Rationalizing Distribution and Utilization of High Value Capital Medical Equipment in Greece

17 | November 2017

The Strengthening Capacity for Universal Coverage (SCUC) action is carried out with funding by the European Union through a grant agreement between the European Commission and WHO/Europe. Its general objective is to contribute to improving health and health equity in Greece, especially among the most vulnerable in the population, by helping the Greek authorities to move towards universal coverage and to strengthen the effectiveness, efficiency and resilience of their health system.

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ABBREVIATIONS

CMMS: Computerized Maintenance Management Systems

CPG: Clinical Practice Guidelines

CT: Computed Tomography

DRGs: Disease Related Groups

ECRI: Emergency Care Research Institute, now ECRI Institute

EEAE: Greek Atomic Energy Commission

EKAPTY: The National Quality Assessment Center of Technology in Health

EOPYY: National Organization for the Provision of Health Services

EU: European Union

GDP: Gross Domestic Product

GMDN: Global Medical Device Nomenclature

HAMP: Hellenic Association of Medical Physicist

HR: Health Regions

HVCE: High Value Capital medical Equipment

INBIT: Institute of Biomedical Technology

LINAC: Linear Accelerator

MDs: Medical Devices

MDDs: Medical Devices Directives

MDR: Medical Devices Regulation

MMU: Mammography Unit

MRI: Magnetic Resonance Imaging

NICE: The National Institute for Health and Care Excellence

OECD: Organization for Economic Co-operation and Development

OTAE: Federation of Technologists-Radiologists of Greece

PET / CT: Positron Emission Tomography / CT

RS: Regional Sector

SPECT: Single Photon Emission Computed Tomography

WHO: World Health Organization

ACKNOWLEDGEMENTS

This report was produced through the Grant Agreement between the European Union, represented by the European Commission and the World Health Organization (WHO) on the action entitled Strengthening Capacity for Universal Coverage Greece/Phase 2 (SCUC2). The general objective of the Action is to contribute to improving health and health equity in Greece, by helping the Greek authorities to move towards universal coverage and to strengthen the effectiveness, efficiency and resilience of the health system. An important area under SCUC2 is related to rationalization of distribution and utilization of high value capital medical equipment. In this context, the present report contains detailed analysis of the regional distribution, use and costs for specific categories of equipment, as well as highlights the general issues identified and provides specific policy recommendations.

The report was drafted by the Institute of Biomedical Technology (INBIT) led by Prof. Nicolas Pallikarakis who acted as senior local expert and the main author and liaised also with all relevant persons and institutions involved. Aris Dermitzakis from INBIT contributed significantly to data gathering, analysis and graphics visualization.

Overall coordination and guidance for the assessment has been ensured by the Division of Health Systems and Public Health (DSP) of WHO Regional Office for Europe, under the leadership of Hans Kluge, Divisional Director. The final version of the report was revised by Hanne Bak Pedersen, Programme Manager, Health Technologies and Pharmaceuticals, DSP and Adriana Velazquez Berumen, Senior Advisor on Medical Devices Innovation Access and Use, Medicines and Health products Department, Health Systems and Innovation, WHO Geneva. The support of the local WHO Project Office in Athens – represented by Silviu Domente, Senior Adviser, Health Policy and Thanos Myloneros, National Professional Officer – in the activities planning and their coordination with the Ministry of Health, the design of the report and their fruitful discussions with the authors are gratefully acknowledged. Vion Psiakis and Giannis Manasis, local consultants of the WHO Project Office in Athens contributed with data cross-checking and technical insights. Thanks also to Chryssa Baroga from the WHO Project Office in Athens who provided administrative and logistical support at all stages.

Report writing was done in a continuous consultative process with relevant institutions and persons, which ended up with a final workshop organized by the Ministry of Health and moderated by Secretary General Dr Giorgos Giannopoulos. The participation of all stakeholders and key informants whose ideas, comments and inputs have been integrated in this report is also gratefully acknowledged.

INTRODUCTION/BACKGROUND

Advances in biomedical research and the resulting development of new diagnostic and therapeutic methods, techniques and equipment, has led to a radical change in the way health care is delivered today. Modern medicine is strongly dependent on technology and some medical specialties have emerged from these technological advances. Health technology as a term, according to World Health Organisation (WHO), refers to the application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of lives. Therefore, medical devices belong to the Health Technologies, and High Value Capital Medical Technologies are an important subgroup of this category.

The global Medical Device (MD) market was estimated to be more than 300 Billion Euros in year 2016, with more than 500,000 medical technologies registered (MedTech Europe, 2016). Mobile applications are proliferating and the data generated are of the order of thousands of terabytes per day. New information technology sectors emerged to analyse this tremendous amount of data and transform it into useful information. Additionally, comprehensive management of medical technology became necessary for its effective and safe use and should be performed by well-trained personnel.

The term High Value Capital Equipment (HVCE) refers to high-tech medical devices that includes all equipment considered costly both in terms of initial investment and operation, requiring specially trained personnel for its use and needs regular quality control, preventive maintenance and management procedures, to function properly and safely. Most of these devices belong to the diagnostic and therapeutic radiation technology category, according to the Global Medical Device Nomenclature (GMDN). In this policy brief, the following groups are considered:

- MRI: Magnetic Resonance Imaging
- CT: Computed Tomography Imaging
- PET/CT: Positron Emission Tomography / CT
- γ-Camera/SPECT: Single Photon Emission Computed Tomography
- RT: Radiotherapy Units (LINAC, Co-60, other)
- Mammography

Their use is continuously expanding worldwide and their mean life cycle, although rather long compared to other technologies, do not exceed ten years in most developed countries. Undoubtedly, HVCE are important health resources, playing a prominent role in enhancing the health care quality.

In Greece, there are quite pronounced inequalities in terms of availability of some of these technologies in different regions around the country. There are also some important organizational, policy and reimbursement procedures that could be considered as problematic, leading to over-prescription and inadequate expenses. As examples can be stated the still lacking full implementation of the Diagnosis Related Groups (DRGs) and limited use of guidelines for prescription in the diagnostic imaging area.

Greece is also characterised by a very pronounced presence of the private sector. Public hospitals lost during the last 20 years their leadership in all fields apart from Radiotherapy. The rapid raise of the number of private diagnostic centres from the late 90's, led to significantly increased costs in the years 2000 and therefore it was necessary to apply the cutting and claw back procedures to bring it back to a realistic level during the economic crisis. The situation is today normalised with the implementation of strict rules and monitoring procedures, imposed by the National Organization for the Provision of Health Services (EOPYY) under the pressure of the *"Institutions"*.

The present study aims to:

- Assess the sufficiency and equity in the distribution of HVCE and its use in Greece
- Identify eventual inequalities in terms of geographical coverage, specific needs and lack of HVCE
- Estimate the costs for the use of HVCE
- Reveal reasons of potential overuse
- Put forward proposals for improvement

WHO published a general approach in performing a needs assessment on the basis of the existing and available equipment in the region or the whole country, comparing it with what should be available, considering the particular demand and needs, and taking into account epidemiological data and recognized standards and Clinical Practice Guidelines (CPG). Taking also into consideration possible financial restrictions and Human Resources (HR) available, the actual technological gap can then be identified.

The whole approach is depicted on the following general needs assessment diagram as provided by WHO (World Health Organization, 2016a).

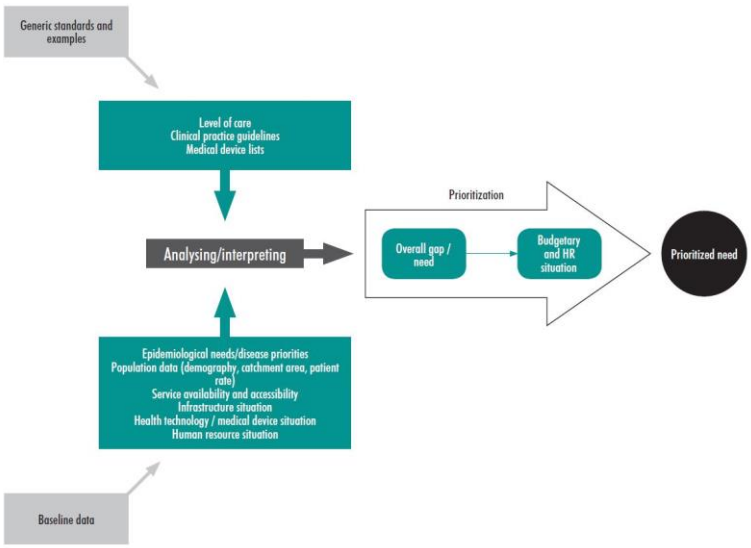

Figure 1 - Needs Assessment Diagram as provided by WHO (World Health Organization, 2016a)

It is important to notice that in order to use such a model, the prerequisite is to have reliable baseline data on the existing situation and evidence based assessment of needs.

The general information sources for this report, apart from the international scientific and technical literature, the standards and best practices in use and the current trends on these technologies, are data available from international organisations like: WHO, Organisation for Economic Co-operation and Development (OECD), European Union (EU), The National Institute for Health and Care Excellence (NICE), ECRI institute (ECRI), etc. and other reliable web sources. Concerning the installed HVCE in Greece, there is no centralised national inventory with the relevant information and the data collected and used in this report are based in cross referenced sources from the Greek Atomic Energy Commission (EEAE), The National Quality Assessment Center of Technology in Health (EKAPTY), the Hellenic Association of Medical Physicists (HAMP), the Federation of Technologists Radiologists of Greece (OTAE) and the inventory for MDs performed in 2015 by the Biomedical Technology Unit (BITU) of the University of Patras (UPAT) under an ESPA project, covering approximately half of the country. This creates a number of problems associated with data integrity, reliability and in some cases compatibility amongst them.

Additionally, data related to the actual use of these technologies are not available, apart from the indirect information on the part of acts that are reimbursed by EOPYY. However, these data do not represent the whole picture of actual use and the associated expenditures, since the part of the diagnostic or treatment acts not reimbursed by EOPPY are not known, and furthermore, EOPPY's data are also partial, since rebate and clawback procedures are applied.

In the next chapter, the results on the distribution of HVCE in Greece and the intensity of use are presented and in spite of the above-mentioned limitations, lead to a number of clear general conclusions and recommendations.

Finally, a number of interviews/discussions with medical specialists in the fields of Radiology, Radiotherapy and Nuclear Medicine, medical physicists, biomedical engineers, technologists and other specialists, provided valuable input to this study.

FINDINGS

Introduction

It is important to assess the current situation of the HVCE in Greece, in order to identify the difference between what exists and what is needed. The existence of a country-wide medical equipment inventory including status and condition would be the ideal source of information for this purpose. However, given that such a general inventory does not exist, various sources were used. This was necessary due to the fact that there is a lack of health technology management systems in most public hospitals in Greece. They also rely on manufacturer's services for these technologies and the way the private sector operate depends on the individual companies. The data collected were compared amongst them in order to obtain the most reliable picture of the situation. The data available from international organisations (OECD, WHO) rely on the initial source providing the information i.e. EKAPTY, EEAE, professional Societies and therefore also present discrepancies in the number of the equipment installed in Greece, due to the fact that the initial purpose of these different sources was not to provide a reliable Medical Devices (MDs) inventory, continuously updated, but other more specific reasons. For instance, the EEAE database, considered as the most reliable, focuses on licensing and radiation safety issues and its content does not provide information on the year of manufacturing and year of put into service for the first time. Additionally, although new information is continuously added to the database, these updates are related to the checks that the agency is performing periodically for radiation safety purposes that vary in frequency from one to five years. As a result, the database does not reflect the actual situation of the installed base (i.e. the number of units actually in use) of these technologies at any moment.

Taking into account the various sources of information this study focused on the existing HVCE installed technology as of November 2017. Starting with the existing online information available at the EEAE site, a cross check was performed with the other sources, already mentioned, duplicate entries were deleted and new data were added where identified.

Overview of Installed HVCE

The overall picture of HVCE in Greece differs depending on the technology and the level of penetration of the private sector. In the case of mammography for instance, where the private sector dominates, the total number of equipment currently installed is quite high. On the other side, Positron Emission Tomography (PET)/CT equipment is available only in Athens and Thessaloniki, in the public sector and the private sector is now starting to get also interested. The evolution of HVCE implemented in the whole country, for the period 2005–2014, is presented in Figure 2, followed by the distribution of these technologies per 1 Million inhabitants in Table 1. All data for the period 2005-2008, come from OECD databases and are available only in units per million inhabitants, absolute number of units was calculated using population shown in the table. Data from 2009-2017 come from EEAE.

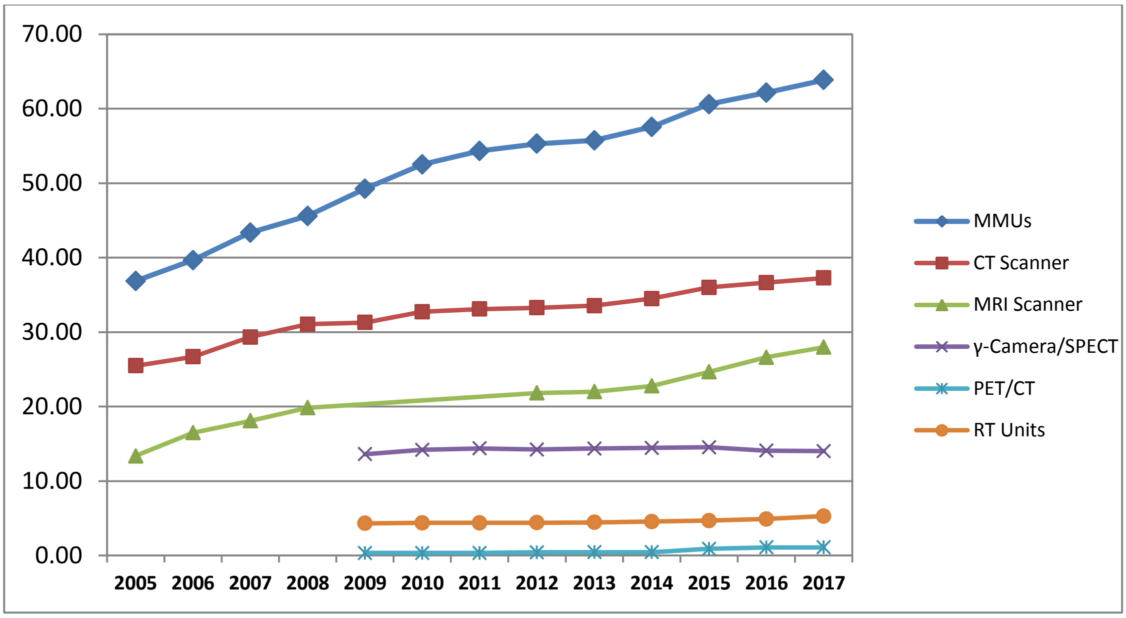

Figure 2 – Evolution of HVCE per million population in Greece from 2005 to 2017
(Data available from OECD (2005-2008) & EEAE (2009-20017))

As shown in Figure 2 and Table 1, the overall HVCE installed per million population in Greece, constantly increased from 2005 to 2017. All HVCE technologies followed this trend during the same time period, with the exception of γ-Cameras/SPECT that remained constant.

A graphical representation of the distribution of HVCE in the whole country, is provided in the Annex, using geographical maps.

Table 1 - Number of HVCE per million population from 2004 to 2017, in relation with the GDP
(Data available from OECD (2005-2008) & EEAE (2009-20017), and World Bank)

Year	*Population (In Millions)	Per capita GDP (€)**	MMUs		CT Scanners		MRI Scanners	
			Units/1 M	Absolute Number	Units/1M	Absolute Number	Units/1M	Absolute Number
2005	10,97	20913	36,9	404	25,5	280	13,4	147
2006	11,00	22029	39,7	436	26,7	294	16,5	182
2007	11,04	22692	43,4	479	29,3	323	18,1	200
2008	11,06	22556	45,6	504	31,1	344	19,9	220
2009	11,09	21529	49,2	546	31,3	347	*	*
2010	11,12	20324	52,5	584	32,7	364	*	*
2011	11,12	18495	54,3	604	33,1	368	*	*
2012	11,09	17238	55,3	613	33,3	369	21,8	242
2013	11,00	16800	55,7	613	33,5	369	22,0	242
2014	10,93	17038	57,5	629	34,5	377	22,8	249
2015	10,86	17100	60,6	658	36,0	391	24,7	268
2016	10,78	17176	62,2	670	36,6	395	26,6	287
Total Units as of November 2017			687		401		301	

*No data available, **GDP Calculated using Constant LCU (World Bank, 2017)

Year	*Population (In Millions)	Per capita GDP (€)**	PET/CT		γ-Camera/SPECT		RT	
			Units/1 M	Absolute Number	Units/1M	Absolute Number	Units/1M	Absolute Number
2009	11,09	21529	0,4	4	13,6	151	4,3	48
2010	11,12	20324	0,4	4	14,2	158	4,4	49
2011	11,12	18495	0,4	4	14,4	160	4,4	49
2012	11,09	17238	0,5	5	14,2	158	4,4	49
2013	11,00	16800	0,5	5	14,4	158	4,5	49
2014	10,93	17038	0,5	5	14,5	158	4,6	50
2015	10,86	17100	0,9	10	14,5	158	4,7	51
2016	10,78	17176	1,1	12	14,1	152	4,9	53
Total Units as of November 2017			12		151		57	

*No data available, **GDP Calculated using Constant LCU (World Bank, 2017)

From 2009 to 2017 the per million population number of MMUs, CT, MRI, PET and RT rose by 30%, 19%, 28%, 175%, and 19 % respectively. Meanwhile, the basic figures of population had been grown from 10,97 to 11,12 million from 2005 to 2010, and the per capita GDP increased from €20.913 in 2005 to reach a maximum of €22.692 in 2007 (World Bank, 2017). Then both declined to 10,78 million and €17.176 in 2016 respectively.

Overview of Use and Cost Data

A general overview of the evolution of exams performed for all HVCE modalities is depicted in Figure 3. It is important to notice the very pronounced decline of the CT and MRI exams between 2008 and 2013. Data available from 2013 and on, for the number of mammograms show also a reduction, while PET exams and RT acts that remained stable between 2013 and 2016, are expected to increase in 2017, based on the number of new RT and PET scanners that are in progress of installation during 2017.

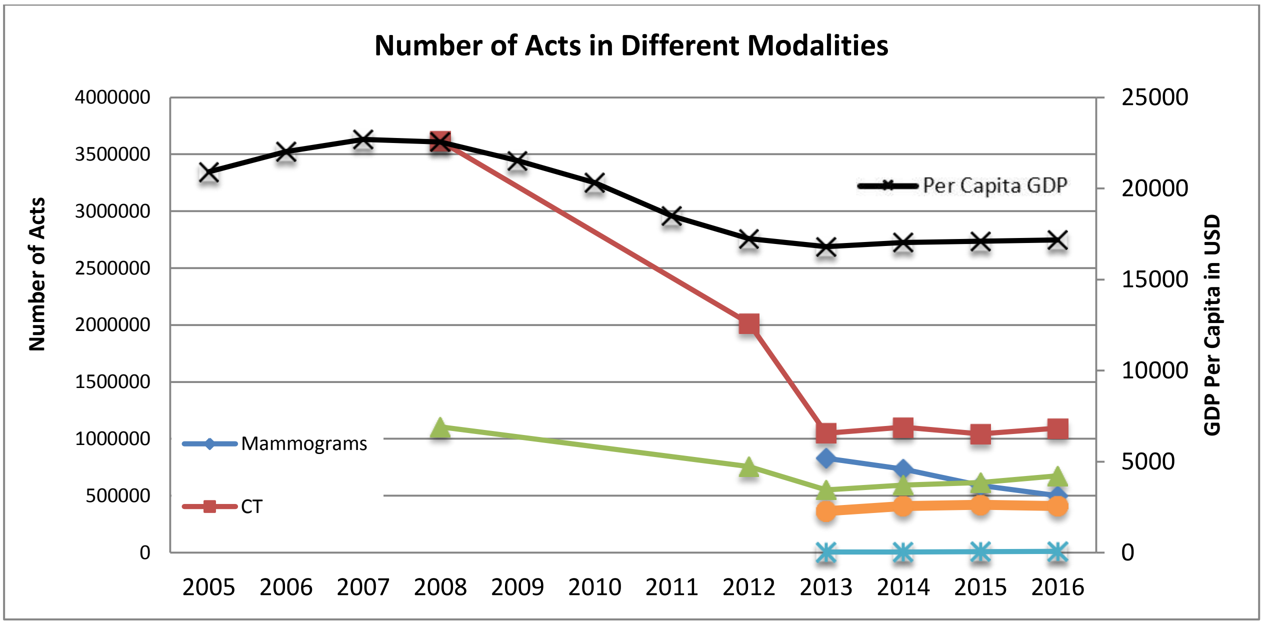

Figure 3 - Evolution in the number of acts in different modalities, together with the GDP. Data on acts from 2008, 2012 from OECD and 2013 to 2016 from EOPPY

Comparison with other EU countries

According to Eurostat the availability of equipment for diagnosis increased rapidly in most EU Member States during the past decade. Relative to population size and subject to data availability, the Eurostat report “Health at a glance: Europe 2017” (OECD, 2017), states that Germany, Greece, Iceland, Italy, Korea and Switzerland also have significantly more MRI and CT scanners per capita than the OECD average (2015 data). Greece was already at the highest places in numbers of MMUs, relative to population size, among the European countries in year 2005, as it appears in the “Health at a glance: Europe 2007” report. PET scanners are generally the least widely available imaging equipment. Concerning health care costs, most EU countries have achieved universal (or near-universal) coverage of health care costs for a core set of services. However, Greece was included amongst the four EU countries (with Cyprus, Bulgaria and Romania) that in 2014 still had more than 10% of their population not regularly covered for health care costs by public (or private) health insurance. This may have changed recently.

In the following sections the data for all different technologies covered in this study, are analysed in more details by Regions or Regional Sectors as appropriate. For comparison, the development of the installed equipment base, from 2005 to 2016, in four other EU countries, (namely Austria, Denmark, Finland and Portugal) with similar population sizes, was used.

Mammography

Regional distribution

The following figure presents the regional distribution of Mammographic Units (MMUs) in Greece.

