Population Review
Volume 65, Number 1, 2026
Type: Article pp. 27-53

Living In Athens: A Study Of Mortality Inequalities By Cause Of Death

Authors: Charalampos Dantis, cdantis@uth.gr, https://orcid.org/0009-0007-6268-4515

Konstantinos Zafeiris, kzafiris@hs.duth.gr, https://orcid.org/0000-0002-2587-6565

Corresponding author: Charalampos Dantis < cdantis@uth.gr >

Abstract

The literature on losses in life expectancy at birth by cause of death is extensive. However, studies examining gender, age, and spatial variation in longevity loss within Greece are scarce, and those focusing specifically on Attica are rarer still. The primary goal of this paper is to assess whether longevity losses vary by cause of death, sex, age group, and Regional Unit within Attica over the period 2014–2019. Analysis of microdata from the Hellenic Statistical Authority and data from Eurostat reveals spatial patterns for several causes of death, notably diseases of the circulatory system, neoplasms, and external causes of morbidity and mortality. Furthermore, the results indicate that for particular disease categories, losses in life expectancy also exhibit clear sex and age dimensions. Finally, it is noteworthy that, overall, Greece shows substantially lower life-expectancy losses at birth across most cause-of-death categories for both men and women.

Keywords: Longevity loss, Attica, Diseases, Causes of Mortality, Gender.

1. Introduction

The 2009 economic crisis, characterised by successive austerity measures, had profound implications for Greece's health system. The contraction of public financing, together with rising unemployment, loss of insurance coverage, and cost-related barriers, led to substantial deterioration in access to healthcare and to widening health inequalities (Economou et al., 2015). Before the crisis, domestic general government health expenditure (GGHE-D) as a share of general government expenditure (GGE) was about 12.5%; by 2019 that figure had fallen to roughly 8.3% (WHO, 2025). Although overall mortality continued its long-term decline, the crisis produced discernible adverse effects on specific health outcomes: the suicide rate increased by over 30% between 2009 and 2013 (Rachiotis et al., 2015), and rises were reported in infectious and respiratory diseases (Karanikolos et

al., 2013). Mental health indicators also worsened markedly, with studies documenting substantial increases in depression and anxiety (Economou et al., 2013).

The period 2014–2019, however, was characterised by gradual stabilization. According to OECD data, total health expenditure in Greece stabilised at around 8% of GDP by 2017, still below the EU average of 9.8% (OECD, 2019). Major reforms during this period included consolidation of primary care services and expansion of universal coverage. The establishment of the National Organization for Health Care Services Provision (EOPYY) and the introduction of the Primary Health Care Network (Law 4254/2014) were central policy milestones (OECD, 2019, Organization, 2019). Despite these developments, structural weaknesses persisted: private out-of-pocket payments accounted for about 35% of total health expenditure in 2019—one of the highest shares in the European Union (OECD, 2019). Per-capita health spending and public financing remained well below the EU average (OECD, 2023), and socioeconomic and geographic disparities in access to care persisted (Vandoros et al., 2017).

This study focuses on the Region of Attica, which accounts for approximately 35% of Greece's population (Commission, 2025a). In Greece's most populous region, the impact of the 2010s economic crisis resembled that in the rest of the country. Nevertheless, the data indicate that the situation in Attica is particularly acute: of the 13 regions of Greece, Attica ranked 12th in 2019 in terms of life expectancy at birth (Commission, 2025a) ife expectancy at birth in Attica was 81.2 years (78.4 years for men and 83.8 years for women), while the Region of Eastern Macedonia and Thrace recorded 81.1 years (Commission, 2025a). The literature documents a marked social and environmental deterioration in quality of life in Attica since the 2008 recession (Zarafonitou and Kontopoulou, 2020); in the central sector of Athens, for example, 70% of residents report a decline in quality of life (Zarafonitou and Kontopoulou, 2020). This decline is reflected in the health sector: available hospital beds fell from 23,863 in 2009 to 18,742 in 2019, a decrease of 21.5% (Commission, 2025a).Such deterioration is especially important for diseases amenable to healthcare intervention (e.g., diseases of the circulatory system), which account for the largest losses in life expectancy at birth (McMinn et al., 2022).

The objective of this article is to investigate losses in life expectancy by disease category, sex, age group, and Regional Unit within Attica. Previous studies have examined mortality by cause of death in Greece see, for example (Kalogirou et al., 2012, Zafeiris, 2020a). The novelty of the present research lies in its focus on a relatively underexplored period (2014–2019) a timeframe that permits assessment of the cumulative impact of the preceding economic crisis on the health sector and of any subsequent improvements and in its concentration on the Region of Attica, which has been largely overlooked in the literature despite being the country's most populous region. Attica presents a particularly burdened health profile (as shown above) and pronounced socioeconomic inequalities (Maloutas, 2018, Vinci et al., 2023): research indicates that more affluent and better-educated groups are concentrated in the

Northern and Southern Sectors of Athens, whereas Western Attica and the Western Sector of Athens contain comparatively disadvantaged populations (Arapoglou and Maloutas, 2011, Maloutas, 2018). This point is central to the study because an area's socioeconomic characteristics strongly influence losses in life expectancy from disease categories such as cardiovascular conditions McMinn et al. (2022) and external causes of morbidity and mortality (Kim et al., 2016, Lachaud et al., 2017, Näher et al., 2020). However, owing to the lack of sufficiently detailed, statistically robust information on Greece's social and economic structures at the departmental level (relevant ELSTAT surveys yielded no statistically significant results), this study does not attempt to link the findings directly to those characteristics. Instead, results are interpreted within the socioeconomic context of the areas concerned using available qualitative data, without testing causal relationships.

Finally, this study ends in 2019 because the onset of the COVID-19 pandemic fundamentally altered patterns of overall mortality in Greece and the distribution of life-expectancy losses by disease category.

Lifetables are constructed using death and population microdata from the Hellenic Statistical Authority (ELSTAT) and data from the Eurostat database.

The paper is structured as follows. Given the spatial dimension of social inequality in Attica, Section 2 reviews how various diseases relate to socioeconomic status. Section 3 presents the data and methods. Section 4 reports the results. Section 5 offers interpretation and discusses the study's limitations.

2. Causes of Death by Age group and by Gender

2.1. Diseases of the Circulatory System

When reviewing the literature on the relationships among sex, age, and socioeconomic status and cardiovascular disease, evidence shows that cardiovascular conditions are the leading cause of morbidity and mortality in Greece (Samaras et al., 2025). (Samaras et al., 2025) report that, of 37,741 hospitalisations for cardiovascular causes over a 12-year period, 66.4% were male and the median age was 70 years. These findings indicate that men face a substantially higher risk of severe cardiovascular events than women, and that risk increases with age. This pattern appears partly attributable to a higher prevalence of hypertension among men and markedly higher smoking rates in the male population (Touloumi et al., 2020). Comparable sex- and age-related patterns have been observed elsewhere, for example in China (Zhou et al., 2016). Finally, research from Scotland highlights a socioeconomic gradient in cardiovascular mortality (McMinn et al., 2020): lower-educated and lower-income groups

experience higher death rates from diseases of the circulatory system, which are often considered amenable to healthcare intervention.

2.2. Diseases of the Respiratory System

Although diseases of the circulatory system display a clear sex disparity, this pattern is less evident for respiratory diseases. In China, for example, mortality from respiratory conditions is high in both men and women; despite higher smoking prevalence among men, no large sex gap is observed because both sexes are exposed to shared risk factors such as air pollution and broader environmental hazards (Zhou et al., 2016). Findings from Greece are similar: Zafeiris (2020a) reports that losses in life expectancy due to respiratory diseases increased among women in the 2010s and converged with those for men, in part because of rising smoking rates among women. Regarding age, studies in Greece (Nikolaou et al., 2024)and across the European Union show that respiratory deaths predominantly affect people aged over 65 Commission (2025b) at the EU level, mortality from respiratory diseases is approximately 32 times higher among those over 65 than in younger age groups (Commission, 2025b).

2.3. External causes of morbidity and mortality

External causes of morbidity and mortality including traffic accidents, suicides, homicides and drug-related deaths exhibit clear differences by sex, age and socioeconomic status (Lachaud et al., 2017, Näher et al., 2020). Evidence from the United States indicates that the risk of fatal motor-vehicle accidents is higher in lower-educated and minority groups (e.g., Black populations) (Harper et al., 2015, Holmes Jr et al., 2024). Contributing factors include ownership of vehicles with poorer crash-test ratings and reduced local access to hospitals and specialists in high-poverty areas. Although traffic-accident mortality declined in the 2010s, socioeconomic disparities persisted (Harper et al., 2015). Comparable patterns have been documented in China (Liu et al., 2014, Zhou et al., 2016) and Greece (Nikolaou et al., 2021).

With respect to suicide, South Korean data show an inverse relationship between educational attainment and suicide attempt rates and a positive association with unemployment; mechanisms proposed include stress from economic insecurity, family pressures and social expectations (Kim et al., 2016). Educational attainment is, in turn, positively associated with employment (Kim et al., 2016). These associations are corroborated by research from Greece (Madianos et al., 2014) and Germany (Näher et al., 2020).

Homicide victimisation is concentrated among young men in deprived neighbourhoods, as observed in Canada and the United States (Lachaud et al., 2017, Males, 2015) indicating strong links between homicide, socioeconomic background, sex and age. Finally, lower socioeconomic status and

limited education are positively associated with higher alcohol and drug use and with drug-related mortality (Harper et al., 2015, Najman et al., 2008).

2.4. Neoplasms

Finally, the literature shows that the negative impact of neoplasms on life expectancy has increased significantly in China and is related to behavioural changes such as negative dietary habits and decreased physical activity (Liu et al., 2014). These trends have also appeared in Greece in recent decades (Zafeiris, 2020a). However, according to Zhou and his colleagues (Zhou et al., 2016), the relationship between socio-economic conditions and neoplasms is unclear. However, the gender and age dimensions of cancer mortality are evident both in Greece and across the European Union: according to OECD data (OECD, 2024), there are 326 cancer deaths per 100,000 inhabitants among men in Greece, compared to 170 among women, while at the level of the European Union, in 2020, 73% of cancer deaths concerned individuals aged 65 and over (COMMISSION, 2026).

