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Demographic change and the future sustainability of emergency departments: a pilot study in Italy

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The structure of the population in western societies is shifting, due to the progressive increase in life expectancy and to the massive migration flows from non western countries. As the use of emergency department (ED) strongly depends on demographic factors (i.e. age, gender, nationality) the evolution in the structure of the population will impact on future demand for emergency services and, therefore, on future health care expenditure. The aim of this paper is to estimate how the ED expenditure will change during the next 50 years (2012-2065) in Liguria (i.e. the oldest region in Italy for average age in 2012) adapting to the change in the demographic structure of the population. With this aim, we used the data provided by the ED of one of the main hospital in Genoa (Liguria, Italy) on the individual probability of accessing ED together with the corresponding individual cost for each visit for different categories of patients (divided by gender, nationality, age and triage code) to compute the expenditure associated to each group. Then, assuming the trend in the population for different groups as the main driver of future demand for emergency services, we computed the expencted ED expenditure for the next 50 years based on the residents projections (2012-2065) provided by the Italian Institute of Statistics (ISTAT). Results show that the ED expenditure will increase by 31% in 53 years, due to two main drivers: immigration and ageing. Indeed, first of all the increase in the number of foreign residents will bring to an increase in the number of accesses (+23%); secondly the increase in the most expensive category of individuals (older than 65), will bring to an increase in the expenditure more than proportional to the number of accesses.

Keywords: · *healthcare system sustainability, ageing, immigration healthcare use, projections on healthcare expenditure, inappropriate accesses*

Jel Classification: *H51, I18 , I12, J11, J14*

1. Introduction

The cost of financing public health services has been highly investigated by the literature. As a matter of fact, health care expenditure represents an important item in the government balance; according to the World Health Organization (WHO) in 2011 the Italian total health expenditure as percentage of GDP accounted to 10%. Therefore, it is a extremely relevant issue for policy makers who are continuously struggling with budget constraints problems. In order to determine the individual health care cost it is necessary to consider two aspects: the demand for health care services and the cost of each service demanded. The decision of using health care services, and therefore health care expenditure, is strongly influenced by several factors. Andersen and Newman (1973) identified three categories of characteristics able to influence individuals' behaviours in health care utilization: predisposing factors (i.e. social structure, demographic characteristics, health beliefs), enabling factors (i.e. logistical aspects of obtaining care, such as income, insurance coverage or waiting time) and need factors (i.e. disability, diagnosis, symptoms). Among the predisposing factors, demographic characteristics, in particular age, gender and nationality, play an important role in the determination of health care demand and, consequently of health care expenditure. A popular theme running to the debate on worldwide health policies concerns the evolution of health care expenditure resulting from the changes in the demographic structure of the population. Western countries are experiencing new and in a way worrying trends in population structure (Anderson and Hussey, 2000). Due to the improvements in living conditions and to innovations in medicine, in western countries life expectancy is increasing, bringing to a higher percentage of people aged 65 years old or more; in addition several countries are experiencing dramatically low fertility rates, together with growing migration flows. These phenomena are significantly changing the shape of the population pyramid; when immigrants'

flows are factored out, the demographic pyramid of most of the western countries assumes a widened shape, as the progressive aging of the population together with the growth in life expectancy and with the decline of births rates will lead to a contraction in population.

Among the demographic characteristics, aging has been long considered the major driver of future health care demand: as life expectancy is increasing and as older people normally require more health care services, it is reasonable to believe that future health care demand will increase due to the progressive ageing of the population. However, several studies (e.g. Zweifel *et al.* 1999) question the effective relevance of this relationship focusing the attention on proximity to death rather than on aging. This is the idea behind this approach: it has been shown (Zweifel *et al.* 1999) that the personal demand for health care services rises impressively during the last year of life. Therefore, in order to avoid overestimating the effect of aging on health care expenditure (Stearns and Norton, 2004) it is necessary to introduce a measure of proximity to death rather than a measure of age as determinant of health care future costs. According to these authors, the fact that several previous studies found out a relationship between expenditure and age is a consequence of the positive correlation between age and probability of dying: "at the age of 80 there are more individuals living in the last two years of life than at age 65" (Zweifel *et al*. 1999).

Also immigration plays an important role in the evolution of the demographic structure. Indeed immigrant population is mainly composed by young people looking for job opportunities; therefore, the raise in immigration flows will probably lead to an increase in juvenile people in the host country. On the other side, as immigration towards western countries was elevate also during the past decades, probably some of the immigrants will decide to get old in the country where they emigrated instead of spending their old age in their native country: this will lead to an extra increase in

the demand for health care services in the next years and, consequently to an increase in health care costs.

For what concerns gender differences in the demand for health care services different studies show contrastive results. In general, life expectancy is longer for women; however, women report greater morbidity and health care use than men (Redondo-Sendino, *et al*., 2006). There are big differences in the use of health care services between male and female depending on the typology of health care service. In detail, women tend to use more preventive and diagnostic services, visits to medical practitioner, home medical visits (Ladwig *et al*., 2000; Krasnik *et al*, 1997; Bertakis *et al*., 2000; Green and Pope, 1999). On the other hand, some studies found out that men make larger use of emergency services (e.g. Gomez, 2002): however, different studies on the use of emergency services between men and women bring to contrastive results.

The three aforesaid factors (i.e. aging, immigration flows, gender differences) can thus be considered key drivers in the future health care expenditure. Looking at the population forecasting by age, gender and nationality it is therefore possible to estimate how health care expenditure will evolve in next decades adapting to the changes in the demographic structure of the population. However, other elements can significantly impact on the evolution of health care expenditure. First of all let's consider the technological progress in medical research. As a matter of fact, the development of new therapeutic and diagnostic cares and treatments results in a dual effect: on one side it brings an increase in the therapeutic and surgical possibilities for elderly people, raising health care expenditure. On the other hand it results in a substitution of old treatments with more efficient ones, reducing the unit cost and the risk associated with certain treatments and, thus, reducing health care expenditure (Dormont *et al*, 2008). To give an example we can think about general anaesthesia: in the past it was very risky to use it with elderly patients, while nowadays it is becoming a more commonly used instrument that enlarges the surgical possibilities for elderly (Polder *et al*, 2002). Also differences in socioeconomic

status, such as income and educational level, can have a role (Economic Policy Committee and European Commission, 2006; Gerdtham *et al* 1992; Smith, 1999): however, the overall impact of socio-economic variables on health is doubtful. Indeed, it is likely that people with high educational level and high income use more prevention health care services as they have better knowledge and more economic resources. In addition they are also probably more conscious about the impact of certain behaviours on health status (e.g. smoking, drinking, exercise) and they often have more healthy lifestyles bringing to a lower need for some kinds of health care services. On the other hand, low income people probably use more public hospital and emergency services when they cannot effort private specialized visits; in addition they usually are riskier individuals due to the fact that they have riskier behaviours (smoking, drinking, worse diet) (Smith, 1999).

The majority of the studies dealing with evolution of health care expenditure centre the attention on the analysis of total health or hospital expenditure. We decided to focus on a particular aspect, namely on the evolution of the expenditure for Emergency Departments (EDs). Indeed, ED represents a particularly demanding departments in terms of economic resources. The main purpose of this work is thus to analyze the impact of demographic changes on future sustainability of EDs. The two research questions that we address in this work are the following:

1. Will the progressive ageing of the population and the increasing migration flows impact the future sustainability of EDs?
2. How will demographic changes influence the inappropriate use of EDs?