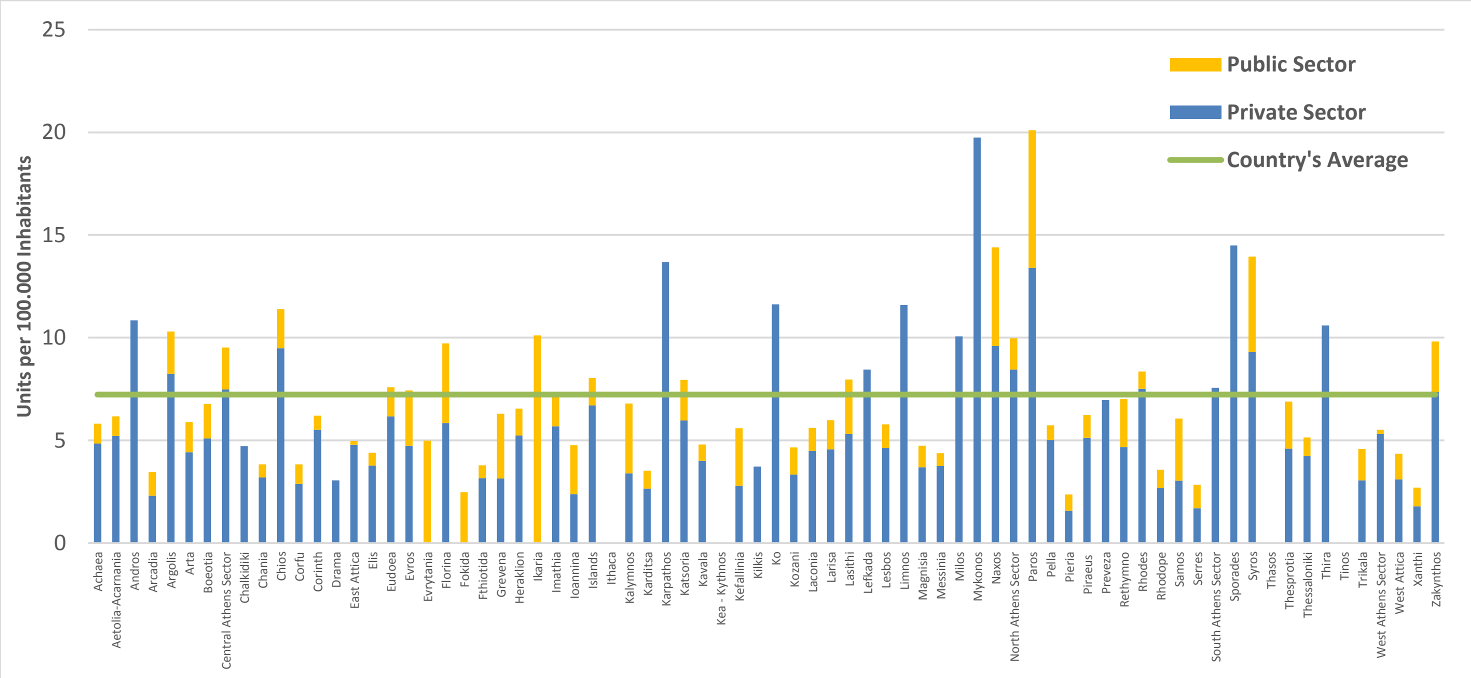

Figure 4 - Regional Distribution of Mammographic Units per 100.000 Inhabitants (Data for 2014 from EKAPTY)

As it is seen MMUs are available in most of the regional sectors of the country, with a few exceptions in the relatively small islands of Kea and Kithnos, but also in the much bigger and populated islands of Thasos and Tinos. This means that any women in these regions that needs a mammograph has to travel, to another island or mainland Greece for this purpose. Highest numbers of Units per 100.000 inhabitants, appear to be in the islands of Paros, Mykonos, Sporades and Naxos, due to the low population of these islands, which influence the metric. On the other hand, Fokida, Xanthi, Serres, Pieria and Drama present lower number of MMUs per 100.000 inhabitants, compared to the rest of the country. Most of these areas are located in the North East part of the country, which is lagging behind other regions in terms of MMUs installed. In total there are 14 regional sectors, 12 of them islands among which and the 2nd highest in terms of units per population island of Mykonos, which are completely covered by the private sector.

Comparison with other EU Countries (Austria, Denmark, Finland and Portugal) is presented in Figure 5. It is clear that the number of MMUs in these countries is less than half compared with those in Greece. The population density, the big number of remote small cities and the big number of islands of Greece, may explain this.

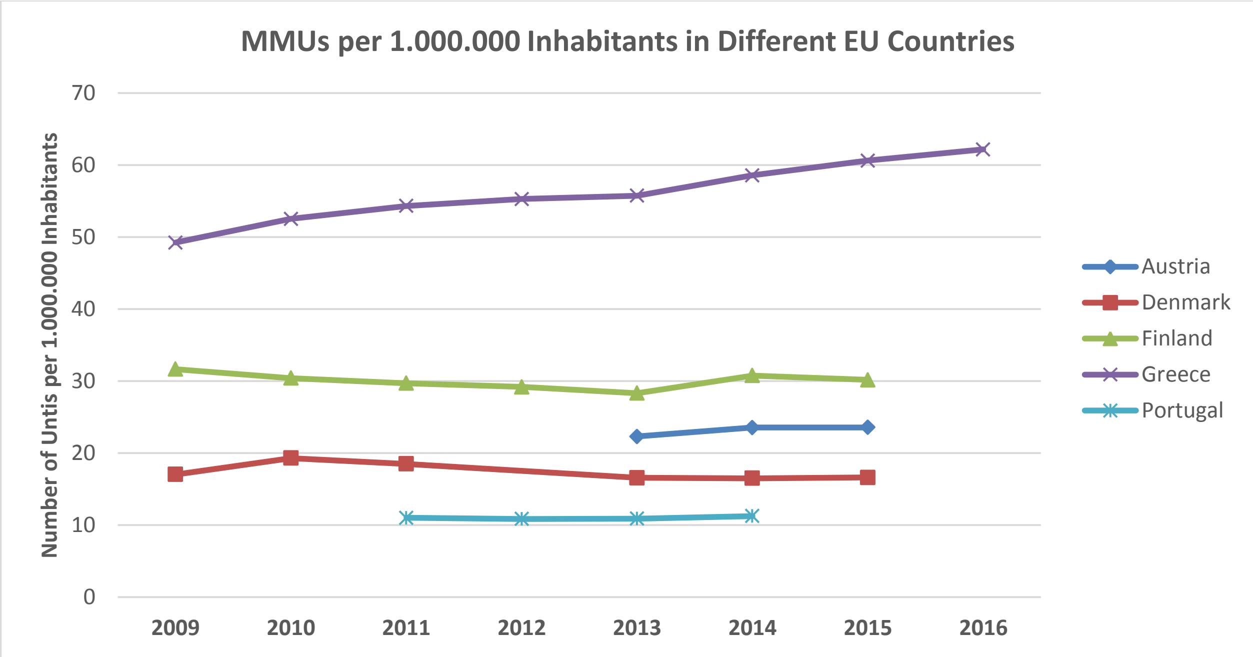

Figure 5 - Comparison of number of MMUs per 1.000.000 inhabitants between EU countries (Data available from OECD (2005-2008) & EEAE (2009-20017))

This implies that units had to be installed in areas with low population in order to assure accessibility. In fact, Austria, Denmark and Portugal have a much denser population and smaller distances to medical centres. The fact that Finland has a much lower population density compared to the above-mentioned three countries, follows Greece in terms of number of equipment, is also supporting this assumption

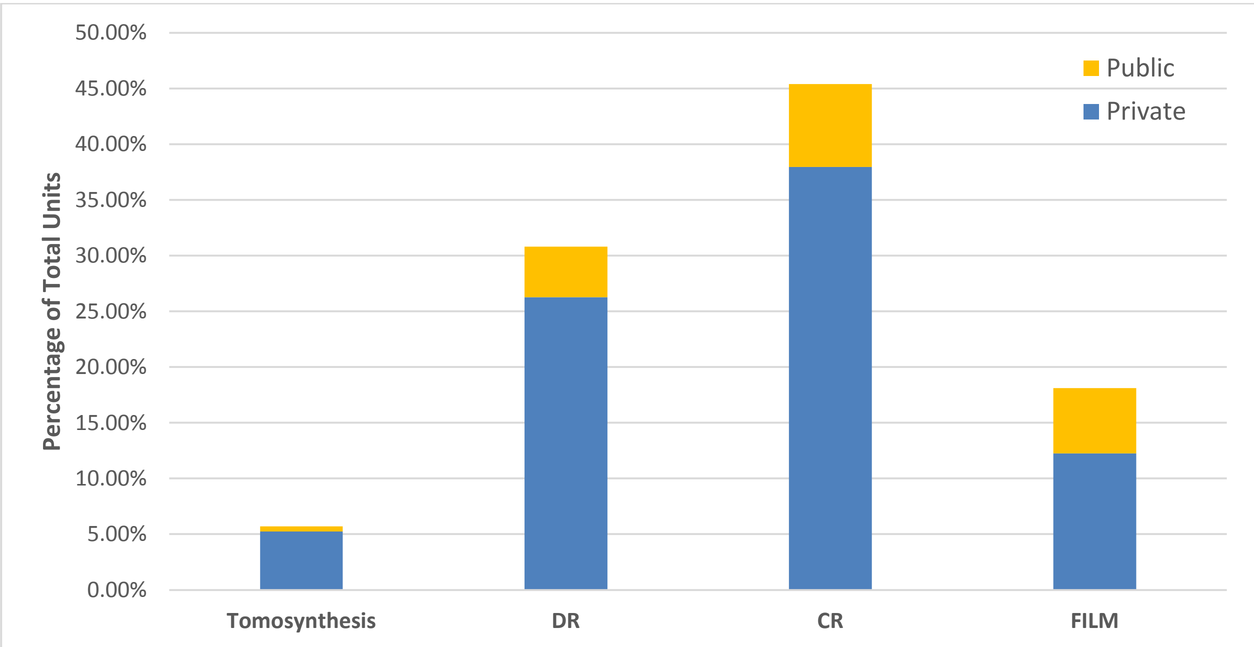

Figure 6 - Distribution of the Four Major Mammographic Technologies (Tomosynthesis, Digital Radiography (DR), Computed Radiography (CR) and Film). (Data for 2017 from EEAE)

In Figure 6 the distribution of the four major mammographic technologies is presented. As it can be seen, tomosynthesis represents only 5,3% of total units and specifically in only 3 public hospitals and 36 private sector's institutes. The dominant technology is Computed Radiography (CR), covering approximately 45% of the installed units, while Digital Radiography (DR) is available in ~30% of the cases while ~18% of the units are still film based.

Use and Cost

In Table 2 the evolution of the number of mammograms and the associated reimbursement cost are presented, from 2013 to 2016, based on data provided by EOPPY. The market share dominated by the private sector shows a shift towards the public sector and towards less number of exams (almost 50% less).

Table 2 - Analytical data, evolution and comparison concerning number of exams, installed units and costs reimbursed by EOPYY for Mammograms. (Data concern 2013 to 2016 provided by EOPYY)

Year	# Exams / Year					Number of Units	Average # Exams /Unit / Year
	Public		Private		Total		
2013	103.380	12%	727.004	88%	830.384	613	1355
2014	110.022	15%	624.788	85%	734.810	629	1168
2015	116.388	20%	474.885	80%	591.273	658	899
2016	131.237	26%	369.418	74%	500.655	670	747

Year	Total EOPYY Expenditure in € per year					EOPYY Charges Per Exams (€)	
	Public		Private		Total	Public	Private
2013	827.887	14%	5.022.878	86%	5.850.765	8	7
2014	880.903	17%	4.329.421	83%	5.210.324	8	7
2015	932.268	22%	3.285.907	78%	4.218.175	8	7
2016	1.108.175	29%	2.659.958	71%	3.768.133	8	7

While in 2013 the percentage of mammograms done in the public sector was only 12%, in 2016 this percentage has increased to 26%. However, this is only partly due to the 30% increase of mammograms performed in the public sector. It is mostly the results of an overall significant decrease of 40% in the total number of exams performed in 2016 compared to 2013. It is also important to point out that digital Mammography is reimbursed by EOPYY from February 2017. Until then patients' payed directly from their pocket. Since these data represent the exams reimbursed by EOPPY this could be an explanation why we see such a drop in the number of exams.

In Table 3 the percentage of the total mammograms done for screening purposes is shown, among different EU countries, as reported by OECD. Out of this table two main conclusions can be drawn.

Table 3 – Comparison of the Percentage of Mammograms for Screening Purposes Between EU Countries (Data from OECD)

Country	First Measurement		Second Measurement	
	Year	% of Total for screening	Year	% of Total for screening
Austria	2006	80,2	2014	72,7
Denmark	2008	73,7	2014	83,9
Finland	2004	87,4	2014	82,8
Greece	2006	53,8	2009	49,5
Portugal	2005	73,6	2014	84,2

First of all, as mentioned before, data availability and analysis in Greece is heavily lagging behind compared to other EU countries, since even in this case the most recent data available concern 2009. As far as the number of mammograms for screening purposes is concerned, it is seen that Greece in 2009 was far behind the percentages of the other EU countries.

The distribution of mammograms per 1.000 inhabitants per Regional Sector in 2016, shown in Figure 7, reveals big differences amongst different regions, in spite of equipment availability.

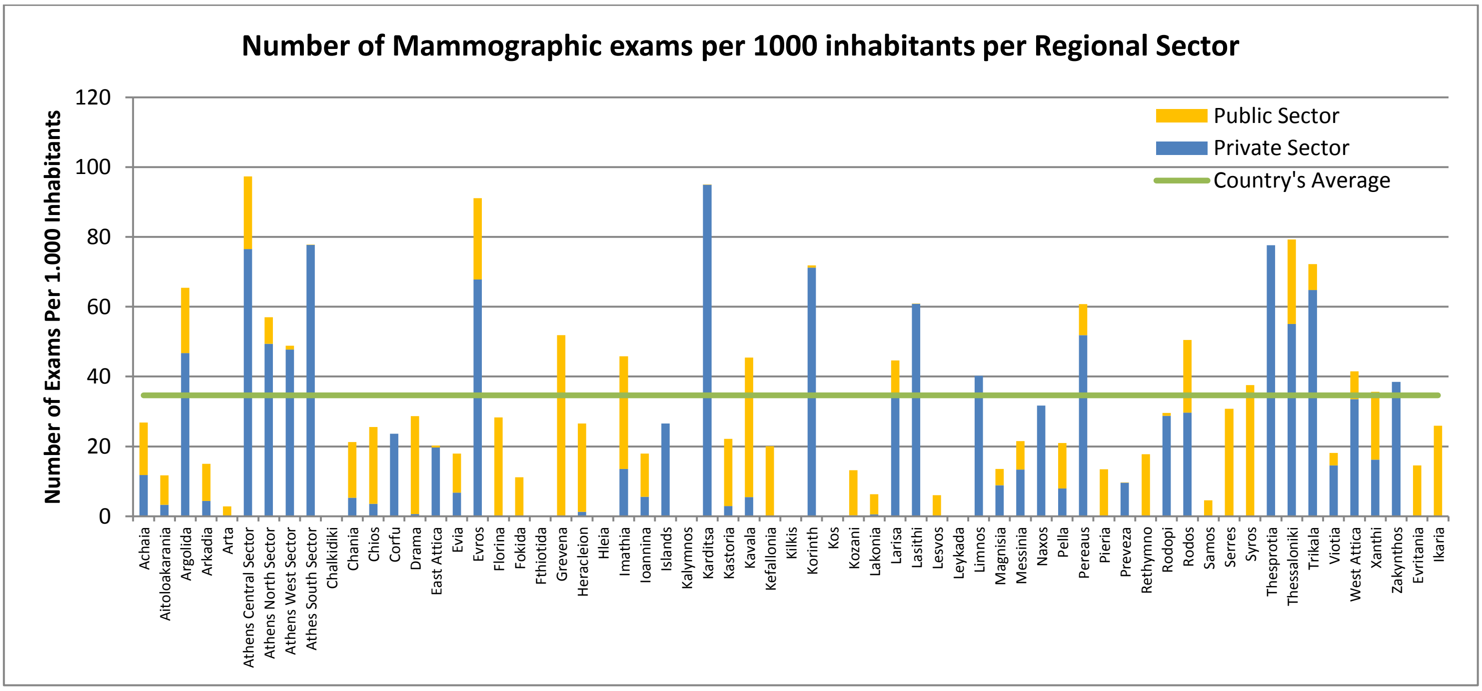

Figure 7 - Number of Mammographic exams per 1000 inhabitants per Regional Sector. Exams in Public Sector are depicted in Orange, exams in Private Sector in Blue. (Data for 2016 available from EOPYY)

The number of mammograms performed per region shows much greater discrepancies than the distribution of the MMUs. Some areas show a significantly higher number of exams per thousand population, whereas in others it is extremely low.

Looking at the time evolution of the number of Mammograms per 1000 inhabitants per region during the 2013-2016 period, shown in Figure 8, it is clear that the whole region of central Greece and North Aegean are heavily lagging behind the other regions.

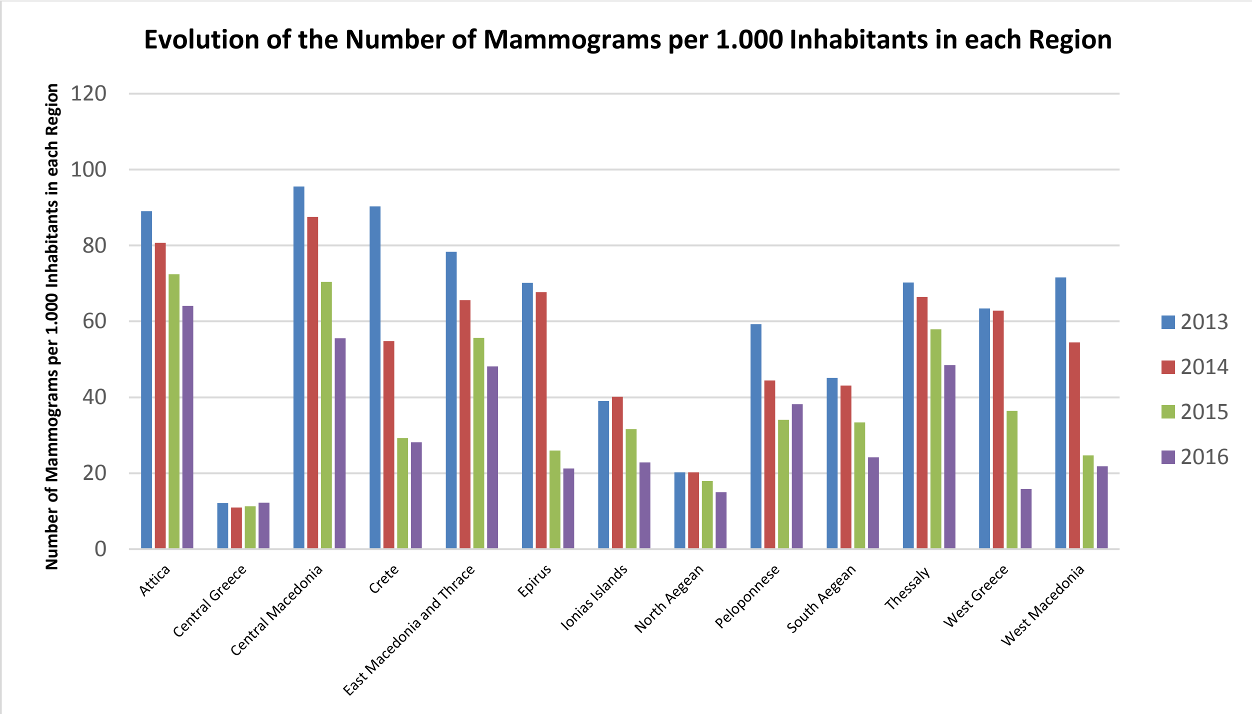

Figure 8 - Evolution over time of the number of Mammograms per 1000 inhabitants in each region. (Data for years 2013 to 2016 available from EOPYY)

Additionally, a general large drop in the number of exams that took place can be clearly seen in the whole country and this is in accordance with the data shown in Table 2. This drop indicates that a large number of women is not participating in the preventing screening programmes. As mentioned before part of this drop could be explained by the fact that digital Mammography is reimbursed by EOPYY from February 2017. Until then patients' payed directly from their pocket. Particularly remarkable is the drop of exams in Western Greece, which is difficult to explain.

Data analysis and Discussion

The number of MMUs in service is considered well above what would be necessary according to the screening recommendations, although considerable variation in their density across the country is observed. High number of MMUs may have undesirable consequences like: insufficient experience in the interpretation of mammograms for optimal sensitivity and specificity, broadening of age ranges and frequency in which mammography is offered and therefore increased costs, as reported by Autier and Ouakrim. In their study they assessed the number of mammography units (MMUs) in 31 European, North American and Asian countries where significant mammography activity has existed for over 10 years, collecting data on the number of such units and of radiologists by contacting institutions in each country likely to provide the relevant information. Around 2004, there were 32.300 MMUs in 31 countries, the number per million women ranging from less than 25 to more than 80 units (Autier and Ouakrim, 2008), whith Greece being in the upper limit. However, this situation seems not to be the case in Greece. Based on EOPYY data, the private sector represents today approximately 70% of the market, demonstrating a significant drop of 20% when compared to 2013. Based on the installed base it is also clear that the private sector has heavily invested in the field of mammography in the last 10 years. It is important to notice that this has now stopped, probably due to small profit margin. Taken into account that EOPYY pays back 7 euros/mammogram in the private sector, plus the patient contribution of (15%), this results into a total of 9.2 euros/mammogram, which leaves very small margin of profit for the private sector, if any. This led to a shift of exams to the public sector, seen in terms of percentages. However, when the absolute number of mammograms performed is considered, a problem in the Greek breast cancer-screening programme appears. In fact, the total number of mammograms reimbursed by EOPYY, has fallen from 830.384 in 2013 to 500.655 in 2016, which represent an almost 40% decrease. In absolute numbers the number of mammograms that were done in the public sector increased by 27.857 exams, while in the private sector there is a very pronounced decrease from 727.004 in 2013 to 369.418 in 2016. According to the data provided by EOPYY, it seems that a considerable number of women did not have any mammogram at all. According to census of 2011, number of women in the age range of 50-69 is approximately 1.300.000 women. Assuming that these populations should have at least one mammogram every two year, more than 700.000 mammograms show be performed only for screening purposes of this age group. In Greece in 2016 we had in total 500.655 mammograms. This means that the number of mammograms for screening purposes are considerably lower than the expected. If we also take into account the data in Table 3, we can see that the percentage of mammograms done for screening in 2009 was approximately 50%. If we assume that, this number is still more or less the same and taking into account that Greece's population is not varying heavily, then we could say that out of the 500.000 mammograms done, only about 250.000 of them are for screening, which is close to the 1/3 of the expected ones.

However, the number of exams reported by EOPYY do not really represent the overall picture, since a percentage of patients use the private sector services that are not reimbursed by EOPYY and therefore they pay out of pocket. In the case of Lefkada Island, for instance, where there is only a private mammography unit it appears that there are no exams at all which apparently is not exact. In such cases the prices that the patients have to pay are higher than EOPYY's reimbursement.

International recommendations and guidelines are quite controversial today as for the ages and frequency that mammographic exams should be performed. There is uncertainty about the magnitude of over diagnosis, associated with different screening strategies, attributable in part to lack of consensus on methods of estimation (Myers et al., 2015). Additionally, it should be mentioned that 63% of the total units installed, are using the outdated or not state of the art technologies of Film and CR imaging. Compared to DR the CR technology was recently reported as failing to image benign lesions and malignant calcification clusters in some cases, resulting to a respective 15 and 22% reduction in cancer cases detected (Myers et al., 2015).

CT

Regional distribution

The following Figure 9 presents the regional distribution of CTs in Greece. In the case of CT imaging, although in general most of the Regional Sectors have smaller fluctuation in the number of CT scanners per 100.000 inhabitants, there are some particular regions that clearly stand out.