2.5. Research question, hypotheses and novelties

To summarize, the research question of this study is: what are the losses in life expectancy by cause of disease, sex, age group and Regional Unit within Attica for the period 2014–2019. As noted in Chapter 1, the novelties of this study are, first, the period under investigation (2014–2019) — a timeframe that allows assessment of the cumulative impact of the preceding economic crisis on the health sector, as well as potential improvements after the end of the crisis — and, second, the focus on the Region of Attica, for which there is scant literature and which is of particular interest given its health and socio-economic profile. Finally, the study's hypotheses are as follows: (i) the disease category producing the largest losses in Attica is diseases of the cardiovascular system; (ii) cardiovascular diseases exhibit both an age dimension (they mainly affect older persons) and a sex dimension (they predominantly affect men); (iii) diseases of the respiratory system mainly affect older persons but do not show a marked sex difference; (iv) external causes of morbidity and mortality produce the greatest losses in life expectancy among young men in deprived areas of Attica; and (v) neoplasms show both an age dimension (they mainly affect older persons) and a sex dimension (they predominantly affect men).

3. Data and Methods

Deaths by cause come from the Hellenic Statistical Authority (ELSTAT) in the form of anonymised microdata and population by age and gender from the Eurostat Database (https://ec.europa.eu/eurostat/data/database).

The life tables were abridged 5-year life tables (age groups: 0, 1–4, 5–9, 10–14, up to 85+), and constructed separately for the two genders of the Greek and Attica populations using conventional methods (Chiang, 1984). The first step was to create life tables for each Regional Unit and each gender, including all causes of death, and afterwards, to eliminate each major cause of death and construct the new life tables without this disease. Thus, these two life tables were compared with the Arriaga method to calculate the loss of life expectancy at birth from each cause of death by age (Arriaga, 1995, Arriaga, 1984, Zafeiris, 2020a). Zafeiris (2022) summarises, *"there is no doubt that life expectancy at birth (e0) is a straightforward and age-standardised measure of mortality (see Modig et al. 2020), i.e., an estimation of the life span. Surely then, any e0 differences between two population groups outline their overall mortality inequalities. However, e0 represents the quotient of the number of person-years lived after an exact age x (Tx) to the number of persons surviving that age (lx) (See Preston et al. 2001, pp. 38-69) . It is then an average measure of longevity, affected by infant, child, juvenile and adult mortality, i.e., the mortality patterns throughout the whole life span. When comparing e0 in two groups of people, any differences result from the simple subtraction of two averages without considering the variability within these groups, while ignoring the fact that quite different mortality patterns may give similar values of life expectancy at birth (e0), not to mention that these patterns retain a dynamic character over time. It is what Arriaga (1984, 1989) notices when comparing a population's average longevity between two-time points: "a 3 change in life expectancy (at any age) does not necessarily mean that mortality rates change in the same magnitude, or even in the same direction at all ages".* Therefore, the Arriaga method is evident when comparing mortality regimes across populations.

To interpret the similarities and dissimilarities among the populations studied, Discriminant Analysis (DA) was employed. DA was selected due to its ability to identify linear combinations of predictor variables (i.e., life expectancy losses by cause of death and age group) that best separate pre-defined groups (gender and Regional Units of Attica). Unlike alternative methods such as logistic regression (limited to binary classification) or cluster analysis (unsupervised), DA is ideal for comparing multiple pre-defined groups and quantifying their separation. The grouping structure was based on gender (male vs. female) and the 8 Regional Units of Attica, with age groups categorized into <30, 30–64, and 65+ years to capture distinct mortality patterns while avoiding multicollinearity. Initial attempts to use finer age groupings (e.g., <30, 30–34, 65+) resulted in Variance Inflation Factors (VIFs) > 5, indicating multicollinearity. Therefore, the final age grouping (<30, 30–64, 65+) was adopted, as it ensured VIF < 5 for all variables, confirming the validity of the analysis (Ayinla and Adekunle, 2015). Within-class covariance matrices were assumed to be different, and prior probabilities were not taken into account.

The classification performance of the DA model was evaluated using confusion matrices, overall classification accuracy, sensitivity, and specificity for each group, while eigenvalues and

canonical correlations were calculated to quantify the degree of separation between groups. All statistical analyses were performed at the 0.05 significance level, and the results were cross-validated to ensure robustness.

To present the spatial variation of longevity loss by cause of death and by gender in the Region of Attica, analysis was done at the level of Regional Units. That is, at level NUTS 3. The Attica Region includes eight Regional Units (Figure 7): 1) "Kentrikos Tomeas Athinon" (Central Athens Regional Unit), 2) "Notios Tomeas Athinon" (South Athens Regional Unit), 3) "Voreios Tomeas Athinon" (North Athens Regional Unit), 4) "Dytikos Tomeas Athinon" (West Athens Regional Unit), 5) "Peiraias" (Piraeus Regional Unit), 6) "Nisoi Attikis" (Islands of Attica Regional Unit), 7) "Dytiki Attiki" (West Attica Regional Unit), 8) "Anatoliki Attiki" (East Attica Regional Unit). However, because in the Eurostat's database the data of Regional Units "Peiraias" and "Nisoi" are given grouped, analysis is based on seven Regional Units: 1) "Kentrikos Tomeas Athinon" (KTA), 2) "Notios Tomeas Athinon" (NTA), 3) "Voreios Tomeas Athinon" (VTA), 4) "Dytikos Tomeas Athinon" (DTA), 5) "Peiraias, Nisoi" (PN), 6) "Dytiki Attiki" (DA), 7) "Anatoliki Attiki" (AA).

Regarding causes of death, we grouped all causes of death included in the ELSTAT and Eurostat databases into ten categories: 1) Neoplasms, 2) Diseases of the circulatory system, 3) External causes of morbidity and mortality, 4) Diseases of the respiratory system, 5) Diseases of the digestive system, 6) Diseases of the nervous system and the sense organs, 7) Endocrine, nutrition and metabolic diseases, 8) Certain infectious and parasitic diseases, 9) Diseases of the genitourinary system, 10) Rest. However, due to the very large volume of data, and given that the loss of life expectancy at birth from some causes of death is extremely limited for many causes of death, we focused on the following six categories in this article: 1) Diseases of the circulatory system, 2) Neoplasms, 3) Diseases of the respiratory system, 4) External causes of morbidity and mortality, 5) Diseases of the digestive system, 6) the sum of the rest causes of death.

4. Results

a. Longevity losses by Gender and by Sex

An examination of the tables and graphs reveals that the most significant losses in life expectancy at birth are attributable to cardiovascular diseases (Tables 1 and 2), followed by neoplasms. It is also evident that, across all categories of causes of death, men consistently experience substantially greater losses in life expectancy over time (Figures 1a, 2a, 3a, 4a, and 5a). Furthermore—with the exception of external causes of morbidity and mortality—in all other categories, the largest losses in life expectancy at birth are primarily observed among individuals aged 65 and over, and secondarily in the 45–64 age group. Additionally, for both sexes—and again excluding external causes of morbidity

and mortality—a decline in life expectancy losses at birth is observed across all other cause-of-death categories from 2014 to 2019 (Tables 1 and 2).

More specifically, for diseases of the cardiovascular system (Figure 1a), the respiratory system (Figure 3a), neoplasms (Figure 2a), and external causes of morbidity and mortality (Figure 4a), the age group exhibiting the greatest losses in life expectancy at birth is clearly that of individuals aged 65 and over. However, in the case of external causes of morbidity and mortality, particularly high life expectancy losses are also evident among men aged 15–29 and 30–44 (Figure 4a, Tables 1 and 2). Finally, the only category in which women exhibit higher losses in life expectancy at birth is that of the "Rest" causes of death (Tables 1 and 2).

b. Descriminant Analysis

The Discriminant Analysis (DA) accounted for a substantial portion of the variability in life expectancy losses, explaining more than 94.4% of the variability in women and more than 91.9% in men regarding diseases of the circulatory system, neoplasms, and external causes of morbidity and mortality. The analysis yielded two canonical discriminant functions, with the first function explaining 78.2% of the total variance (eigenvalue = 2.45, canonical correlation = 0.92, $p < 0.05$) and the second function explaining an additional 12.1% (eigenvalue = 0.38, canonical correlation = 0.55, $p < 0.05$). The high canonical correlations confirm that the groups (gender and Regional Units) are well-separated based on the predictor variables. The classification performance of the DA model was strong, with an overall accuracy of 87.3%. Specifically, 89.1% of male observations and 85.5% of female observations were correctly classified into their respective groups.. Leave-one-out cross-validation confirmed the robustness of these results, with a cross-validated accuracy of 85.8%.

For diseases of the circulatory system, the study of centroids revealed a clear differentiation of populations by gender, despite some overlap in observations. In both genders, the Northern Sector of Athens (Voreios Tomeas Athinon), Southern Sector of Athens (Notios Tomeas Athinon), and Eastern Attica (Anatoliki Attiki)—which share more similarities with Greece as a whole (GR)—were distinct from the Central Sector of Athens (Kentrikos Tomeas Athinon), Western Attica (Dytiki Attiki), and Piraeus and Islands (Figure 1b). The Western Sector of Athens (Dytikos Tomeas Athinon) occupied an intermediate position, suggesting a gradual transition in life expectancy losses between these groups.

In the case of neoplasms, the centroids analysis revealed a differentiation among the populations of the Regional Units of Attica (Figure 2b). In both genders, Western Attica, Piraeus and Islands, and Greece as a whole were clearly separated from the remaining Regional Units of Attica. Among the latter, the Southern and Northern Sectors of Athens (Notios and Voreios Tomeas Athinon) were closer to each other, as were the Western and Central Sectors of Athens (Dytikos and Kentrikos Tomeas Athinon).

Finally, Eastern Attica (Anatoliki Attiki) appeared to bridge the gap between Greece and the groups of the Northern and Southern Sectors of Athens, indicating a moderate level of life expectancy losses compared to the other Regional Units.

