CHARACTERISTICS OF THE ELDERLY IN METROPOLITAN CITIES: A GEO STATISTICAL DATA VISUALISATION[1]

Vito Fabio Bellafiore, Donatella Cangialosi, Giuseppe Lancioni

Abstract. A rapidly ageing population, such as the Italian one, has different social demographic characteristics from those of a few decades ago. The general improvement in living conditions makes it possible to consider the elderly today not as a burden on the community but as an opportunity.
The aim of this work is a study on the profile of the elderly and on some social aspects that highlight the changes that have occurred over time in the 14 Italian metropolitan cities. In order to make the reading of the profiles more effective on the territory, a geo-statistical tool for visualising and reading data is implemented.

1. Introduction

The demographic trends that have developed in Italy over the years have led to a strengthening of the ageing process. Migratory dynamics have failed to counteract the natural population dynamics and these factors have led overall to a strong imbalance in the age structure in favour of the elderly component (Reynaud and Miccoli, 2016).

The elderly, conventionally identified as the population aged 65 and over, today have different socio-demographic characteristics from those of the same class a few decades ago. Their age has been superseded by changes in lifestyles, active participation in work and society, educational attainment and improved health conditions (WHO, 2002; Istat, 2023). Old age is no longer only a matter of age itself: the transition from maturity to senility must also take into account the state of mind. A good cognitive level makes it possible to cope actively with old age, with benefits for the individual and the community (Quattrociocchi and Tibaldi, 2020). The active ageing programme, promoted by the WHO, supports a vision of ageing with policies aimed at maximising the physical, mental, social and economic potential of older people (De Santis, 2015).

A significant interpretation of ageing comes from observing the territories of the 14 Italian metropolitan Cities established by Law No. 56 of April 7, 2014. They are territorial entities of vast area born from the aggregation of neighbouring municipalities (replaced provinces). This level of governance offers the territory a new local

[1] The paper has been jointly written by all the authors but § 1 and 4.2 can be attributed to D. Cangialosi, § 2 and 4.1 to V.F. Bellafiore, § 3 and 4.3 to G. Lancioni.

government tool and new opportunities of development for the citizens. The territories involved have specific characteristics due to physical conurbation, geographical location, socio-demographic issues and economic potential or disadvantage. The geography of metropolitan cities allows for an internal classification of the municipalities that are part of them, in which the city, understood as a large urban agglomeration (the capital municipality), is surrounded by an aggregate of municipalities that gravitate around it, forming the first- and second urban belts that allow us the observation of the dynamics of city evolution.

This work therefore proposes an in-depth study of the target elderly population (65+ years) in order to outline its socio-demographic profile through a set of indicators calculated for the 14 Metropolitan Cities (MC) at the municipal level, and to examine the demographic dynamics of the two sub-groups of the 'young elderly' and the 'great elderly' with the aim to highlight the diversity and evolution over time of the metropolitan contexts and their internal articulations. In order to make the various dimensions of the data simultaneously accessible, the descriptive analysis is supported by the implementation of a geo-statistical tool for the dynamic visualization of the processed indicators based on ArcGIS Dashboards technology, navigable in the different territorial levels and articulations of metropolitan cities.

2. Indicators and methods

The analysis of ageing in metropolitan cities and their urban contexts developed through a focus on the elderly (65+ years) offers an informative overview to identify socio-demographic characteristics and to understand social welfare.

To this end, a set of demographic indicators relating to the population structure and dynamics, family network, single-person households of the elderly, educational level and employment status was selected, with the integrated use of different statistical sources. In addition, the demographic dynamics of the two subgroups that make up the population segment of 65 years and over are also examined: the 'young elderly' (65-74 years) and the 'great elderly', aged 85 years and over, i.e. population groups whose psycho-physical functions and thus active role in society are progressively restricted on the basis of the progression of a set of conditions. The indicators have been elaborated in time series for the four territorial sub-domains of the 14 metropolitan Cities (capital municipalities, first and second belt municipalities and other metropolitan city municipalities) and updated to the municipal boundaries on 1 January 2023. The belts have been identified according to a criterion of spatial contiguity: the first belt is formed by the ring of municipalities contiguous to the capital municipality, i.e. sharing its boundary at least at one point; the second belt is composed of the municipalities contiguous to those in the first belt. The remaining municipalities of the metropolitan area form the outer ring. (Istat, 2020).

