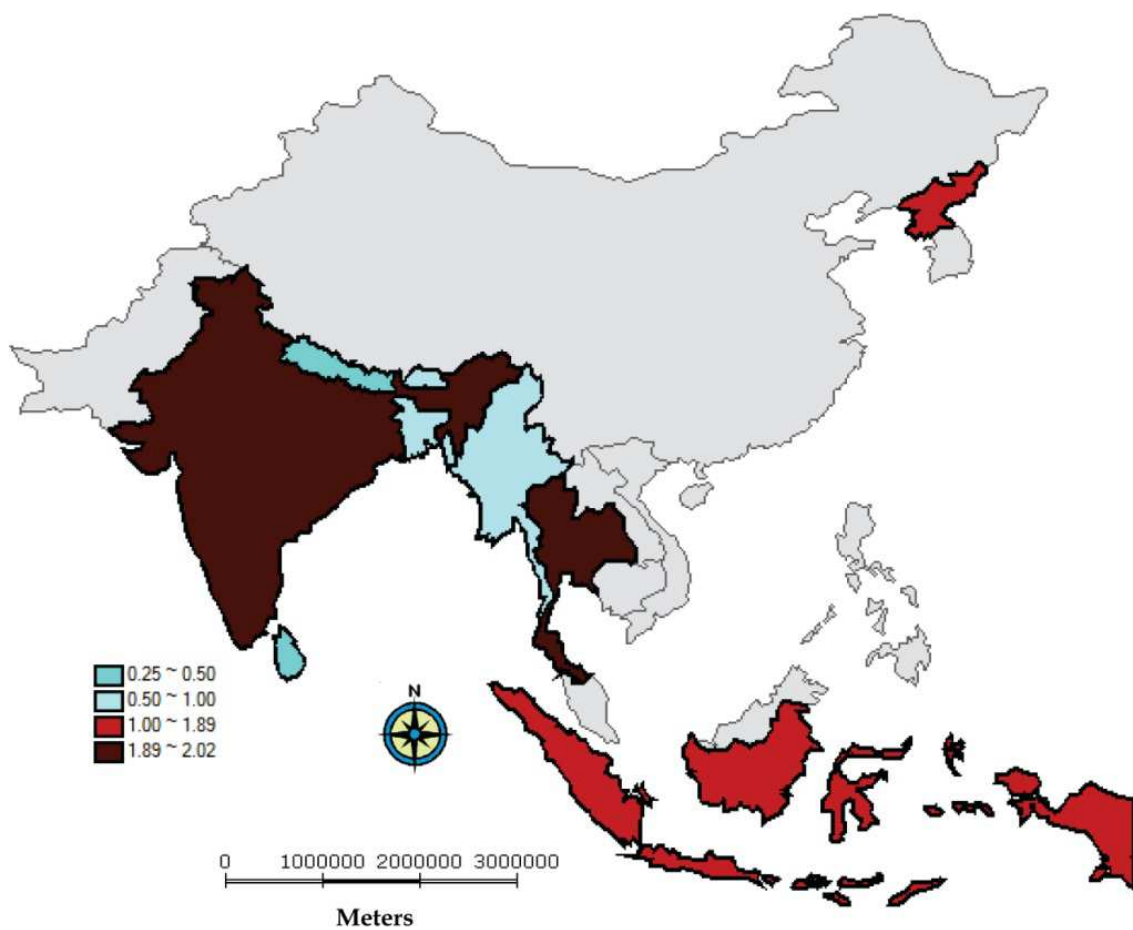Fig. 13. PAR caries according to the countries in the SEARO Region

Fig. 14. Spatial distribution of relative risk of DMFT in relation to the average for the region SEARO

4.4 WHO European Region (EURO)

The European region comprises 53 countries. Data from 51 countries on dental caries in schoolchildren 12 years-old were available.

The average publication year was 1998. Half of the studies were of the year 2000. The surveys ranged from the years 1973 to 2008. The mean DMFT index was 2.3 (± 1.3). Half of the countries in the region of Europe had 2.2 teeth decayed, missing or filled teeth. The index ranged from 0.7 to 7.8.

Figure 15 shows the distribution of studies according to the year in which they were made and according to the DMFT index.