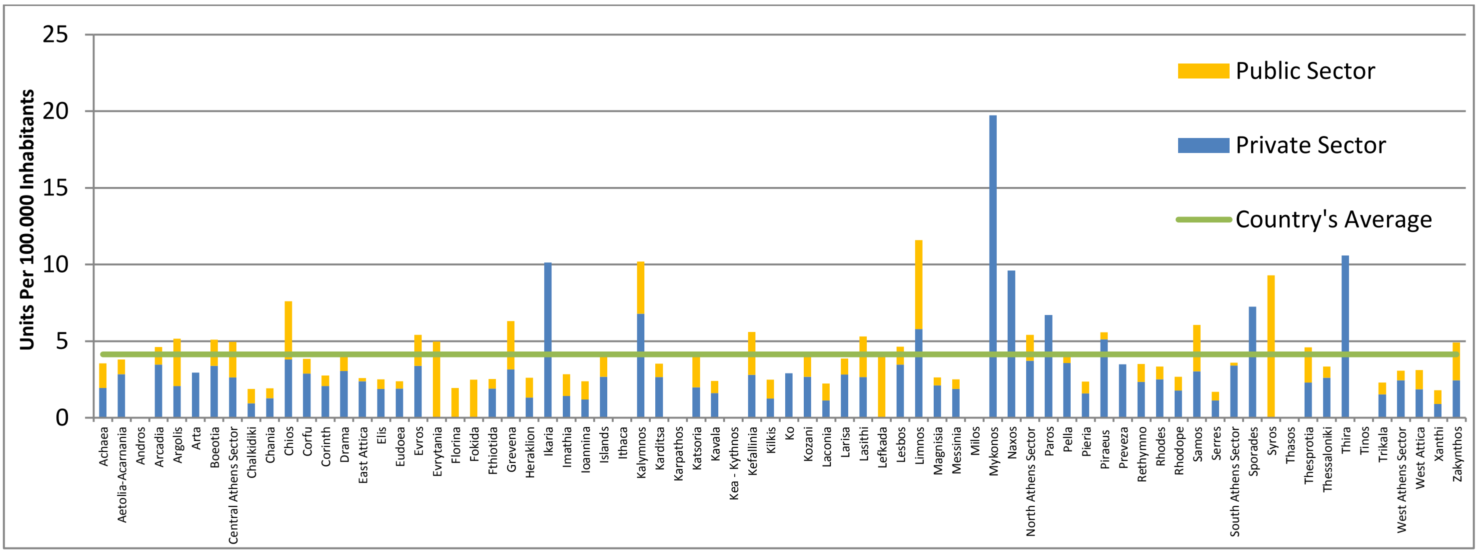

Figure 9 – Regional Sector Distribution of CT Units per 100.000 Inhabitants (Data for 2017 from EEAE)

In spite of the large total number of units it is observed that there are several areas where no CT scanner is available. All these areas are islands (Andros, Ithaca, Kea, Kythnos, Milos, Thasos, Tinos) which means that any patient that needs a CT scan has to travel, or to be transferred depending on the condition, to another island or mainland Greece for this purpose. On the other hand, there are some regions where the number of CT scanners per 100.000 inhabitants, appears to be twice as high compared to the rest of country's regions. These areas are again mostly islands (Mykonos, Limnos, Syros, Sporades, Thira, Ikaria, Kalymnos, Chios, Naxos) where the presence of even one or two CT scanners, highly increase their unit per 100.000 inhabitants' ratio, due to their small population.

Another fact also interesting to point out, is that there are four regions that are fully covered only by the private sector. These are again islands and in particular Mykonos, Thira, Ikaria and Naxos. For the case of Mykonos and Thira, this could be explained by the fact that both these islands are world widely known touristic destinations, attracting great number of high income tourists. This is not the case for Naxos and even more for Ikaria. In all cases patients on these areas, if a CT scan is needed, are obliged to go to a private centre if they are not willing to travel.

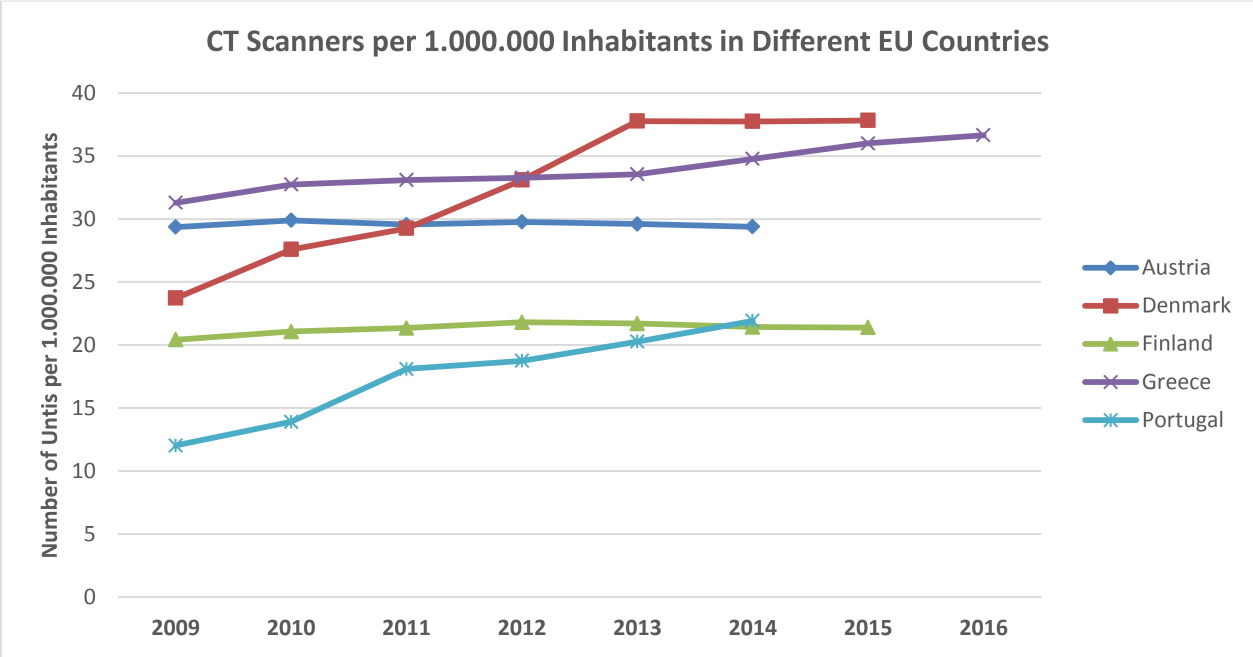

Figure 10 - Comparison of number of CT scanners per 1.000.000 inhabitants between EU countries
(Data for EU Countries from OECD and for Greece from EEAE)

In comparison with other European countries, Greece has again a high number of CT scanners, equal to that in Denmark in terms of number of units per 1.000.000 inhabitants, and almost double than in Finland and Portugal.

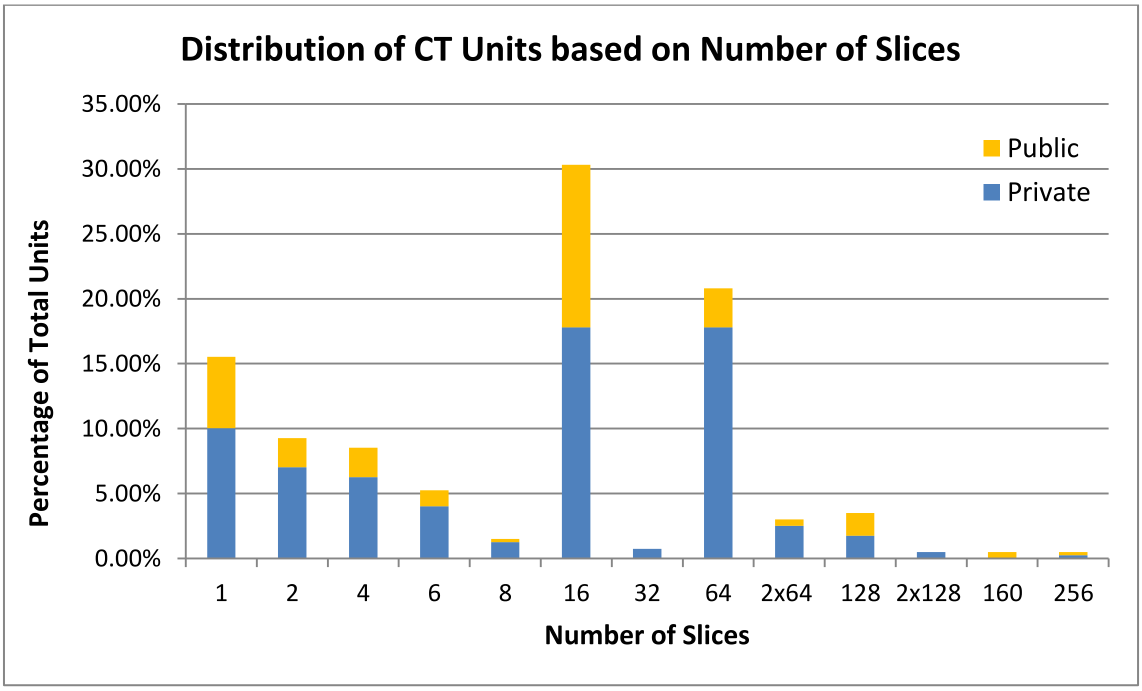

Figure 11 - Distribution of installed CT Units based on the number of Slices

In Figure 11, the distribution of CT Units based on the number of slices they acquire is shown. Looking at the number of slices is a good way to indirectly estimate the age of the scanner, since manufacturing date data were not available for all cases, neither the technological status of the installed units. As it is seen the most dominant technology is 16 slices (approximately 30% of total scanners) followed by 64 slices scanners (approximately 20% of total scanners). Although these two technology generations are not new, they are still not outdated (especially the 64 slices technology) and they cover more than 50% of the total installed CT scanners. On the other hand, it is noticed that the 3rd most common technology is 1 slice CT scanners, followed by 2, 4 and 6 slices scanners, which are very old and outdated technologies. Most of them are available in the private sector. It is important to state that discussing with medical doctors, they pointed out that although obviously old, these scanners can still have diagnostic value, when 3D volume imaging is not needed. In general, approximately 70% of the total CT scanners installed are below 64 slices, and only a few new, high-end scanners are available, indicating rather aged units installed in the country.

Use and Cost

In Table 4 the evolution of the number of CT exams and the associated reimbursement cost are presented, from 2013 to 2016, based on data provided by EOPPY.

Table 4 - Analytical data, evolution and comparison concerning number of exams, installed units and costs reimbursed by EOPYY for CT imaging. (Data concern 2013 to 2016 provided by EOPYY)

Year	# Exams/year					Number of Units	Average # Exams /Unit / Year
	Public		Private		Total		
2013	255.918	24%	794.566	76%	1.050.484	369	2847
2014	271.622	25%	830.043	75%	1.101.665	377	2922
2015	257.574	25%	785.318	75%	1.042.892	391	2667
2016	251.553	23%	842.131	77%	1.093.684	395	2769

Year	Total EOPYY Expenditure in € per year					EOPYY Charges Per Exam	
	Public		Private		Total	Public	Private
2013	17.470.577	33%	35.009.926	67%	52.480.503	68	44
2014	18.495.464	33%	36.723.221	67%	55.218.685	68	44
2015	17.636.519	33%	35.674.458	67%	53.310.977	68	45
2016	16.908.803	30%	38.753.036	70%	55.661.839	67	46

In the case of CT imaging modality, both the number of CT units installed and their use seem to be in a rather stable state. Following a remarkable drop of almost 70 % between 2008 and 2013 the number of CT exams remains stable during the last four years. The fluctuations in the number of exams and the percentage of exams done in the private and public sector are very small. In general, only 25% of the exams are done in the public sector.

In terms of EOPYY reimbursement, the average cost of a CT scan when performed in the public sector is 68 euros, while in the private sector it is 45 which represents 85% of the total cost, the rest 15% is being paid by the patients. However, no data were possible to be found concerning the number of exams performed and directly covered by private insurances or out of pocket, without any EOPYY reimbursement. It is the same for the exams performed at public hospitals to non-covered patients. These numbers may be quite large.

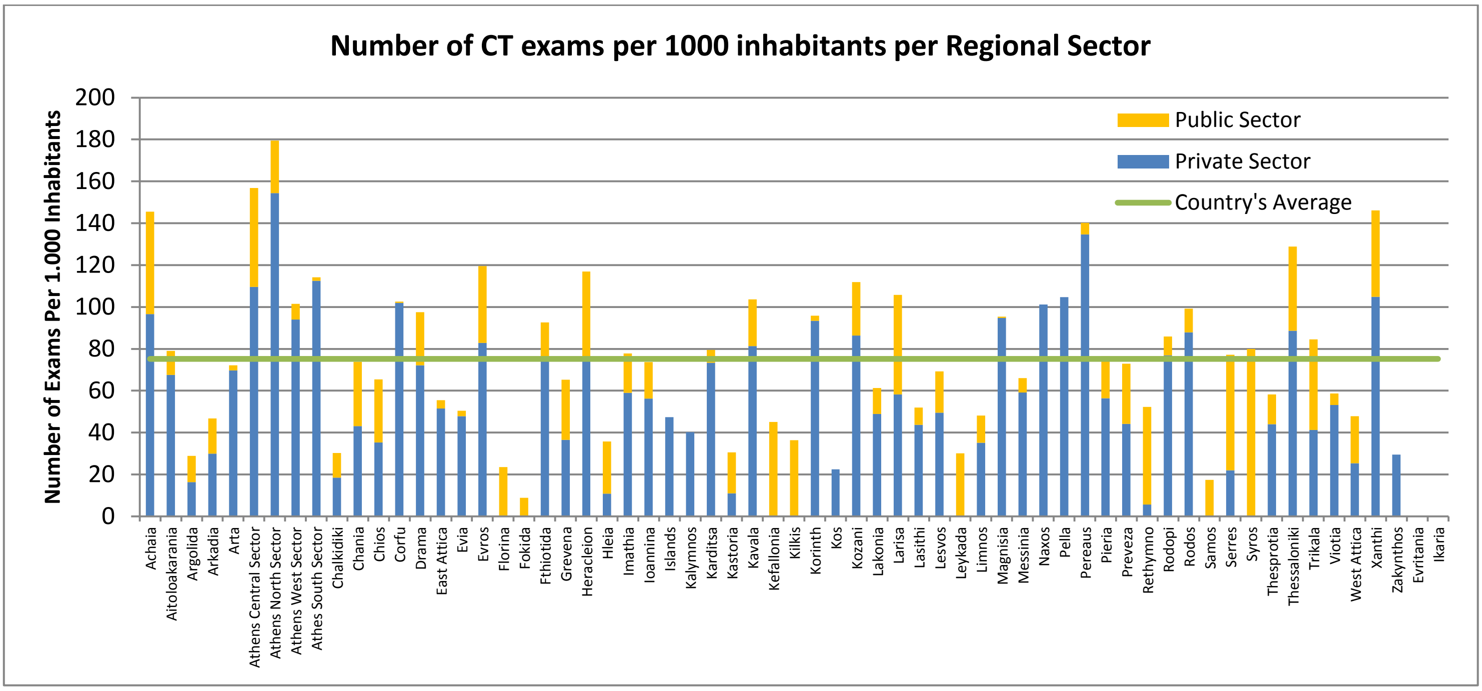

Figure 12 - Number of CT exams per 1000 inhabitants per count. Exams in Public Sector are depicted in Orange, exams in Private Sector in Blue. (Data for 2016 available from EOPYY)

In terms of number of exams, it is seen that higher number of exams per population appears mainly in areas where big cities are present (Achaia, Heraklion, Ioannina, Thessaloniki) and in the case of Xanthi. This is an expected result, since in most of the cases larger and more equipped hospitals are in these areas, receiving patients and providing services to population from the neighbouring regions. The same applies for Athens, but also for other areas as Larisa and the island of Corfu, Lesvos and Rhodes where neighbouring islands, as presented in the previous section, may not have any CT scanner available.

Time Evolution of the number of CT exams per 1000 inhabitants per Region (2013-2016)

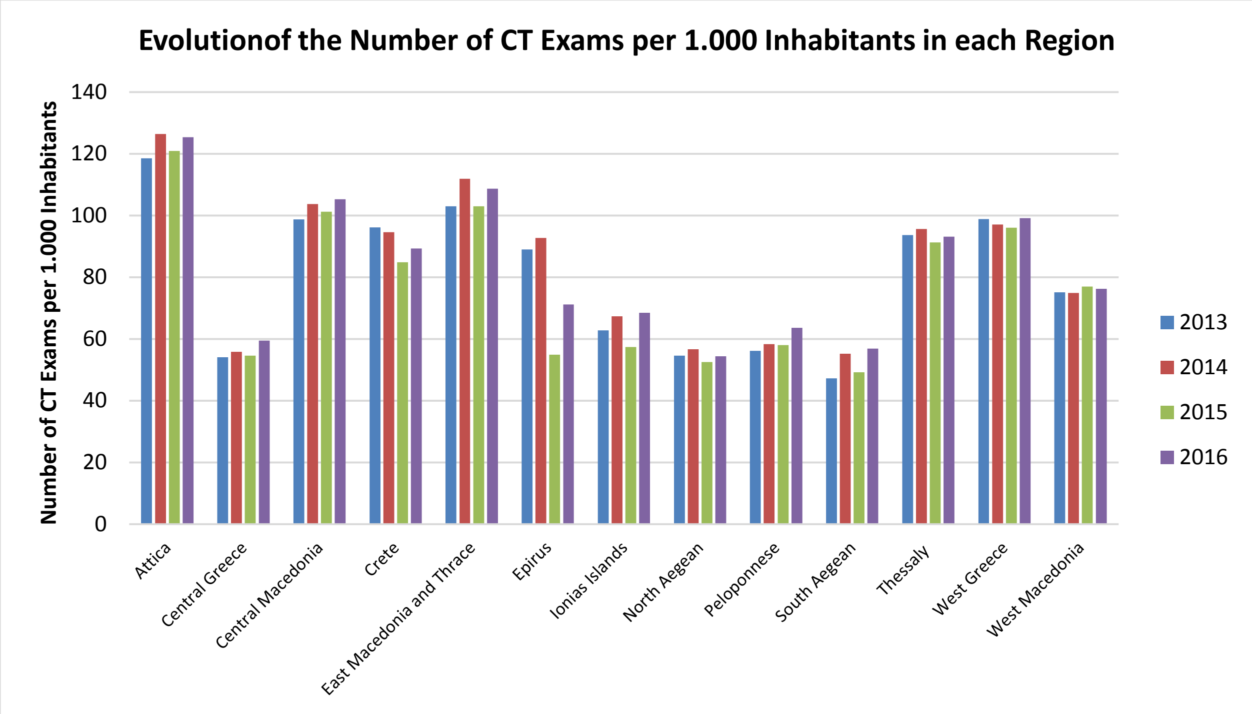

Figure 13 - Evolution over time of the number of CT exams per 1000 inhabitants in each region.
(Data for years 2013 to 2016 available from EOPYY)

The number of CT exams are relatively stable for the last 4 years, which is expected since CT imaging is a widely spread technology used for many years. It is the standard imaging technique for many cases and its use has been stabilized throughout the years. In term of regional distribution of CT use, the areas of Central Greece, Islands and Peloponnese are the lowest in terms of number of exams.

MRI

Regional distribution

The following Figure 14 presents the regional distribution of MRIs in Greece. MRI scanners' regional distribution is not as even as in the case of CTs. As it is seen the number of regional sectors without MRI is much higher; in total 17 regional sectors, 12 of which are islands and only 5 of them in the mainland.

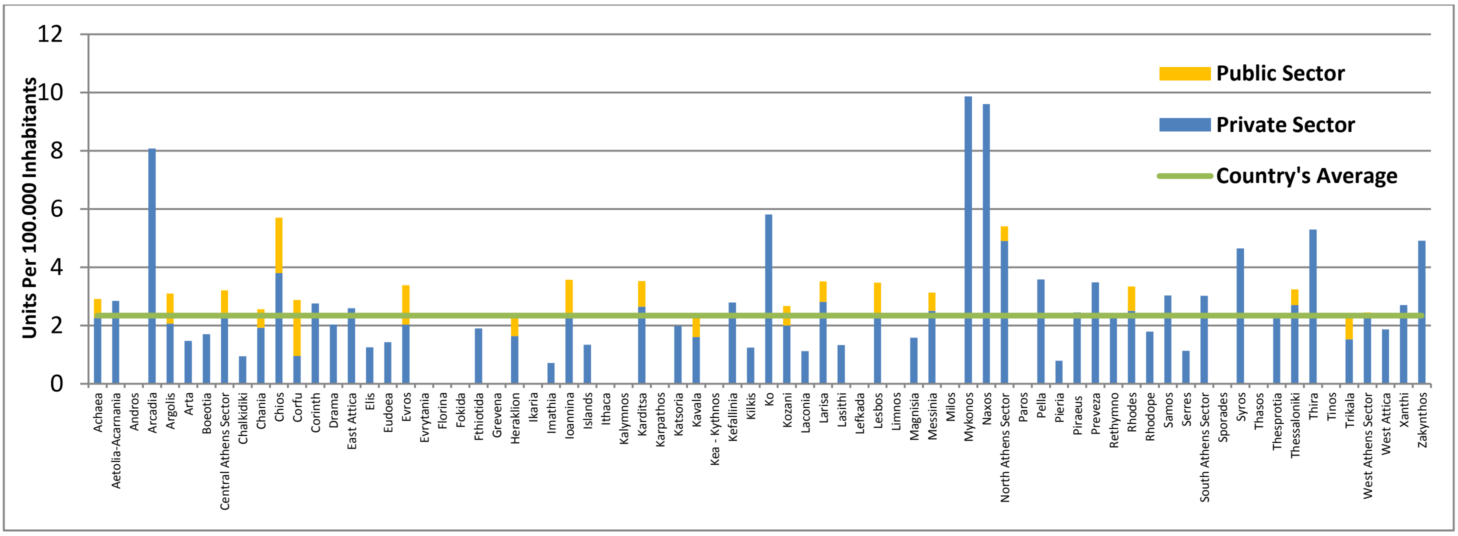

Figure 14 – Regional Sector Distribution of MRI Units per 100.000 Inhabitants (Data for 2017 from EEAE)

Coverage by the private sector in the case of MRI imaging heavily differs from CT, having 37 regional sectors that are fully covered solely by the private sector. This finding comes into accordance with the 90% market share of the private sector in the number and EOPYY reimbursements on MRI exams, as presented in the next section. The islands of Mykonos and Naxos have again a very high ratio of units per 100.000 and they are both 100% covered by private sector only. This high ratio may be justified, due to the high numbers of high income travellers.

As in the case of MMUs and CT scanners, Greece has one of the highest number of Units to population ratio compared to other EU countries.

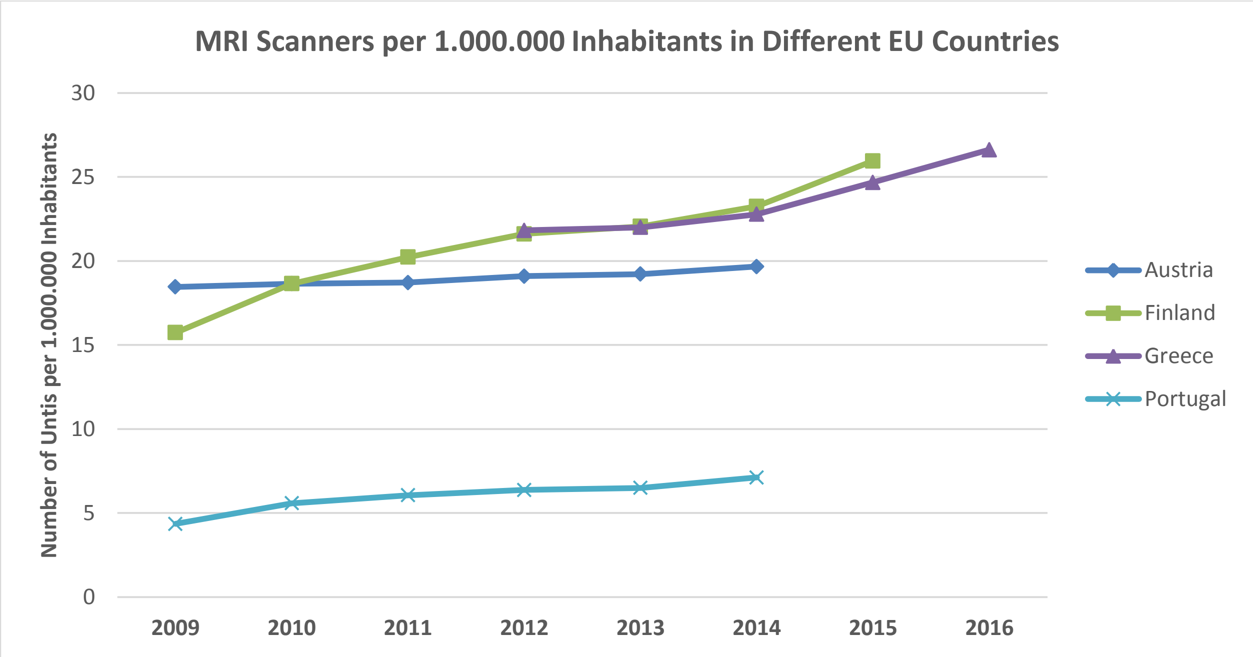

Figure 15 - Comparison of number of MRI scanners per 1.000.000 inhabitants between EU countries
(Data for EU Countries from OECD and for Greece from EEAE)

In Figure 16 a distribution of the installed units based on the strength of their magnetic field is presented. This figure is a good index for the technological status of the installed units.