The statistical analysis is supported by the implementation of a geo-statistical tool for the dynamic visualisation of the calculated indicators, presented in section 3.

In Italy, there are 1,268 municipalities belonging to the 14 metropolitan Cities (16% of Italian municipalities), with 14 capitals, 177 municipalities in the first belt, 213 in the second belt and 864 municipalities in the outer ring of the territory. These municipalities cover an area of 46,637 square kilometres (15.4% of the Italian surface area).

3. Methods

There is a strong request in order to facilitate the access to the information embedded in data published in official statistics, supported by both researchers and students communities, as well as by a growing amount of people interested in socio-demographic phenomena. International institutions are actively backing these needs by periodically publishing recommendations on communication and dissemination strategies, aiming at ensuring and extending accessibility to data and promoting an informed use of data for correct interpretation and analysis of phenomena (Eurostat, 2021; Unece, 2021; Oecd, 2021). With the aim to comply with these requests, a geo-statistical data visualization tool has been developed on elderly analysis. It is based on ArcGIS Dashboards technology.

The key targets of the tool, established from the beginning of the design phase, can be summarized as:

- allowing a simultaneous representation of the different aspects of the phenomena in study, as well as a detailed description of its articulation in the territory;
- promoting structural and geographical comparisons;
- improving the general easy of use and cleaning of design.

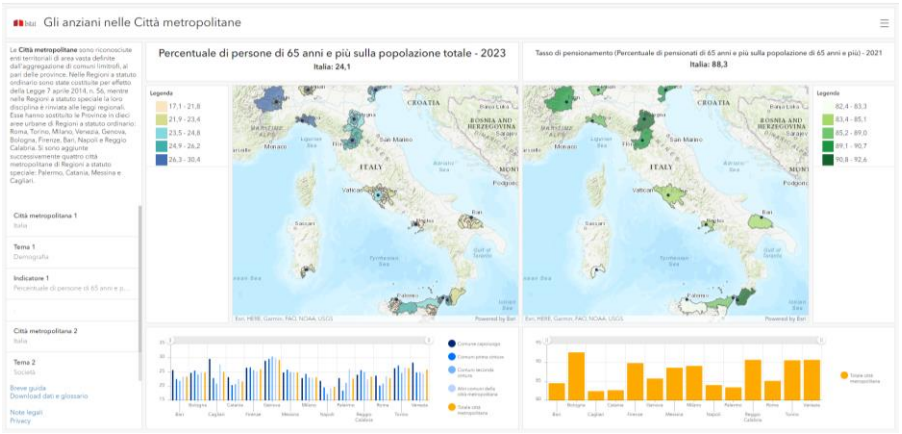
3.1. General layout of the dashboard

The dashboard is based on a clean and simple design, and consists of a single-page web applications with only two graphical objects used to represent statistical information: cartograms and histograms. This boosts the expected effect of immediate data integration and representation. Underlying data, as well as a short guide, are available for download in excel and pdf format, and are accessible by means of web links. Software versions consist of ArcGIS Pro 2.8.0 (Maps creation and editing), ArcGIS Enterprise 10.9.1 (Dashboard creation and editing).

A constant effort has been spent in simplifying as much as possible the interactivity. The general layout is split in two main parts, as shown in Figure 1:

- a *left-side panel*, which contains all the controls and filters;
- a *central area* devoted to data visualization, which in turn is split in two identical panels, each embedding a map and an histogram.

Figure 1 – *Dashboard.*



General layout: the left-side panel with the controls, and the central area split in two identical informative panels, each composed of a map and a histogram showing the same indicator.