Figure 16 shows the distribution of countries according to the PAR. It was observed that most Western European countries have lower risks compared to the regional average.
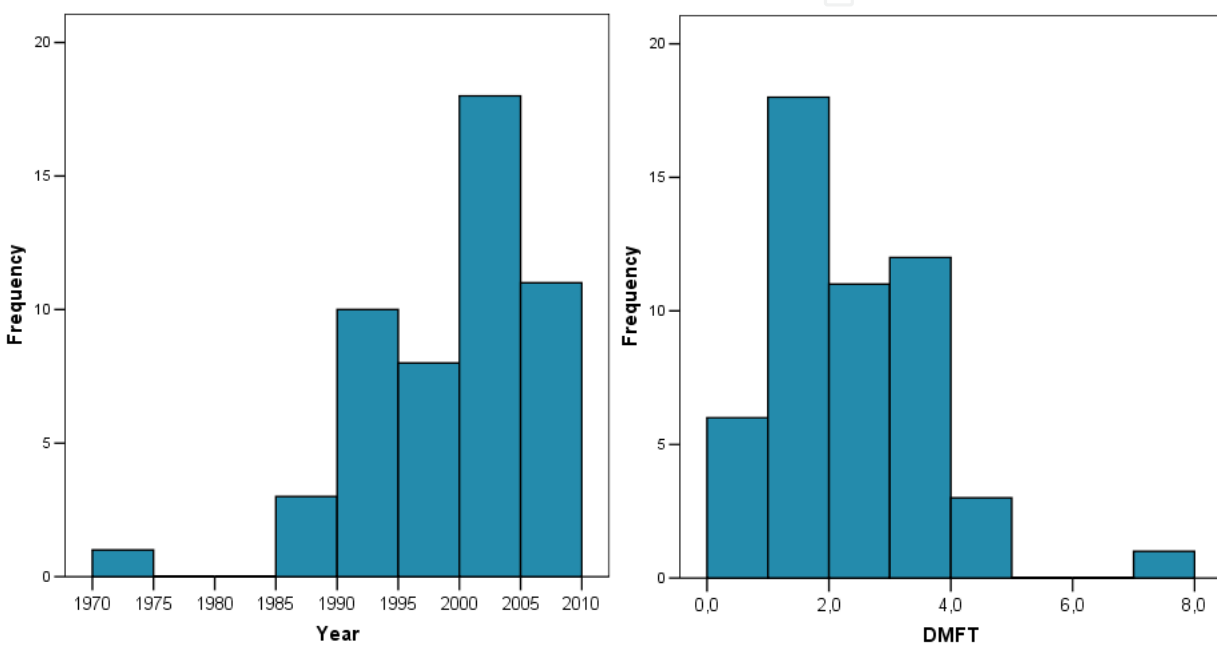

Fig. 15. Distribution of the EURO countries according to the year of the study and the DMFT index
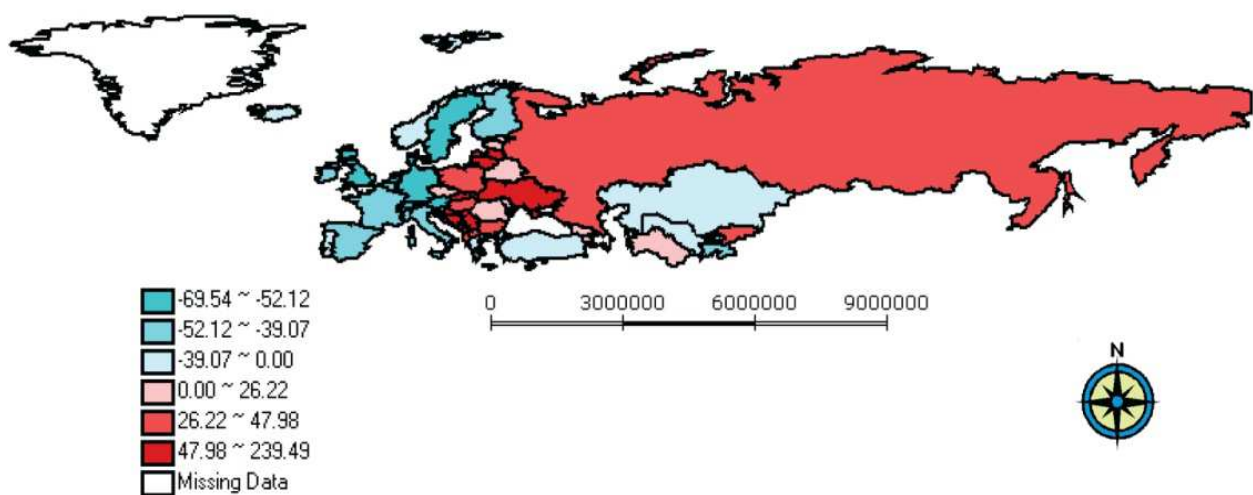