Dealing with this particular department allows us to ignore some of the aforesaid factors affecting general health care expenditure. First off, it is likely that the demand for ED services is less dependent on proximity to death than the general demand for health care services as, for a person with a severe illness or for a terminally ill, ED is usually just the first step of intervention. We

can instead believe that the demand for emergency services is dependent on aging as older people will suffer from urgent health problems more often. Moreover, if we ignore inappropriate use of ED (i.e. use of ED services for not urgent treatments), emergency services are mainly used as responses towards urgent problems and therefore they cannot be substituted by specialized visits, therefore socio-economic differences should not be particularly relevant. On the other side, the cost of each person treatment in ED is highly connected to the severity of the situation, which can be approximated using the triage code. Indeed, young people often use emergency services after severe crashes: therefore, despite their young age, they can become an expensive category of patients if the percentage of red triage code is higher than the one for other categories of patients.

The data used for this analysis come from different sources. First of all we used official data on people attending the ED of one hospital (i.e. Galliera ED) in Genoa (Italy) matching this dataset with the official regional fees that are paid back as a reimbursement for each treatment to the ED by the Government. Using these two datasets allows us to obtain, for each individual, the cost of attending ED adding up the costs of all the treatments used (i.e. visits and exams). Secondly we matched this dataset with the demographic registry of Genoa (number of residents for urban area) obtained by the Municipality of Genoa; this dataset contains the number of residents by age, gender and nationality for each urban areas of the city. It has been used to obtain information on the catchment area of the ED and, thus, to compute the access rates to ED for different categories of individuals divided by gender, age, nationality and triage code. Lastly we used the population forecasting (year: 2012-2065) provided by the Italian Institute of Statistics (ISTAT) to estimate the evolution of the population by gender, nationality and age during next 50 years in the region around Genoa (Liguria). Matching these three datasets we estimate the evolution of ED expenditure and of the number of accesses to

ED in Liguria, in future 50 years resulting from the changes in the demographic structure of the population.

2. Literacy background

As we already said, our analysis will be focused on ED expenditure. In the last decades the utilization of ED services has evolved as today ED is not only used for acute emergency care but also to provide minimum services to needy patients and to provide 24-hour accessible basic health care (Moskop *et al*., 2008). However, the increase in the number of services provided, has not gone hand in hand with an raise in beds, facilities and staffs. Thus, many studies focused the attention on the efficient management of ED department as over-crowding, high frequency and inappropriate use of ED services exploded in many countries. It has been demonstrated that demographic factors affect the behaviour when demanding emergency services. Therefore the changes in the demographic pattern expected in the next years will drastically modify the composition of patients and, subsequently, the ED expenditure. The determinants of health care demand have been widely explored by the literature and they include both demographic and non demographic factors (LaCalle *et al*., 2013). Future health care expenditure strongly depends on the future number of users (which can be estimated using the projections of population size by age, gender and nationality) and on the future cost of health care services. Thus, future expenditure is affected by the intensity of use of the different services (which depends on health status and on population composition) and by the type and cost of the service used (which depends on the medical progress and technology). First of all we proposed a review of the previous researches on the determinants of health care and ED expenditure, focusing the attention on demographic determinants, namely aging, migration and gender differences: this review helps in understanding which categories of people are likely to be more

responsible for the increase in future expenditure for emergency services.

The impact of aging

Aging has been long considered a key driver of future health care demand. Gray (2005) proposed a comprehensive review of the research studies on the relationship between aging and future health care expenditure. One of the earliest work studying this phenomenon was developed by Abel-Smith and Titmuss (1956): the authors assumed that the changes in health expenditure are only due to changes in population while everything else (e.g. incidence of sickness, standards of diagnosis, quantity and quality of treatments) stays unchanged; results showed that the total health expenditure will increase by 10.6% in the years from 1951 to 1971 due to the progressive ageing and to an increase in the total population. During the 1970s the interest for this topic increased and brought to the publication of a study from the House of Commons Expenditure Committee (1977) who estimated the total future expenditure for health care services resulting from aging by weighting the projected population forecasting for each age group by the estimated personal health expenditure in these categories. This approach became a landmark for the researches conducted in the following years (1970s- 1990s) in several countries. Among the others, Marzouk, in 1991, analyzed the evolution of hospital expenditures over GDP in Canada over 40 years, estimating that the expenditure will double as a consequence of aging and changing in usage patterns. Similar studies were developed in Usa (Smith *et al*., 1999) and in OECD countries (Dang, *et al*, 2001). Nowadays, aging is a dramatically relevant issue in western countries where life expectancy is increasing, birth rates is falling and the baby boom generation is getting older. The first intuition from these events is that health care expenditure will increase in the future, as health care demand for services by elderly people will increase. However, deeper econometric researches (e.g. Gerdtham *et al* 1992, O'Connell, 1996; Anderson and Hussey, 2000) came to

a different conclusion, showing that future health expenditure is not significantly affected by the demographic structure of the population. Among the others, O'Connell (1996) proposed an analysis of the determinants of health care expenditure in OECD countries, finding out that aging significantly affects health care expenditure only in some of the countries analyzed; the author thus concluded that some unobserved country-specific factors play a role. In response to this new hints, Zweifel *et al*. (1999) first introduced the debate on age as a "red herring", (i.e. they claim that aging does not have a significant effect on future health care expenditure). The authors, applying a Heckman sample selection model (Heckman, 1979) to a dataset on individuals who died in the period 1983-1992 provided by a Swiss health insurer, pointed out the relevance of proximity to death, rather than age, in the determination of future health expenditure. Several subsequent studies, applied to different datasets, led to the same conclusion stating that the impact of age on health care expenditure is almost irrelevant compared to the impact of time to death. This is the case in several countries including England (Seshamani and Gray 2004a and 2004b; O'Neill *et al*, 2000), USA (Stearns and Norton, 2004; Reinhardt, 2003; Miller 2001; Hogan *et al*., 2001; Lubitz and Prihoda, 1984; Riley *et al*., 1987), Switzerland (Zweifel *et al*. 2004; Werblow *et al*, 2007; Felder, Meier *et al* 2000), France (Dormont, Grignon *et al*, 2006), Canada (Barer *et al*. 1995),the Netherlands (Stooker *et al*., 2001), Israeli (Chernichovsky and Markowitz, 2004). Indeed, people tend to use health care services mostly in the latter stages of life when they need more hospital interventions, palliative care, nursing, hospice care (Hogan *et al*., 2001); several studies showed that this is the case for particular categories of disease, such as heart disease and cancer (Riley *et al*., 1987). The fact that, previous studies (e.g. Hitiris and Posnett, 1992) showed a relationship between age and expenditure is simply a consequence of the positive relationship between age and probability of dying and, therefore, between age and proximity to death. Moreover, other factors not considered in previous analysis (income, lifestyle,

environmental factors) can impact health expenditure confounding the results. Stearns and Norton (2004) found out that the overestimation bias produced in future expenditure predictions when proximity to death is ignored is 9%. A different conclusion is suggested by other studies: according to Levinsky *et al*. (2001) and Perls and Wood (1996) after a certain age, the relationship between hospital expenditure in the last year of life and age is reverse. This can be explained by the fact that older people (e.g. older than 85) cannot stand some kinds of serious medical and surgical treatments (e.g. general anaesthesia) and thus they receive less medical treatments during the last months of life.