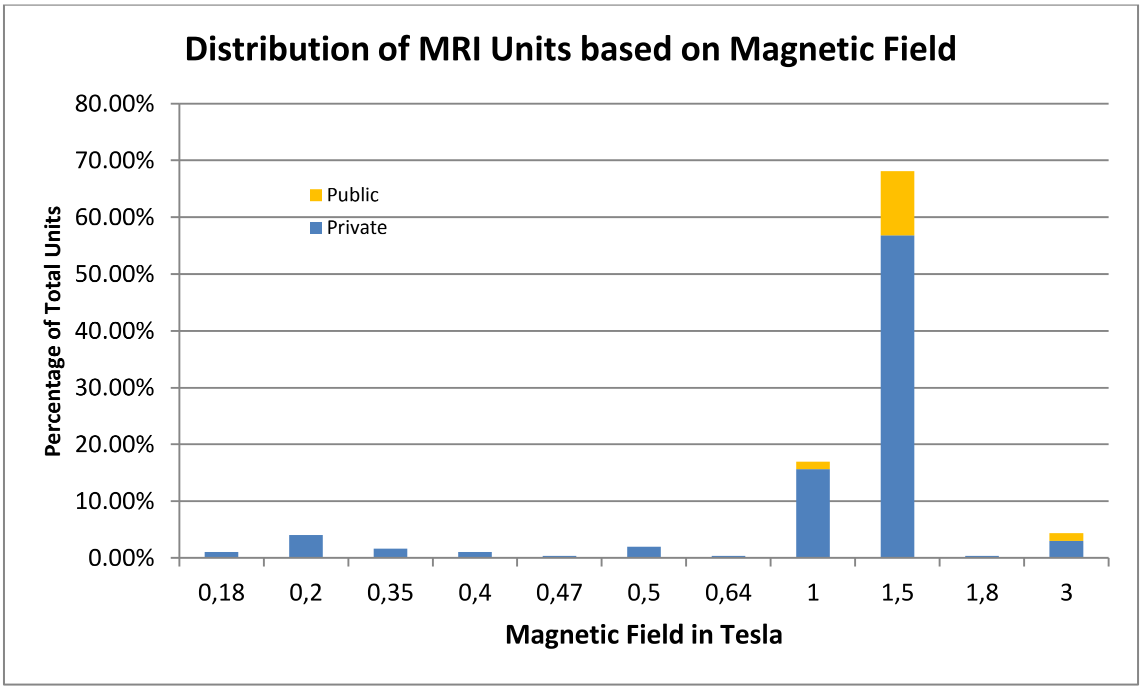

Figure 16 - Distribution of installed MRI Units based on the strenght of their magnetic field
(Data extracted from EAAE)

As it is known, although obviously not the only determinant factor, MRI scanners with stronger magnetic fields, have the ability to produce higher resolution images and implicate more advanced modern imaging techniques. In Greece approximately 70% of all installed

MRI units are 1.5 Tesla, 25% have a magnetic field of 1 Tesla or less, (most of them in the private sector), and only 5% use a stronger magnetic field, (3T) which is used mainly for research.

Use and Cost

In Table 5 the evolution of the number of MRI exams and the associated reimbursement cost are presented, from 2013 to 2016, based on data provided by EOPPY.

Table 5 - Analytical data, evolution and comparison concerning number of exams, installed units and costs reimbursed by EOPYY for MRI imaging. (Data concern 2013 to 2016 provided by EOPYY)

Year	# Exams / year					Number of Units	Average # Exams /Unit / Year
	Public		Private		Total		
2013	55.471	10%	496.049	90%	551.520	242	2279
2014	59.542	10%	535.316	90%	594.858	249	2389
2015	58.087	9%	557.350	91%	615.437	268	2296
2016	59.546	9%	614.365	91%	673.911	287	2348

Year	Total EOPYY Expenditure in € per year					EOPYY Charges Per Exam	
	Public		Private		Total	Public	Private
2013	13.069.053	15%	75.531.702	85%	88.600.755	236	152
2014	13.958.605	15%	81.694.905	85%	95.653.510	234	153
2015	13.766.343	14%	85.126.315	86%	98.892.659	237	153
2016	14.053.203	15%	76.843.713	85%	90.896.916	236	125

The use of MRI in the last 4 years follows a steady increasing trend. Since 2013 an increase of 22% has been recorded. This increase has been taken up mainly by the private sector, which is dominant in this modality.

In terms of cost, the mean reimbursement from EOPYY, for the private sector is almost 50% lower compared to the public. In 2016 the average prices were fixed to 236 € / exam in the public sector and 125 € / exam reimbursed from EOPYY to the private. Private's sector reimbursement represents 85% of the total amount private sector charges for an MRI scan, the rest 15% (approximately 20€) is paid by the patient.

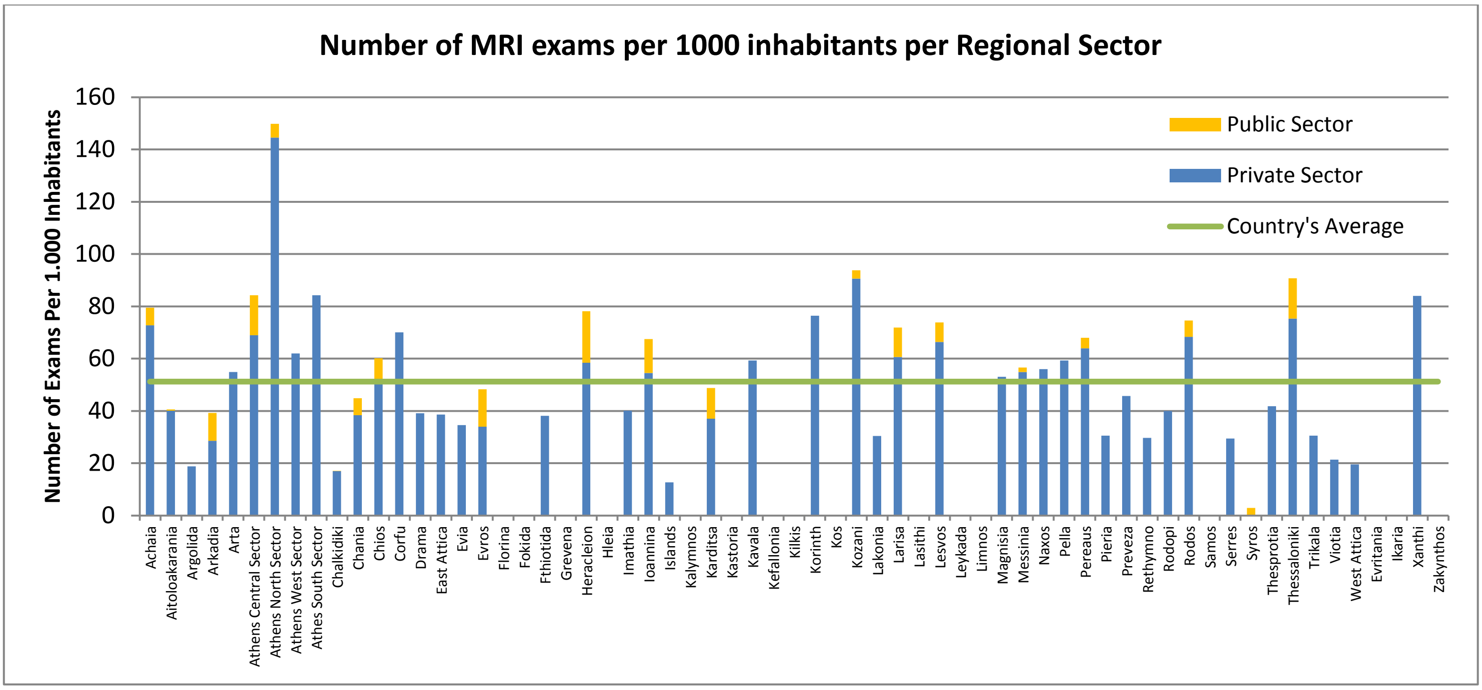

Figure 17 - Number of MRI exams per 1000 inhabitants per Regional Sector. Including RSs where no units are available. (Data for 2016 available from EOPYY)

In terms of exams per population ratio, as in the case of CT, regions with big cities are showing the highest scores. Again, this is expected due to the fact that they attract and serve part of the population of the close regions and not only the inhabitants of the Regional Sector in which they are installed. The market share presented above is also shown in this graph, indicating that the private sector is covering the vast majority of needs for MRI scans in the country.

As seen in the evolution of the number of MRI scans in the last 4 years shown in Figure 18, the number of exams is increasing. This is in accordance with the fact that, MRI scans have become faster and less expensive as the technology evolves.

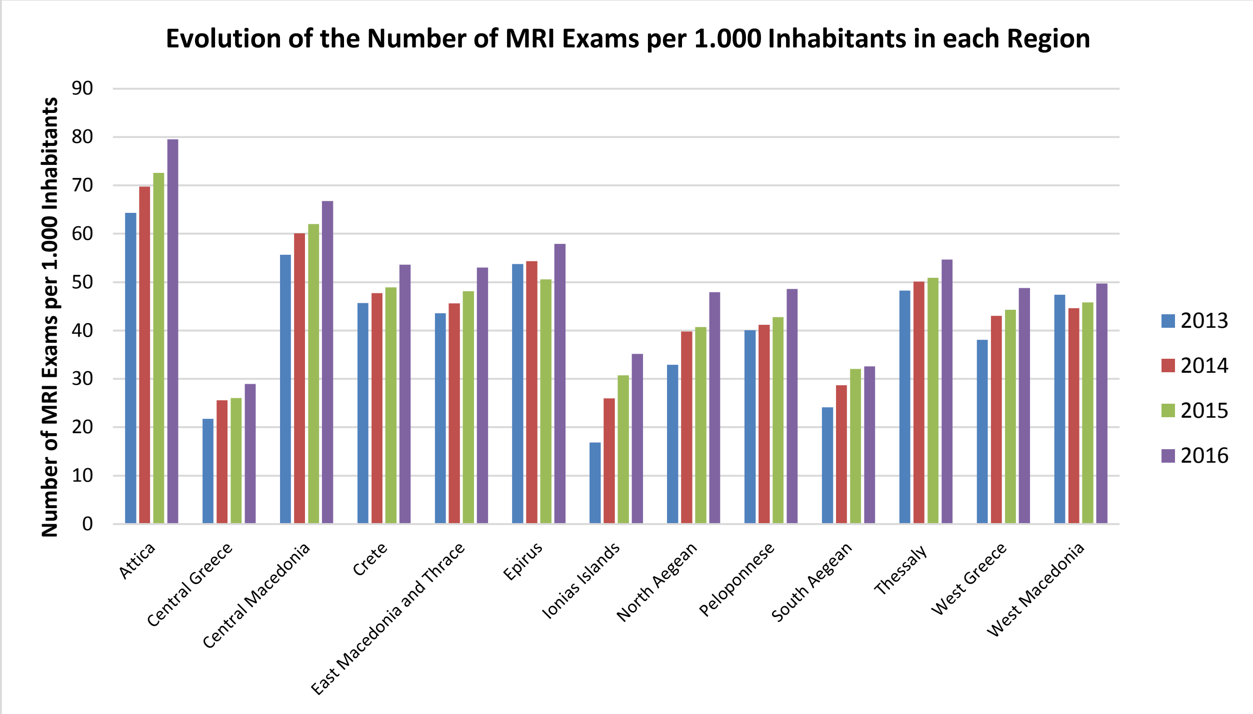

Figure 18 - Evolution over time of the number of MRI exams per 1000 inhabitants in each region. (Data for years 2013 to 2016 available from EOPYY)

The following Table 6 present the actual picture of installed units and number of units per 100.000 inhabitants for CT and MRI units in each Greek Regional Sector in 2017. All data come from the website of EEAE.

Table 6 - Absolute number and number of units per 100.000 inhabitants for CT and MRI units in each Greek Regional Sector (Data for 2017 available from EEAE)

Regional Sector	CT		MRI		Regional Sector	CT		MRI	
	Absolute Number	Units / 100K	Absolute Number	Units / 100K		Absolute Number	Units / 100K	Absolute Number	Units / 100K
Achaea	11	3,6	9	2,9	Ko	1	2,9	2	5,8
Aetolia-Acarnania	8	3,8	6	2,8	Kozani	6	4,0	4	2,7
Andros		0,0		0,0	Laconia	2	2,2	1	1,1
Arcadia	4	4,6	7	8,1	Larisa	11	3,9	10	3,5
Argolis	5	5,2	3	3,1	Lasithi	4	5,3	1	1,3
Arta	2	2,9	1	1,5	Lefkada	1	4,2		0,0
Boeotia	6	5,1	2	1,7	Lesbos	4	4,6	3	3,5
Central Athens Sector	51	5,0	33	3,2	Limnos	2	11,6		0,0
Chalkidiki	2	1,9	1	0,9	Magnisia	5	2,6	3	1,6
Chania	3	1,9	4	2,6	Messinia	4	2,5	5	3,1
Chios	4	7,6	3	5,7	Milos		0,0		0,0
Corfu	4	3,8	3	2,9	Mykonos	2	19,7	1	9,9
Corinth	4	2,8	4	2,8	Naxos	2	9,6	2	9,6
Drama	4	4,1	2	2,0	North Athens Sector	32	5,4	32	5,4
East Attica	13	2,6	13	2,6	Paros	1	6,7		0,0
Elis	4	2,5	2	1,3	Pella	6	4,3	5	3,6
Eudoea	5	2,4	3	1,4	Pieria	3	2,4	1	0,8
Evros	8	5,4	5	3,4	Piraeus	25	5,6	11	2,4
Evrytania	1	5,0		0,0	Preveza	2	3,5	2	3,5
Florina	1	1,9		0,0	Rethymno	3	3,5	2	2,3
Fokida	1	2,5		0,0	Rhodes	4	3,3	4	3,3
Fthiotida	4	2,5	3	1,9	Rhodope	3	2,7	2	1,8
Grevena	2	6,3		0,0	Samos	2	6,1	1	3,0
Heraklion	8	2,6	7	2,3	Serres	3	1,7	2	1,1
Ikaria	1	10,1		0,0	South Athens Sector	19	3,6	16	3,0
Imathia	4	2,8	1	0,7	Sporades	1	7,2		0,0
Ioannina	4	2,4	6	3,6	Syros	2	9,3	1	4,6
Islands of Attica	3	4,0	1	1,3	Thasos		0,0		0,0
Ithaca		0,0		0,0	Thesprotia	2	4,6	1	2,3
Kalymnos	3	10,2		0,0	Thessaloniki	37	3,3	36	3,2
Karditsa	4	3,5	4	3,5	Thira	2	10,6	1	5,3
Karpathos		0,0		0,0	Tinos		0,0		0,0
Katsoria	2	4,0	1	2,0	Trikala	3	2,3	3	2,3
Kavala	3	2,4	3	2,4	West Athens Sector	15	3,1	12	2,5
Kea - Kythnos		0,0		0,0	West Attica	5	3,1	3	1,9
Kefallinia	2	5,6	1	2,8	Xanthi	2	1,8	3	2,7
Kilkis	2	2,5	1	1,2	Zakynthos	2	4,9	2	4,9
					Total	401	3,7	301	2,8

CT & MRI Data analysis and Discussion

The positive impact of CT and MRI in early diagnosis of serious health diseases and the resulting improvement in the quality of care is widely acknowledged. These two modalities present also a good installation base in Greece. However only a few new, high-end scanners are available, approximately 70% of the total CT scanners installed are below 64 slices and 40% below 16 slices, indicating 40% rather aged units installed in the country. It is important to point out that although obviously old, these scanners can still have diagnostic value, when 3D volume imaging is not needed.

As it can be seen by the use and cost data, there are high discrepancies in the number of exams performed per 100.000 inhabitants in the different regional sectors. If we don't consider regional sectors with big urban areas and cities with university hospitals, which provide services to a larger population, CT exams range from a ratio of 10 to 145 and MRI from 5 to 95. This could be an indication of overuse, as for instance examples have been identified when a single CT unit seems to perform on average 10.000 exams per year or a single MRI unit 6.000 exams per year, compared to the mean value of 2700 CT exams per unit and 2350 MRI exams per unit in the rest of the country for 2016. This clearly demonstrates the value of reliable data to investigate potential abuse.

The number of the installed CT and MRI units in Greece, put the country on the top level in Europe. However according to a recent report published by the European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry (COCIR) in 2014 (COCIR, 2014), the installed base of diagnostic imaging equipment in many countries in Europe is becoming older and inequalities in access to these technologies are quite pronounced. The golden rule, according to COCIR, is that 60% of the installed equipment base should be younger than five years, 30% should be between six and ten years old and not more than 10% should be older than ten years. Although these figures could be partially questioned, because COCIR represent the industry, on an evidence based assessment approach, the fact that medical technology life-cycle is shortening, results in quicker outdate of high tech devices, which may become inadequate to support new medical guidelines and best practices. The above-mentioned report classifies Greece amongst the European countries with rapid and extensive ageing of CT and MRI equipment, with 20% and 25% of the installed base over 15 and 20 years old for CT and MRI respectively. Therefore, in Greece, in spite of the high number of installations, it seems that in terms of age the machines are quite old.

Due to missing information on the dates of manufacturing and putting into service of these devices in Greece, it was not possible to verify these figures. However, taking into account that in terms of number of installations, the differences are of the order of 10%. The parallel import of refurbished equipment by the private sector and the fact that there is no strict control of their technological conformance, age and operational status, is also resulting into this aging phenomenon.

The use of old machines may have negative consequences in the diagnostic results, since they depend on image quality and resolution and consequently to lower quality of services rendered to the patients. New scanners like for example the latest MRIs of 7 Tesla, that just got approval by both the EU and the FDA, are now able to clearly distinguish in high detail between the white and grey matter of the brain and in the near future should be installed in some large University Hospitals.

γ-Camera/SPECT

Regional distribution

Since the distribution of γ-Camera / SPECT units, is much sparser than the modalities presented before, and only few regional sectors have these facilities, the data are organized and presented based on the administrative region in which each unit is installed. A list of the administrative regions and the corresponding populations, based on which all units per inhabitant ratios were calculated, can be seen in Table 8. Health Regions (HR) are not used, due to the fact that Athens and Thessaloniki, are each one divided into two different HR (Athens 1st & 2nd, Thessaloniki 3rd & 4th), with vague and not clear geographical borders, making it almost impossible (or at least easily subject to errors) to define their exact population and the available equipment especially for the private sector.

Figure 19 clearly shows that some particular areas of the county, such as South Aegean, Central Greece and Peloponnese administrative regions, are heavily lacking γ-camera/SPECT facilities compared to the rest of the regions and the country's mean value.

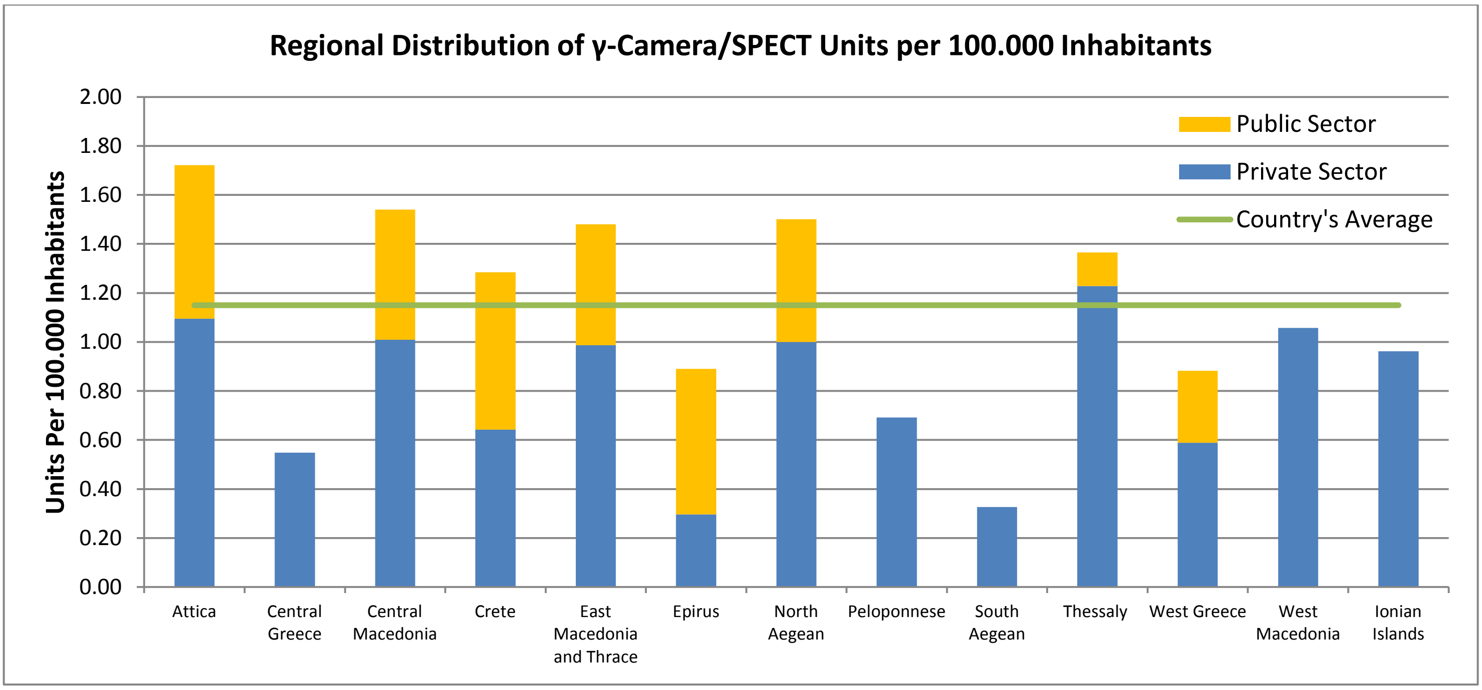

Figure 19 - Regional distribution of γ-Camera & SPECT units per 100.000 Inhabitants (Data for 2017 availiable from EEAE)

Especially for the case of Central Greece, this lack of facilities comes into accordance with the pattern seen in the number of exams in all the previously presented modalities, indicating that Central Greece is lagging behind in health care coverage. In all the three afore mentioned administrative regions and additionally the regions of West Macedonia and Ionian Islands, all the available units are installed in the private sector. As discussed before also for CTs and MRIs, it can be seen that in many islands of South Aegean, the private sector is dominant and is the only one that covers the relevant needs in these areas. Attica and

Central Macedonia have the highest number of units installed, which is expected since country's two bigger cities (Athens and Thessaloniki) are in these regions.

In Table 7 the analytical data for each region and sector can be seen.