The left-side panel is designed to be the control panel of the whole dashboard. All the selectors are gathered in this area, as well as short description and historical summary of the Italian MC, and a set of links to the navigation guide and to the data for downloading. Selectors are all of the same type, namely *categorical*, and are grouped in two identical blocks, one for each of the two visualization panels. They filter two kind of information:

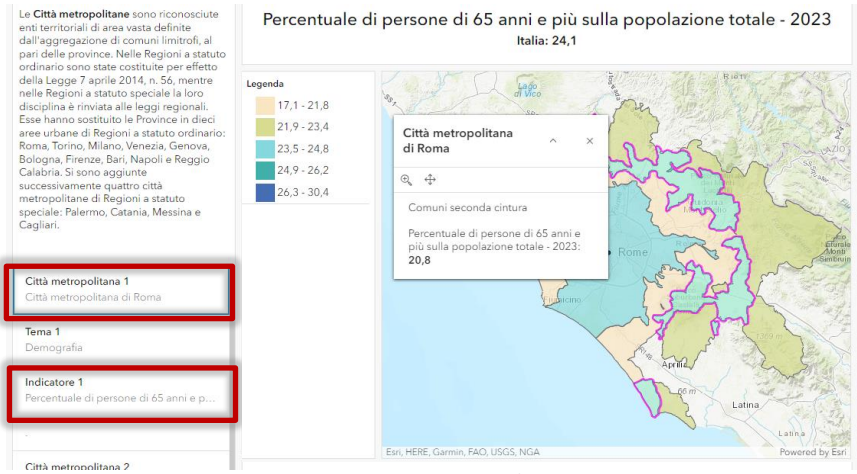
- the *territorial detail*, i.e. the metropolitan city;
- the *indicator* to be shown in both the histogram and the map.

The last characteristic implies the possibility to select a particular layer on the map without acting on the map itself, but by selecting the indicator from an external control. The implementation of this non-trivial characteristic will be discussed in the next subsection.

Having all the filter controls grouped in the same area greatly improves the ease of use and cleaning of design of the whole dashboard, these being some of the key features established from the very beginning of the project phase. Each of the two informative panels of the central area consists of a cartogram and a histogram, for the simultaneous representation of territorial and structural aspects of the information. Also reported is a legend showing the range of the values classified in quintiles, and, on the top of each panel, the name of the selected indicator and its value referred to Italy. Cartograms are based on *ArcGIS map* (Esri, 2019) previously created in ArcGIS Pro suite and imported in the web portal. Details include the urban centres and belts articulations; by clicking a point in the map, a pop-up shows the punctual value of the indicator for that territorial detail (Figure 2). Being identical, they are useful to instantly compare the same theme

on two different territories, or two different aspects of data in the same geographical context, or in general any different pair of: indicator, territory.

Figure 2 – *Cartograms.*



Both the territorial detail and the indicator are selected in the left-side panel; pop-ups reporting punctual values are available by clicking on the map.

The histograms are leveraged to perform a simultaneous comparison between the 14 MC. Territorial structure of urban cities and belts is customizable by clicking the legend icons on the map, toggling visible or not the related detail (Figure 3). Note that in the histogram the option "Total MC" is available, showing the value for the entire MC. This value cannot be visualized in the maps, due to aggregative structure of the belt levels. Punctual value of the columns are available via pop-up, which activates on mouse moving.

3.2. Selection of the layers

Cartograms are ArcGIS maps which consist of multiple layers, each one representing an indicator. A layer, in the form of the ESRI shapefile (ESRI, 1998), is a data object which contains both geographical and thematic information, organized in a data structure that can be visualized as a table. In the standard use case, the indicator to be shown is selected directly *on the map* using specific interaction tools, which shows the list of the available layers with the possibility to toggle visible or not visible each one of them. As per the GIS[2] tools standards and conventions, only the top visible layer is visualized in the map. Note that this interaction affects only the choice of the layers, that is the

[2] Geographic Information System

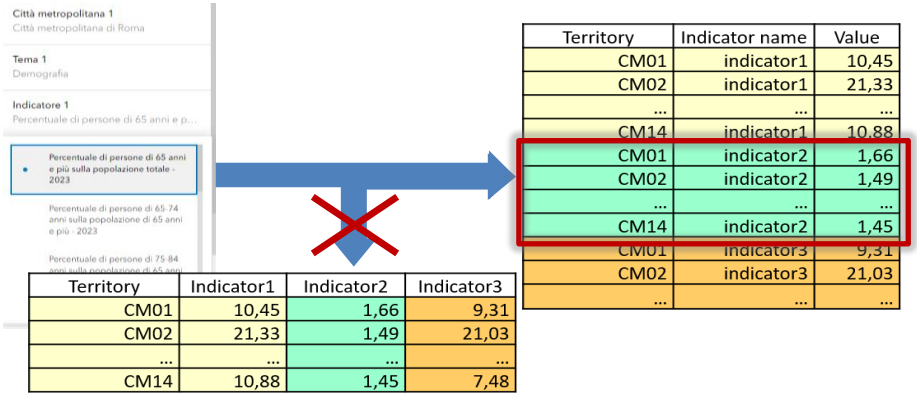
indicator in the map, and *cannot* be used to select the same indicator in the histogram. In contrast, the possibility to select a single layer by the selectors *outside* of the map is a feature that is typically lacking in GIS tools, and ArcGIS Dashboard is not an exception. This limitation frustrates our clean approach, which dictates to use one only control to filter the indicators in both the cartogram and the histogram, and to set all the controls in a specific area.