For external causes of morbidity and mortality, a significant differentiation was observed among male populations (Figure 4b). Specifically, the male populations of Western Attica, Piraeus and Islands, and Greece were distinct from the other Regional Units of Attica. These findings highlight the specific socio-economic situation of men in the poorest Regional Unit of Attica (Western Attica), as well as the substantial difference between Attica and rural areas concerning external causes of morbidity and mortality. In contrast, for women, differentiation was observed only between Greece as a whole and the Regional Units of Attica, suggesting a less prono unced regional variation in life expectancy losses due to external causes among female populations.

c. Other Results

The results of our analyses are notable not only in terms of gender or age group differences but also in their spatial dimension. As shown in Tables 1 and 2, the Regional Units of West Attica and the Western Sector of Athens exhibit the highest losses in life expectancy at birth. Specifically, for cardiovascular diseases, losses reach 6.9 years for women in West Attica (2016) and 8.21 years for men (2018), while in the Western Sector of Athens, the figures are 7.81 years for women (2015) and 6.23 years for men. For neoplasms, losses in West Attica are 3.06 years for women (2018) and 5.21 years for men (2015 and 2018), whereas in the Western Sector of Athens, they are 4.84 years for women (2015) and 4.95 years for men. Regarding external causes of morbidity and mortality, losses in West Attica amount to 1.24 years for women (2017) and 1.89 years for men (2017 and 2019), while in the Western Sector of Athens, they are 1.28 years for women (2018) and 1.84 years for men.

For diseases of the respiratory system (Tables 1 and 2), the highest losses in life expectancy at birth are observed in the Central Sector of Athens. Conversely, the smallest losses in life expectancy at birth due to cardiovascular diseases are found in the Northern and Southern Sectors of Athens, while for neoplasms, the lowest losses occur in the Regional Unit of East Attica. Finally, it is worth noting that, for both women and men, losses in life expectancy at birth across all causes of death—except for the "Rest" category—are significantly lower for Greece as a whole compared to the Regional Units of Attica (Tables 1 and 2).

5. Discussion and Conclusion

As outlined in the introductory section of this study, the primary objective is to investigate life expectancy losses categorized by disease type, sex, age group, and Regional Unit. The extensive data

generated provide a lucid illustration of both the demographic (gender and age) and spatial dimensions of causes of death within the Attica Region. The most substantial reductions in life expectancy at birth are attributable to cardiovascular diseases and, secondarily, to neoplasms. Furthermore, across nearly all cause-of-death categories, males and residents of Attica aged 65 and over exhibit the most pronounced losses. These findings corroborate existing literature (Samaras et al., 2025, Touloumi et al., 2020). Finally, it is noteworthy that for both sexes—with the exception of external causes of morbidity and mortality—there was a measurable decline in life expectancy losses across all other categories between 2014 and 2019. This trend aligns with evidence indicating a steady increase in life expectancy in Greece during this five-year period (Kastrinaki, 2025, Zafeiris, 2023).

Regarding the age-specific distribution of life expectancy losses due to cardiovascular and respiratory diseases, as well as neoplasms, the data indicate that these losses predominantly affect individuals over the age of 65. These observations are consistent with established research regarding the epidemiological profile of the aforementioned conditions (Commission, 2025b, Nikolaou et al., 2024, Samaras et al., 2025). However, the distinct patterns observed in life expectancy losses from external causes of morbidity and mortality warrant specific attention: beyond the 65+ age cohort, significantly high losses are also recorded among males in the 15–44 age groups. This phenomenon may be attributed to what is described in the literature as the "accident hump". These findings appear to be in line with international studies indicating that causes of death such as traffic accidents and homicides primarily affect young men in socioeconomically disadvantaged urban (Lachaud et al., 2017, Nikolaou et al., 2021, Zhou et al., 2016) environments (Males, 2015).Concerning the elevated mortality rates among the 65+ population due to external causes, this may be linked to the high incidence of traffic accidents within this demographic, which is often associated with age-related declines in sensory-motor coordination and reflexes.

The results that provide a spatial dimension to life expectancy losses at birth are of particular interest. As previously noted, the greatest losses in life expectancy at birth due to circulatory system diseases and neoplasms are observed in Western Attica and the Western Sector of Athens. Previous literature has demonstrated that such patterns are prevalent in areas characterized by low socio-economic levels (McMinn et al., 2022), as these diseases are considered amenable to healthcare interventions. To interpret these findings, a brief examination of the socio-economic geography of Attica is necessary: higher-income and more educated populations are predominantly concentrated in the Regional Units of North and South Athens (Arapoglou and Maloutas, 2011, Maloutas, 2018), whereas the opposite is true for the Western Sector of Athens and West Attica. The Regional Units of Central Athens and Piraeus exhibit an intermediate socio-economic profile, characterized by vertical social differentiation, with higher socio-professional classes residing on the upper floors of apartment buildings, and working-class individuals and immigrants occupying the lower floors (Maloutas, 2018).

In conclusion, residents in the northern and southern sectors of Athens enjoy the highest quality of life in the entire capital region, while the opposite holds for residents of West Attica and the Western Sector of Athens.

Additionally, the results indicate that life expectancy losses at birth from respiratory diseases are significantly lower in Greece as a whole compared to the Regional Units of Attica, with the highest losses within Attica recorded in the Central Sector of Athens. Both findings may be attributed to the fact that residents in the capital's center are exposed to extremely high levels of air pollution (Zafeiris, 2020a, Zhou et al., 2016).

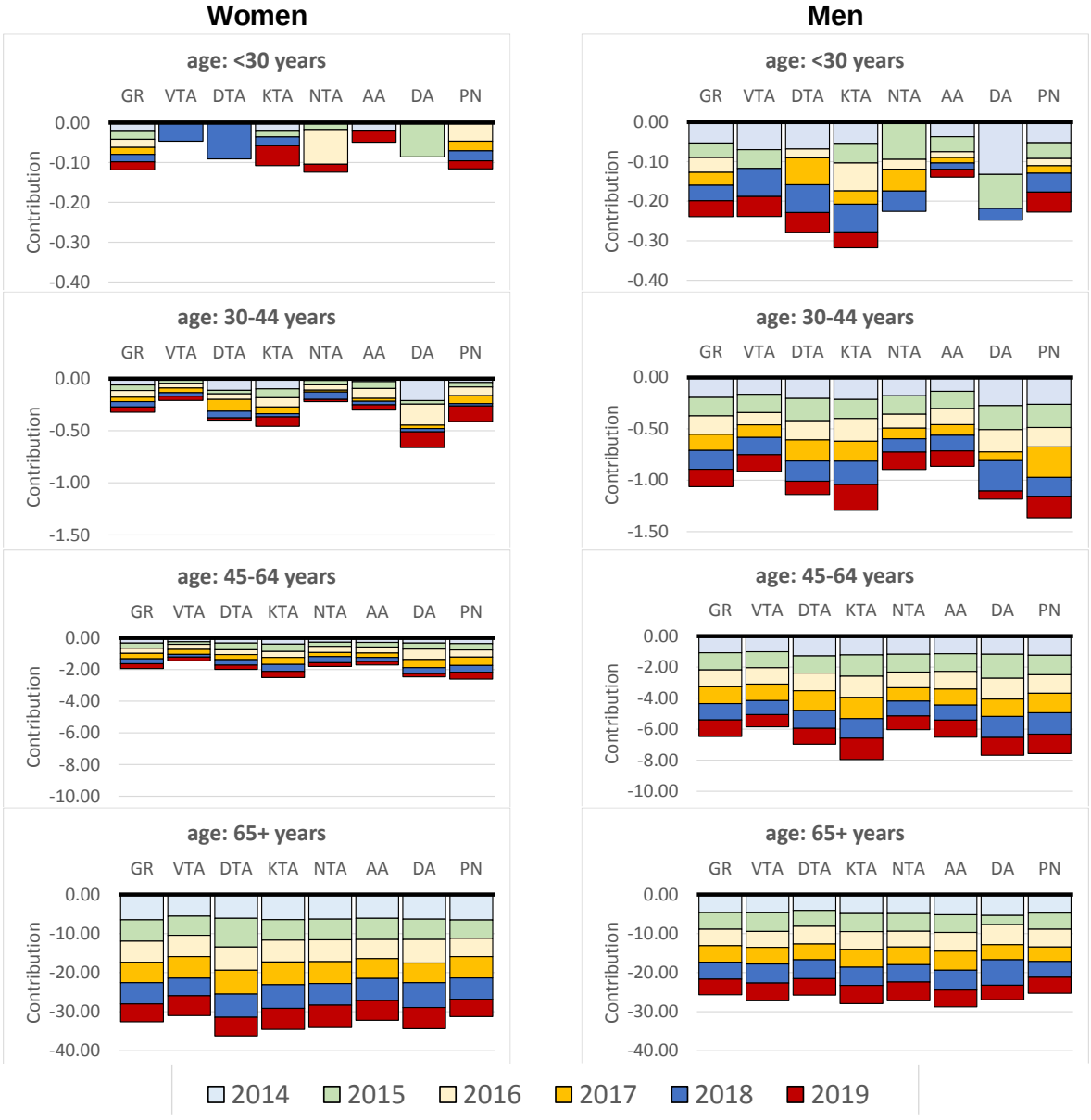
This study is subject to certain limitations. Chief among these is the temporal scope of the research: data could not be extended before 2014, as it was necessary to analyze the pre-2010 economic crisis period, nor after 2019, due to the unique circumstances of the COVID-19 pandemic. Furthermore, the administrative division of Attica has changed over time, leading to variations in the distribution of population and deaths across the capital's administrative units. Finally, due to the extensive volume of data, it was not feasible to display and discuss all causes of death. Consequently, graphs and tables were produced only for diseases of the circulatory system (as they account for the most substantial life expectancy losses at birth), external causes of mortality and morbidity (due to their significance in age-specific life expectancy losses), neoplasms, respiratory diseases (as they have a minor but notable impact on life expectancy at birth), and other causes of death. Nevertheless, this study is among the few to provide a comprehensive overview of life expectancy losses by cause of death category in Attica, offering a clear and detailed picture.

Future research could focus on specific diseases and extend the temporal scope of analysis. Moreover, the contribution of each cause of death to life expectancy loss in Attica should inform health—and broader—policy considerations for the region. Indeed, the severity of each disease's impact on life expectancy in Attica, as highlighted in this article, necessitates interventions across the entire spectrum of social policy. For instance, diseases amenable to healthcare interventions, such as cardiovascular diseases, require policies that reverse the negative impacts of the 2008 Economic Recession on the health sector, particularly its severe underfunding. Additionally, given that life expectancy losses from neoplasms are linked to modern lifestyles, public health campaigns should emphasize the importance of the Mediterranean diet (Benetou et al., 2008, Trichopoulou et al., 2010) and physical activity in the lives of Athenians (Lagiou et al., 2008, Papadopetraki et al., 2022). Improving the situation also depends on enhancing sports infrastructure. It is worth noting that Athens, with only 6.6 m² of green space per capita, has one of the lowest ratios of green space among European capitals (Bove and Ghiraldelli, 2025).