Table 7 - Absolute number and number of units per 100.000 inhabitants for γ-Camera & SPECT units in each Health Region (Data for 2017 available from EEAE)

Administrative Region	Total Units		Private Sector		Public Sector	
	Absolute Number	Per 100K Inhabitants	Absolute Number	Per 100K Inhabitants	Absolute Number	Per 100K Inhabitants
Attica	66	1,72	42	1,10	24	0,63
Central Greece	3	0,55	3	0,55		0,00
Central Macedonia	29	1,54	19	1,01	10	0,53
Crete	8	1,28	4	0,64	4	0,64
East Macedonia and Thrace	9	1,48	6	0,99	3	0,49
Epirus	3	0,89	1	0,30	2	0,59
Ionian Islands	2	0,96	2	0,96		
North Aegean	3	1,50	2	1,00	1	0,50
Peloponnese	4	0,69	4	0,69		0,00
South Aegean	1	0,33	1	0,33		
Thessaly	10	1,36	9	1,23	1	0,14
West Greece	6	0,88	4	0,59	2	0,29
West Macedonia	3	1,06	3	1,06		
Total	147	1,36	100	0,92	47	0,43

List of Administrative Regions and their corresponding population are shown in Table 8. All data are based on census of 2011.

Table 8 - Regions' Population data

Regions	Population
Attica	3.833.272
Central Greece	547.390
Central Macedonia	1.882.127
Crete	623.065
East Macedonia and Thrace	608.182
Epirus	336.856
Ionian Islands	207.855
North Aegean	199.929
Peloponnese	577.903
South Aegean	306.644
Thessaly	732.762
West Greece	679.796
West Macedonia	283.689

Use and Cost

In Figure 20 the number of γ-camera / SPECT exams per 1.000 inhabitants is shown, distributed by administrative sectors.

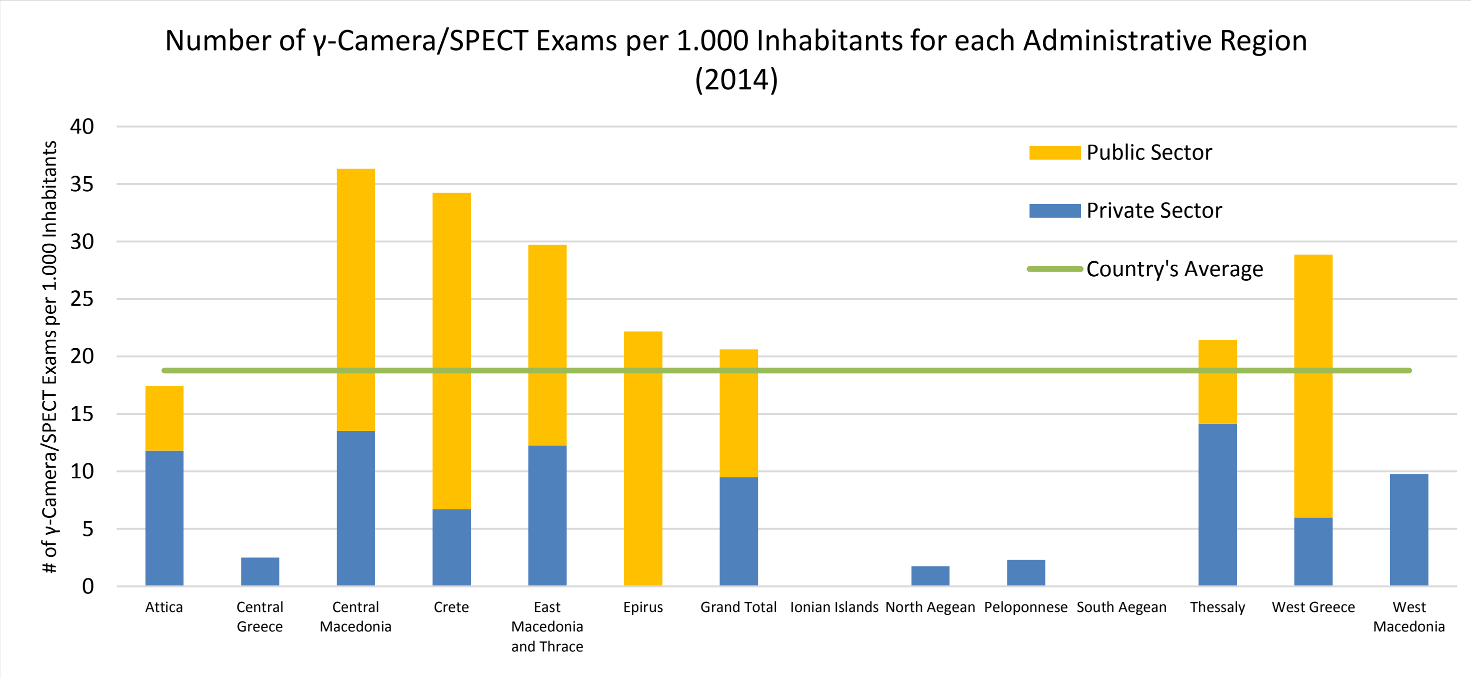

Figure 20 - Number of γ Camera/SPECT exams per 1000 inhabitants per administrative region. Exams in Public Sector are depicted in Orange, exams in Private Sector in Blue. (Data for 2014 available from EOPYY)

In terms of number of exams per region, there are some regions that clearly step out from the rest. These regions are Central Macedonia, East Macedonia and Thrace, Crete, and West Greece. This could be explained taking into account the cities that exist in these regions. Thessaloniki, Alexandroupoli, Heraklion and Patras respectively, are the only cities that have γ -Camera/SPECT units in their broad area, thus covering needs of population much bigger than the local.

These data are presented in administrative regions since the only data available have been using prefectures (previous Greece's Administrative Division). Explicit cost data for γ-camera are not available, especially concerning number and type of exams.

PET/CT

Regional distribution

In Figure 21 the number of units installed is shown. PET/CT units are only available in Athens and Thessaloniki.

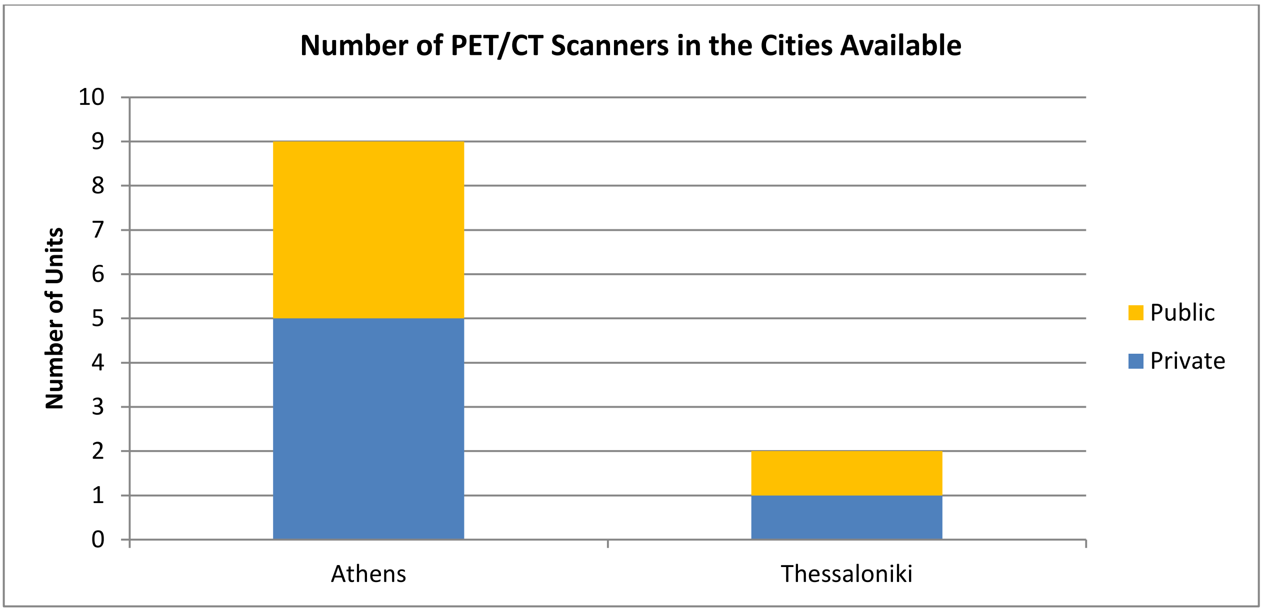

Figure 21 - Distribution of PET/CT units in absolute numbers (Data for 2017 available from EEAE)

This was expected; since it's an expensive technique first units were installed in Athens and then Thessaloniki, in order to cover the larger population possible, given that approximately 40% of the population lives in these two cities. According to the data available from EEAE, as it can be seen in Table 9, six out of eleven units are in the private sector. In Athens nine units are installed while in Thessaloniki only two.

Table 9 - Number of PET/CT units in each city that is available (Data for 2017 available from EEAE)

City	Private	Public	Total
Athens	5	4	9
Thessaloniki	1	1	2
Total	6	5	11

Use and Cost

In Table 10 the evolution of the number of PET exams and the associated reimbursement costs are presented, from 2013 to 2016, based on data provided by EOPPY.

Table 10 - Analytical data, evolution and comparison concerning number of exams, installed units and costs reimbursed by EOPYY for PET imaging. (Data for 2013 to 2016 provided by EOPYY)

Year	# Exams/ year					# Installed Units					# Exams/ Unit/ year?	
	Public		Private		Total	Public		Private		Total	Public	Private
2013	3.582	69%	1.574	31%	5.156	2	40%	3	60%	5	1.791	525
2014	4.493	63%	2.624	37%	7.117	2	33%	4	67%	6	2.247	656
2015	4.725	53%	4.257	47%	8.982	2	33%	4	67%	6	2.363	1.064
2016	5.542	49%	5.884	51%	11.426	5	45%	6	55%	11	1.108	981

Year	Total EOPYY Expenditure in € per year					EOPYY Charges Per Exam (€)	
	Public		Private		Total	Public	Private
2013	2.352.271	73%	854.318	27%	3.206.589	657	543
2014	2.815.375	66%	1.420.044	34%	4.235.419	627	541
2015	2.875.459	54%	2.427.515	46%	5.302.974	609	570
2016	3.197.965	53%	2.892.737	47%	6.090.702	577	492

The use of PET is steadily increasing, which is expected taken into account that the number of units for this modality recently almost doubled. The number of PET exams that have been done since 2013 has been increased by approximately 55%, with the market share in 2016 being evenly divided between the public and private sector. One possible explanation for the difference in the number of exams per unit between the public and the private sector, could be the big out of pocket cost.

In terms of installed units, the increase in the private sector is more pronounced, demonstrating that this sector is now investing in this technology. The number of scanners in the private sector has doubled from 3 to 6 between 2013 and 2016.

In terms of cost for the EOPYY, the difference between the mean reimbursement of each scan is approximately 15% in the case of PET, with the average price of 577 Euros for the public sector and 492 Euros for the private sector plus approximately 90 Euros paid by the patient. In both sectors EOPYY reimburses the full cost of the radiopharmaceuticals based on the invoice from the provider. It is apparent that the profit margin in this modality is higher for the private sector.

In Figure 22 the number of PET exams per 1.000 inhabitants in Athens and Thessaloniki is shown.

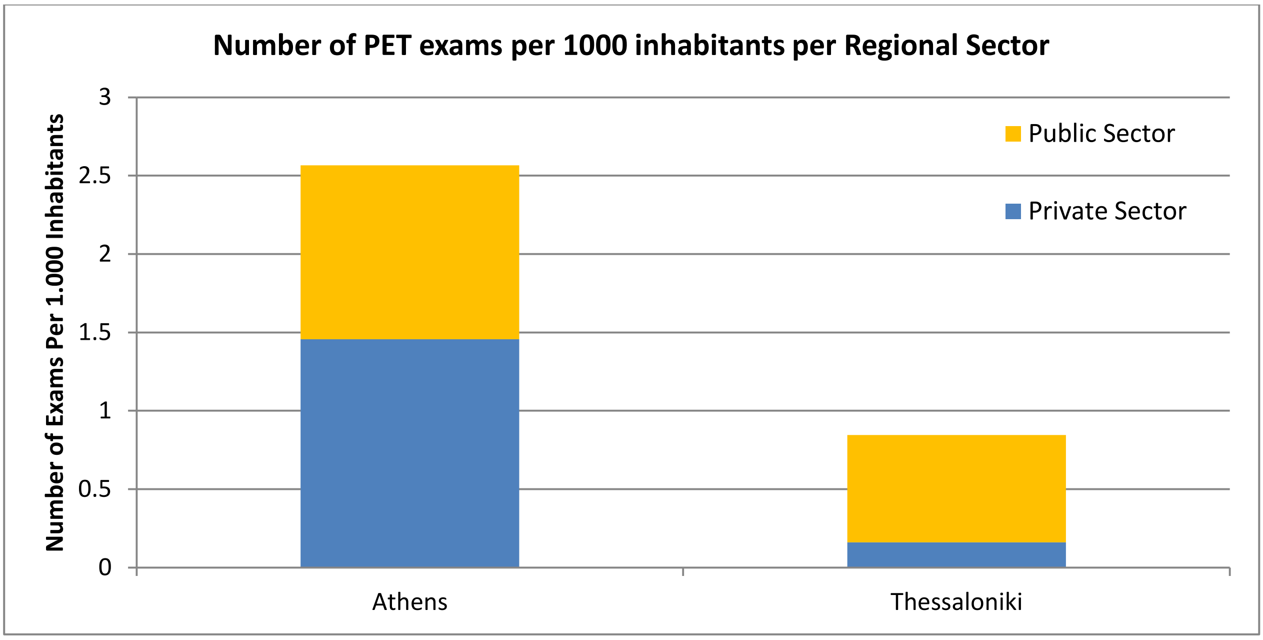

Figure 22 - Number of PET exams per 1000 inhabitants in the regions PET scanners are available. (Data for 2016 available from EOPYY)

Since the number of scanners installed in Athens is much higher than in Thessaloniki, it is expected that there will be a difference in the number of exams. The inequality seen in the number of exams between private and public sector in Thessaloniki, although there is 1 scanner in each sector, is explained by the fact that the scanner in the private sector was installed by the end of 2016.

As far as the evolution of the number of exams per 1.000 inhabitants is concerned, in Figure 23, it can be seen that there is a steady increase in the demand in the case of Athens, were the technology is available for more years and therefore the market is more stable. Since in Thessaloniki both PET scanners were installed in 2016 no evolution in time can be seen.

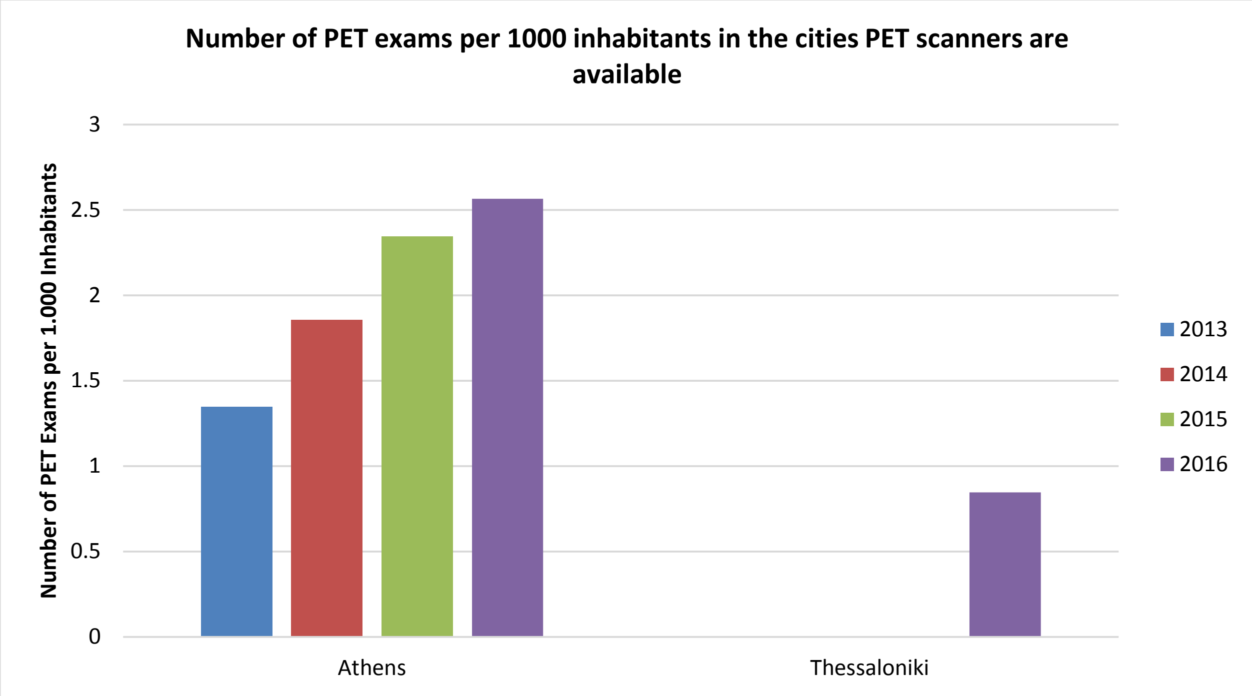

Figure 23 - Evolution over time of the number of PET exams per 1000 inhabitants in the regions PET scanners are available. (Data for years 2013 to 2016 available from EOPYY)

Nuclear Medicine Data analysis and Discussion

These modalities are also essential for early diagnosis and monitoring of an expanded range of diseases especially but not limited to functional imaging. In the domain of γ-Cameras and SPECT the number of installations in the public sector is very low. The private sector has more installed units covering half of total administrative regions, while the public sector is present in only eight out of them.

Regarding SPECT/CT and according to the Hellenic Society of Nuclear Medicine & Molecular Imaging (EEPI&MA), the great imaging value of this technology is underestimated in Greece. Although SPECT/CT is a powerful tool, only seven units are installed: four in Athens and one in Patras, Thessaloniki and Ioannina. Only one of them belongs to the private sector. This lack of equipment in the private sector is probably due to the high cost of equipment, combined with the low reimbursement by EOPYY.

PET installation started with a certain delay in Greece, compared to other EU countries, mainly due to the lack of the necessary short live positron emitting radioisotopes and radiopharmaceuticals. The situation today is close to the EU average and due to this delay the technology installed is quite new. However, there is only one supplier of radioisotopes, which leads to relatively high prices, as the market is monopolized. According to EEPI&MA, the cost of radiopharmaceuticals in Greece is amongst the highest in EU, while at the same time the reimbursement of the exams by EOPYY is among the lowest. EEPI&MA believes that a second isotope production site is necessary and in some cases isotopes should be produced within the hospital.

An increase in the number of PET units is expected to be seen in the following years. In fact, the installation of one PET unit, donated at the University Hospital of Patras, is in progress and three additional units accompanied by Baby Cyclotrons for radioisotope production, are included in the just announced donation of Stavros Niarchos Foundation to be installed in public hospitals. Therefore, the needs for PET scanners in the country will be met soon with the public sector keeping the leadership in this high tech medical imaging sector.

RT

Regional distribution

The distribution of RT units is very sparse in comparison with the other modalities presented before (except PET), and only few regional sectors have these facilities. Therefore the data are organized and presented based on the administrative region in which each unit is installed. The list of the administrative regions and the corresponding populations can be seen in Table 8. Health Regions (HR) are not used for the same reason as in the nuclear medicine, due to the fact that Athens and Thessaloniki, are each one divided into two different HR (Athens 1st & 2nd, Thessaloniki 3rd & 4th).

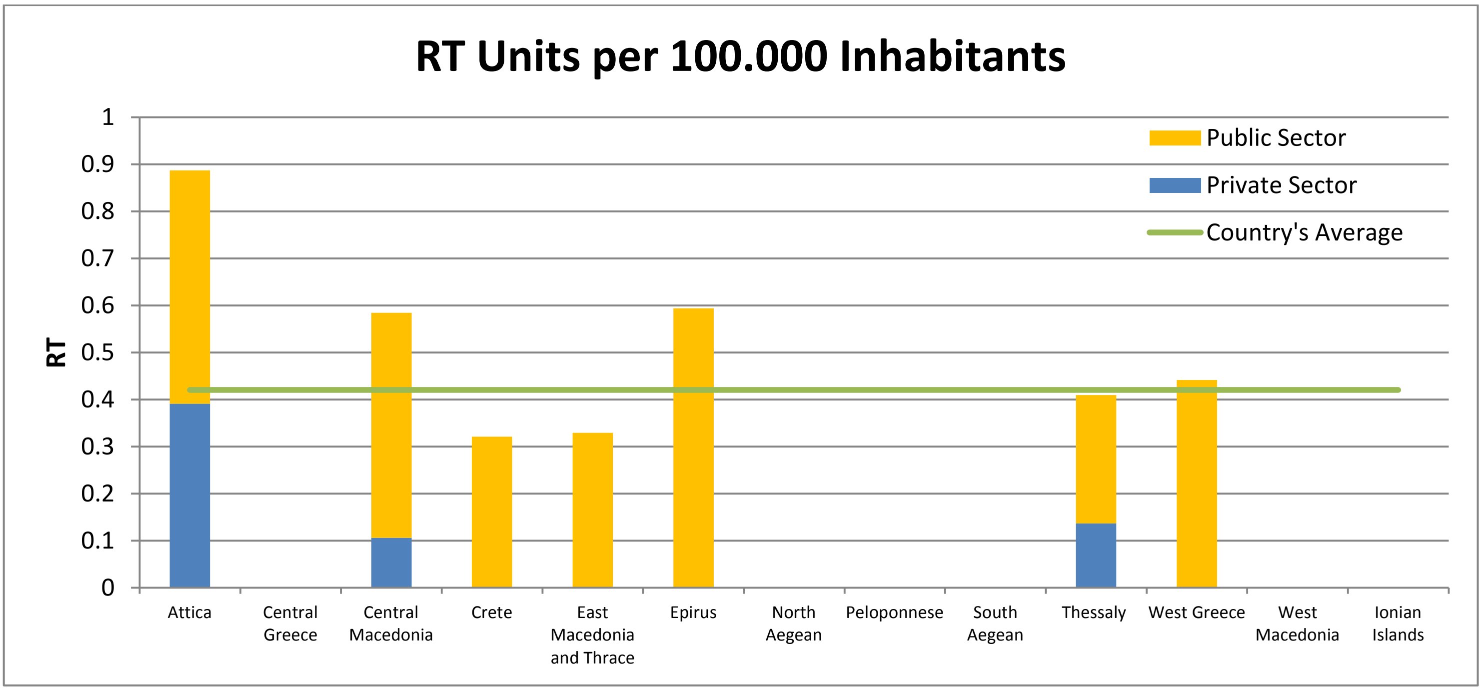

Figure 24 – Administrative Region distribution of RT units per 100.000 Inhabitants (Data for 2017 availiable from EEAE)

In Figure 24, the distribution of RT units in the different administrative regions of the country can be seen. As we can see there are 5 out of 13 regions that do not have any RT units. These regions are Central Greece, North Aegean, Peloponnese, South Aegean, west Macedonia and Ionian Islands. As commented before, Central Greece and South Aegean regions are again lagging behind compared to the other regions. Out of the seven regions that have RT units available, only three have units in the private sector, which is expected since RT facilities are very expensive and need dedicated infrastructures and dedicated specialized human resources and should be linked to cancer diagnosis and treatment facilities. On the other hand, RT units in public hospitals are available on all the other 7 regions. Athens (placed in the region of Attica) has the greatest number of radiotherapy units.

In total 57 RT units are available in the country, resulting in 0,53 units per 100.000 inhabitants' ratio, making Greece to meet the EU recommendations (Dunscombe et al., 2014). Out of these 57 units, 39 units are in the public sector and 18 units in the private. The exact number along with the technologies installed in each region can be seen in Table 11. It is important to point out, that technologies other than LINAC and Co-60, are available only in Athens.