Figure 3 – *Histograms.*

Left: the list of the available indicators is accessible by the left side panel selectors.
Right: clicking the icons in the legend toggles the related detail visible or not visible.

It has been possible to overcome such setback by a critical rethinking of the dataset structure (Abbate *et al.*, 2024), in which the same set of rows is replicated for each indicator, with only the indicator column being different. In this way, the choice of a specific indicator in the selector filters out all but one set of the rows, exactly the one of the matching indicator name. In other words, with this dataset structure the filter on the indicator is applied to the rows, not to the columns (Figure 4).

Figure 4 – S*electing layers from outside of the map.*



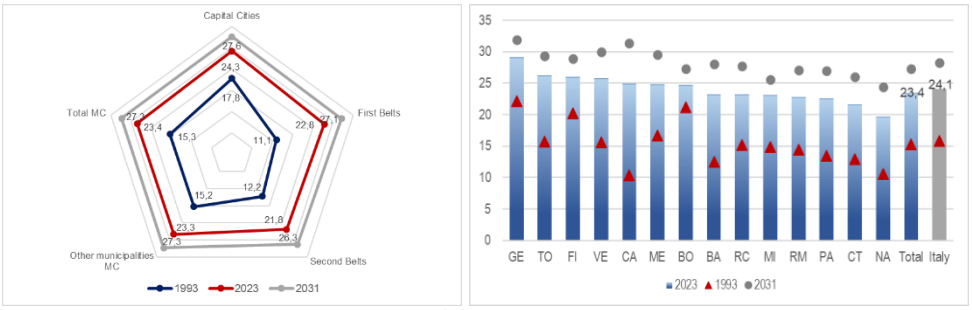
Selection of an indicator in the categorical selector can filter the rows in the right table, but not the columns in the bottom table. Hence dataset is structured as per the right table.

4. Results

4.1 Dynamics and demographic characteristics of the elderly

The 14 metropolitan cities are home to almost 5 million people aged 65 and over, more than a third of the national contingent; they have increased by 1.9 million in 30 years and account for almost a quarter of the total population. There is a predominance of women, and the gender gap widens as people get older, with 77 men for every 100 women 65+ years (the national average is 78.5) due to women's longer life expectancy.

Figure 5 – *Resident population aged 65 years and over in the metropolitan cities and urban belts (% of total) –1993- 2023- 2031.*



Source: elaboration on Istat data, Nowcasting system for demographic indicators.

Residents aged 65 and over live predominantly in the most urbanized contexts: 45% in the capital municipalities, almost a third distributed between the first and second urban belts, and the remaining 24% in the outer ring of the metropolitan city. The incidence of the elderly on the total population in 2023 is higher in the northern metropolitan cities and in those of Cagliari and Messina, lower in the southern ones. Genoa has the highest incidence of the elderly (29%) and Naples the lowest (almost one person in five); there is a greater presence of this segment of the population in the urban poles compared to the first two belts (Figure 5). Forecast estimates confirm a strengthening of the ageing population such that the population aged 65 and over will represent 27.3% of the total population in metropolitan cities in 2031, with remarkable territorial differences.