Several authors investigated the effect of aging on ED visits (Roberts *et al*., 2008; Peters, 2010); in the vast majority of cases, elderly people (aged over 65) were found to be the most relevant category of individuals attending ED for absolute number of visits, length of staying in ED and cost for each visit both in terms of time and resources (Aminzadeh and Burd Dalziel, 2002; Samaras *et al*., 2010; Dunbar, 1996; Flercher, 2008; Frazier, 2005). Aminzadeh and Burd Dalziel (2002) proposed a systematic review of the previous studies on ED use. Comparing the results of 11 international large-scale studies, they found out that visits by older adults composed from 12% to 21% of all ED events; these percentages, in almost all cases, are larger than the proportion of older people in the total population and thus detect a over-representation of this category in ED services use. Older patients tend also to have higher level of emergency and more serious medical conditions. The reasons behind this phenomenon are several and include multiple comorbilities, functional status, higher level of emergency (triage code), age, social supports, polypharmacy, cognitive impairment, hearing and vision impairment and depression (Peters, 2010; Miller, 2002; Newbern and Burnside, 1994 ; Parke, Friesen, 2005; Samaras *et al*., 2010; Aminzadeh and Burd Dalziel, 2002). The most frequent medical conditions that bring elderly to visit ED are ischemic heart diseases, syncope, neuropsychiatric disorders, falls, coronary

disease, polypharmacy and adverse drug effects, alcohol and substance abuse, dehydration, abdominal pain, infections (Samaras *et al.*, 2010; Peters, 2010). As it is evident, except for falls which can require surgeries, the majority of the diagnosis are of medical nature. Another element that differentiates the older people by young people can be found in the means of transportation used to get to ED: older individuals (aged more than 65) tend to use more ambulance services than younger people. This is even more evident for people aged more than 85 (Pitts *et al*., 2008; Singal *et al*., 1992; Platts-Mills *et al*., 2010). In addition, the biggest cost of elderly people has an impact on hospital health care expenditure: indeed, older patients attending ED, have from 2.5 to 4.6 times higher probability of being hospitalized than young people (Samaras *et al*., 2010; Aminzadeh and Burd Dalziel, 2002).

The impact of gender differences

A number of studies focus the attention on the different use of health care services between men and women (see, for a review, Redondo-Sendino *et al.*, 2006). Several factors should be considered as relevant for the analysis of this phenomenon, namely the biological risk, the risk acquired from different lifestyle and the different attitude towards health status. For what concern factors affecting biological risk we mention: differences between men and women in life expectancy and demographic patterns as well as differences in medical conditions. It is common knowledge that life expectancy for women is higher than for men: according to the last available data from WHO, in Italy in 2011 the life expectancy at birth (in years) was 80 for men and 85 for women. This fact can impact health care expenditure as women live longer and, if we assume that health care expenditure is positively correlated with age, then women will use more resources than men. In addition, women tend to use more health care services than men, due to a greater morbidity and disability level, especially during the last period of life (Nathanson, 1975; Verbrugge, 1985; Macintyre, 1996; Redondo-Sendino *et al.*, 2006). Despite the differences in the

level of morbidity and disability between men and women, the gap in health care utilization can be partially explained by a different attitude towards morbidity (e.g. different beliefs and behaviours when they are sick or worried, different perception of health status) and by risk acquired from different lifestyles (Verbrugge, 1985; Macintyre, 1996; Redondo-Sendino *et al.*, 2006). Among the others, Verbrugge (1985) found out that, even if women suffer more frequently for illnesses, their problems are usually less serious than the ones suffered by men. According to Verbrugge (1985) gaps in the use of health care services are mainly due to the different levels of risk acquired by men and women and deriving from dissimilarities in work, level of stress and lifestyles. Other factors that marginally influenced this pattern in Verbrugge (1985) are psychological factors (e.g. perception of health) and biological risk (intrinsic differences due to genes) as well as health reporting. Many authors investigate the differences in use of health care between men and women, depending on the type of service. In particular, women tend to use more preventive and diagnostic services and they visit the general practitioner more often than men (Ladwig *et al*., 2000; Krasnik *et al.*, 1997; Bertakis *et al*., 2000; Green and Pope, 1999) especially for mood anxiety disorders (Rhodes *et al*., 2002). On the other hand, many studies agree on the fact that men tend to use more hospital services (Mutran *et al*., 1988; Fernandez and Schiaffino, 1999; Dunlop *et al*., 2002; Redondo-Sendino *et al*., 2006). However, this is not always the case: some studies reported that, when controlling for potential confounders, there is an equal use of hospital services between men and women (Bertakis *et al*., 2000). If we focus the attention on gender differences in the use of ED services rather than on hospital services, some contrastive results emerged from researches performed in different countries and on different datasets. Many studies showed that women tend to use more ED services than men (LaCalle, 2009; Blank *et al*., 2005; Lucas and Sanford, 1998; Mandelberg *et al*., 2000; Fuda and Immekus, 2006; Zuckerman and Shen, 2004). However, some studies showed that the contrary is

true (i.e. men use more emergency services than women) (Gomez, 2002). Several authors focused the attention on the analysis of access rates between male and female for single medical condition or single symptom (Macintyre *et al*., 1996). Among the others, Stevens and Sogolow (2005) studied differences in access rates between men and women for non-fatal unintentional fall-related injuries using US data provided by National Center for Health Statistics: results showed that, for all types of fall, the access rates are increasing in age and higher for women.

Additionally, different stages of life can lead to a different use of medical services (Macintyre *et al*., 1996): in particular, during the reproductive age, women need gynaecological care as well as emergency services during childbirths. Mustard *et al*. 1998 found out that the 22% of expenditure for female subjects is associated to conditions dependent on sex (namely pregnancy and childbirth) while for men this percentage accounts to 3%. It can be particularly interested to perform specific analysis on the older (e.g. people aged 60 years and over) class of population (Dunlop *et al*, 2002; Irizarry, 1988; Mustard *et al*. 1998; Redondo-Sendino *et al.* 2006): indeed, as previous studies showed that women make larger use of health care services and as women live longer than men, the population composed by older female is progressively increasing, and with it, the demand for health services is growing. Redondo-Sendino *et al*. (2006) proposed a research based on a cross-sectional survey representative of the non-institutionalized Spanish population aged 60 years and over. They analyzed the potential determinants of gender differences in the use of several health care services among the older people identifying three possible categories of factors: predisposing factors (age and health status), need factors (e.g. lifestyles, chronic diseases, health-related quality of life HRQOL[1]) and enabling factors (educational level, marital

[1] HRQOL is a broad multidimensional that aims at giving a measure of overall quality of life concept. It usually includes self-reported measures of

status, employment status, social network). Results showed that the factors that mostly affect the higher use of health care services by women are HRQOL and chronic diseases: indeed, when controlling for these two elements women receive hospital services less frequently than men.

The impact of migration flows

Western countries are experiencing increasing migration flows from both Western and non-Western countries (Österie, 2007): according to the Italian Institute of Statistics (ISTAT) the percentage of foreign people over the residents in Italy rose from 2.3% in 2001 to 7.4% in 2013. Immigration flows are responsible for significant changes in the population structure which has several consequences on the provision and consumption of all public services. In particular, larger proportion of immigrants (both of first and second generation) decide to spend all their lives, up to old age, in the welcoming country, due to the fact that they are highly integrated in the host country. This phenomenon has many consequences on the provision and financing of public services. It is thus evident that the demand for ED services, which is dependent on age, will be affected by immigration flows. In addition, the structure of the population will also be affected by differences in fertility rates between immigrants and native born people as several non western countries have higher fertility rates than western ones. This means that the increase in the number of female immigrants will increase the use of emergency services related to pregnancy.