Furthermore, the significant impact of respiratory diseases on life expectancy underscores the urgency of environmental upgrades in Athens. Despite improvements over the past three decades, the city remains burdened by air pollution compared to other European cities (Kladakis et al., 2025). Finally, the external causes of morbidity and mortality highlight the need for improved traffic education in Greece and the modernization of a road network that currently fails to meet contemporary road safety standards (Kehagia et al., 2022). As George Seferis aptly remarked, our "words are the children of many people."

Figures and Tables

Figure 1a The contribution of each age group to the loss of life expectancy at birth from diseases of the circulatory system, by gender, by Regional Unit of Attica and by year, 2014-2019



Source: *own elaboration from Hellenic Statistical Authority (ELSTAT) and Eurostat Database*

Figure 1b Discriminant analysis, 2014-2019, Regional Units of Attiki, Diseases of the circulatory system

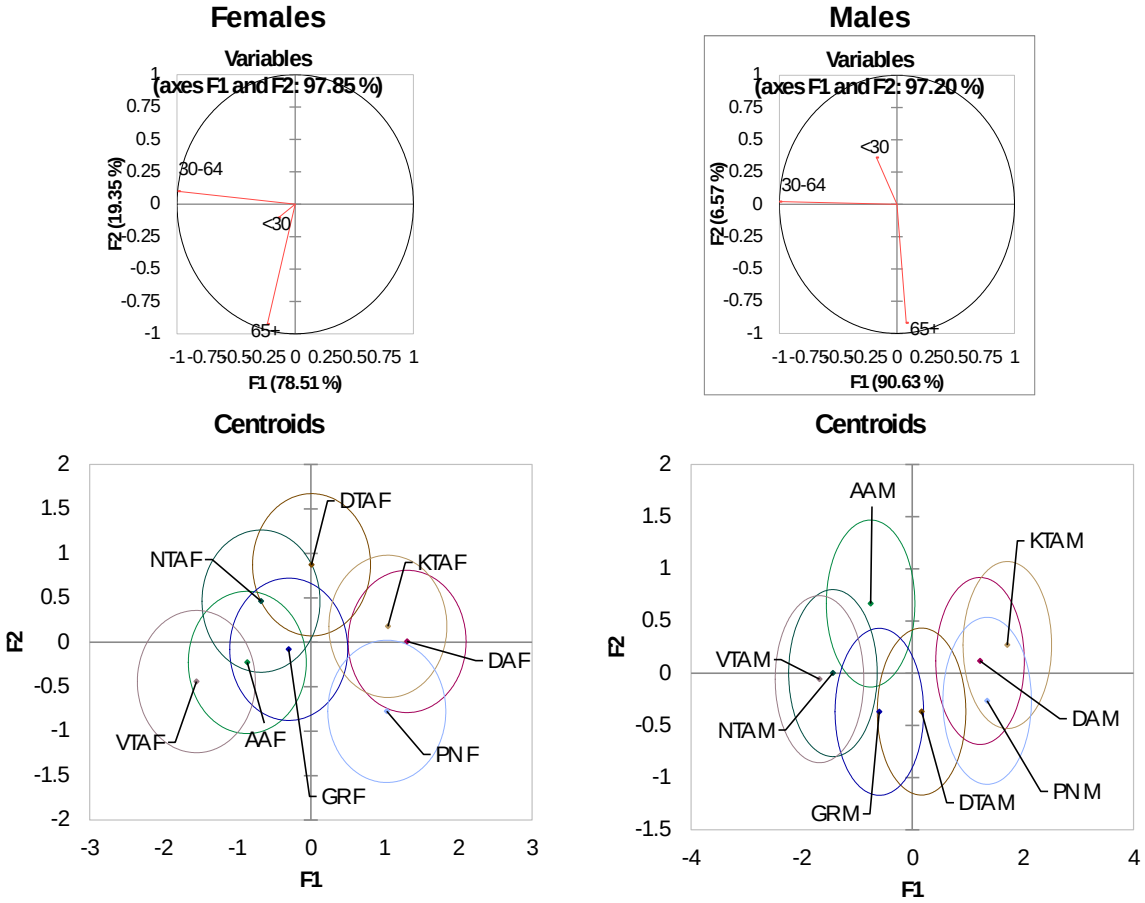
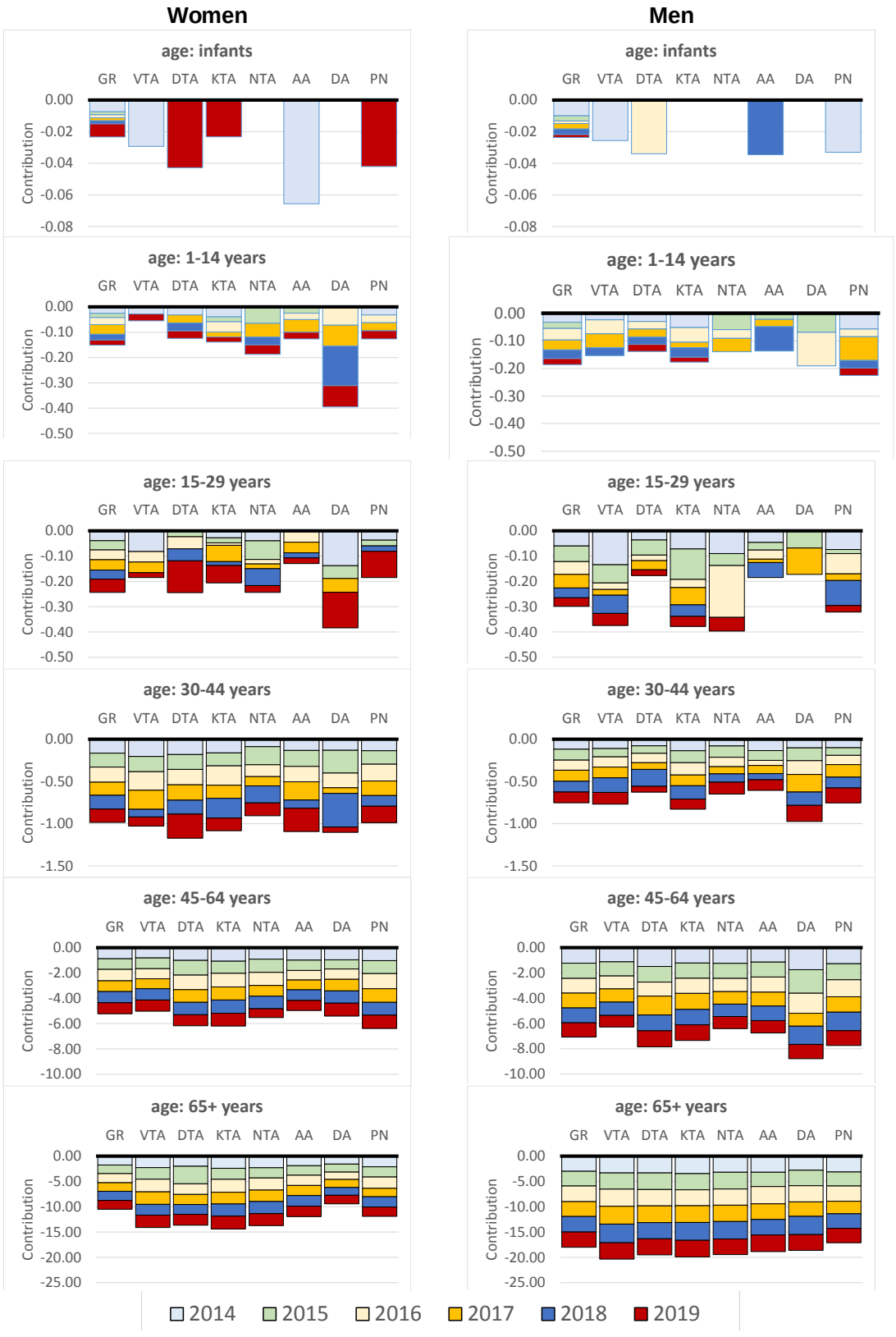


Figure 2a The contribution of each age group on the loss of life expectancy at birth from neoplasms, by gender, by Regional Unit of Attica and by year, 2014-2019



Source: own elaboration from Hellenic Statistical Authority (ELSTAT) and Eurostat Database