The indicators measuring the ageing of the population confirm the strengthening of this process: people are living longer and the age structure is becoming increasingly skewed towards the senile ages. The Italian old-age index in 2023 reached its all-time high: there are 193 elderly people for every 100 young people under the age of 15. However, it is lower in the 14 MC as a whole (183 elderly per 100 young people), with the intensity of the phenomenon varying between territories. The ageing gap is more marked in the North where it reaches its peak in Genoa (272.3%); the South on the other

hand is on average 'younger', with the exception of Messina (Figure 6). Within the metropolitan cities, the capitals have an 'older' profile (Cagliari the 'oldest' with 321 elderly for every 100 young people); while the urban belts are demographically younger (first urban ring of Palermo with 112% and second ring of Naples with 110%), probably due to the housing choices of the younger segments of the population caused by the more advantageous housing costs.

Figure 6 - *Old age index in the metropolitan cities – 2023 (%).*

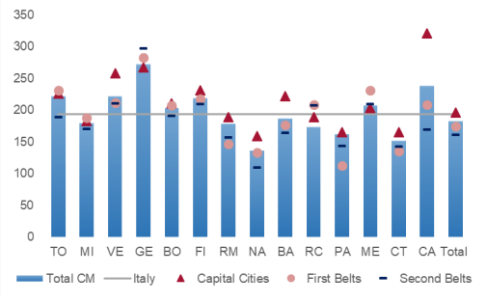
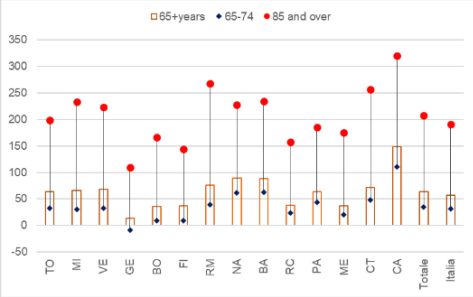


Figure 7 - *«Young» and «great» elderly in the metropolitan cities (change % 2023/1993).*



Source: elaboration on Istat data, Nowcasting system for demographic indicators.

The substantial increase in the 65+ years population over thirty years (+63.6%) encompasses an exponential growth in the segment of the 'great' elderly (+208%); and a slower growth of the 'young' elderly (+35%). Among metropolitan cities Cagliari stands out (Figure 7). The 'young' elderly in urban contexts make up almost half of the aged 65 and over collective and this incidence has decreased by 10 percentage points over thirty years. The lengthening of the average life span has produced above all the increase in the very old, aged 85 and over, who have more than tripled over the same period (there are almost 16 for every 100 people aged 65 and over) in MC and with a gender disparity in favour of women which is accentuated at a very advanced age (52 men for every 100 women aged 85 and over). The age composition of the elderly still shows a divide in the North-South metropolitan axis: the North has the highest incidence of the great elderly (among whom Genoa stands out with almost 19%) while in the metropolitan cities of the South the young elderly have a greater incidence. Naples stands out with over 54%. Within the metropolitan areas, as one moves further away from the capital city, the 'younger' segment of the elderly residing in the first two urban belts increases and the share of the over 75s decreases.

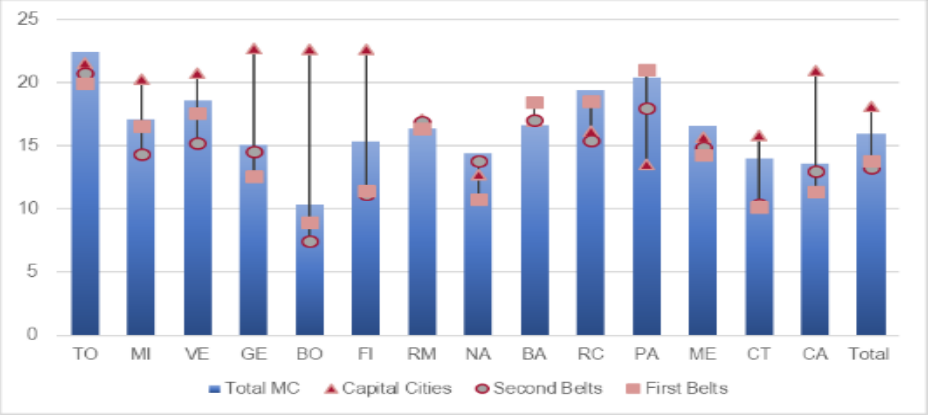
4.2 Support for the elderly and social characteristics