Kolodzijczyk (2013a) analyzed the impact of an increase in Non-Western immigrants in Denmark on health care expenditure finding out that the demographic pattern is the key factor to be considered. Results showed that the increase in health care expenditure due to immigrants is mostly due to aging and not to the different use of health care services between immigrants and

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physical and mental health perceptions and their correlates—including health risks and conditions, functional status, social support, and socioeconomic status.

natives which plays only a minor role as it is constant over time. However, other studies highlight the importance of gaps in habits in the use of health care services both between natives and immigrants and between immigrants with different countries of origin (Gadd *et al*., 2006; Sundquist and Li, 2006). Indeed, despite the demographic element, four factors that make immigrants consumption of health care different from the one of native born subjects have been identified by the literature: biological risk, acquired risk, socio-economic gaps, insurance coverage. First of all there are differences in health status and type of diseases experienced by immigrants and natives (biological risks) and in the acquired risk deriving from lifestyle (e.g. smoking, drinking behaviour, stress due to discrimination). Holmberg, Ahlmark *et al* (2009) found out that immigrants in Denmark experience more chronic diseases, such as diabetes. A more general research has been performed by Solè-Auro and Crimmins (2008) and Solè-Auro, Guillen *et al*. (2009) using the data of the Survey of Health, Aging and Retirement in Europe (SHARE): the survey collects data on the health status and behavioural risk of natives and immigrants aged 50 and older in 11 European countries. The two studies showed that, when there are differences, migrants have worse health status than native population and that immigrants have between 6% and 27% more expected visits to the doctor, general practitioner or hospital stays when compared to native-born populations in a number of European countries. On the other hand, immigrants are less likely to visit specialist doctors (Gravelle *et al*., 2006). Other authors (e.g. Dinesen, Nielsen *et al*, 2011; Derose *et al*., 2007) highlighted the relevance of cultural and socio-economic differences, such as language barriers, income and education differences. Immigrants are likely to have lower socio-economic status as they are probably moving to improve it; this can lead to worse health status due to the stress of moving or to the worse employment conditions (Silveira *et al*., 2002). Gaddini *et al*. (2008) proposed a study on the use of emergency room by immigrants in Italy for mental disorders caused by trauma experienced during the

migration period: results showed that this category of people is particularly relevant in the total number of people attending ED. However, not all the studies came to the same conclusions: European researches found out the so-called "health immigrant paradox" namely the fact that recent arrived immigrants have a better health status than native-born residents despite their socioeconomic deprivation status (Ronellenfitsch and Razum, 2004; Lucas *et al*., 2003; McDonald and Kennedy, 2004; Crimmins *et al*., 2007). Lastly, the different types of economic incentives given to native or immigrant users, depending on the type of health insurance system, can play a role (Angel *et al*., 2002; Derose *et al*., 2007). Hernandez-Quevedo and Jimenez-Rubio (2009) analyzed the different patterns in health care consumption between native and immigrant populations in Spain: results showed that there are inequalities in the access to some health care services (i.e. specialized visits) as immigrants seem to face barriers to entry to this kind of visits. On the other hand, emergency departments are usually highly used by immigrants coming from a low-income country (Ruè *et al*., 2008). This means that discrimination, different coverage of insurance, language barriers (Derose *et al*., 2007) and habits imported from the country of origin can impact immigrants use of health care services as immigrants experience various sources of vulnerability (Kaiser, 2012). Even more dramatic is the stigma effect towards non legal immigrants, where the higher risk of being uninsured has a relevant impact on the demand for health care services (Derose and Lurie, 2007; Cornelius). It is immediately clear that, if all the aforesaid elements are realistic, immigrants will probably make larger use of emergency services due to the fact that, in many countries (e.g. Italy), these services are responses towards urgent problems, usually free of charge and they are guaranteed to all the individuals with no concern about their nationality, race, ethnicity and insurance. Moreover, emergency services can be obtained without prior appointment and 24h (Walls *et al*., 2002). This acknowledged phenomenon will increase the number of inappropriate access to the ED as immigrants tend to use

ED as a substitute to other health care services due to their economic condition or to the lack of knowledge about the country's of origin health care system (Cots *et al*., 2002; Jimènez-Rubio, 2008). This is even more relevant in countries where insurance is needed in order to receive medical care (e.g. USA): in these countries the lack of insurance for general health care services, could shift help-seeking to less appropriate and efficient modes of healthcare, namely emergency services (Newton *et al*., 2008). This will impact future ED expenditure, as it will bring to an increase in the use of ED services for non-acute services. However, as the integration of immigrants (both from a social and economic point of view) will increase, it is reasonable to imagine that this gap in the use of ED services by immigrants and natives will decrease in the next decades. This intuition is confirmed by Garcìa-Gòmez (2007): the authors showed that, as the number of years living in the host countries increase, the differences in utilization of emergency services between immigrants and natives decrease.

Not all the researchers agree on the fact that immigrants use more ED services than native-born people. Some authors (Tarraf *et al*., 2013) came to the opposite conclusion finding out that natives make larger use of ED services. Many studies (Baker *et al*. (1996); Beckman *et al*., 2004; Cornelius, 1993) found out that, after controlling for the other determinants of emergency services use (i.e. age, health insurance coverage, regular source of care, and barriers to health care), race and ethnicity are not important determinants of emergency services use.

3. Data

The datasets used for this analysis come from different sources: Galliera ED registry, Ministry of health fees, Municipality of Genoa demographic registry and Italian Institute of Statistics (ISTAT) projections of the population. Data on the accesses and demographic characteristics of the patients who went to the ED during 2012 were obtained from the exhaustive Galliera ED

registry (Genoa). The dataset contains clinical information about the access (e.g. laboratory, non laboratory exams and visits for each access, diagnosis for the event, triage code) and demographic information about the patient (i.e. gender, nationality, age). The official ED fees have been obtained from the Law (23/2013) issued from the Italian Ministry of Health. In Italy these tariffs represent the standard cost established by the Ministry of Health for each ED visit or exam (e.g. standard ED visits, X-ray, blood analysis) and they are used as a benchmark for the reimbursements given from the Government to the single hospital for each patient/treatment. Lastly data on the residents in Genoa by age, gender and nationality have been obtained from the Municipality of Genoa for each urban area; this dataset allows us to identify the catchment area of the ED (urban areas around the ED) and to determine the access rates to the ED for each group of individuals (e.g. probability of going to ED during one year for an older foreign male vs younger Italian female). The projection of the residents in future 53 years (2012-2065) have been obtained at a regional level by ISTAT using a cohort component model: this dataset has been used to estimate the future expenditure for ED generalizing the results to the region around Genoa (Liguria). ISTAT proposed three different scenarios: the main, the low and the high scenario; in this work we present the results obtained using the main scenario.

First we provide some general descriptive statistics of the dataset. We decided to cut the records refereed to patients aged less than 14 as Galliera ED is not paediatric and it is thus realistic that the majority of the children with health problems will be brought to another specialized ED in Genoa (Gaslini). If we cut people who quitted the ED before receiving visits and exams the total number of accesses to Galliera ED in 2012 was 49,969. The 47% of the patients are male, while the 53% are female; the average age is 52 years old, with people older than 65 being the 31% of the total number of patients. The 21% of the total number of accesses is composed by foreign patients who are, overall, a younger population (average age: 39 years old) than the Italian one (average

age: 55 years old). Table 1 shows the percentage of individual for different triage code and age; we can see that the vast majority (73%) of individuals attending ED are classified as white or green triage code (less severe medical condition), while only the 3% of the patients present really urgent and severe medical conditions (red triage code). However, the distribution of triage code is not equal among different age classes: indeed, older individuals (older than 65) present red triage code more often than younger, due to the fact that their general health status is worse.