Figure 2b Discriminant analysis, 2014-2019, Regional Units of Attiki, Neoplasms

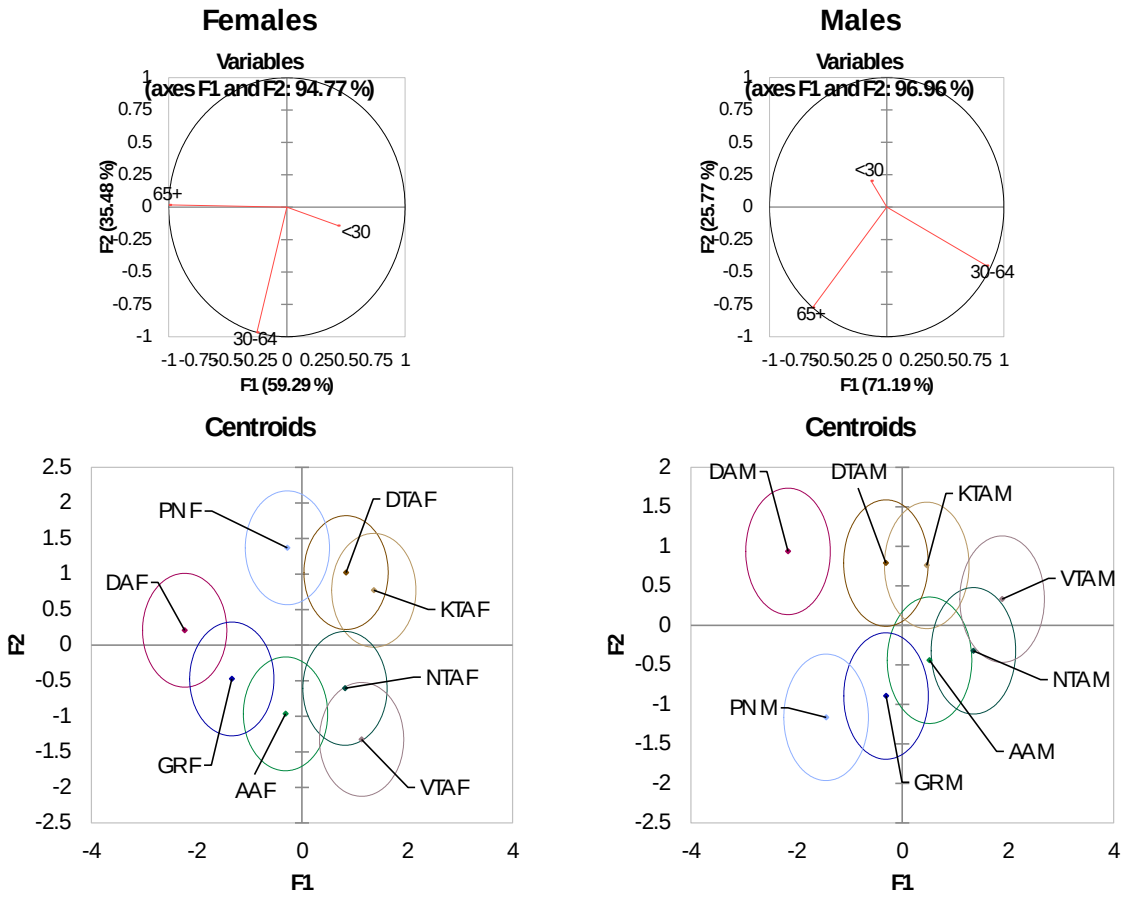
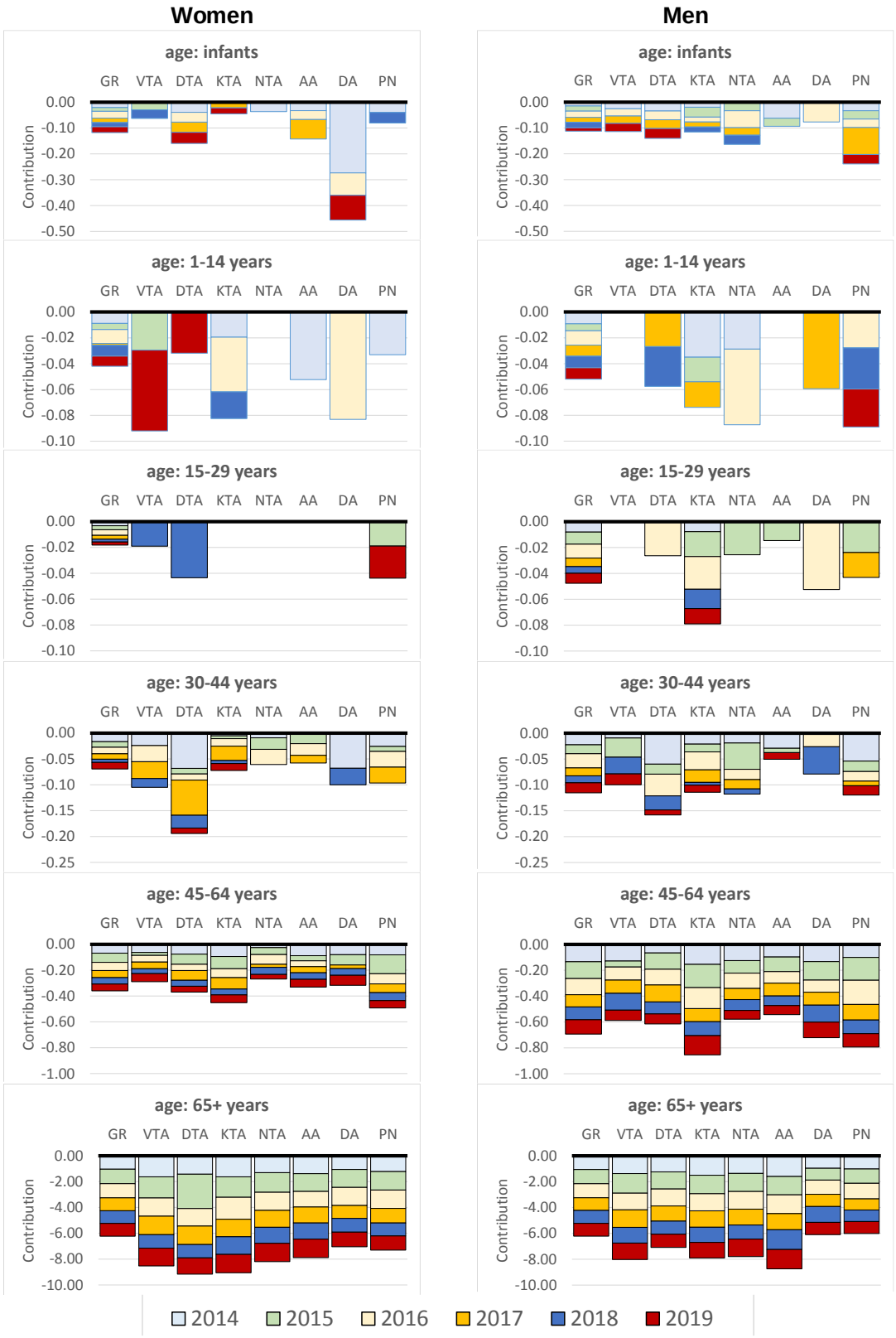


Figure 3a The contribution of each age group to the loss of life expectancy at birth from diseases of the respiratory system, by gender, by Regional Unit of Attica and by year, 2014-2019



Source: own elaboration from Hellenic Statistical Authority (ELSTAT) and Eurostat Database

Figure 3b Discriminant analysis, 2014-2019, Regional Units of Attiki, Diseases of the respiratory system

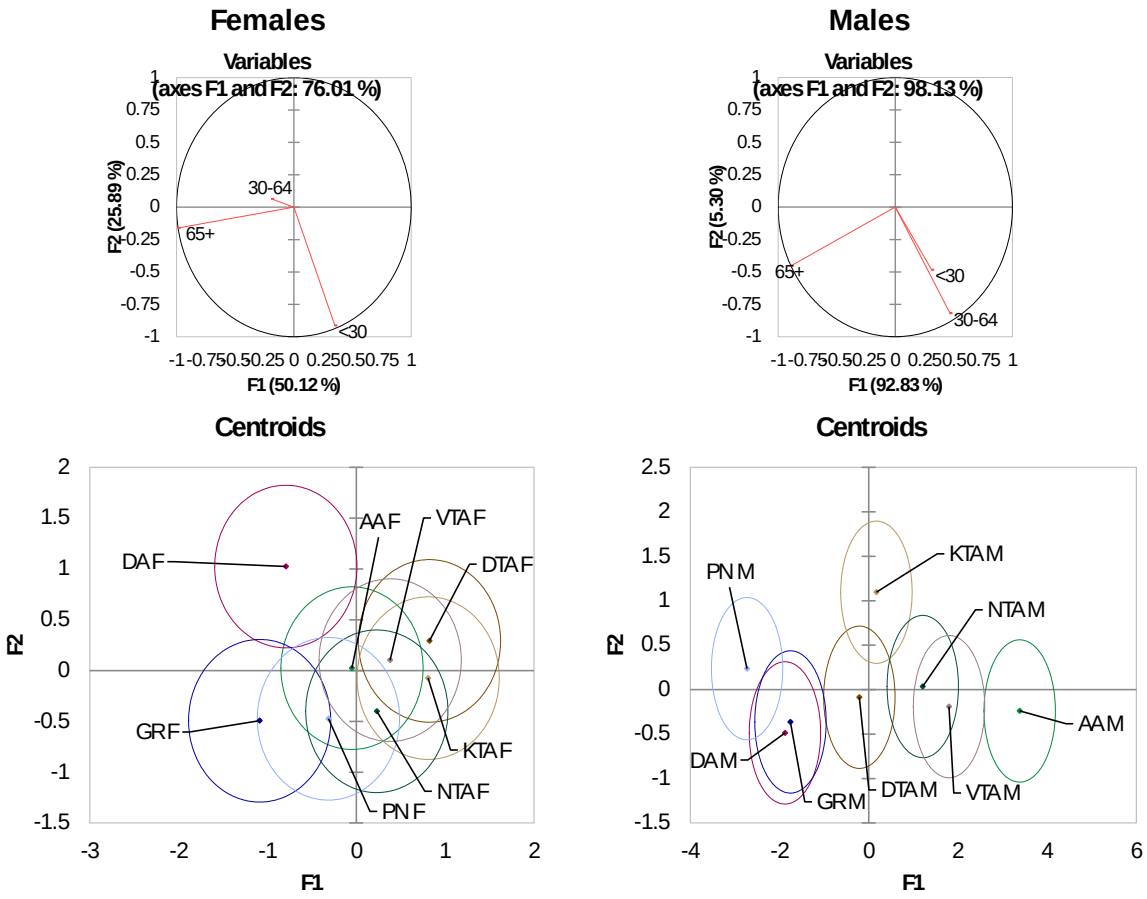
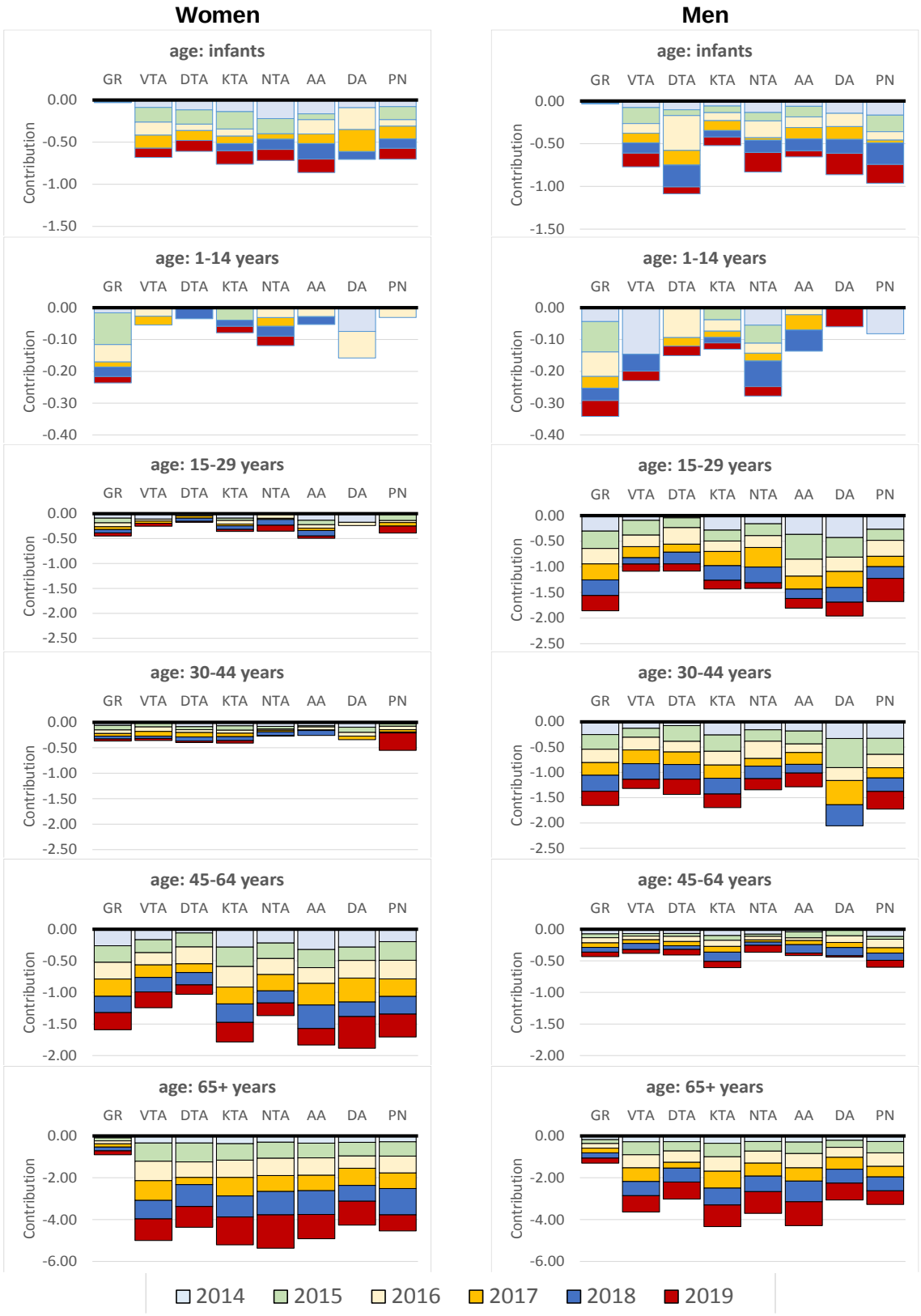