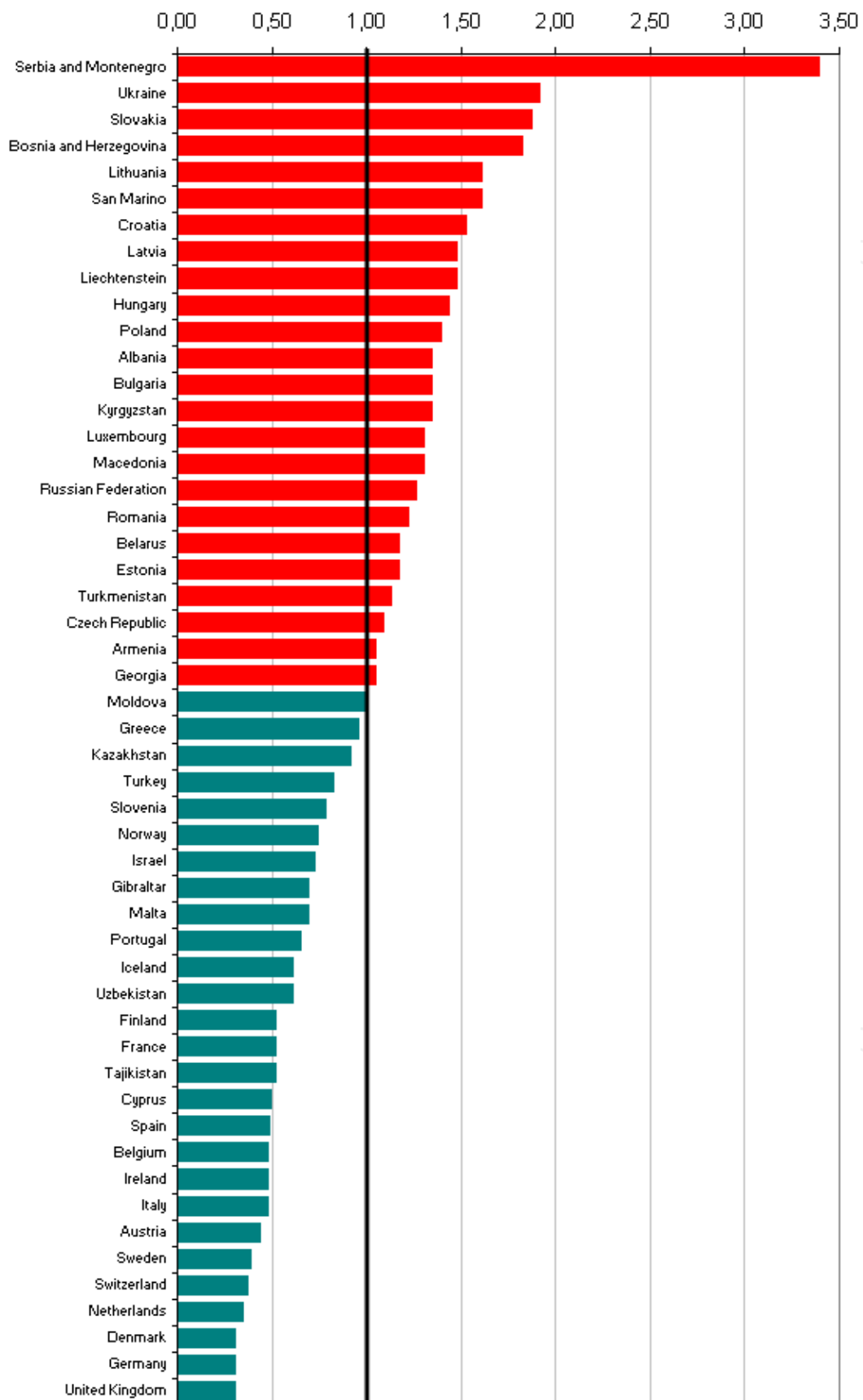Fig. 16. Spatial distribution of PAR from the average for the Euro Region

Fig. 17. RR caries according to the countries of the Euro Region

Regarding the relative risk observed in Figure 17, it was found 24 European countries with a rate of decay higher than the average for the region. Among them were Serbia, Montenegro and Ukraine, being the first two countries with risk of 3.4 and the last with a risk 1.9 times higher than the regional average. The countries with the lowest rates were United Kingdom, Germany and Denmark with a relative risk around 0.3.

4.5 WHO Eastern Mediterranean Region (EMRO)

Comprising the EMRO region 21 countries. Data on caries was available for 20 countries, only Quatar did not provide data.

Both the mean and the median date of the studies was 1998. The researches ranged from 1987 to 2008. The average DMFT index found in the region was 2 (± 1.3). Half of the countries had a index of 1.6 and the values ranged from 0.4 to 5.9.