Table 11 - Absolute number and number of units per 100.000 inhabitants for RT units in each Health Region (Data for 2017 available from EEAE)

Health Region	Total RT Units		Private Sector		Public Sector	
	Absolute Number	Per 100K Inhabitants	Absolute Number	Per 100K Inhabitants	Absolute Number	Per 100K Inhabitants
Attica (Athens)	34	0,89	15	0,39	19	0,50
Cyberknife	1	0,03	1	0,03		0,00
LINAC	22	0,57	11	0,29	11	0,29
Co-60	8	0,21			8	0,21
Tomotherapy	2	0,05	2	0,05		
γ Knife	1	0,03	1	0,03		
Central Macedonia (Thessaloniki)	11	0,58	2	0,11	9	0,48
LINAC	9	0,48	2	0,11	7	0,37
Co-60	2	0,11			2	0,11
Crete (Heraklion)	2	0,32		0,00	2	0,32
LINAC	2	0,32		0,00	2	0,32
East Macedonia and Thrace (Alexandropolis)	2	0,33		0,00	2	0,33
LINAC	1	0,16		0,00	1	0,16
Co-60	1	0,16		0,00	1	0,16
Epirus (Ioannina)	2	0,59		0,00	2	0,59
LINAC	2	0,59		0,00	2	0,59
Thessaly (Larisa)	3	0,41	1	0,14	2	0,27
LINAC	3	0,41	1	0,14	2	0,27
West Greece (Patras)	3	0,44		0,00	3	0,44
LINAC	3	0,44		0,00	3	0,44
Total	57	0,53	18	0,17	39	0,36

Although Greece meets the recommendations for RT units installed, the country has still a low ratio of units per 100.000 inhabitants, when compared to Finland and Denmark that have a more than 2 times higher ratio, as seen in Figure 25.

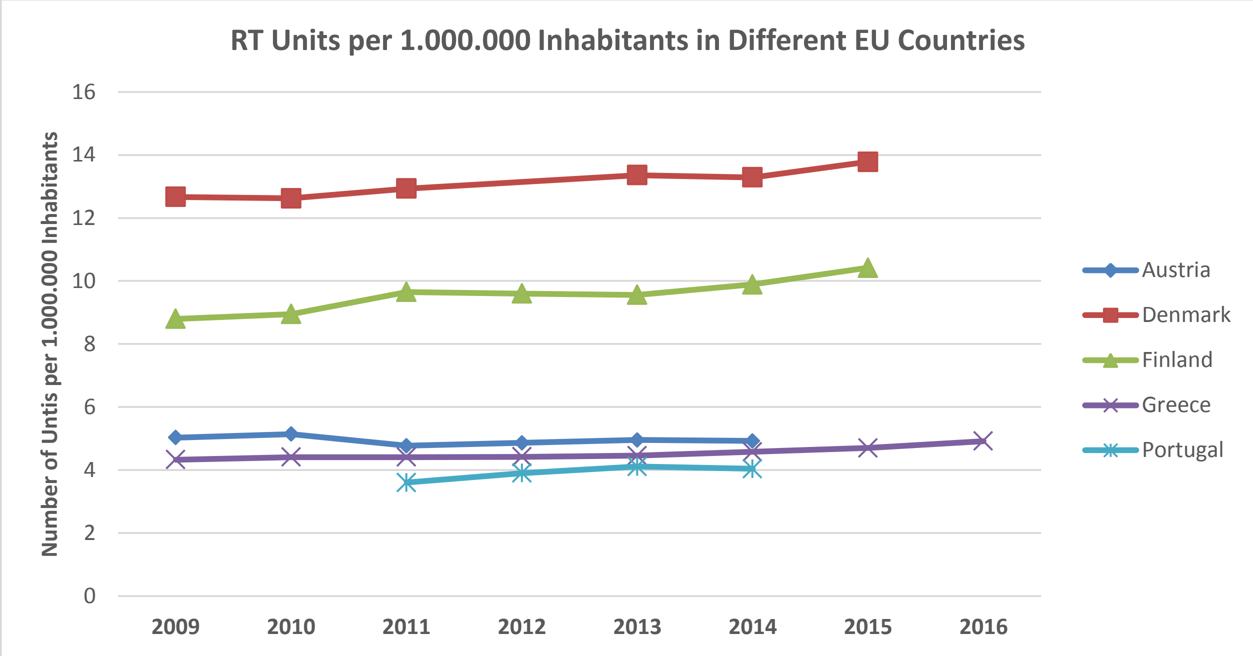

Figure 25 - Comparison of number of Radiotherapy units per 1.000.000 inhabitants between EU countries
(Data for EU countries available from OECD & fro Greece from EEAE)

Use and Cost

In Table 12 the evolution of the number of RT reimbursed acts and the associated reimbursement cost are presented, from 2013 to 2016, based on data provided by EOPPY.

Table 12 - Analytical data, evolution and comparison concerning number of acts, installed units and costs reimbursed by EOPYY for Radiotherapy acts. (Data for 2013 to 2016 provided by EOPYY)

Year	# Reimbursed Acts / Year					Number of Units
	Public		Private		Total	
2013	232.574	64%	132.986	36%	365.560	49
2014	248.409	61%	160.617	39%	409.026	50
2015	245.393	58%	174.443	42%	419.836	51
2016	233.892	57%	176.549	43%	410.441	53

Year	Total EOPYY Expenditure in € per year				
	Public		Private		Total
2013	18.564.495	50%	18.630.985	50%	37.195.480
2014	19.373.735	47%	21.625.454	53%	40.999.189
2015	19.416.459	44%	24.896.716	56%	44.313.175
2016	18.616.010	40%	27.935.467	60%	46.551.477

The situation in the case of radiotherapy (RT) is more stable. The number of RT acts, despite a few fluctuations, is more or less steady in the last 4 years. The market share also appears to be evenly distributed between the public and the private sector with a 57/43 ratio.

The relative distribution of radiotherapy acts per 1000 inhabitants per region in the year 2016 is shown in Figure 26. In this graph only the regions where RT units are available are shown.

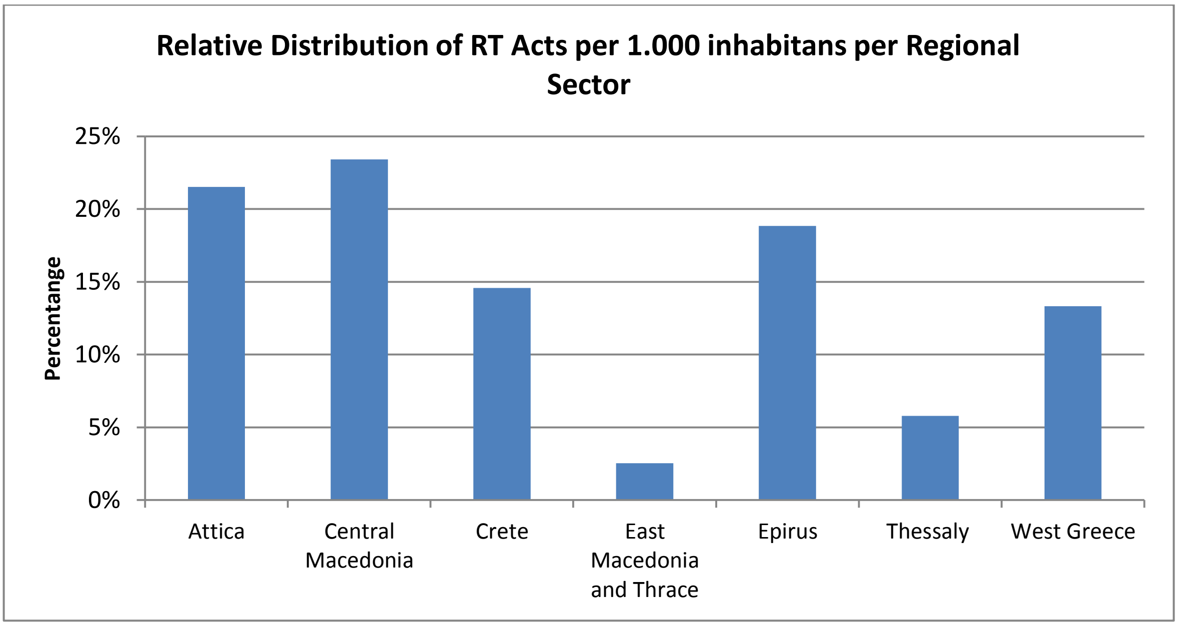

Figure 26 - Relative distribution of radiotherapy acts per 1000 inhabitants per region. Regions without RT facilities, are not depicted. (Data for 2016 available from EOPYY)

Central Macedonia and Attica have the highest percentages of acts due to the fact that they compensate for the lack of RT facilities in the regions around them. Some technologies such as gamma and cyber knife and tomotherapy are only available in Athens. The time Evolution of the number of Radiotherapy acts per 1000 inhabitants per Region, between 2013 and 2016 is shown in Figure 27.

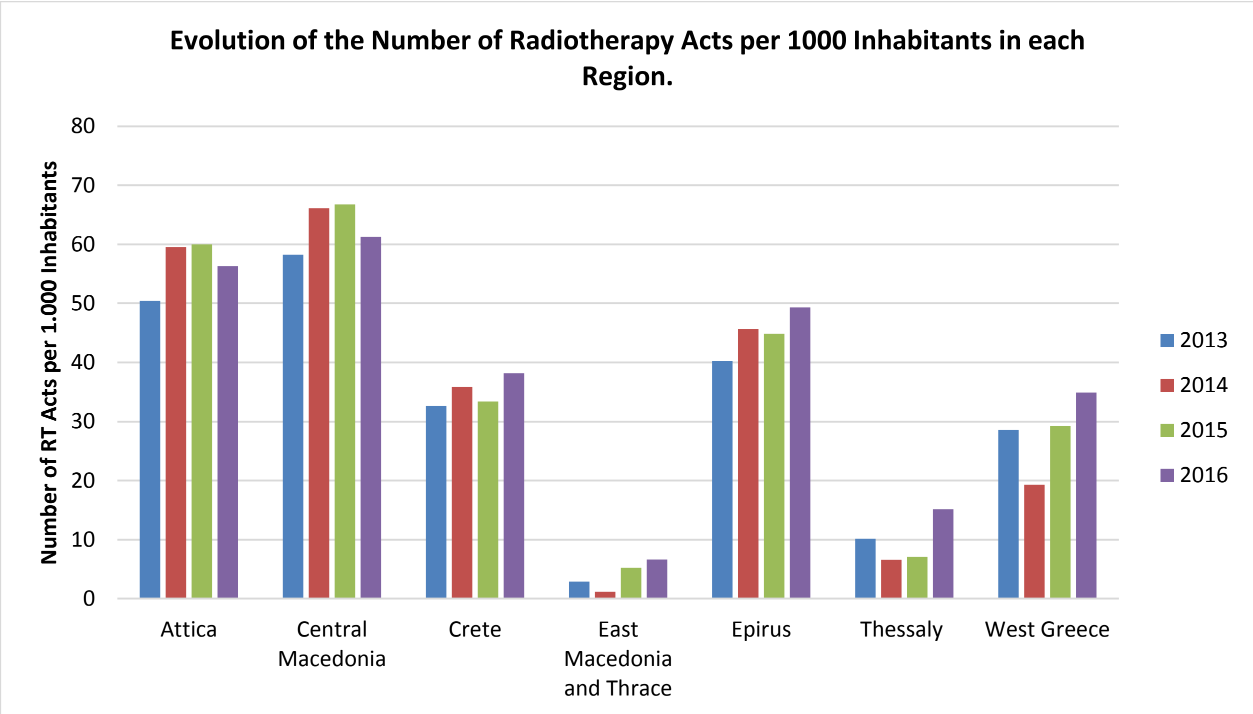

Figure 27 - Evolution over time of the number of Radiotherapy acts per 1000 inhabitants in each region. Regions without RT facilities, are not depicted. (Data for 2016 available from EOPYY)

The number of acts has an increasing trend in all regions where RT units are available, except for Athens (Attica) and Thessaloniki (Central Macedonia). In these 2 regions although there was a steady increase from 2013 to 2015, during 2016 there is slight drop in the number of acts, which may indicate a lower number of patients moving to these cities from other regions.

Data analysis and Discussion

All Radiotherapy Departments in Greece, both in the private and public health sectors, are licensed according to the national law of Radiation Protection (EEAE, 2001) and are closely supervised by the EEAE in terms of radiation protection and compliance with quality and safety regulations for radiotherapy treatments. Common practice for the lifetime of treatment machines, at 8-15 years, appear not to have changed over the last decade. In Greece until 2016, the vast majority of the radiotherapy equipment (mainly linear accelerators and Co-60 units) of the public sector, was more than 15 years old. In 2017, this situation has radically changed, thanks to the donation from Stavros Niarchos Foundation of 10 new linear accelerators replacing the old ones in 7 public Hospitals. All of them will be in clinical operation until the end of this year.

Concerning the important issues of accessibility and availability in radiotherapy equipment, the European directive, which is based on the corresponding ESTRO (European Society of Radiotherapeutic Oncology) and EFOMP (European Federation of Organizations for Medical Physicists) guidelines, considers that at least 1 Radiotherapy equipment should be available for every 200.000-250.000 inhabitants. Taking into account that Greece has 11.4 million inhabitants, it is evident that Greece should have at least 45-50 Radiotherapy Machines. Therefore it should be concluded that in terms of number of units the guidelines are met.

Staff levels however, are far below the European standards and guidelines for both private and public health sectors. As far as Medical Physicists are concerned, according to HAMP, the New European Directive 2013/59/EURATOM, on basic safety standards for protection against the dangers arising from exposure to ionising radiation, includes a number of articles related to the medical physics profession and competence requirements (articles 14 and 18) and actually details the tasks required for experts in medical exposures and radiation protection that are pertinent to the roles and responsibilities of the medical physicist; namely the Medical Physics Expert (MPE) and the Radiation Protection Expert (RPE) (Greek Government, 2017). Greece like all EU Member States must transpose this European Directive into the national legislation by February 2018.

According to HAMP, under-staffing is one of the reasons that lies behind the finding that, while in Europe and in USA, radiotherapy is the primary treatment for more than 60% of the cancer patients, this percentage in Greece is 30% (Atun et al., 2015). As a result the health system in Greece is forced to pay more expensive treatments (e.g. surgery and extensive chemotherapy), which at the same time is less effective.

A structural problem should also be mentioned. The fact that most of the centres have only one or two RT machines is resulting in high overhead cost for the accompanying equipment; while at the same time the wide spread of equipment critically affects the patient's treatment. In fact 28 LINACs are installed in 15 Public Sector's RT departments, in 7 big Greek cities. Out of them 4 have only 1 unit, 10 have 2 units and only 1 has 3 units. Having single unit RT departments, in cities where other public RT departments also exists, is not effective in terms of organisation and service provided. A reorganisation in bigger radiotherapy centres, could lead to serious resource savings and improvement of treatment provided.

GENERAL ISSUES

Medical devices are used today in virtually every health care delivery process. As diverse as medical devices are, so are the range and complexity of problems that can arise from their use. These problems include mechanical failure, faulty design, poor manufacturing quality, adverse effects of materials implanted in the body, improper maintenance/specifications, user error, etc. Whether equipment is used for diagnosis or therapy, the healthcare facility should ensure that the equipment is performing as intended by the manufacturer. Additionally, the uncontrolled use of technology in medicine can also result in increased costs of delivering healthcare services. Therefore, the need to develop a proper infrastructure for evaluating, supporting and managing biomedical technology has become evident. In Greece there is lack of reliable information related to medical devices, including the technologies addressed in this study. In the following sections, there are some general facts and comments related to this issue as well as to maintenance and staffing.

Regional Distribution

As it is presented in annex 7.4: There are 4 regional sectors, Ithaca, Kea/Kythnos, Thasos and Tinos that have none of the investigated HVCE modalities. Among the rest RSs, 3 have only MMUs and another 10 have both MMUs and CT scanners. All three modalities (MMUs, CT and MRI) are available in only 22 out of 74 RSs.

Further analysing the distribution of the three most common modalities, we see that MMUs are not present in 4RSs, the lack of which is covered with mobile MMU operated by the Hellenic Cancer Society. Only private sector exists in 14 RSs, while only public sector is available in 3. In all the rest RSs both sectors provide this modality. CT scanners are not available in 7 RSs. Only private sector is available in 9 RSs and in another 5 only public sector exists. In the rest 53 RSs both sectors provide this modality. There are no MRI units available in 17 RSs, while in the rest only private sector is present in 37 of them and there are in total 20 RSs that both sectors are present.

As far as nuclear and RT facilities are concerned, γ-Cammera/ SPECT units are available in 25 regional sectors, RT is available in 10 and PET is available in only 4 RSs, which practically means in the two major cities of Greece (Athens and Thessaloniki).

Concerning the share between public and private sector: PET and RT are available only in big urban areas with the public sector having very good presence in these two modalities, especially in RT where it clearly precedes the private sector. Concerning γ-Camera/SPECT units are not available in 39 regional sectors, while in the rest RSs, only the private sector is present in 23 of them. Eventually only in 12 RSs there is coverage from both public and private sector.

In conclusion four major facts can be pointed out:

1. 4 RSs don't have the investigated HVCE modalities (Ithaca, Kea/Kythnos, Thasos, Tinos)
2. 3 have only MMUs and no MRI or CT scanners (Andros, Karpathos, Milos)
3. 4 RSs have only 3 modalities (MMU, CT, MRI) and all of them are available only in the private sector (Ko, Mykonos, Preveza, Thira)

4. In 5 RSs, only private sector is available in CT and MRI (where these are present)

Strategic planning of investments in HVCE:

Strategic Planning for HVCE is essential for a better coverage of needs, through prioritisation of actions for the best use of available resources. The most important step in this procedure is the needs assessment for medical devices, at all levels of the Health care sector. This issue is addressed in details in the *Needs assessment for medical devices* book, published by WHO within its Medical device technical series. In brief, it proposes a seven-step procedure, with five of them being related to baseline information on: health service requirement, health service availability, medical devices, human resources and finances. The next step is dedicated to analysis and interpretation and the final one to prioritization, appraisal of options and implementation. Following this procedure, prioritization of needs and final decisions are evidence based. The emphasis on the importance of information and data is very clear.

The implementation phase is also very important in order to well specify the technology requirements according to the real needs. One of the most critical parameters is the preparation of the functional and technical specifications, as well as the terms and conditions for warranty, maintenance and user training. For high value capital equipment, as the group of the technologies addressed here, this task should primarily be fulfilled centrally, in order to guarantee the best outcomes in terms of quality and costs. The installation issues should also not be neglected and acceptance testing is essential for quality and safety reasons, prior to putting into service and use.

In general Strategic investment planning, correct maintenance and management of medical technology should become a priority. Control in high tech and value capital, in terms of equipment acquisition, distribution, performance, maintenance procedures and safety, are essential and should be reorganised.

Lack of Reliable Data

Data on purchase price, maintenance cost per year, downtime and the actual use of the devices are lacking. Therefore, it was not possible to calculate the median age of the installed bases, their value, annual service costs, annual use, estimate potential underuse of the machines and calculate incremental cost of corrective actions. Without adequate data and information, evidence based decisions are not possible. During the last 3 decades, Computerized Maintenance Management System (CMMS) for medical equipment are used world-wide providing all necessary data for a cost-effective management and evidence based decisions.

Another issue is related to information concerning the parallel import of refurbished equipment by third parties. This concerns mainly the private sector and although its extent could not be estimated in numbers, it is adding negatively to the ageing problem, since these devices are already more than 5 years old when they start to be used in Greece. At the same time, apart from the control and licensing of EEAE, there is no clear procedure to certify that these devices continue to comply with the EU 2017/75 regulations in terms that they function as intended by the manufacturer.

Maintenance:

Aggregated data on maintenance costs of HVCE in the public sector are not available. Most of the hospitals have maintenance contracts with the equipment providers that are however negotiated on a case-by-case basis and the actual costs are not known. As a general rough estimate, the assumption of a cost of 8 to 10% on the initial equipment purchase price per year could be used. Maintenance and repair issues are becoming more critical as the equipment becomes older. After the initial 3 to 5 years period during which the maintenance is usually well defined in the procurement agreement, in many cases price negotiations are under the control of manufacturers.

It is necessary to apply modern computerised tools for medical equipment management (like CMMS) which include functional inventory) available since the late 80's, but installed in just a few Greek hospitals. The advantages of such systems are multi fold. They provide a complete and updated inventory at any time, with at least the following essential information: make and model of each machine, its value, the annual maintenance costs, the weekly operating hours and the number of uses. With such a system the data collected within this study that required a lot of effort and could not be 100% verified, would be available instantly to the Ministry of Health. Additionally, such systems are essential for vigilance purposes, evidence based decisions on replacement and control of service providers (i.e. in terms of response time, cost, respect of service contract rules) amongst many others.

Staffing

Modern health care delivery is today definitely based on a team approach. Apart from medical doctors a number of other professionals are involved in most cases. Medical physicists, Radiographers and other technologists, nurses and Biomedical/Clinical engineers are directly involved in the everyday activities. Adequate and balanced staffing of the departments providing diagnostic imaging and RT services is necessary. Additionally, the rapid technological developments, leading to the introduction of new or improved devices at an extremely high pace, impose lifelong learning and continuous training of all these professionals. Healthcare systems should guaranty the level of knowledge and skills of the staff through certification procedures, as well as provide means and facilitate conditions towards this aim.

Professional associations should play an important role in this procedure and assessment should become a priority for all. It is very important to convince staff members that the whole procedure aims to improve quality and safety and provide better diagnosis and treatment to the patients.

CONCLUSIONS AND RECOMMENDATIONS

General Conclusions

Uneven geographic distribution of HVCE is a problem in many EU countries, resulting in inequalities in access for people living in rural and remote areas. Greek landscape with tens of islands and difficult to access mountainous areas is a major concern for health care delivery. According to the findings of the present study, the installed base in Greece of the medical equipment categories covered, is above the European average. However, in terms of distribution, apart from mammography, these technologies are mostly installed in large urban areas. The private sector is more present than the public and in some smaller cities in central Greece and some islands is the only provider of diagnostic imaging services with CT and MRI. Especially the Aegean Sea islands are not well covered and in most of them there is a lack of modern diagnostic imaging equipment. As far as Radiotherapy is concerned, it is available only in 7 big cities and it is the only case where the public sector is dominant. Finally, PET is available only in Athens and Thessaloniki.

There is no data centrally available concerning medical equipment in general, due to the lack of a continuously updated inventory and the situation is similar for the information concerning the maintenance, age and actual use of the devices. The EEAE database on Medical Radiation installations, although well-structured and publicly available, provides information basically related to radiation safety and licensing purposes. This lack of information did not allow calculating critical indicators, like the median age of the installed equipment, in the context of this report. Estimations based on other sources indicate that in most cases the average age of these machines is higher than the optimum. Maintenance cost information in the public sector is not available, although it is quite high since it can range from 5 to 12% of the equipment purchase price. Sources for reliable information are generally needed, in order to be able to estimate potential underuse, unjustified high management costs or calculate incremental cost of corrective actions. Without adequate data and information, evidence based decisions are not possible.

Concerning the use and costs issues related to these technologies, EOPYY uses a quite comprehensive information system for reimbursement purposes that provides reliable data on the acts performed and the associated payments. However, this represents only the part of the acts reimbursed by the organisation. The rest, covered either out-of-pocket, or by private insurance, remains unknown. Based on EOPYY's data it seems that some areas are overusing diagnostic means while others are underusing, even when the technology is available. In general prescription of diagnostic tests is still not based on clinical guidelines and best practices, which leaves room for over prescription, unnecessary exams with associated costs and burden, but also may lead to potential harm to the patients.

Additionally, EOPPY does not differentiate enough the reimbursement costs according to the technological status of the equipment used in the diagnostic exams, a fact that encourages the private sector to keep using older and less performing machines. This is also reflected in the parallel import of refurbished equipment by the private sector. The fact that there is no strict control of their technological conformance, age and operational status, may lead to lower quality of services rendered to the patients.