The growing trend of the elderly component of the population has the effect of increasing the proportion of adults who will need to support and care for elderly parents or relatives. The family has a fundamental role in caring for and supporting older members, forming a real social support network. The *Parent Support Ratio* (PSR), ratio of the population aged 85 and over to the population aged 50-64 per 100, indicates that in 2023, in metropolitan cities as a whole, there will be 16 people aged 85 and over for every 100 people aged 50-64 (the national average is 16.5 per cent). The 50-64 year old segment of the population represents the support in the future of very old parents or relatives in need of care and assistance. The need for elderly support is greatest in the metropolitan areas of Turin and Palermo (22.4% and 20.4% respectively), and least in Bologna (10.4%); it is greatest in the capital municipalities (18.1%) especially in those in the Centre-North, especially Genoa, Bologna and Florence (22.7%) (Figure 8).

Moreover, the elderly living alone are 30.2% of the total in the respective age group, with a higher incidence among the northern cities, reaching the highest value in Genoa (37%). In addition, this indicator signals the need for support that may be required for the care and assistance of the elderly.

However, over the years, the people in the collective of those who are at least 65 years old and who, progressively, enter the 'elderly' bracket, have improved their level of education and increased participation and permanence in the labour market. Education represents a competence that can influence social choices, and the attainment of work goals can guarantee greater protection in terms of employment and healthier lifestyles. Generally, high levels of education and training correspond to conditions of individual and collective well-being.

Figure 8 – *Parent Support Ratio (PSR) in the metropolitan cities – 2023 (%).*



Source: elaboration on Istat data, Nowcasting system for demographic indicators.

Table 9 – *Educational qualification and employment rate (%) – 2021.*

Metropolitan cities	Licenza elementare e media	Primary and secondary school	Tertiary education	Employment rate - Total	Employment rate - M	Employment rate - F
Turin	62,1	25,4	8,1	5,7	8,4	3,5
Milan	54,7	30,3	11,5	6,9	10,8	4,0
Venice	66,9	21,2	7,0	6,1	9,4	3,6
Genoa	55,3	30,7	11,4	6,7	10,2	4,1
Bologna	58,0	25,9	12,1	7,4	11,2	4,5
Florence	60,9	23,2	11,6	7,7	11,7	4,8
Rome	49,8	30,8	15,5	7,8	11,5	5,0
Naples	63,8	20,2	9,2	6,5	10,6	3,3
Bari	61,7	20,1	8,9	5,4	8,7	2,7
Reggio Calabria	57,3	20,8	10,1	6,1	9,1	3,7
Palermo	62,0	18,4	10,1	5,5	8,4	3,2
Messina	60,8	21,9	10,6	5,9	8,6	3,8
Catania	59,3	20,4	9,7	6,0	9,1	3,5
Cagliari	54,7	24,8	13,2	7,2	10,3	4,8
Capital Cities	**50,6**	**28,9**	**16,2**	**7,5**	**11,6**	**4,7**
First Belts	**62,5**	**24,4**	**7,5**	6,0	9,0	3,5
Second Belts	**64,9**	**21,4**	**6,5**	5,8	8,9	3,3
Total MC	**58,0**	**25,4**	**11,1**	**6,7**	**10,1**	**4,0**
Italy	**61,9**	**23,3**	**8,8**	**6,5**	**10,0**	**3,8**

Source: elaboration on Istat data, Permanent population census.

In the metropolitan cities, the 65+ years people are better educated than the Italian average. More than a third have at least an upper secondary degree (4.4 percentage points higher than the Italian average) and 11% hold a university degree or other tertiary qualification. In the capital municipalities there is a higher level of education among the elderly (45% with at least a diploma), compared to the urban belts, probably because they are poles of the greatest school and university supply and more densely populated (Figure 9).

Active participation in the labour market is one of the cornerstones of the active ageing approach and the legislative framework, which has raised the age requirements for retirement, has contributed to the extension of working careers. Today, the elderly continue to use their potential, contributing to economic growth and the production of wealth in the territories. However, this permanence in the labour market, if not supported by consistent investments in education, technical and digital skills training, research and innovation, will also adversely affect the younger generations.