Figure 4a The contribution of each age group to the loss of life expectancy at birth from external causes of morbidity and mortality, by gender, by Regional Unit of Attica and by year, 2014-2019



Source: own elaboration from Hellenic Statistical Authority (ELSTAT) and Eurostat Database

Figure 4b Discriminant analysis, 2014-2019, Regional Units of Attiki, External causes of morbidity and mortality

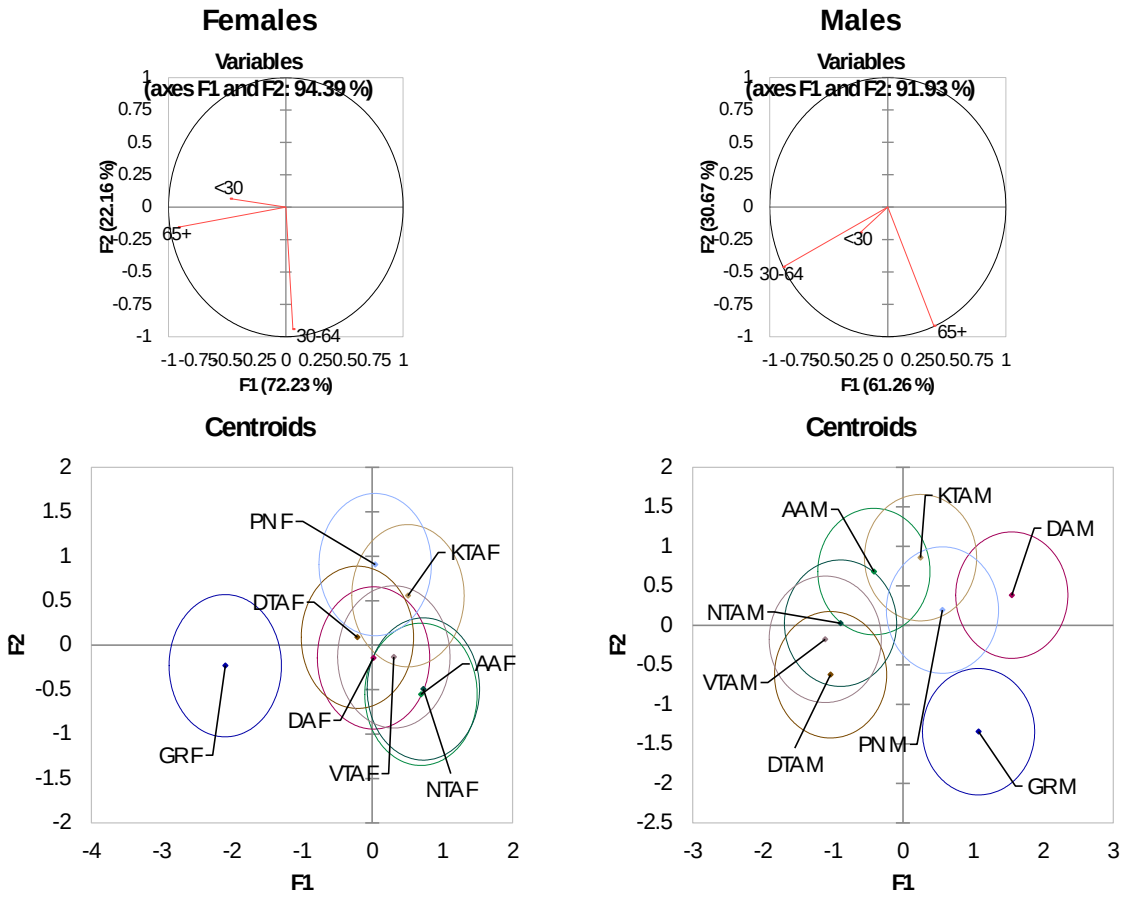
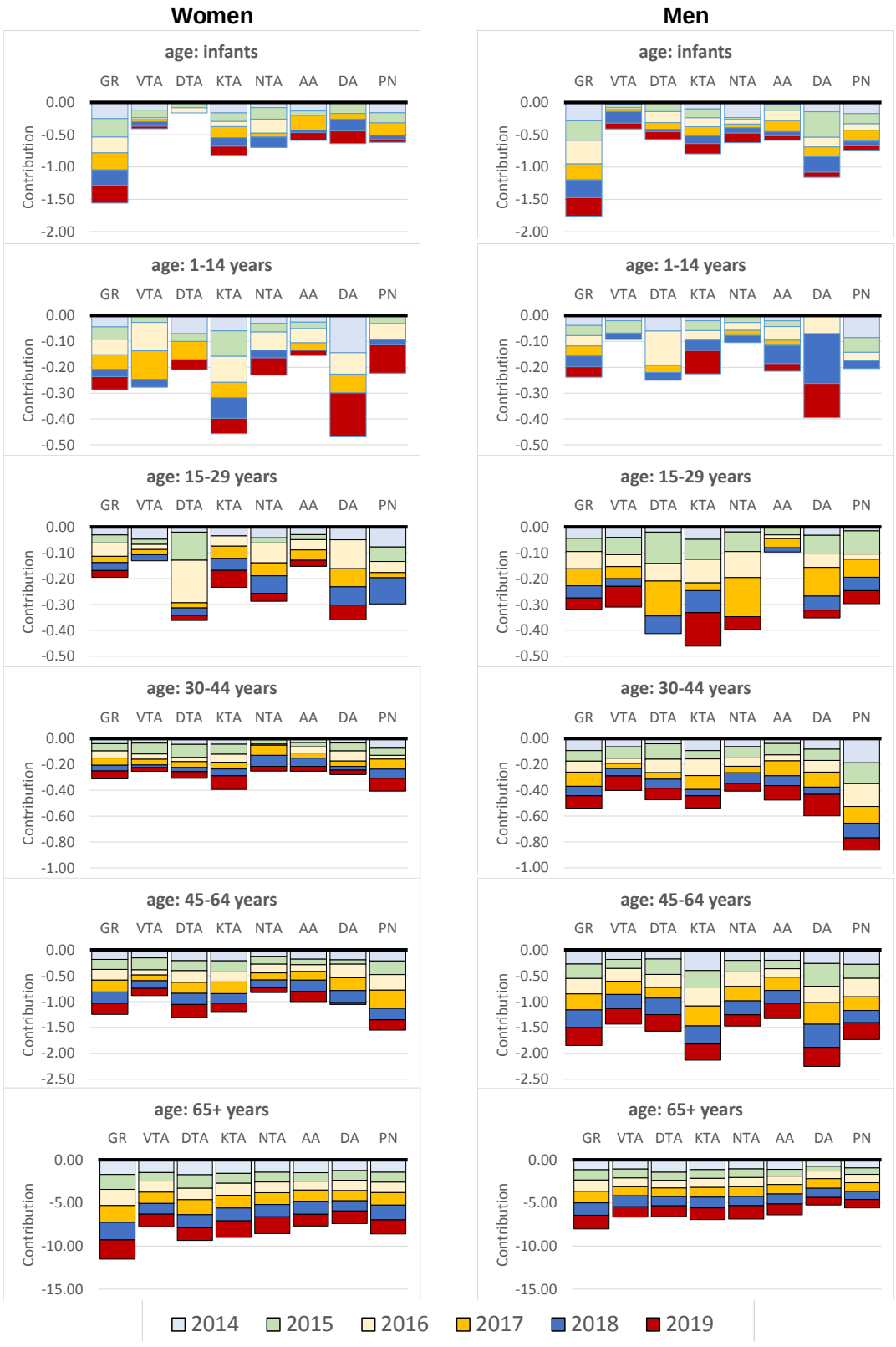


Figure 5a The contribution of each age group to the loss of life expectancy at birth from the rest causes of death, by gender, by Regional Unit of Attica and by year, 2014-2019



Source: own elaboration from Hellenic Statistical Authority (ELSTAT) and Eurostat Database

Figure 5b Discriminant analysis, 2014-2019, Regional Units of Attiki, Rest causes of death