Figure 18 shows the distribution of studies according to the year in which they were made and according to the DMFT index. Figure 19 shows the ranking of countries according to the DMFT. It is observed that only four countries (20%) had higher values than the target recommended by WHO in 2000 (DMFT = 3). They are: Saudi Arabia, Lebanon, Jordan and Yemen.
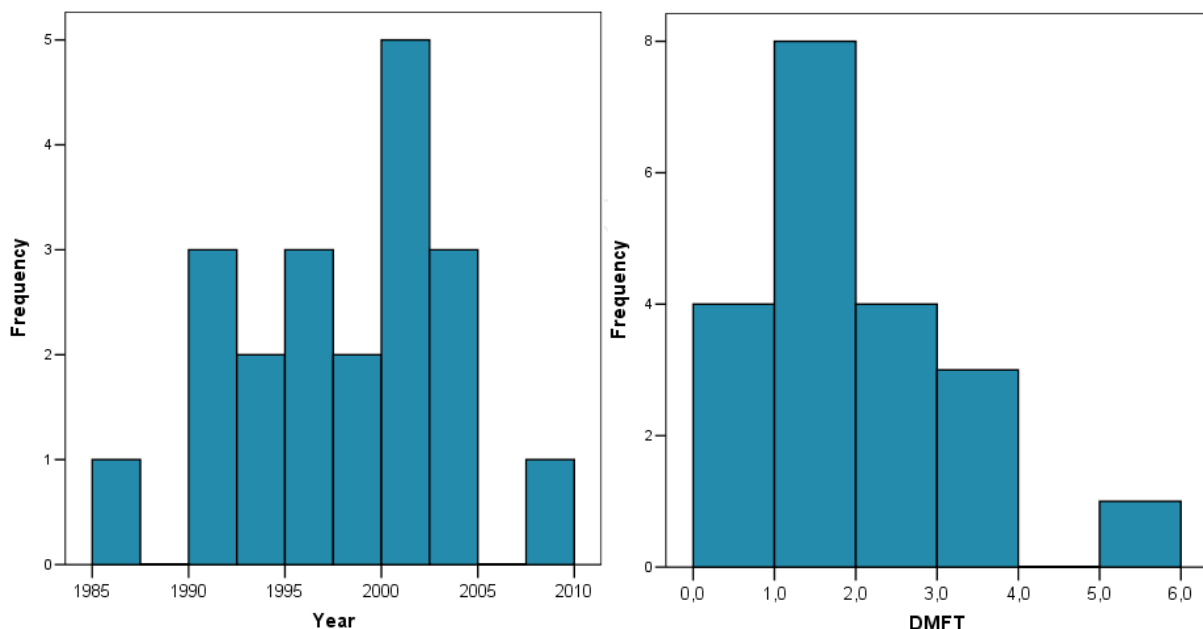

Fig. 18. Distribution of the EMRO countries according to the year of the study and the DMFT index
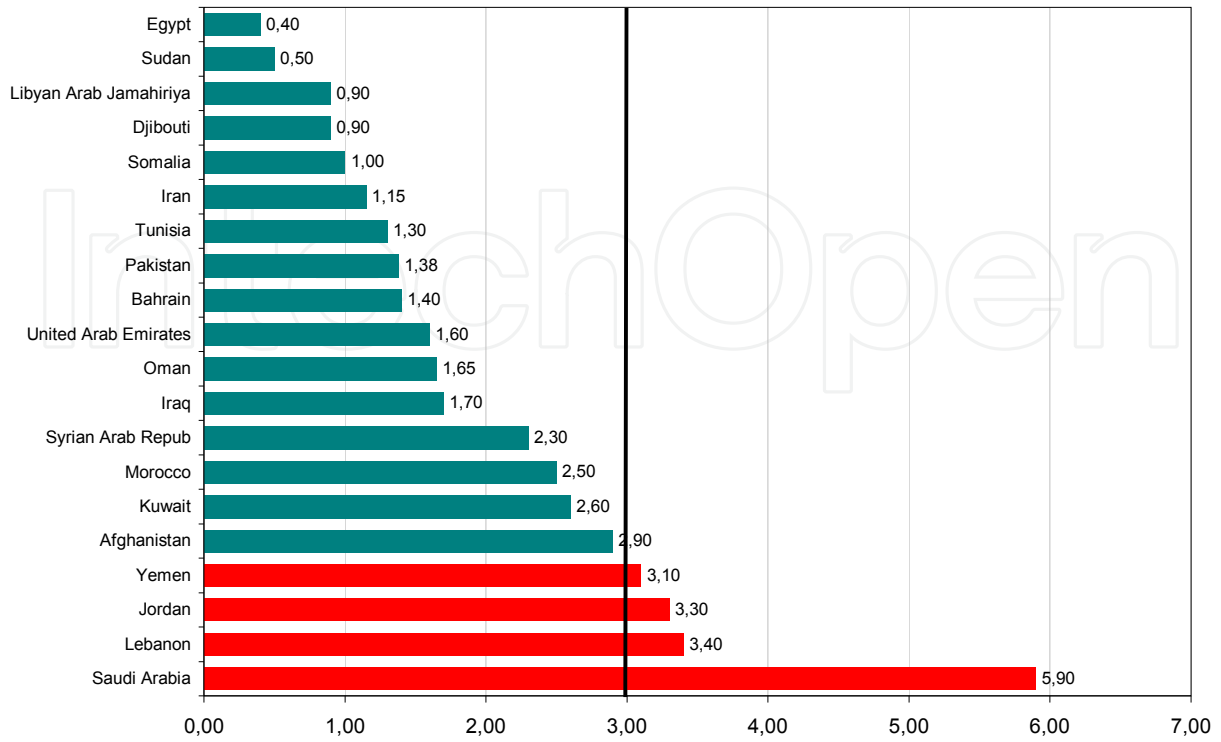
Fig. 19. Distribution of DMFT according to the countries of the EMRO region