Table 1 - Number of accesses by triage code and demographic characteristic (Year 2012, Galliera ED)

Age	White	Green	Yellow	Red	Total %
15-24	474	3,840	618	31	**10%**
25-44	2,034	12,430	1,943	110	**33%**
45-64	1005	8,713	2,589	248	**25%**
65-84	576	5,773	4,192	666	**22%**
>85	92	1,810	2,344	481	**9%**
M	1,223	11,908	4,320	648	**47%**
F	1,627	13,083	4,614	523	**53%**
ITA	1,849	19,466	7,833	1,066	**79%**
STR	1,001	5,525	1,101	105	**21%**
Total %	**8%**	**65%**	**23%**	**3%**	**100%**

The inappropriate use of ED (white triage code) seems to be a more relevant phenomenon for people aged between 25 and 44. There are not relevant differences in the severity of medical conditions between men and female. On the contrary, if we look at the distributions for Italian and foreign people we notice that, as expected, immigrants tend to use, improperly, ED also for less acute medical situations, as the percentage of white and green code

accounts to 84% versus a total average of 73%. It is important to notice that our analysis only includes legal immigrants.

4. Methods

Different methods can be used to project the impact of demographic change on health care or, as in our context, specifically on ED expenditure (Gray, 2005; Vilpert *et al*., 2013). The majority of the researches on this topic obtained future health care expenditure multiplying the actual health care expenditure per capita for the base year (2012 in our context) for different categories of individuals (by gender, age and nationality) with the projected number of people in each category of patients (Dang *et al*., 2001). Several studies introduced weighted indexes, based on the distribution and intensity of use of different services for different patients: using information on the utilize of services among different individuals it is thus possible to weight the average cost of each category with the probability of using the different health care services (House of Commons Expenditure Committee, 1977; Smith *et al*., 1999).

The projections of future health care expenditure computed using this method are based on restrictive assumptions, first introduced by Abel-Smith and Titmuss, (1956). First of all, this approach assumes that the demand and consumption for health care services remain constant over time within each age, gender and nationality group. This means that the future demand for health care services only depends on changing in population size of each group as all the other factors (e.g. incidence of sickness and injury, consumption pattern among groups, quantity and quality of treatment; level of unsatisfied demand) stay the same. In addition, the average per capita expenditure within each group is assumed to be constant over time, and thus to be independent of the technological and medical progress. The Economic Policy Committee and European Commission (2006) identified six approaches to make projections of the future health care

expenditure when considering ageing as the key demographic driver. The most widely used approach is the so-called "Pure ageing scenario": the authors following this approach assume that the age-related expenditure per capita stays constant over time, and thus all gains in life expectancy are assumed to be spent in bad health. In our context, in addition to ageing we consider three other aspects: nationality, gender and triage code.

Under this approach, in order to obtain the future expenditure for each category of individuals for each year *t* ($S_{g,a,n,t}$), it is necessary to multiply the constant per capita cost for the individuals with a certain age (*a*), nationality (*n*) and gender (*g*) and triage code (*tc*) $c_{g,a,n,tc}$ by the projected number of individuals in each group in the future years ($p_{g,a,n,t}$).

$$S_{g,a,n,t} = c_{g,a,n,tc} * p_{g,a,n,t} \quad (1)$$

The major critic of this approach is that it provides a pessimistic estimation of future health care expenditure as, despite the increase in life expectancy, it assumes that the future number of years spend in good health will stay constant.

An opposite approach is provided by the "Constant health scenario" which assumes that the number of years spent in bad health in future years will be the same as in the base year (i.e. all future gains in life expectancy are spent in good health). Practically this approach works shifting the age-related expenditure computed in the base year in direct proportion with the estimated gains in life expectancy for each group. The first step is the computation of the change in life expectancy with respect to the base year ($e_{g,a,n,BaseYear}$) for all the prediction years:

$$\Delta e_{g,a,n,t} = e_{g,a,n,t} - e_{g,a,n,BaseYear} \quad (2)$$

Secondly, for each future year, the respective reference age on the original age profile curve is obtained by subtracting the just computed change in life expectancy from the concerned age cohort. This is done only for those sections of the age-profile where the cost per capita is growing.

Lastly, the cost per capita for each group is obtained as:

$$c_{g,a,n,t} = c_{g,n,a-\Delta e_{g,a,n,t,},BaseYear} \quad (3)$$

where $c_{g,n,a-\Delta e_{g,a,n,t},BaseYear}$ is the per capita cost for a person of a given gender (g), nationality (n) and age $(a - \Delta e_{g,a,n,t,})$ in the base year. This cost is then used to compute the estimated expenditure in health care for the different groups of individuals. For example, if life expectancy is estimated to increase by 4 years between 2012 and 2032 for an Italian male aged 50, the per capita cost for this individual in 2030 will be the same as the cost of an Italian male aged 46 (50-4) in 2012.

The third approach, the so-called "Death-related cost scenario", assumes a strong relationship between health care expenditure and the remaining years of life, computing different costs for people who survive or die within the calendar year. This approach can only be used if data on deceased and survived in the period considered are available.

The last three scenarios proposed by the Economic Policy Committee and European Commission (2006) evolve the pure ageing scenario, introducing non demographic factors able to impact health expenditure (i.e. income, GDP per worker).

In our context we will make use of a Pure Ageing Approach, stating that the future ED expenditure only depends on the evolution of population structure but not on changing in other factors (i.e. non demographic drivers) and holding the group-specific expenditure per capita constant over time. As we already said, we will also assume that the debate on proximity to death is not so relevant when looking at ED expenditure: indeed, terminally

ill and people close to death consume several hospital resources (e.g. palliative care, nursing home stays) rather than emergency services.

We followed this approach dividing the analysis in four steps. First we computed group specific annual cost of attending ED using all available patients recorded in 2012 at the Galliera ED (80 groups). Then we estimated the catchment area of Galliera ED and we used the ratio between patients and number of residents in the catchment area to compute the probability of accessing ED for each category of individual. We multiplied the access rates by the projected number of residents (main scenario has been used) in each group in the next 50 years, finding out the estimated number of access for years 2012-2065. Assuming that the average cost for each category stays the same, we estimated the future ED expenditure associated to each group of patients.

5. Results

First of all we computed, based on the Galliera ED registry (2012) the average cost average cost for each category of individual (Table 2). As expected the cost is increasing in the severity of the medical condition: on average, a red code costs 6 times more than a white code (208 euro versus 35 euro). In general, within each triage code, the cost is increasing in age; one exception is evident in red triage code: among patients attending ED for a severe condition (red triage code) patients aged between 15 and 44 years compose the most expensive category of people. This can be partially explained by the fact that, during this stage of life, the principle cause for going to ED is after a traffic crash which is usually an event that requires several medical investigations.

Table 2 - Average cost of attending ED (€) (Year 2012, Galliera ED)

Average Cost		Italian BY TRIAGE CODE				Foreign BY TRIAGE CODE				Total
	Age	White	Green	Yellow	Red	White	Green	Yellow	Red	
Male	15-24	30.20	60.69	111.26	340.77	39.79	55.92	101.40	372.22	67.08
	25-44	35.99	61.62	116.48	331.77	35.27	57.09	109.78	248.91	67.70
	45-64	34.59	66.40	129.55	229.12	36.83	58.76	135.80	209.72	81.53
	65-84	36.39	84.56	147.36	203.31	40.57	81.56	143.14	269.63	115.97
	>85	38.01	90.62	155.29	182.00		108.23	126.68	226.94	129.30
	Total	35.23	68.95	137.59	214.40	36.39	58.30	119.70	248.36	86.22
Female	15-24	35.06	59.26	109.49	376.29	36.10	53.16	96.84	577.86	61.51
	25-44	35.57	53.78	105.84	205.71	37.54	55.78	114.55	307.19	57.80
	45-64	33.75	70.05	123.10	209.86	36.89	65.30	123.72	142.48	77.88
	65-84	34.93	89.97	151.76	187.97	37.33	86.51	145.79	271.30	113.43
	>85	39.95	106.74	160.53	185.90	36.15	94.40	153.32	257.81	140.89
	Total	35.14	71.05	142.53	191.87	37.15	59.34	121.81	275.04	84.84
Total		35.17	70.07	140.12	203.94	36.78	58.85	120.72	257.66	85.49