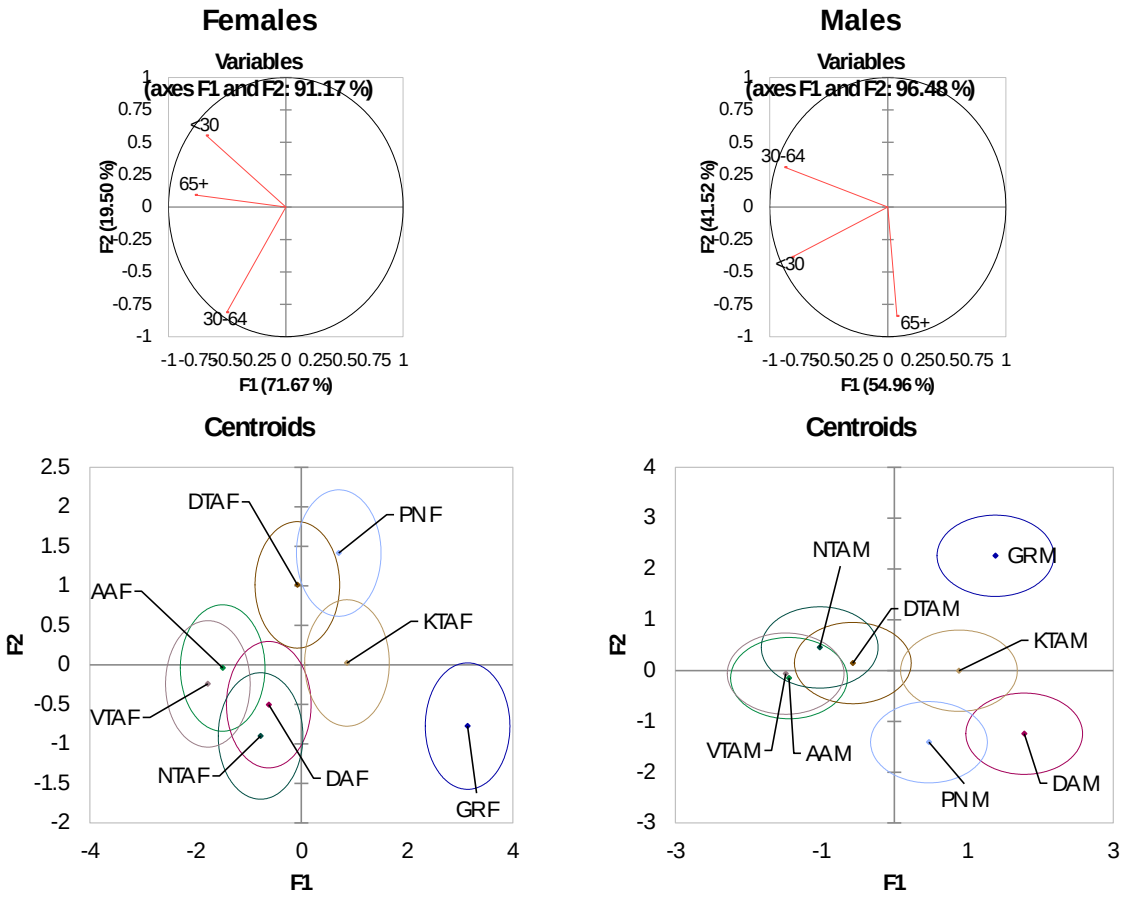


Figure 7 Regional Units of Attica

Source: https://www.patt.gov.gr/, and own elaboration

Table 1 The loss of life expectancy at birth (in years) of women by disease and by Regional Unit of Attica, 2014-2019

Females									
Cause of death	**Year**	**Greece**	**Anatoliki Attiki**	**Voreios Tomeas Athinon**	**Dytiki Attiki**	**Dytikos Tomeas Athinon**	**Kentrikos Tomeas Athinon**	**Notios Tomeas Athinon**	**Peiraias kai Nisoi**
Diseases of the circulatory system	**2014**	6,9	6,41	5,81	6,86	6,55	6,93	6,61	6,93
	2015	5,83	5,81	5,06	5,67	7,81	5,83	5,62	5,15
	2016	5,86	5,36	5,82	6,9	6,28	6,06	6,11	5,25
	2017	5,61	5,39	5,89	5,6	6,55	6,32	5,85	6,11
	2018	5,83	5,95	4,78	6,77	6,44	6,56	6,03	5,91
	2019	4,93	5,33	5,33	5,75	5,05	5,91	6	5,07
Neoplasms	**2014**	2,88	3,09	3,42	2,81	3,21	3,71	3,33	3,35
	2015	2,74	2,91	3,34	2,62	4,84	3,34	3,42	3,23
	2016	2,97	3,03	3,53	2,53	3,49	3,89	3,58	3,64
	2017	2,77	3,07	3,55	2,69	3,21	3,59	3,3	2,96
	2018	2,91	3,05	3,1	3,06	3,16	3,7	3,68	3,2
	2019	2,85	3,19	3,48	3	3,49	3,81	3,27	3,26

Diseases of the respiratory system	**2014**	1,16	1,56	1,72	1,48	1,61	1,75	1,37	1,4
	2015	1,22	1,43	1,71	1,48	2,74	1,69	1,59	1,61
	2016	1,22	1,31	1,49	1,56	1,45	1,82	1,5	1,53
	2017	1,09	1,38	1,51	1,03	1,61	1,49	1,34	1,23
	2018	1,07	1,29	1,15	1,15	1,15	1,44	1,3	1,1
	2019	1,08	1,49	1,5	1,3	1,39	1,52	1,45	1,19
External causes of morbidity and mortality	**2014**	0,35	0,75	0,61	0,75	0,66	0,77	0,68	0,51
	2015	0,49	0,98	1,17	0,86	1,18	1,24	1,04	1,07
	2016	0,43	1,21	1,3	1,16	0,96	1,14	1,03	1,15
	2017	0,35	0,97	1,32	1,24	0,66	1,17	0,95	1,1
	2018	0,41	1,69	1,03	0,98	1,28	1,41	1,51	1,5
	2019	0,39	1,40	1,3	1,16	1,26	1,7	2	1,48
Rest	**2014**	1,17	0,7	0,64	0,48	0,66	0,75	0,58	0,61
	2015	1,19	0,15	0,22	0,22	0,27	0,31	0,25	0,22
	2016	1,27	0,13	0,29	0,21	0,26	0,37	0,31	0,18
	2017	1,33	0,34	0,29	0,32	0,66	0,34	0,31	0,4
	2018	1,34	0,24	0,2	0,17	0,16	0,27	0,35	0,28
	2019	1,6	0,32	0,23	0,33	0,24	0,45	0,44	0,37

Source: own elaboration from Hellenic Statistical Authority (ELSTAT) and Eurostat Database

Table 2 The loss of life expectancy at birth (in years) of men by disease and by Regional Unit of Attica, 2014-2019

Males									
Cause of death	**Year**	**Greece**	**Anatoliki Attiki**	**Voreios Tomeas Athinon**	**Dytiki Attiki**	**Dytikos Tomeas Athinon**	**Kentrikos Tomeas Athinon**	**Notios Tomeas Athinon**	**Peiraias kai Nisoi**
Diseases of the circulatory system	**2014**	5,93	6,49	5,91	6,95	5,61	6,38	6,24	6,32
	2015	5,58	5,88	6,02	4,21	5,44	6,22	5,94	5,65
	2016	5,53	6,12	5,28	6,71	5,84	6,22	5,2	5,96
	2017	5,5	6,01	5,47	5,05	5,61	6,16	5,57	5,27
	2018	5,62	6,21	5,99	8,21	6,23	6,19	5,53	5,65
	2019	5,28	5,61	5,55	4,94	5,4	6,37	5,93	5,58
Neoplasms	**2014**	4,47	4,50	4,73	4,64	4,95	4,93	4,61	4,66
	2015	4,31	4,18	4,61	5,21	4,66	4,67	4,73	4,18
	2016	4,46	4,72	4,76	5,05	4,54	4,57	4,58	4,57
	2017	4,32	4,31	4,75	4,19	4,95	4,82	4,36	3,96
	2018	4,44	4,47	5,01	5,21	4,67	4,96	4,5	4,58
	2019	4,33	4,39	4,32	4,43	4,56	4,71	4,25	4,27
Diseases of the respiratory system	**2014**	1,25	1,79	1,54	1,1	1,4	1,74	1,54	1,21
	2015	1,28	1,58	1,6	1,05	1,47	1,71	1,61	1,36
	2016	1,29	1,54	1,42	1,35	1,53	1,56	1,63	1,48
	2017	1,13	1,35	1,48	1,1	1,37	1,44	1,36	1,11
	2018	1,14	1,59	1,39	1,41	1,64	1,32	1,21	1,03
	2019	1,15	1,58	1,41	1,07	1,14	1,38	1,42	1,11
External causes of	**2014**	1,04	1,23	0,89	1,4	0,56	1,24	1	1,31
	2015	1,19	1,7	1,48	1,51	1,24	1,6	1,31	1,56

morbidity and mortality	**2016**	1,12	1,58	1,4	1,45	1,84	1,62	1,63	1,61
	2017	1,1	1,64	1,45	1,89	1,01	1,75	1,46	1,22
	2018	1,18	1,92	1,52	1,76	1,64	1,79	1,71	1,69
	2019	1,15	1,94	1,53	1,89	1,5	1,9	1,84	2,03
Rest	**2014**	0,89	0,47	0,38	0,22	0,54	0,5	0,55	0,46
	2015	0,89	0,13	0,19	0,32	0,28	0,22	0,12	0,33
	2016	1,04	0,3	0,18	0,29	0,36	0,24	0,27	0,23
	2017	0,92	0,33	0,19	0,3	0,35	0,26	0,29	0,31
	2018	1	0,15	0,29	0,4	0,22	0,28	0,12	0,17
	2019	1,15	0,32	0,36	0,24	0,27	0,47	0,49	0,25

Source: *own elaboration from Hellenic Statistical Authority (ELSTAT) and Eurostat Database*

Declarations

Funding statement: The authors did not receive support from any organization for the submitted work.

Ethics statement: No animals/humans were used for studies that are the basis of this research.

Bibliography

ARAPOGLOU, V. & MALOUTAS, T. 2011. Segregation, inequality and marginality in context: The case of Athens. *The Greek Review of Social Research,* 136**,** 135–155. 10.12681/grsr.47.

ARRIAGA, E. E. 1984. Measuring and explaining the change in life expectancies. *Demography,* 21**,** 83–96. 10.2307/2061029.

ARRIAGA, E. E. 1995. Changing trends in mortality decline during the last decades. *Differential mortality.* Oxford: Clarendon Press.

BENETOU, V., TRICHOPOULOU, A., ORFANOS, P., NASKA, A., LAGIOU, P., BOFFETTA, P. & TRICHOPOULOS, D. 2008. Conformity to traditional Mediterranean diet and cancer incidence: the Greek EPIC cohort. *British Journal of Cancer,* 99**,** 191–195. 10.1038/sj.bjc.6604418.