Figure 20 shows the map of the spatial distribution of relative risk (RR) with reference to the regional average. Saudi Arabia presented a RR three times higher than the regional average, followed by Lebanon and Jordan with RR of 1.7. Egypt and Sudan appeared to countries with lower risks, respectively, 0.20 and 0.25 and Libya with RR of 0.45.
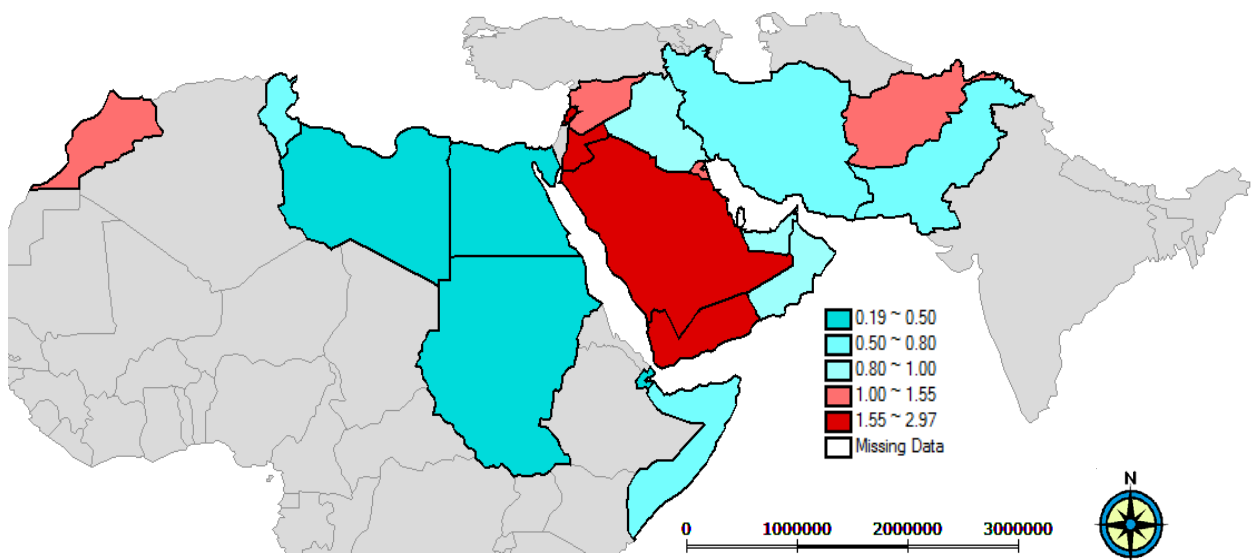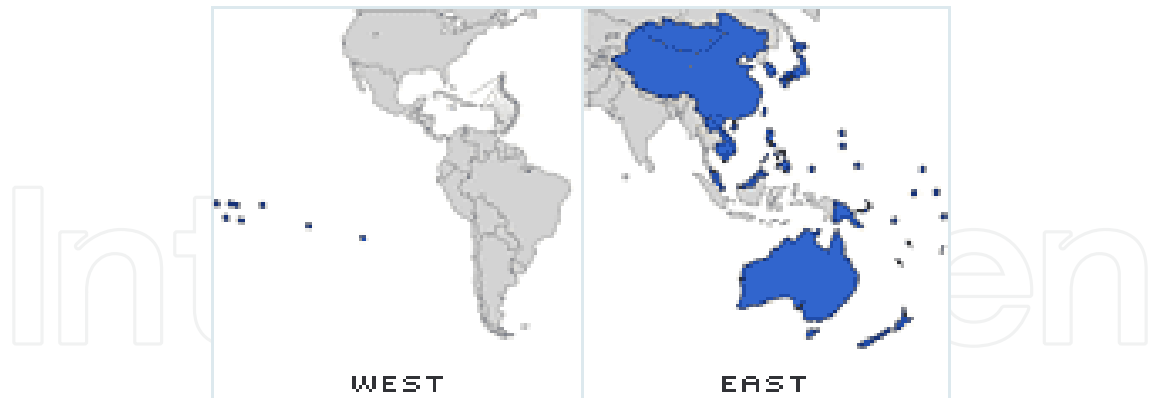

Fig. 20. Spatial distribution of RR in relation to the average DMFT for the EMRO region

4.6 WHO Western Pacific Region (WPRO)

The WPRO comprises 27 countries. Data on caries was available for 24 countries in the region.