In order to obtain data on the access rates (probability of going to ED in one year) for each category of individuals we first determined the catchment area of the ED. Genoa has 7 EDs well distributed on the urban space: we selected, as catchment area, 14 urban areas (total number of accesses: 19,140) which are closely located to Galliera ED. We assumed that the number of residents living in these 14 areas is a good predictor of the people that, in help-seeking condition, will go to Galliera ED rather than to another ED. This is a strong assumption as, theoretically, for very urgent problems it is likely for people to go in the closest ED available, depending on the position where the problem arises (work place, city center, ...). Thus, this hypothesis is particularly unrealistic when considering acute medical conditions that require a fast intervention (e.g. heart attacks, crashes). However, if we

consider the modern use of ED, this kind of medical problems are not the main components of the total number of accesses as, for several medical conditions (e.g. falls, pain, infections) people often wait some hours or days before going to ED and thus they usually decide to go in the ED closest to their home. This is confirmed by the fact that, on percentage, the percentage of really severe conditions (red triage code) is really small (3%). Moreover we decided to select a small area (and thus a low number of accesses) as catchment area to avoid the underestimation of the rates: indeed, if we enlarge the number of urban areas selected it is likely to obtain more biased access rates to ED. Let's suppose that a person lives in an urban area where two EDs are equally distanced by his home: in this case the decision on which ED accessing will probably depend on factors other than distance to the ED (e.g. knowledge of doctors, reputation of ED, chance) and thus, including these residents in the denominator of the access probability will, in our opinion, lead to a higher bias due to the fact that it is more difficult to estimate the decision on the favourite ED for a resident of these "border"urban areas.

Table 3 shows the probability of going to ED during the year for different individuals and for different health condition (triage code). Data for foreign people aged more than 85 are supposed to be equal to the same category of Italian due to some inaccuracies found in the data on this (small) category. From Table 3 it is evident that access rates are increasing in age and, for white and green triage code, they are higher for foreign people. Older people are more likely to access ED with yellow and red triage code, which are the most expensive categories of accesses.

Table 3 - Access rates (Year 2012, Galliera ED)

Access rate		ITALIAN by triage code				FOREIGN by triage code				Total
	AGE	White	Green	Yellow	Red	White	Green	Yellow	Red	
Male	15-24	0.33%	11.79%	1.77%	0.11%	2.47%	13.09%	2.27%	0.21%	14.71%
	25-44	0.64%	8.78%	1.94%	0.08%	3.24%	17.67%	3.15%	0.27%	14.11%
	45-64	0.61%	8.10%	3.03%	0.27%	3.65%	17.84%	4.32%	0.49%	13.30%
	65-84	0.94%	9.39%	8.07%	1.28%	7.78%	33.53%	24.55%	4.19%	20.39%
	>85	1.32%	18.63%	23.13%	5.09%	1.32%	18.63%	23.13%	5.09%	49.01%
	Total	1.23%	16.39%	8.02%	1.09%	5.69%	29.86%	6.79%	0.75%	28.66%
Female	15-24	1.04%	10.92%	1.61%	0.05%	4.47%	21.62%	2.78%	0.00%	11.59%
	25-44	1.64%	11.28%	1.64%	0.04%	4.57%	21.98%	2.64%	0.13%	52.42%
	45-64	0.59%	7.66%	1.98%	0.15%	1.76%	15.35%	4.46%	0.00%	13.96%
	65-84	0.81%	9.64%	6.02%	0.69%	3.13%	37.05%	17.41%	2.68%	14.68%
	>85	0.60%	15.74%	20.67%	4.41%	0.60%	15.74%	20.67%	4.41%	10.79%
	Total	1.68%	17.83%	7.94%	1.05%	6.21%	35.46%	7.10%	0.43%	30.64%

In order to correctly interpret the forecasting results, it is necessary to analyze the projections in demographic pattern estimated by ISTAT following the main scenario. According to the estimates, due to the joined effect of birth and migration pattern, the total number of residents in Liguria will decrease by 6.89% over 50 years. In particular, while certain categories of people will decrease in absolute number (people aged between 25 and 64) other categories will increase (people aged more than 65 and foreign people). If we split the data between Italian and foreign people, over 50 years Italian residents are estimated to decrease by 26%, while foreign people will increase by 203%.

Table 4 reports the estimated evolution in the number of accesses and in the total expenditure between 2012 and 2065, together with the projections of older and foreign residents. Results show that, as expected, future number of accesses and total expenditure will increase over time due to changes in the

demographic pattern. The fact that the increase in number of accesses is lower than the increase in total expenditure (+26% vs + 35%) suggests that, the increase in number of accesses is higher for more expensive individuals (e.g. older people).

Table 4 Forecasts of number of accesses and expenditure –Liguria-

Year	Residents aged more than 65	Foreign People	Number of accesses	Total Expenditure (euro)
2012	436,878	134,243	234,200	21,543,638
2022	451,275	209,081	248,291	23,208,664
% Variation (2012-2022)	3.30%	55.75%	6.02%	7.73%
2032	499,249	269,045	248.312	23,883,527
% Variation (2022-2032)	10.63%	28.68%	0.01%	2.91%
2042	549,183	320,849	280,047	27,028,095
% Variation (2032-2042)	10.00%	19.25%	12.78%	13.17%
2052	532,447	364,941	294,841	28,916,179
% Variation (2042-2052)	-3.05%	13.74%	5.28%	6.99%
2065	492,399	407,228	296,262	29,075,633
% Variation (2052-2065)	-7.52%	11.59%	0.48%	0.55%
% Variation(2012-2065)	12.71%	203.35%	26.50%	34.96%

If we consider the single subgroups of individuals we can first analyze the impact of changes in age structure on future number of accesses and expenditure. Figure 1 and Table 5 show the evolution in number of accesses and expenditure for the next 50 years. As expected ageing is responsible for a large increase in the number of accesses and expenditure. Indeed the number of accesses and expenditure related to older people (>85 years old) will increase continuously over the period, with an increase by 131% for expenditure and by 133% for accesses. Accesses and expenditure for people aged between 65 and 84 will increase for the first 30 years (2012-2042) while slightly decreasing in the

following 20 years (2042-2065), with a total increase of expenditure from 2012 to 2065 of 33%.

Table 5 - Variation in the total expenditure and accesses by group

	% Variation (2012-2065)	
Group	**Total Expenditure**	**Number of Accesses**
M	37.44%	30.53%
F	32.87%	23.10%
ITA	-3.75%	-12.49%
FOR	403.49%	292.37%
15-24	12.79%	16.28%
25-44	-5.42%	-4.39%
45-64	-7.78%	-4.26%
65-84	33.26%	35.67%
>85	131.12%	133.03%
Total	34.96%	26.50%

Figure 2 and Figure 3 report the changes in the total expenditure spitted by gender and nationality: as it is shown in Table 5 the biggest proportion of the increase in expenditure refer to foreign people (+403% of the estimated expenditure in 53 years), while expenditure due to Italian people will decrease by 4% due to the contraction in the population. If we split the total expenditure by nationality, the percentage of expenditure by foreign people will increase from 9% in 2012 to 35% in 2065. On the other hand, there are not big differences in the expenditure pattern between men and women.