Appropriate staffing is also considered as a problem in many cases. Particularly in the Radiotherapy departments there is a discrepancy between the actual number of staff employed (especially non-medical) and the recommended by (already approved) EU guidelines. Additionally, no system for continuous training and lifelong learning and no monitoring and evaluation scheme for staff competences, where appropriate, exist.

Concerning the strategic planning for investments in new HVCE it is not well defined and decision-making is not evidence based and transparent in the public sector. The private sector follows its own approaches, based on market analysis and assuming a stable state policy, which is not the case this period.

Recommendations

Although this report covers only part of the HVCE, the recommendations below apply to all technologies of this category and even to the broader medical equipment related technologies. Improvement of HVCE investment planning is a critical factor for health care systems, in order to be more cost effective and able to respond to patient needs in the most efficient way. Therefore, HVCE should be installed and used according to well-defined criteria, needs assessment analysis and priority settings, at all levels of the National Health System. Greece should develop its Health Technology Assessment (HTA) capacity, as suggested by the WHO Mission report on Health Technology Assessment in Greece (World Health Organization, 2016b), including Medical Devices (MDs). Rapid assessment and hospital based HTAs are very powerful tools into decision making for this type of technology. It is recommended to establish a working group on HTA for MDs, within the framework of the HTA mechanisms to be put in place by the end of this year, aiming at: Facilitating information exchange and enhancing collaboration between stakeholders with an interest in MDs HTA, organizing translation or commissioning adaptations of existing HTA reports, to the Greek context and creating and maintaining a database of relevant reports.

Evidence based decisions for HVCE procurement, in the public sector, should be promoted at all levels. Involvement of scientific/professional societies and other stakeholders should be encouraged in an open dialog procedure. Technical specifications should be provided centrally, cover various needs, depending on the size and nature of the hospital, and be annually updated. Rules and restrictions for parallel import of refurbished equipment should be established.

Availability of reliable data on the technology installed is absolutely necessary for correct decisions on technology procurement, management and replacement. A well-structured medical equipment inventory is essential in order to have an immediately available, clear and updated picture of the technology in use, in both the public and the private sector. A basic data set of information (including equipment make and model, value, age, technology status, etc) should be provided by all hospital, clinics or diagnostic centres, for their entire HVCE installed base, in order to get reimbursement. The decision for an international nomenclature system, which should comply with the new EU regulation of medical devices, is expected to be taken by 2020. This nomenclature system which should be enforced and translated in Greece, is additionally essential for MD vigilance purposes.

The new Medical Devices Regulation (MDR) themselves, were adopted on 5 April 2017 and they entered into force on 25 May 2017 (EU) 2017/745, replacing the Medical Device Directives (MDDs). They will become in full force after 3 three years transitional period. However there a number of critical actions to be undertaken by the authorities during that period, in order to assure a smooth from the directives to the regulation. Amongst others, the MDR requires improved transparency and traceability for MDs based on Unique Device Identification, the reinforcement of the rules on clinical evidence, including an EU-wide coordinated procedure for authorisation of multi-centre clinical investigations, the strengthening of post-market surveillance requirements for manufacturers, but also improved mechanisms from the EU countries in the fields of vigilance and market surveillance. A detailed action plan is should be prepared (if not already done) and the necessary actions be carefully implemented, to be ready to work under this new regulatory environment.

The absence of Biomedical/Clinical engineering departments in most Greek hospitals is a great obstacle in the effective and safe management of medical technology, resulting in incomplete records and no maintenance quality and cost control. Maintenance of HVCE and the relevant costs should be followed, using modern computerized systems in all hospitals of the public sector. This is essential for the overall management of medical equipment in use. Such systems are available, but are actually used in a very limited number of public hospitals. Maintenance services should also be regulated in terms of technicians' experience, skills and certification required to perform these tasks. External service providers should employ certified and adequately trained technicians, for what they should be accountable.

The adoption and use of international best practices and clinical guidelines should be regulated in collaboration with the relevant medical societies. Apart from the direct benefits for the patients, this would also reduce the induced demand for unjustified prescriptions and the related costs. Data on non-reimbursed exams by EOPYY, should be made available by the private sector, in order for the health authorities to have a complete picture of the performed diagnostic and therapeutic acts that are not registered elsewhere.

Staffing of the relevant departments using HVCE should also be regulated taking into account best practices and guidelines, and according to the EU regulations and Directives. The application of these regulations should become a priority and the personnel in the respective departments to be based on the HVCE installed and not on the number of beds. Adequate staffing could allow the available infrastructure and equipment in Greece to be fully exploited, resulting in economy of resources and better patient treatment. Continuing professional development (CPD) should also be organised in collaboration with professional societies, to assist personnel to keep in pace with recent technological developments. Given the tremendous progress in medical imaging, the establishment of subspecialties in Radiology should be examined in order to take full benefit of the potential offered.

Finally, all actions and initiatives towards the implementation of such recommendations, should be well designed, based on correct baseline data concerning the existing needs, population, infrastructure, availability of human resources and additionally been accepted, through consensus building approaches with the users and stakeholders, to the larger possible extent. Clinical guidelines and best practices and safety issues, should be also taken into account during the analysis for prioritisation of needs.

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- Hellenic Society of Biomedical Technology (ELEVIT)
- Hellenic Society of Nuclear Medicine & Molecular Imaging (EEPI&MA)
- Hellenic Association of Medical Physicists (HAMP)
- Association of Health – Research & Biotechnology Industry (SEIV)
- Hellenic Radiological Society (HELRAD)

The aggregated data provided from Greek Atomic Energy Commission (EEAE) is also appreciated.

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Annexes

A number of meetings were arranged with the following professional bodies of stakeholders in the field: Hellenic Association of Medical Physicists (HAMP), Hellenic Society of Biomedical Technology (ELEVIT), Federation of Technologists Radiologists of Greece (OTAE), Hellenic Society of Nuclear Medicine & Molecular Imaging (EEPI&MA), Association of Health-Research & Biotechnology Industry (SEIV) and the Hellenic Radiological Society (HelRAD)

The meeting with the Hellenic Society of Radio Therapeutic Oncology (EEAO) was not possible for the time being, whereas the Greek Association of Medical Diagnostic Centres (PASIDYK) replied that there is no interest to participate in such a meeting. All the meetings held were extremely interesting and provided valuable input for this report.

Minutes of the meetings

Federation of Technologists Radiologists of Greece (OTAE)

The meeting with the Federation of Radiologic Technologist of Greece (OTAE) took place on 31/08/2017 at the offices of WHO, in the premises of the Greek Ministry of Health.

Present on behalf of OTAE were, Konstantinos Georgiadis President of OTAE, Mr. Spiros Droulias General secretary ,Mr. Lefteris Sigalos member of the board. On behalf of WHO/INBIT, Dr Athanasios Myloneros, Prof. Nicolas Pallikarakis and Dr. Aris Dermitzakis.

After a short presentation of the objectives and aims of this study, the representatives of OTAE outlined the role of the federation since 2009, as the only secondary professional institutional instrument of representing its members that possess statutory occupational rights (Presidential Decree 164/1996) and corresponding licensure (Presidential Decree160/2014) to daily apply the practical aspects of medical exposure aiming imaging and treatment both in the public and in private healthcare structures. Radiology Radiotherapy Technologists are the health care professionals exclusively assigned (Presidential Decree 198/2007) to use the imaging radio therapeutic and nuclear medicine units. Then the sources of information and the data collected so far were presented and discussed extensively.

Main outcomes and issues pointed from this meeting is that the available infrastructure and equipment in Greece, is not exploited in its full capacity. Main reason for this is the understaffing of the departments with radiographers, although the number of available trained individuals in the country is more than enough to cover all the needs of the health system. Another factor is the working hours split between the health professionals involved and the lack of a 2nd shift almost in all facilities. A very important issue is that personnel with no adequate training is used to cover the personnel gaps in understaffed hospitals, and that even the personnel now employed, do not receive proper long life education and continuous training to meet the current developments and needs so that all capabilities of the new technologies are exploited.

As far as the understaffing is concerned, the European Commission's guidelines, as pointed out by OTAE, are that 2 technologists must be present per shift, for every CT and 3 for every LINAC facility respectively. In Greece the needed personnel in the respective departments is based on the number of beds available in each hospital, and not on the radiological equipment installed. Another very important issue that was pointed out is that there must be a considerable number of installed equipment in Greece that is used for medical purposes without the necessary license from EEAE. The related inventory prepared by OTAE in 2016 was made available to WHO/INBIT for the purposes of this report and was used to cross check the data from EEAE.

OTAE STATEMENT: The Federation of Technologists Radiologists of Greece (FTRG) is the only secondary professional-scientific body representing Radiology/Radiotherapy Technologists (Radiographers) professionals, exclusively assigned (Presidential Decree198/2007) to use imaging, radio therapeutic and nuclear medicine devices in Greek health care institutions. Its members possess statutory occupational rights and corresponding licensure to daily apply the practical aspects of medical exposure imaging and treatment equipment, in public and private healthcare institutions. The productive and qualitative deployment of, ionizing and non-ionizing HVCE, is highly dependent on the number, dispersion and competences of the professional users. Taking into account the data presented in CT, MRI, PET, LINAC etc, the biggest issue observed is the lack of the above-mentioned specialized staff. In the public sector, the number of Radiology Radiotherapy Technologists is not based on the medical infrastructures available in the hospitals, but on the number of beds of each hospital. The Federation which is closely monitoring the commissioning of high tech medical systems and identifies problems in its distribution, false criteria during acquisition and use errors, strongly believes that is indispensable to establish a legal framework, linking the installed base of the above systems with the needed number of Radiology Radiotherapy Technologists specialists (Radiographers), in order to ensure productive and qualitative function of Imaging, Radio therapeutic and Nuclear Medicine technology.

Hellenic Society of Biomedical Technology (ELEVIT)

Meeting with the Hellenic Society of Biomedical Technology (ELEVIT) took place on 31/08/2017 at the offices of WHO, in the premises of the Greek Ministry of Health.

Present at the meeting were on behalf of ELEVIT, Mr. VASILEIOS GKERGKIS Vice President of ELEVIT and on behalf of INBIT Prof. Nicolas Pallikarakis president of the board and Dr. Aris Dermitzakis.

The objectives and aims of this study as well as the sources of information and the data collected so far were presented at the beginning of the meeting. According to ELEVIT main reasons for the problems that the Greek Health System is facing are: the unorganized growth without the existence of a central action plan, the fact that the procurement procedures do not take into consideration the real needs and the maintenance and operation costs for a time period of 10 years that is the expected life span of the equipment. Additionally, the downtime of the equipment is not taken into account and monitored.

Specifications should be created centrally by a dedicated working group, and should be multilevel, covering needs depending on the size and nature of the hospital. Specifications should be annually updated.

Equipment donations, as they are managed right now, do not provide full benefit to the health system. In cases of donation, four main issues should be considered: a) who is doing the donation, b) is the person connected with hospital, c) is the equipment suitable for the hospital, d) are the maintenance costs included.

The technology management is not well organized, with no use of Computerized Medical Equipment Management Systems, resulting in incomplete records and no service cost control. As for the services provided by third parties, it was pointed out that it is a critical issue, since in Greece anyone can maintain medical equipment just by having a verification of experience and not a certification. According to ELEVIT each company should provide a list with certified and trained technicians, for whom they will be accountable.

ELEVIT STATEMENT The Hellenic Society of Biomedical Technology created in 1972, is continuing following the developments of medical technology that revolutionised modern healthcare delivery over the past 60 years. The society has been very active in organising various scientific events both at National and International level, contributing at the involvement of its members in R&D, continuous education and training activities. ELEVIT stresses the lack of Biomedical engineers, as distinct officially recognised professionals/specialists in the Greek healthcare sector. The absence of Biomedical/Clinical engineering departments in most Greek hospitals is a great obstacle in the effective and safe management of medical technology. Strategic investment planning, correct maintenance and management of medical technology should become a priority. Control in high tech and value capital, in terms of equipment acquisition, distribution, performance, maintenance procedures and safety, are essential and should be reorganised.

Hellenic Society of Nuclear Medicine & Molecular Imaging (EEPI&MA)

Meeting with the Hellenic Society of Nuclear Medicine & Molecular Imaging (EEPI&MA) took place on 31/08/2017 at the offices of WHO, in the premises of the Greek Ministry of Health.

Present at that meeting were on behalf of EEPI&MA, MD. Koytsikos Ioannis, General Secretary of EEPI&MA and MD. Prasopoulos Vasilis, treasurer, and on behalf of INBIT Prof. Nicolas Pallikarakis president of the board and Dr. Aris Dermitzakis.

After a short introduction on the objectives and aims of this study, INBIT presented the sources of information and the data collected so far. According to EEPI&MA, the nuclear medicine equipment (γ-cameras) in Greece is old, influencing the quality of the supplied health services. EEPI&MA stressed out that GAEC has probably the best database on all equipment involving ionizing radiation, installed in Greece. Concerning the number of diagnostic and therapeutic acts related to the technologies in question, they estimate that EOPPY's data, based only on those reimbursed by the organization, represent about 60% of the total number of acts performed in Greece, since acts paid directly by the patients, or by private assurance, as well as at military hospitals', are not included. The issue of induced demand should be faced with more direct state control. The great imaging value of SPECT/CT was also stressed, which is underused. Only one SPECT/CT is available and only in the private sector.

Concerning the PET scanners, EEPI&MA pointed out that although for the time being the number is lower that the European average, with the new installations of PET scanners in Herakleion, Patras, and Alexandropolis the needs will be met. A great issue is present, though, that there is only one supplier for nuclear isotopes and thus the market is monopolized. This leads to a cost of isotopes that in Greece is amongst the highest in EU, while at the same time the reimbursement of the exams by EOPPY is among the lowest. EEPI&MA believes that the number of cyclotrons used in isotope production, should be increased and in some cases isotopes should be produced within the hospitals.

EEPI&MA also pointed out that although the needed trained personnel is available in Greece, the departments of Nuclear Medicine are understaffed. Additionally, they suggested that each department should obtain EARL certification.

EEPI&MA STATEMENT: Hellenic Society of Nuclear Medicine and Molecular Imaging (HSNM&MI) is one of the oldest European societies in Nuclear Medicine (founded in 1968) and its membership now numbers approximately 400 colleagues.

Taking into account the data presented in this report, we have to mention that Nuclear Medicine examinations, did not burden the cost of health care during last years, as opposed to other imaging applications, as we did not notice an increase in Nuc Med examinations ("evolving demand").

Furthermore, we have to mention that the Nuc Med equipment (γ-cameras) in Greece are old, influencing the quality of the supplied health services. On the other hand, the "subcosting" of our medical exams leads to the lack of the ability to depreciate new equipment. However, the Greek government has to invest in new Hybrid Technologies and especially in SPECT/CT, which is especially underused (only one SPECT/CT in Athens is available in the private sector – the number of PET/CT per million inhabitants is the lowest between 10 EU countries).

Finally, a crucial problem that has to be solved in the near future is the fact that the departments of Nuclear Medicine (particularly in the public hospitals) are understaffed.

Hellenic Association of Medical Physicists (HAMP)

The meeting with the Hellenic Association of Medical Physicists (HAMP) took place on 05/09/2017 at the offices of WHO, in the premises of the Greek Ministry of Health.

Present at the meeting were on behalf of HAMP Dr Virginia Tsapaki, President of HAMP and Dr Pola Platoni, Secretary General, Kiriaki Theodorou, Professor of Medical Physics and on behalf of WHO/INBIT Prof. Nicolas Pallikarakis.

After a short introduction on the objectives and aims of this study, issues concerning the number of installed units, QC, Radiation protection and the role of Medical Physicists, were extensively discussed. The representatives of HAMP offered to prepare a report in order to assist the completeness of the present report. A high-quality HAMP input was prepared and delivered at a second stage and were widely used for the purposes of this study. The main points are directly used in the report and outlined in the followings.

Until 2016, the vast majority of the radiotherapy equipment (mainly the linear accelerators and the Co-60 units) of the public sector was more than 15 years old. As a result, no modern and effective radiotherapy techniques (namely IMRT/IGRT treatments) could be offered to cancer patients. Whereas the mean turnover of these kind of equipment is 7-8 years in Europe and in USA, the corresponding time in Greece is over 16 years in public health sector and over 10 years in private sector.

One other consideration is the service of the above equipment. In private sector, all machines are covered by service contracts both for maintenance and for repair actions (usually the repair process is in 24h). In the public sector, most of Radiotherapy Departments have service contacts as well, but due to administrative reasons the departments could be out of maintenance for a big period of time and this rise the total down time of those equipment.

Finally, staffing levels, as far as Medical Physicists are concerned, are far below the European standards and guidelines for safety both in private and in public health sector. This fact is deteriorating the quality and the safety of treatments.

Concerning Imaging equipment, based on data from the public sector, it is mentioned that among the 7 HRs of the whole country the 4th HR has a significant lack of γ-camera while in MRI and γ-camera are less commonly available in the 5th HR. This low availability per population in the mentioned HR might be compensated by the equipment of the private sector. It is also considered that imaging equipment needs upgrading or replacement to a significant degree. In addition, the distribution of new equipment should be assessed according to the capacity and capabilities of each hospital.

HAMP STATEMENT: The Hellenic Association of Medical Physicists, over the past 30 years, is closely monitoring the status of radiological diagnostic and therapeutic equipment all over the country, the QA/QC procedures applied to clinical practices as well as the development of its own members in terms of professional status and of education and training. Taking into account the data presented in this report, one of the major problems is the staffing levels as far as Medical Physicists are concerned. The shortage of qualified MP experts in the current diagnostic and therapeutic radiological procedures is actually deteriorating the quality and safety of the health services provided and this has to be solved in the near future. Furthermore, the Greek government has to invest in new technologies for both diagnosis and treatment, which will improve the accessibility and availability in quality health services for all citizens and thus providing early and accurate diagnosis and efficient treatment. This will benefit as well, in long term, the health economics of the country. Finally, steps have to be made concerning the compliance with the EU BSS and the IAEA/WHO recommendations concerning the professional status of Medical Physicists, the registration scheme and the Continuing Professional Development (CPD).

Association of Health – Research & Biotechnology Industry (SEIV)

The meeting with the Hellenic Association of Health Research & Biotechnology Industry (SEIV) took place on 14/09/2017 at SEIV premises in Athens.

Meeting participants on behalf of SEIV were Mr. Pavlos Arnaoutis, President of SEIV, Mr. John Baferos, Director of SEIV, Mr. Gerry Livadas General Secretary of SEIV, Mr. Dimitris Kapatsoris and Mr. Yannis Pratikakis, representatives of SIEMENS HEALTHCARE ABEE. Prof. Nicolas Pallikarakis and Dr. Aris Dermitzakis were present on behalf of INBIT.

According to the attendees, although the number of CT and MRI scanners in Greece is high, if we don't take into account the old units, then the resulting number becomes significantly lower. They estimate that if all the devices older than 12 years were withdrawn, the number of available units would decrease approximately by 50%. In Germany, all HVCE are renewed every 10 years. They also stressed out that reimbursement from EOPPY is independent of the age of the equipment.

Regarding the acquisition of HVCE, it was pointed out that devices can be imported from abroad, without restrictions. Because of that, even the manufacturing companies don't have a clear view of the devices imported by third parties. These devices can be old, not properly maintained, yet still they are used for medical practice, getting reimbursed by EOPPY. In other countries, it is forbidden to import old equipment or even equipment refurbished by the manufacturer.

On the topic of procurements' specifications, they stressed out that public hospitals still use the old specifications of EKEVYL (now EKAPTY). They still apply outdated specifications, despite of technological progress (i.e. while the doses in CT scanning have been decreased, thus the needed generators are smaller, they still blindly look for greater figures in the generators). Additionally, in many cases the requirements are not in accordance with real needs, resulting in acquisitions of equipment more expensive than needed, with features that will never be used by the hospital.

In Greece EEAE is responsible to measure and check the doses applied to the patients, while the quality control is also done by each company.

In terms of vigilance, all manufactures are obliged to share any information on adverse events concerning their devices. This is not possible since there are not aware of all the devices operating in the country.

They also stressed out that there is a very important issue concerning the software available in the market. An example is the case of PACS, where anyone can download a free DICOM Viewer, connect it with a database and sell it as a PACS system.

Hellenic Society of Radiology (HelRAD)*

The meeting with the Hellenic Radiology Society took place on the 17/10/2017 at their premises of the society in Athens.

Present at the meeting were: Prof. Panos Prassopoulos, President of the Society, on behalf of HelRAD and Prof. Nicolas Pallikarakis, Chairman of INBIT, on behalf of WHO/NBIT.

After a presentation of the objectives and aims of this study, the sources of information and the data collected so far were presented and discussed extensively.

According to HelRAD, equipment of Diagnostic Radiology (CT & MRI) in Greece in general is rather old, influencing the quality of the supplied health services. The way decisions are taken for the purchase of new equipment, to cover new needs, or replace old machines due to obsolescence in the public sector are not evidence based. There are not well-defined procedures and rules on priority settings, according to real needs, for different medical procedures that equipment should be able to cover. Concerning CT for example each public hospital should have at least one CT of recent technology. The age of equipment of this type should not exceed 8 to 10 years. Older equipment could continue to run, following cost effectiveness evaluation for use, in not so demanding procedures. In the private sector the costs of diagnostic tests should be controlled and reimbursed according to the technology used. The installation of refurbished equipment should be restricted and maintenance contracts should be obligatory in order to minimize the breakdown time and assure quality of output and patient safety, amongst others.

Concerning the number of diagnostic and therapeutic acts related to the technologies in question, it is necessary to establish and apply guidelines in order to protect the patients, avoid misuse and overuse with unnecessary exams, and reimbursement should be able only if prescriptions will be according to these guidelines.

Finally, Prof. Prassopoulos stressed out that Education and Training of Radiologists is a key factor. The system applied today is dated from 1994. The sector experienced a very rapid evolution, mainly due to the new technological developments and a radical restructure of this system is necessary to face the current needs. HelRAD has already worked out proposals for both, the guideline and educational issues, and is committed to continue to work towards this direction.

** Not yet reviewed and confirmed by HelRAD.*

Population Data (Census 2011)

All population related data presented, have been calculated based on the latest revised results of the 2011 census. All data are available by the Hellenic Statistical Authority (http://www.statistics.gr/documents/20181/1210503/resident_population_census2011rev.xls/956f8949-513b-45b3-8c02-74f5e8ff0230), analytical data are available only in Greek language.