The studies, on average, were from the years of 1998 and half of them were developed in 1997. The researches ranged between 1984 and 2007. With respect to the DMFT index, the average for the region was 1.93 (± 0.9). Half of the countries had an index of 1.75. DMFT values ranged from 1 to 5.

Figure 21 shows the distribution of studies according to the year in which they were made and according to the DMFT index. Figure 22 shows the values of the PAR. It may be noted that six countries had a higher risk with reference to the regional average. Brunei Darussalam had an increase of 127% in the risk of caries, followed by the Republic of Korea and Tonga (both with an increase of 47%), Philippines (37%), Solomon Islands (28%) and Samoa (18%). Singapore, Kiribati, China and Australia showed a 52% lower risk compared to the reference value.

Figure 23 shows the map of the RR with reference to the regional average. There is more risk in the Philippines, Korea, Mongolia and Vietnam.
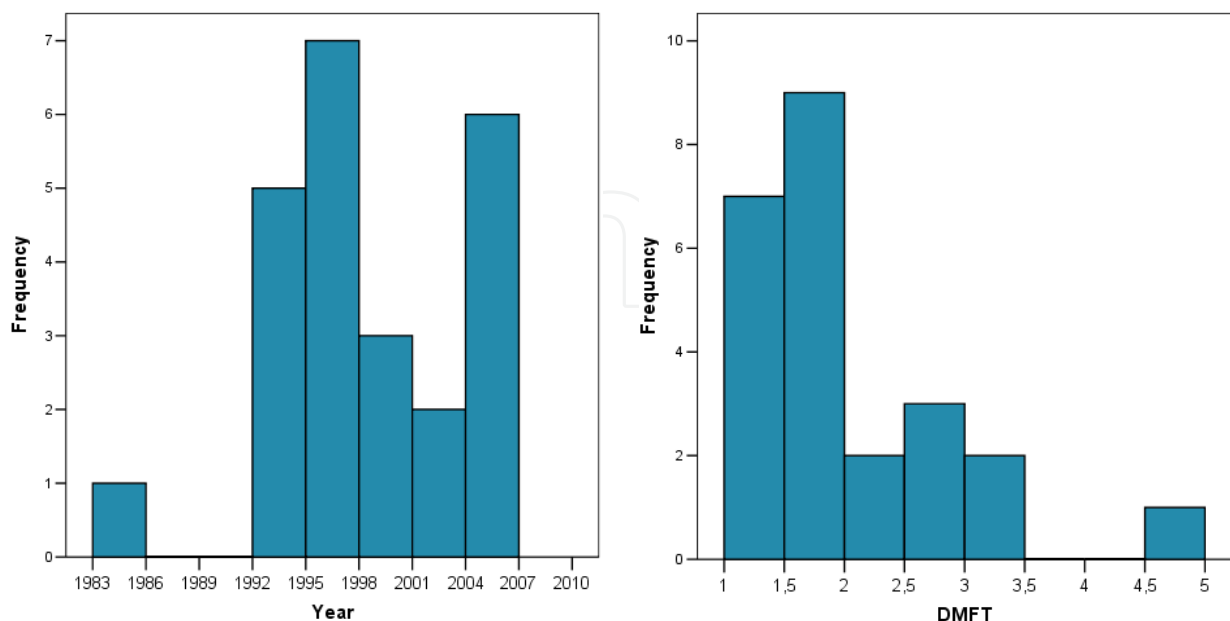