Figure 1 - Forecasts of total expenditure by age

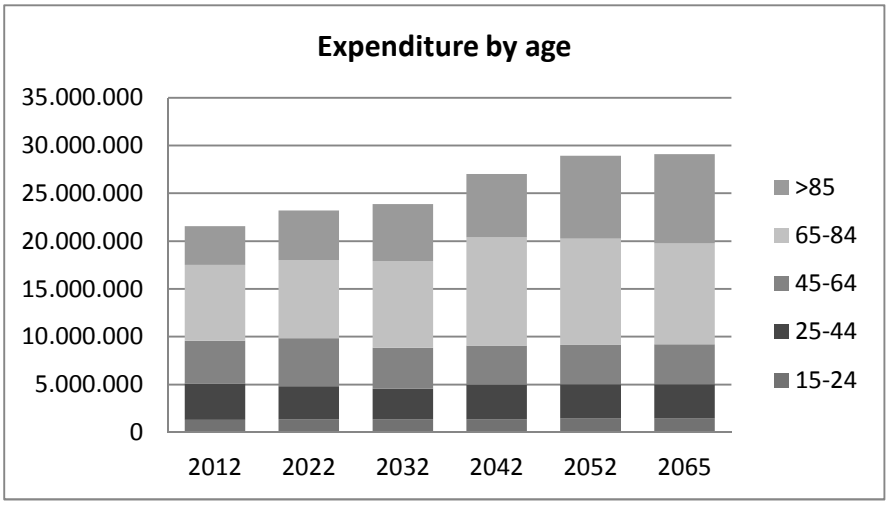
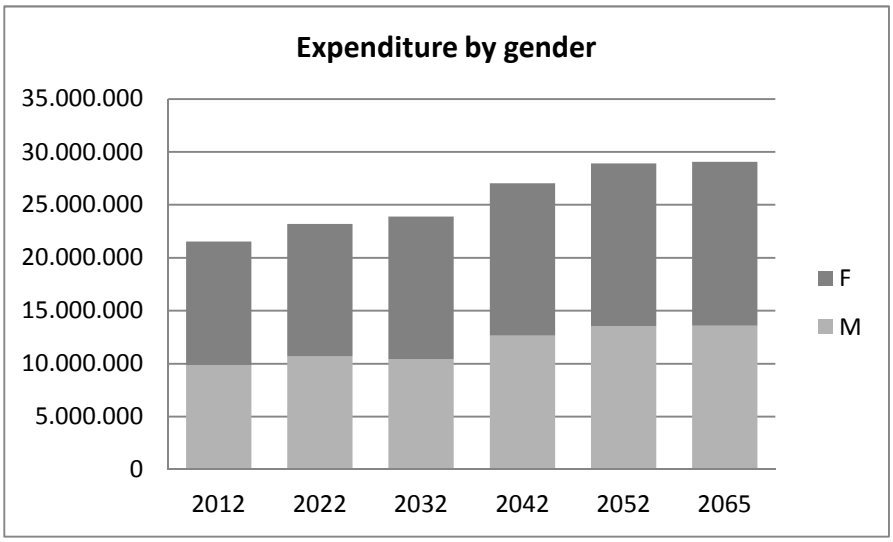


Figure 2 - Forecasts of the expenditure by gender



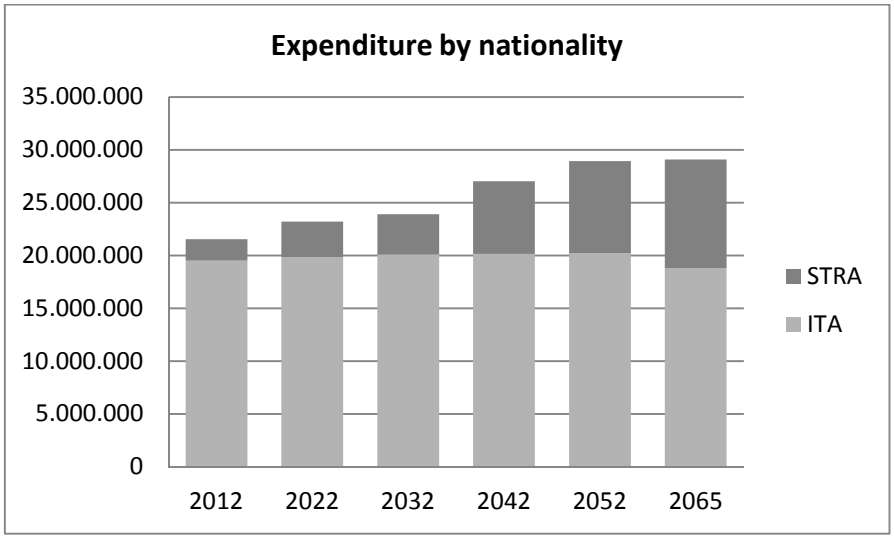


Figure 3 - Forecasts of the expenditure by nationality

Table 6 sums up the results, showing the total expenditure and the expenditure variation for Italian and foreign patients divided by age. From the table it is evident that two phenomena will be relevant in the future increase of total expenditure: ageing and migration flows. Indeed, if we look at Italian people, the unique group of patients for which expenditure will increase is the oldest one (people aged more then 85), with an increase of 101%, while for the other categories total expenditure will decrease due to a contraction in the population. Conversely, if we look at the contribution of migration flows it is clear that patients of all age categories will increase, but the oldest ones (people age more than 85) will increase dramatically (+6714%) as foreign people will decide to get old in the host country.

Table 6 - Variation in the total expenditure by group

	Group	Total Expenditure 2013	Total Expenditure 2065	Variation 2012-2065%
ITALIAN	**15-24**	1,048,220.51	856,300.66	-18%
	25-44	2,803,937.49	1,773,843.56	-37%
	45-64	4,022,306.75	2,479,044.42	-38%
	65-84	7,607,787.11	5,590,998.23	-27%
	>85	4,013,474.97	8,064,371.13	101%
FOREIGN	**15-24**	240,796.40	597,526.49	148%
	25-44	979,912.91	1,804,923.65	84%
	45-64	488,889.09	1,680,967.38	244%
	65-84	319,911.94	4,973,755.68	1455%
	>85	18,400.80	1,253,902.07	6714%

Lastly we can look at the trend in the number of accesses by triage code: Table 7 shows that, in absolute number, the accesses for not severe medical conditions (white and green code) will increase by 55% while the number of more severe conditions (yellow and red code) will increase by 105%. Table 7 reports the different composition by triage code in the total number of accesses over the period: results show that, in future decades, the percentage of red and yellow code on the total number of accesses will increase while the percentage of white and green code will decrease or stay the same. The last column of Table 5 reports an index that allows us to understand how the ratio between the expenditure due to more severe medical conditions (yellow + red triage) and not severe medical condition (white + green triage) will evolve. This ratio can be a useful indicator of the weight of inappropriate use of ED: indeed, a ratio that decreases over time, indicates that a larger part of the total expenditure is devoted to inappropriate use of ED

(i.e. use of ED as a provider of primary care instead of a provider of care in urgent situations). Between 2012 and 2065 the ratio is increasing over time, stating that the expenditure due to yellow and red triage codes will increase more than the expenditure in white and green triage code. The main reason behind this phenomenon is related to aging: indeed, as a larger proportion of patients will be composed by people aged more than 65 and as older people are usually classified as yellow or red code due to the fact that their general health status is more worrying, the percentage of inappropriate use of ED will decrease.