BOVE, A. & GHIRALDELLI, M. 2025. Smart but Unlivable? Rethinking Smart City Rankings Through Livability and Urban Sustainability: A Comparative Perspective Between Athens and Zurich. *Sustainability,* 17**,** 8901. 10.3390/su17198901.

CHIANG, C. L. 1984. *Life Table and Its Applications,* New York, Robert E. Krieger Publishing Company. 316.

COMMISSION, E. 2025a. *Eurostat Database* [Online]. Luxembourg: European Commission. Available: https://ec.europa.eu/eurostat/databrowser/view/demo_r_d2jan/default/table?lang=en&category=demo.demopreg.

COMMISSION, E. 2025b. *Respiratory diseases* [Online]. Luxembourg: European Commission. Available: https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/37379.pdf.

COMMISSION, E. 2026. Cancer statistics [Online]. Luxembourg: European Commission. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Cancer_statistics.

ECONOMOU, C., KAITELIDOU, D., KENTIKELENIS, A., SISSOURAS, A. & MARESSO, A. 2015. The impact of the financial crisis on the health system and health in Greece. *In:* MARESSO, A., MLADOVSKY, P. & THOMSON, S. (eds.) *Economic crisis, health systems and health in*

Europe: Country experience. Copenhagen: World Health Organization, European Observatory on Health Systems and Policies.

ECONOMOU, M., MADIANOS, M., PEPPOU, L. E., PATELAKIS, A. & STEFANIS, C. N. 2013. Major depression in the era of economic crisis: A replication of a cross-sectional study across Greece. *Journal of Affective Disorders,* 145**,** 308–314. 10.1016/j.jad.2012.08.008.

HARPER, S., CHARTERS, T. J. & STRUMPF, E. C. 2015. Trends in socio-economic inequalities in motor vehicle accident deaths in the United States, 1995–2010. *American Journal of Epidemiology,* 182**,** 606–614. 10.1093/aje/kwv099.

HOLMES JR, L., ENWERE, M. M., R., HOLMES, M. S., NGALIM, P., NSONGKA, K. & MAGE, D. T. 2024. Medical Misadventures as Errors and Mistakes and Motor Vehicular Accidents in the Disproportionate Burden of Childhood Mortality among Blacks/African Americans in the United States: CDC Dataset, 1968–2015. *Healthcare MDPI,* 12**,** 477.

KALOGIROU, S., TSIMBOS, C., VERROPOULOU, G. & KOTSIFAKIS, G. 2012. Regional mortality differentials in Greece by selected causes of death: 2006–2008. *Journal of Maps,* 8**,** 354–360.

KARANIKOLOS, M., MLADOVSKY, P., CYLUS, J., THOMSON, S., BASU, S., STUCKLER, D. & MCKEE, M. 2013. Financial crisis, austerity, and health in Europe. *The lancet,* 381**,** 1323-1331.

KASTRINAKI, Z. 2025. Lifestyles, health expenditure and the production of healthcare: evidence from Greece. *Discover Social Science and Health,* 5**,** 75.

KEHAGIA, F., BRAZIOTIS, C. & KOPELIAS, P. 2022. Road safety audit findings on two-lane road: case study in Greece. *International Journal of Transport Development and Integration,* 6**,** 333–346.

KIM, J. L., KIM, J. M., CHOI, Y., LEE, T. H. & PARK, E. C. 2016. Effect of socio-economic status on the linkage between suicidal ideation and suicide attempts. *Suicide and Life-Threatening Behavior,* 46**,** 588–597.

KLADAKIS, A., FAMELI, K. M., MOUSTRIS, K., ASSIMAKOPOULOS, V. D. & NASTOS, P. T. 2025. Threefold Threshold: Synergistic Air Pollution in Greater Athens Area, Greece. *Atmosphere,* 16**,** 888.

LACHAUD, J., DONNELLY, P. D., HENRY, D. K., K., CALZAVARA, A., BORNBAUM, C. & ROSELLA, L. 2017. A population-based study of homicide deaths in Ontario, Canada using linked death records. *International Journal for Equity in Health,* 16**,** 1–7.

LAGIOU, A., SAMOLI, E., GEORGILA, C., MINAKI, P., BARBOUNI, A., TZONOU, A. & LAGIOU, P. 2008. Occupational physical activity in relation with prostate cancer and benign prostatic hyperplasia. *European Journal of Cancer Prevention,* 17**,** 336–339.

LIU, P. L., C., WANG, Y., ZENG, W., WANG, H., WU, H. & HAO, M. 2014. The impact of the major causes of death on life expectancy in China: a 60-year longitudinal study. *BMC Public Health,* 14**,** 1–8.

MADIANOS, M. G., ALEXIOU, T., PATELAKIS, A. & ECONOMOU, M. 2014. Suicide, unemployment and other socio-economic factors: evidence from the economic crisis in Greece. *The European Journal of Psychiatry,* 28**,** 39–49.

MALES, M. 2015. Age, poverty, homicide, and gun homicide: is young age or poverty level the key issue? *Sage open,* 5**,** 2158244015573359.

MALOUTAS, T. 2018. *The social geography of Athens. Social groups and structured environment in a southern European metropolis,* Athens, Alexandria Publications.

MCMINN, M. A., SEAMAN, R., DUNDAS, R., PELL, J. P. & LEYLAND, A. H. 2022. Socio-economic inequalities in rates of amenable mortality in Scotland: Analyses of the fundamental

causes using the Scottish Longitudinal Study, 1991–2010. *Population, Space and Place,* 28**,** e2385.

NÄHER, A. F., RUMMEL-KLUGE, C. & HEGERL, U. 2020. Associations of suicide rates with socio-economic status and social isolation: findings from longitudinal register and census data. *Frontiers in Psychiatry,* 10**,** 898.

NAJMAN, J. M., TOLOO, G. & WILLIAMS, G. M. 2008. Increasing socio-economic inequalities in drug-induced deaths in Australia: 1981–2002. *Drug and Alcohol Review,* 27**,** 613–618.

NIKOLAOU, D., FOLLA, K. & YANNIS, G. 2021. Impact of socio-economic and transport indicators on road safety during the crisis period in Europe. *International Journal of Injury Control and Safety Promotion,* 28**,** 479–485.

NIKOLAOU, M., THEODORAKIS, N., FERETZAKIS, G., VAMVAKOU, G., HITAS, C. K., S. & TOUTOUZAS, K. 2024. Nationwide mortality trends from 2001 to 2020 in Greece: health policy implications under the scope of aging societies. *Hellenic Journal of Cardiology*.

OECD 2019. Greece: Country Health Profile 2019. Paris.

OECD 2023. Greece: Country Health Profile 2023. Paris.

OECD 2024. Tackling the Impact of Cancer on Health, the Economy and Society: Greece. Paris.

ORGANIZATION, W. H. 2019. Monitoring and documenting systemic and health effects of health reforms in Greece. Copenhagen.

PAPADOPETRAKI, A., MARIDAKI, M., ZAGOURI, F., DIMOPOULOS, M. A., KOUTSILIERIS, M. & PHILIPPOU, A. 2022. Physical exercise restrains cancer progression through muscle-derived factors. *Cancers,* 14**,** 1892.

RACHIOTIS, G., STUCKLER, D., MCKEE, M. & HADJICHRISTODOULOU, C. 2015. What has happened to suicides during the Greek economic crisis? Findings from an ecological study of suicides between 2003 and 2012. *BMJ Open,* 5**,** e007295.

SAMARAS, A., PAPAZOGLOU, A. S., MOYSIDIS, D. V., BEKIARIDOU, A., TSOUMAKAS, G., TZIKAS, A. & GROUP, C. S. 2025. Clinical Profiles and Temporal Trends of 37,741 Cardiovascular Hospitalizations in Greece over 12 years: Initial Insights from the CardioMining Database. *Hellenic Journal of Cardiology*.

TOULOUMI, G., KARAKOSTA, A., KALPOURTZI, N., GAVANA, M., VANTARAKIS, A., KANTZANOU, M. & STERGIOU, G. 2020. High prevalence of cardiovascular risk factors in adults living in Greece: the EMENO National Health Examination Survey. *BMC Public Health,* 20**,** 1665.

TRICHOPOULOU, A., BAMIA, C., LAGIOU, P. & TRICHOPOULOS, D. 2010. Conformity to traditional Mediterranean diet and breast cancer risk in the Greek EPIC (European Prospective Investigation into Cancer and Nutrition) cohort. *The American Journal of Clinical Nutrition,* 92**,** 620–625.

VANDOROS, S., HESSEL, P., LEONE, T. & AVENDANO, M. 2017. Have health trends worsened in Greece as a result of the financial crisis? A quasi-experimental approach. *European Journal of Public Health,* 27**,** 856–861.

VINCI, S., VARDOPOULOS, I. & SALVATI, L. 2023. A tale of a shrinking City? Exploring the complex interplay of socio-demographic dynamics in the recent development of Attica, Greece. *Cities,* 132**,** 104089.

WHO. 2025. *Domestic general government health expenditure (GGHE-D) as percentage of general government expenditure (GGE) (%)* [Online]. World Health Organization. Available: https://data.who.int/indicators/i/8C8FB8F/B9C6C79.

ZAFEIRIS, K. N. 2020a. Tobacco-related Mortality in Greece: The Effect of Malignant Neoplasms, Circulatory and Respiratory Diseases, 1994–2016. *Data Analysis and Applications 4: Financial Data Analysis and Methods.*

ZAFEIRIS, K. N. 2022. How to study life expectancy at birth (e0) differences between the two genders: A methodological proposition. *Population Review,* 61**,** 1-25.

ZAFEIRIS, K. N. 2023. Greece since the 1960s: the mortality transition revisited: a joinpoint regression analysis. *Journal of Population Research,* 40**,** 3.

ZARAFONITOU, C. & KONTOPOULOU, E. 2020. Environmental degradation and fear of crime: The research evidence in the center of Athens. *Urban Crime. An International Journal,* 1**,** 3–33.

ZHOU, M., WANG, H., ZHU, J., CHEN, W., WANG, L., LIU, S. & LIANG, X. 2016. Cause-specific mortality for 240 causes in China during 1990–2013: a systematic subnational analysis for the Global Burden of Disease Study 2013. *The Lancet,* 387**,** 251–272.