Fig. 21. Distribution of the WPRO countries according to the year of the study and the DMFT index
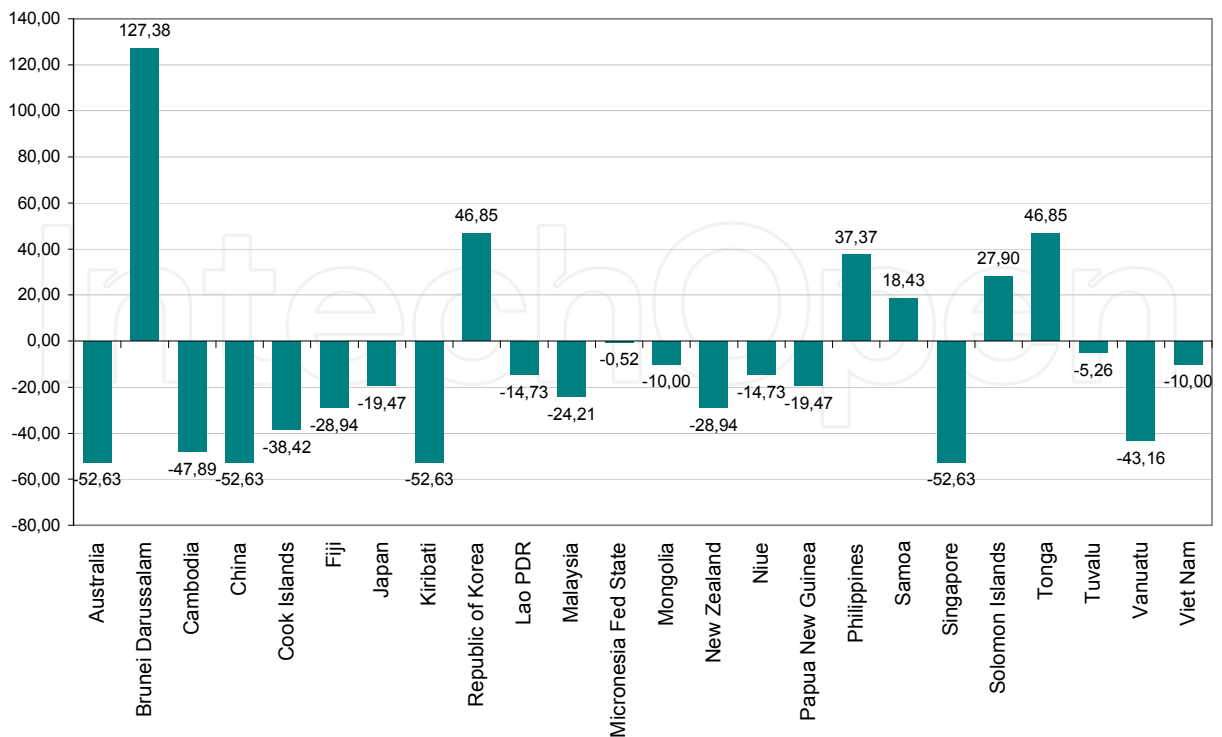
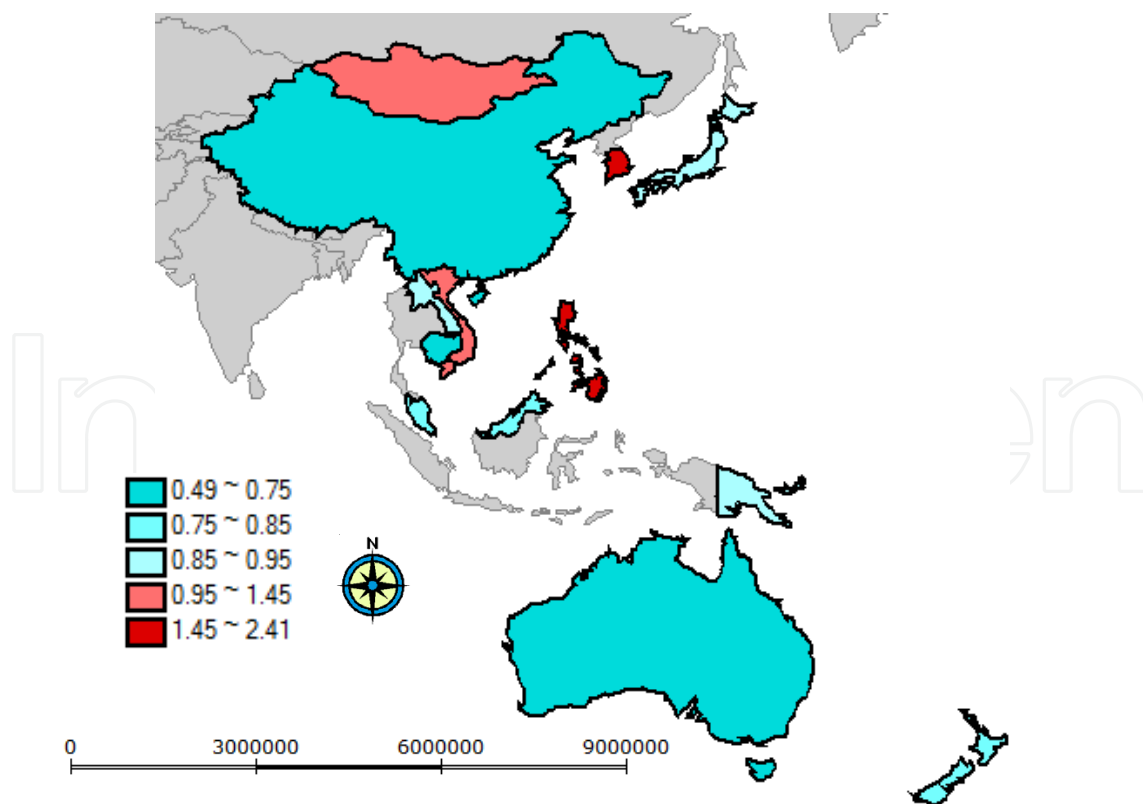Fig. 22. PAR caries according to the countries of the WPRO Region

Fig. 23. Spatial distribution of relative risk of DMFT in relation to the average for the region WPRO

5. Discussion

The reduced level of caries in schoolchildren of 12 years-old is quite visible in the period and has been the subject of several other studies. This reflects the very recommendation of WHO to monitor the DMFT index at age 12. It is noteworthy, in this scenario, the traditionally history of the national oral health systems have on the public school.