Table 7 - Number of accesses and percentage composition of accesses by triage code

Year	Number of Accesses				
	White	Green	Yellow	Red	$\frac{Exp\,(Y+R)}{Exp\,(W+G)}$
2012	14,854 6%	148,361 63%	62,875 27%	8,110 3%	0.95
2022	16,053 6%	154,684 62%	68,317 28%	9,237 4%	0.99
2032	14,366 6%	152,199 61%	71,794 29%	9,954 4%	1.06
2042	19,009 7%	168,654 60%	80,751 29%	11,633 4%	1.08
2052	19,967 7%	174,715 59%	86,995 30%	13,164 4%	1.13
2065	20,425 7%	175,035 59%	87,349 29%	13,453 5%	1.13
Variation 2012-2065	37.50%	17.98%	38.92%	65.89%	

Table 8 focuses the analysis on the evolution of white triage code in order to understand better which demographic characteristics affect mostly the inappropriate use of ED. According to the estimation on Liguria, in 2012 Italian people contribute to the 74% of white triage, while foreign people were the 26%. The majority of the white triage are women (59%), and, in

general, they are mainly young people (the 74% is aged less 64 years old).

Table 8 - White triage code composition-2012/2065

	M				F				Total	
	ITA		FOR		ITA		FOR			
Age	2012	2065	2012	2065	2012	2065	2012	2065	2012	2065
15-24	1.31%	0.77%	1.52%	2.89%	3.88%	2.35%	2.60%	4.52%	9.32%	11%
25-44	7.31%	3.33%	6.14%	9.03%	18.51%	8.60%	9.66%	11.95%	41.62%	33%
45-64	8.90%	3.95%	2.83%	8.42%	8.85%	4.01%	2.00%	4.26%	22.58%	21%
65-84	10.05%	5.76%	0.99%	12.10%	11.21%	5.60%	0.56%	5.88%	22.80%	29%
>85	1.75%	3.24%	0.01%	0.49%	1.91%	2.47%	0.01%	0.40%	3.68%	7%
Total	29.31%	17.04%	11.50%	32.94%	44.36%	23.02%	14.84%	27.00%	100%	100%

If we look at the composition of white triage code accesses in 2065 we can see that the demographic patter impacts, particularly the increase in foreign people. In 2065 the triage code will be composed by the 40% of Italian and by the 60% of foreign. Moreover, female will compose the 50% of this subgroup; due to the progressive ageing, a larger amount of older people will be classified as white triage code.

6. Conclusion and further work

The aim of this work was to analyze the impact of demographic change on the future sustainability of ED in the oldest region in Italy (i.e. Liguria). Indeed, the expenditure for emergency services is a relevant item in the total public expenditure for health care and it is thus important to understand how it will evolve during future years. According to the projections of the population

estimated by ISTAT for Liguria three main forces will influence the future number of residents (2012-2065): on one side, the increase in life expectancy will increase the number of residents aged more than 65, while, on the other side, the decline in birth rates will provoke a contraction in the number of young Italian residents. In addition, the increasing migration flows will significantly grow during the next 50 years, more than compensating the decline in birth rates and thus bringing to an increase in the total number of residents. The use of emergency services is strongly influenced by demographic factors: a descriptive analysis of our datasets shows that the probability of accessing ED and the cost associated to each access are increasing with age and they are higher for foreign people. These results are in accordance with previous research studies: indeed as age increases it is more likely to require more urgent treatments due to the fact that the general health status of older patients is worse (Salvi *et al*., 2007; Peters, 2010; Saramas *et al*., 2010). This means that the increase in the number of older residents will increase the number of patients classified as yellow and red triage code which composed the most expensive category of patients. For what concerns the impact on EDs of the increase in migration flows, previous studies show that foreign people tend to use more emergency services than natives due to the fact that they have a scarce knowledge of the health care system of the host country and to the fact that, in several countries, EDs offer a 24h free of charge service (Walls *et al*., 2002; Jimenez-Rubio, 2008; Newton *et al*., 2008). As a result, the rise in the number of foreign people will lead to an increase in the number of accesses for all triage codes. Indeed, on one side the use of ED as a source of primary care services will increase the accesses for not urgent treatments from indigent patients (white and green codes); in addition, the progressive ageing of foreign people in the host country will lead to an increase in the use of ED by foreign people for more severe medical conditions (yellow and red triage).

Looking at the results of our analysis we can see that the estimated increase in the number of accesses and total expenditure between 2012 and 2065 are, respectively, 26% and 35%. The impact of demographic change has thus a dual effect: on one side a pure monetary problem (increase in expenditure) and on the other side it will bring to management and organizational problem (increase in accesses will cause overcrowding and waiting time). We will now provide an answer to the two research questions proposed in the Introduction.

1. Will progressive ageing of the population and the increasing migration flows impact the future sustainability of EDs?

Results suggest that the categories of more expensive patients (i.e. older, foreign) are estimated to increase more than the less expensive ones. Despite the big contribution of ageing in the increase of total expenditure (+131% expenditure for people aged more than 85), the biggest increase in the expenditure can be related to the increase in foreign people (+403% expenditure and +292% accesses). From Table 6 it is evident that total expenditure from Italian and foreign people aged more that 85 will increase respectively by 101% and 6714%. It is thus evident that the future sustainability of EDs is questioned. If EDs will not be adapted to the changes in the demographic structure of the population, a problem of overcrowding of the facilities and of worsening in the quality of the services offered will emerge; this will bring to difficulties to deliver a person-oriented care (Moskop *et al*., 2009). In addition, congestion and waiting times can be particularly serious problems as they can bring to particularly dramatic outcome for vulnerable patients (such as elderly).

2. How will demographic changes influence the inappropriate use of EDs?

If we look at the changes composition of code accesses by triage code in 2065 we can see that the demographic patter impacts:

indeed, the number of accesses for not severe medical conditions (white and green code) will increase by 55% while the number of more severe conditions (yellow and red code) will increase by 105%, leading to a reduction in the percentage of inappropriate accesses on the total number of accesses. This is partially explained by ageing, as usually older people are classified as yellow or red triage due to their worse general health status. Despite this fact, in absolute number, the accesses classified as white triage will increase significantly (+38%) , leading to ED management problem as inappropriate users are often responsible for crowding and waiting times.

Although the results are in line with the conclusions of similar studies, the analysis proposed suffers from some shortcomings. First of all, the estimation of the probability of accessing ED is based on several assumptions: we identified the catchment area of the ED using a simple graphical tool, namely selecting the urban areas around the aforesaid ED (sufficiently close to it and far from the others EDs of Genoa) and selecting the number of residents as the denominator of the access rate. This is a strong assumption as the closeness to the place of living is not the unique determinant in the decision of going to one ED rather than to another one: other elements (e.g. closeness to the place where the health problem arises, knowledge of doctors, reputation of different ED) can have a role. However we believe that this assumption is not going to bias to much the results as the vast majority of accesses to ED (74% in 2012) are classified as white and red triage code, meaning that urgency of intervention is not always so relevant. Many patients accessing ED wait some time before going to ED and thus, they often turn to the closest ED to their home. This cannot be the case for really urgent problems (e.g. heart attacks, car crashes) which, however, compose a minor part of the total number of accesses. In addition, when one urban area is equally distanced from two or more EDs it is not easy to established to which EDs, in case of urgency, a resident of this

urban area will decide to go. However, we believe that this way of running the analysis is reasonable, given the limited amount of data that we obtained (i.e. data on only one ED of Genoa). It is important to note that we followed the Abel-Smith and Titmuss (1956) approach, namely we assumed that the changes in health expenditure are only due to changes in population while everything else (e.g. incidence of sickness, standards of diagnosis, quantity and quality of treatments, cost of each category of individual) stay the same. This is a strong assumption that can be relaxed in future works introducing, for example, a correction for technological progress in medical research in the average cost of treatments.

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