Επίπεδο διοικητικής διαίρεσης	α/α	Γεωγραφικός κωδικός Καλλικράτη	Περιγραφή	Μόνιμος Πληθυσμός
4	20948	99	ΑΓΙΟ ΟΡΟΣ (ΑΥΤΟΔΙΟΙΚΗΤΟ) (Έδρα: Καρυαί,αι)	1811
4	11327	38	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΙΤΩΛΟΑΚΑΡΝΑΝΙΑΣ (Έδρα: Μεσολόγγιον,το)	210802
4	15937	49	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΝΑΤΟΛΙΚΗΣ ΑΤΤΙΚΗΣ	502348
4	17531	59	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΝΔΡΟΥ	9221
4	13588	41	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΓΟΛΙΔΑΣ (Έδρα: Ναύπλιον,το)	97044
4	12878	40	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ (Έδρα: Τρίπολις,η)	86685
4	5008	19	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΤΑΣ (Έδρα: Άρτα,η)	67877
4	10526	37	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΧΑΪΑΣ (Έδρα: Πάτραι,αι)	309694
4	8145	28	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΒΟΙΩΤΙΑΣ (Έδρα: Λεβάδεια,η)	117920
4	15829	46	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΒΟΡΕΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ	592490
4	3529	15	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΓΡΕΒΕΝΩΝ (Έδρα: Γρεβενά,τα)	31757
4	292	02	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΡΑΜΑΣ (Έδρα: Δράμα,η)	98287
4	16228	50	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΥΤΙΚΗΣ ΑΤΤΙΚΗΣ	160927
4	15889	47	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΥΤΙΚΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ	489675
4	500	03	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΕΒΡΟΥ (Έδρα: Αλεξανδρούπολις,η)	147947
4	8374	29	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΕΥΒΟΙΑΣ (Έδρα: Χαλκίς,η)	210815
4	9008	30	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΕΥΡΥΤΑΝΙΑΣ (Έδρα: Καρπενήσιον,το)	20081
4	9982	33	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΖΑΚΥΝΘΟΥ (Έδρα: Ζάκυνθος,η)	40759
4	12187	39	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΗΛΕΙΑΣ (Έδρα: Πύργος,ο)	159300
4	1611	08	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΗΜΑΘΙΑΣ (Έδρα: Βέροια,η)	140611
4	18684	71	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΗΡΑΚΛΕΙΟΥ (Έδρα: Ηράκλειον,το)	305490
4	775	04	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΘΑΣΟΥ	13770
4	5396	20	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΘΕΣΠΡΩΤΙΑΣ (Έδρα: Ηγουμενίτσα,η)	43587
4	1249	07	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΘΕΣΣΑΛΟΝΙΚΗΣ (Έδρα: Θεσσαλονίκη,η)	1110551
4	17652	60	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΘΗΡΑΣ	18883
4	10125	34	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΙΘΑΚΗΣ	3231
4	16862	54	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΙΚΑΡΙΑΣ	9882
4	4141	18	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΙΩΑΝΝΙΝΩΝ (Έδρα: Ιωάννινα,τα)	167901
4	824	05	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΒΑΛΑΣ (Έδρα: Καβάλα,η)	124917
4	17752	61	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΛΥΜΝΟΥ	29452
4	6403	23	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΡΔΙΤΣΑΣ (Έδρα: Καρδίτσα,η)	113544
4	17857	62	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΡΠΑΘΟΥ	7310
4	3729	16	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΣΤΟΡΙΑΣ (Έδρα: Καστοριά,η)	50322
4	17928	63	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΕΑΣ - ΚΥΘΝΟΥ	3911
4	15801	45	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΕΝΤΡΙΚΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ	1029520
4	9548	32	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΕΡΚΥΡΑΣ (Έδρα: Κέρκυρα,η)	104371
4	10158	35	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΕΦΑΛΛΗΝΙΑΣ (Έδρα: Αργοστόλιον,το)	35801
4	1805	09	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΙΛΚΙΣ (Έδρα: Κιλκίς,το)	80419
4	3119	14	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΖΑΝΗΣ (Έδρα: Κοζάνη,η)	150196
4	13886	42	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ (Έδρα: Κόρινθος,η)	145082
4	17990	64	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΩ	34396
4	14247	43	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ (Έδρα: Σπάρτη,η)	89138
4	5917	22	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΡΙΣΑΣ (Έδρα: Λάρισα,η)	284325
4	19390	72	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΣΙΘΙΟΥ (Έδρα: Άγιος Νικόλαος,ο)	75381
4	16573	53	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΕΣΒΟΥ (Έδρα: Μυτιλήνη,η)	86436
4	10399	36	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΕΥΚΑΔΑΣ (Έδρα: Λευκάς,η)	23693
4	16987	55	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΗΜΝΟΥ	17262
4	6860	24	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΑΓΝΗΣΙΑΣ (Έδρα: Βόλος,ο)	190010
4	14882	44	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ (Έδρα: Καλαμάτα,η)	159954
4	18033	65	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΗΛΟΥ	9932
4	18125	66	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΥΚΟΝΟΥ	10134
4	18150	67	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΑΞΟΥ	20877
4	16329	52	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΗΣΩΝ	74651

Επίπεδο διοικητικής διαίρεσης	α/α	Γεωγραφικός κωδικός Καλλικράτη	Περιγραφή	Μόνιμος Πληθυσμός
4	15910	48	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ	529826
4	1023	06	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΞΑΝΘΗΣ (Έδρα: Ξάνθη,η)	111222
4	18326	68	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΠΑΡΟΥ	14926
4	16307	51	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΠΕΙΡΑΙΩΣ	448997
4	2071	10	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΠΕΛΛΑΣ (Έδρα: Έδεσσα,η)	139680
4	2307	11	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΠΙΕΡΙΑΣ (Έδρα: Κατερίνη,η)	126698
4	5689	21	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΠΡΕΒΕΖΑΣ (Έδρα: Πρέβεζα,η)	57491
4	19829	73	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΡΕΘΥΜΝΟΥ (Έδρα: Ρέθυμνον,το)	85609
4	5	01	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΡΟΔΟΠΗΣ (Έδρα: Κομοτηνή,η)	112039
4	18423	69	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΡΟΔΟΥ	119830
4	17086	56	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΣΑΜΟΥ (Έδρα: Σάμος,η)	32977
4	2469	12	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΣΕΡΡΩΝ (Έδρα: Σέρραι,αι)	176430
4	7166	25	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΣΠΟΡΑΔΩΝ	13798
4	17478	58	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΣΥΡΟΥ	21507
4	18600	70	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΤΗΝΟΥ	8636
4	7215	26	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΤΡΙΚΑΛΩΝ (Έδρα: Τρίκαλα,τα)	131085
4	7628	27	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΦΘΙΩΤΙΔΑΣ (Έδρα: Λαμία,η)	158231
4	3929	17	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΦΛΩΡΙΝΑΣ (Έδρα: Φλώρινα,η)	51414
4	9292	31	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΦΩΚΙΔΑΣ (Έδρα: Άμφισσα,η)	40343
4	2845	13	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΧΑΛΚΙΔΙΚΗΣ (Έδρα: Πολύγυρος,ο)	105908
4	20271	74	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΧΑΝΙΩΝ (Έδρα: Χανία,τα)	156585
4	17248	57	ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΧΙΟΥ (Έδρα: Χίος,η)	52674

Regional Distribution of HVCE

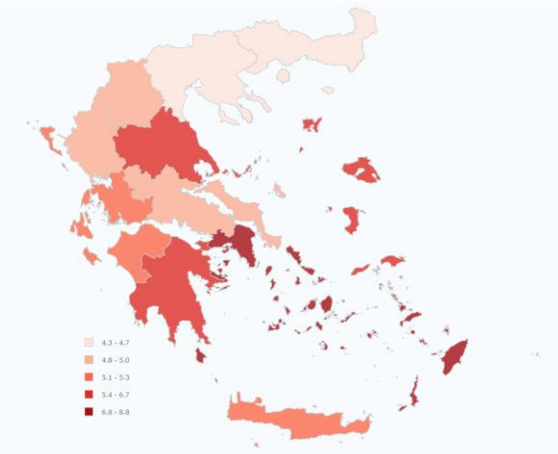
Regional Sector	MMUs	CT	MRI	γ-Cammera	RT	PET
Central Athens Sector	98	51	33	28	12	4
North Athens Sector	59	32	32	16	14	3
Thessaloniki	57	37	36	23	11	2
Piraeus	28	25	11	8	6	2
Larisa	17	11	10	6	3	
Achaea	18	11	9	6	3	
Heraklion	20	8	7	7	2	
West Athens Sector	27	15	12	6	2	
Ioannina	8	4	6	3	2	
Evros	11	8	5	3	2	
South Athens Sector	40	19	16	6		
Kozani	7	6	4	3		
East Attica	25	13	13	2		
Pella	8	6	5	2		
Messinia	7	4	5	2		
Lesbos	5	4	3	2		
Corfu	4	4	3	2		
Kavala	6	3	3	2		
Trikala	6	3	3	2		
Drama	3	4	2	2		
Serres	5	3	2	2		
Rhodes	10	4	4	1		
Corinth	9	4	4	1		
Karditsa	4	4	4	1		
Chania	6	3	4	1		
Eudoea	16	5	3	1		
Magnisia	9	5	3	1		
Chios	6	4	3	1		
Fthiotida	6	4	3	1		
Xanthi	3	2	3	1		
Boeotia	8	6	2	1		
Rhodope	4	3	2	1		
Imathia	10	4	1	1		
Pieria	3	3	1	1		
Laconia	5	2	1	1		
Arcadia	3	4	7			
Aetolia-Acarnania	13	8	6			
Argolis	10	5	3			
West Attica	7	5	3			
Elis	7	4	2			
Rethymno	6	3	2			
Preveza	4	2	2			

Regional Sector	MMUs	CT	MRI	γ-Cammera	RT	PET
Zakynthos	4	2	2			
Naxos	3	2	2			
Ko	4	1	2			
Lasithi	6	4	1			
Islands	6	3	1			
Chalkidiki	5	2	1			
Arta	4	2	1			
Katsoria	4	2	1			
Kilkis	3	2	1			
Syros	3	2	1			
Thesprotia	3	2	1			
Kefallinia	2	2	1			
Mykonos	2	2	1			
Samos	2	2	1			
Thira	2	2	1			
Kalymnos	2	3				
Grevena	2	2				
Limnos	2	2				
Florina	5	1				
Paros	3	1				
Lefkada	2	1				
Sporades	2	1				
Evrytania	1	1				
Fokida	1	1				
Ikaria	1	1				
Andros	1					
Karpathos	1					
Milos	1					
Ithaca						
Kea - Kythnos						
Thasos						
Tinos						

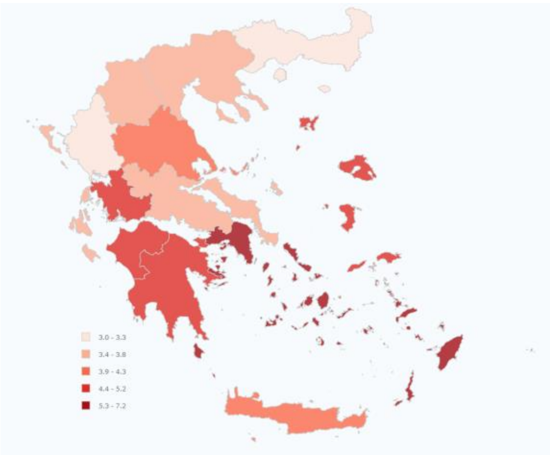
Mapping of Distribution of Units

MMUs

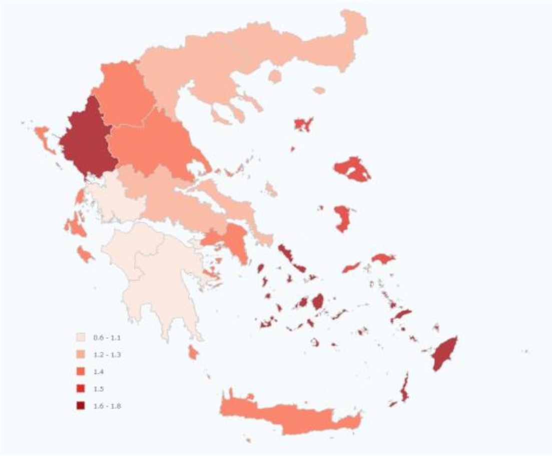
Total number of units per 100.000 Inhabitants



Private Sector number of units per 100.000 Inhabitants

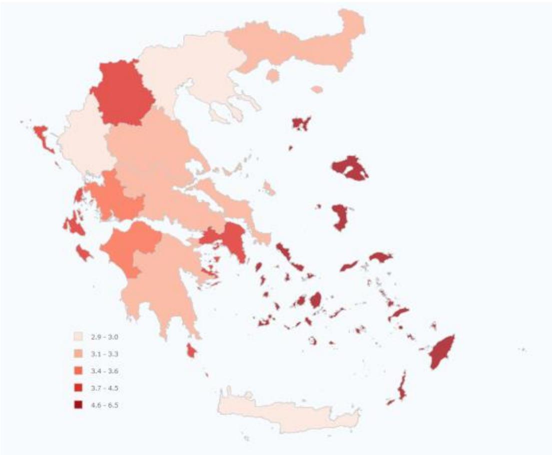


Public Sector number of units per 100.000 Inhabitants

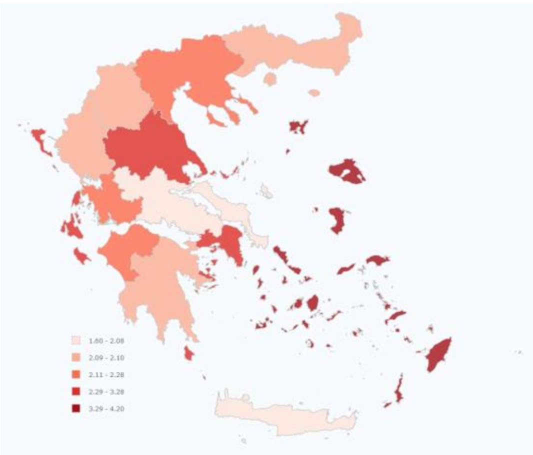


CT Units

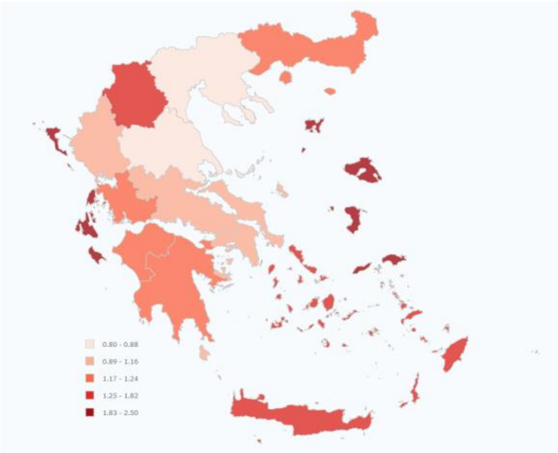
Total number of units per 100.000 Inhabitants



Private Sector number of units per 100.000 Inhabitants

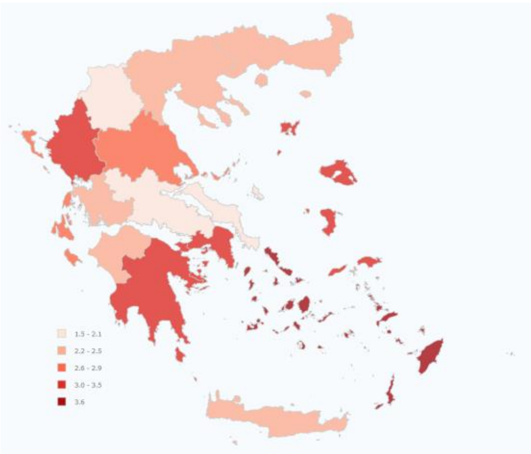


Public Sector number of units per 100.000 Inhabitants

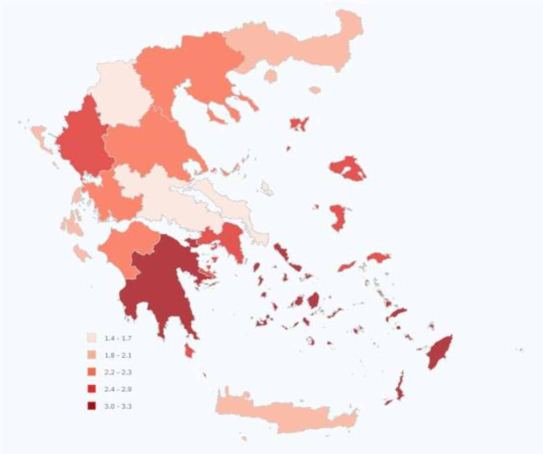


MRI Units

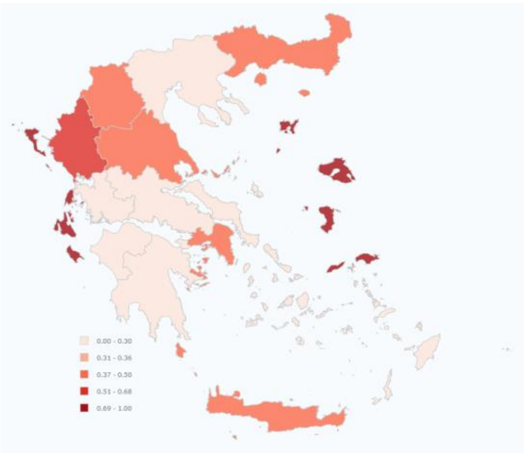
Total number of units per 100.000 Inhabitants



Private Sector number of units per 100.000 Inhabitants



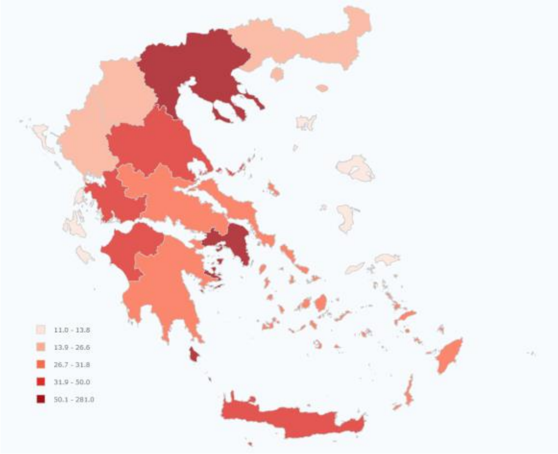
Public Sector number of units per 100.000 Inhabitants



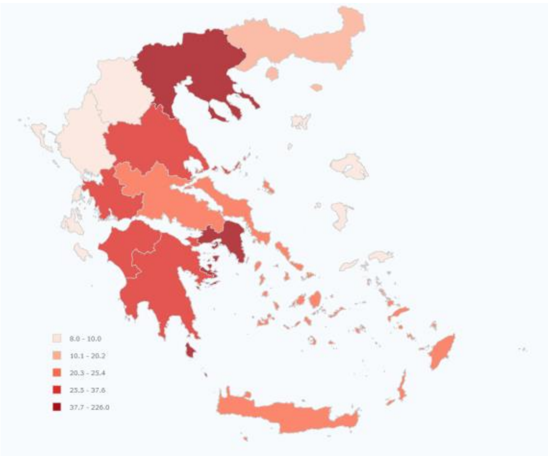
Mapping of Distribution of Exams

Mammograms

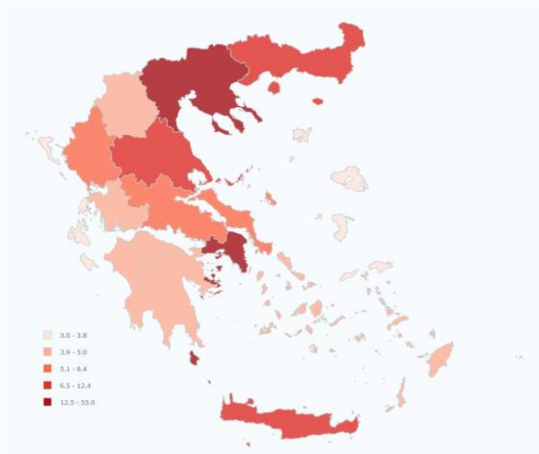
Total number of exams per 1.000 Inhabitants



Private sector number of exams per 1.000 Inhabitants

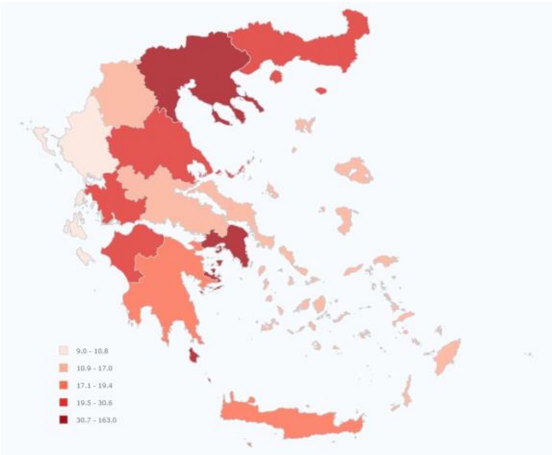


Public sector number of exams per 1.000 Inhabitants

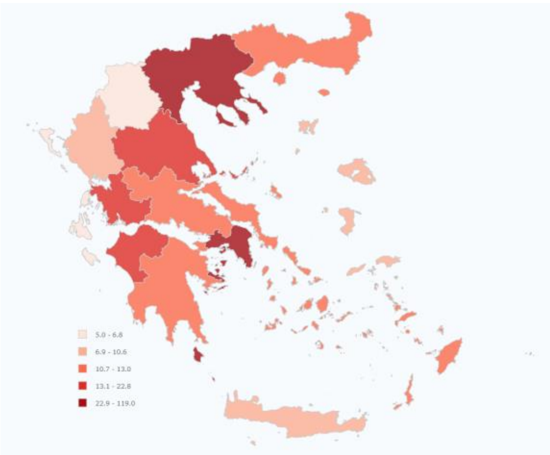


CT Scans

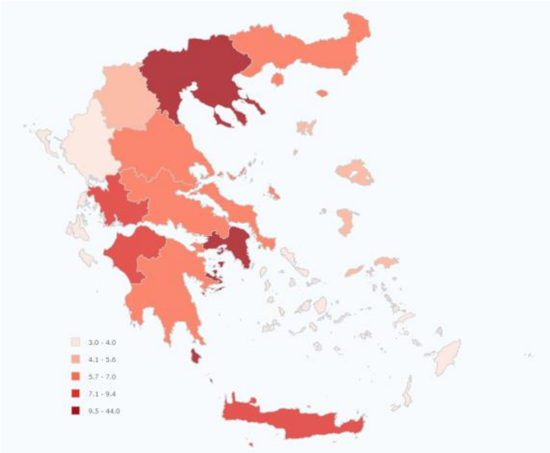
Total number of exams per 1.000 Inhabitants



Private sector number of exams per 1.000 Inhabitants

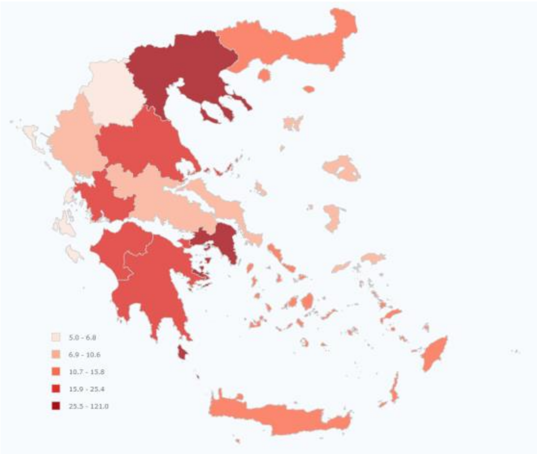


Public sector number of exams per 1.000 Inhabitants

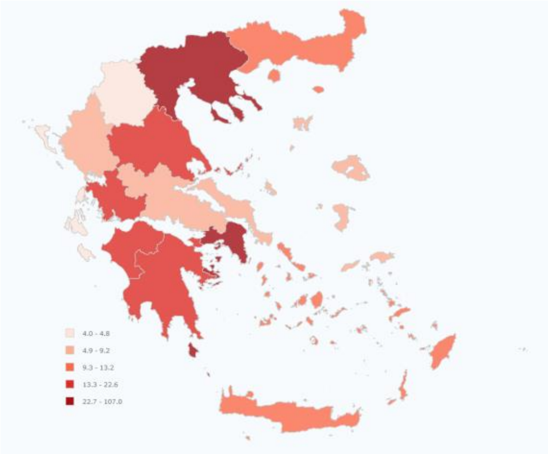


<u>MRI Scans</u>

Total number of exams per 1.000 Inhabitants



Private sector number of exams per 1.000 Inhabitants



Public sector number of exams per 1.000 Inhabitants