The WHO Oral Health Program (Petersen, 2003) presented in its report on the global oral health conditions, a four-level scale for the classification of the DMFT index at 12 years-old. They are: very low (less than 1.2), low (1.2 to 2.6), moderate (2.7 to 4.4) and high (over 4.4). In this sense, it was established that all WHO regions had an average DMFT classified as low, since the change occurred between the values from 1.7 to 2.4. However, when you look at differentials between countries, this classification varies widely, with representatives in all categories of the index.

The Fedération Dentaire Internacionale (FDI), the International Association for Dental Research (IADR) and WHO set oral health goals for the year 2020 (Hodbell et al., 2003). Unlike the goals for the year 2000, which indicated a rate of not more than 3 DMFT at age 12, the target set was: "to reduce the DMFT at age 12, in particular the component 'D' on X%, with special attention for high-risk groups, considering both the average values as their distributions."

Antunes et al. (2006) make three observations about this statement. First, should be given special attention to high-risk groups. This indication is due to intensely unequal distribution of caries. Second, the idea of monitoring not only the average values, but also their distributions, which tries to correct the effect on the measurement of a disease with high inequality in its distribution. And third, there is not the establishment of absolute values, because they must adapt to local conditions regarding the availability of databases, priorities, current levels of prevalence and severity, socioeconomic status, available resources and characteristics of health systems.

It was observed that the more developed countries, especially in the EURO, presented DMFT index greater than the least developed countries, especially the AFRO region. This finding corroborates the fact that most of the twentieth century (the period when most studies were performed), the decay was seen as a disease of rich countries with low prevalence in the poorest countries. The most obvious reason for this is the standard diet. The high consumption of refined carbohydrates in the richer countries has led to a selective proliferation of cariogenic bacteria, unlike the poorest countries that had a diet based on hunting and subsistence agriculture, with low-carbohydrate diets (Burt & Eklund, 2005).

However this scenario is quite out of date due to data analyzed being old. There is strong evidence that this pattern is altered with marked reduction in caries experience in children and young adults in rich countries. Other factors are helping reverse this scenario within a context of a globalized world. The increased access to foods and the exclusive and selective oral health services offering are changing the global profile of caries. Recent studies are needed to evaluate such changes.

6. Conclusions

The existence of a database with information on tooth decay of 12 years-old favors the presentation of an epidemiological scenario of oral health in the world. Easy access to the data publicly available over the internet enables the analysis by the researchers favoring the transformation of data into information. Such information may serve to guide policy goals for oral health according to the different realities observed.

However, this analysis has some limitations. Besides being restricted to countries that are part of the regional offices of the WHO, some countries had no data available on oral health. Another factor was wide variations in the years to disseminate the studies. It was observed studies from 1973 to 2008. This distance of 35 years makes comparisons very weak and outdated. However, this evidence should be that the countries and regions where data are more outdated, especially countries in the AFRO, pay greater attention to the epidemiological diagnosis of the oral health of their populations.

The existence of information about the DMFT index for most WHO member states legitimize this indicator as a measure universally accepted and used for global comparisons. However, the lack of other oral health indicators reduces to only one face of its characteristics and consequences. Index that measure other dimensions, such as periodontal disease, tooth loss and access to oral health services should have the same range observed in the systematization of the DMFT index.

It was observed that all regions had an average of DMFT below 3, which represents the achievement of targets set by WHO for the year 2000. However, there was wide variation between countries. Moreover, it is noteworthy that this global ecological analysis, assuming the countries as units of analysis, it homogeneous areas with large heterogeneities in their local realities. Studies with smaller units, with increased geographic scale are needed to access the micro-realities concealed by means of their countries.

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Oral Health Care - Pediatric, Research, Epidemiology and Clinical Practices

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Oral health care in pediatric dentistry deals with complete oral health, including preventive aspects for children right from their conception to adolescence, encompassing all the spheres of dentistry including various specialties. It also includes planning a preventive program at individual and community levels. The current research interests in oral health care include studies regarding the role of stem cells, tissue culture, and other ground-breaking technologies available to the scientific community in addition to traditional fields such as anatomy, physiology, and pharmaceuticals etc of the oral cavity. Public health and epidemiology in oral health care is about the monitoring of the general oral health of a community, general afflictions they are suffering from, and an overall approach for care and correction of the same. The oral health care-giver undertakes evaluation of conditions affecting individuals for infections, developmental anomalies, habits, etc. and provides corrective action in clinical conditions. The present work is a compendium of articles by internationally renowned and reputed specialists about the current developments in various fields of oral health care.

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