In 2021 there will be 328,000 '64 and over' employed in the 14 metropolitan cities (6.7% of the population in the same age group), in line with the national average but decreasing, compared to 2019, by about one percentage point, with a rather marked gender gap: one in ten elderly people is employed, while women are less than half (4%). The metropolitan cities of the Centre-North host the largest workforce of the aged 65 and over, both men and women, with Rome leading the way (7.8% employment rate for the elderly), followed by Florence and Bologna. The capital municipalities have higher employment rates of the '64 and over', although the wide gender gap persists, and among

these the city of Milan holds the record for male employment (14 employed per 100). Moving away from the capital city has an impact on labour market participation in old age: employment decreases by 1.5 percentage points in the municipalities of the first and second urban belt. In particular, greater labour participation emerges in the metropolitan urban belts of the Centre-North.

4.3 Dashboard

Analysis of the results after an extensive session of tests on dashboard prototype proves that it allows an integrated reading of the data through thematic and territorial representations of a selection of indicators. The design choices taken in the planning phase proven crucial in obtaining a balance between completeness and instant comprehension of the phenomenon on study. In particular, the single-page layout, the use of only a limited number of visualization objects and interaction controls, stress the search for the ease of use and the immediacy of the information presented. Moreover, the accurate choice of the set of indicators grants general awareness and comprehension of the phenomenon. On the other side, the crucial choice of using only a selector control to filter the indicator in both the map and the histogram implies that *all* the layers of the map are to be visible, which means a great computational effort. This reflects on the performance, making the dashboard less responsive with respect to a similar layout with standard controls, in which one only layer is visible at a time. During the test sessions, accurate stress tests have been performed with the target to find an optimum trade-off between performance and completeness of the information, i. e. the number of indicators. The result is that a set of about 30 indicators, up to a maximum of 50, can be managed without a relevant performance degradation. Also to reduce the computational burden, the shapefiles representing the geographical layers are chosen in their generalized version (Istat 2024), less detailed than the standard ones, but lighter and less RAM-demanding. For the purposes of this study, the difference in geographical detail is irrelevant.

All that considered, the described dashboard successes in meeting the design specifications, and stands as a useful and powerful tool for the interactive representation and integration of thematic and geographic information.

References

ABBATE R., LANCIONI G., PATRUNO E., TACCINI M. 2024. La mobilità territoriale: un progetto per l'analisi geografica di trasferimenti di residenza e spostamenti quotidiani. In *Conference ESRI Italia, 9 maggio 2024*, https://www.esriitalia.it/component/eventiesri/calendario/858/

DE SANTIS G. 2015. Invecchiamento (c)attivo. In Salvini S. *Longevità, vecchiaia, salute*, Neodemos. pp 69-73. ISBN 978-88-941008-8-4.

ESRI. 1998. *ESRI Shapefile Technical Description*. In ESRI whitepapers.
ESRI. 2019. Getting started with ArcGIS Pro. In ESRI ArcGIS Pro: Essential Workflows, Redlands, California, USA, https://www.esri.com/training/, pp. 15-31.
EUROSTAT. 2021. *Eurostat Communication and Dissemination Strategy 2021–2024*, https://ec.europa.eu/eurostat/about-us/policies/communication-dissemination
ISTAT. 2020. Rapporto sul territorio 2020. Ambiente, economia, società, Roma, ISBN 978-88-458-2014-4.
ISTAT.2023. Gli anziani nelle città metropolitane. Profilo sociodemografico e analisi comparativa fra i contesti urbani. Statistiche Focus (2 agosto).
ISTAT.2024. Rapporto Annuale, Roma.
OECD. 2021. OECD *Report on Public Communication: The Global Context and the Way Forward*, OECD Publishing, Paris, https://doi.org/10.1787/22f8031c-en
QUATTROCICOCCHI L., TIBALDI M. 2020. *Invecchiamento attivo e condizioni di vita degli anziani in Italia*, Roma: Istat, ISBN 978-88-458-2028-1.
REYNAUD C., MICCOLI S. 2016. Invecchiamento demografico: dinamica nelle province italiane, *EyesReg*, Vol.6, N.2.
REYNAUD C., MICCOLI S., MONNI S. 2018. Mezzogiorno: l'invecchiamento della popolazione è sostenibile? *Economia e Politica*, March, ISSN: 2281-5260.
UNECE. 2021. *Strategic Communications Framework for Statistical Institutions*, United Nations, Geneva, https://unece.org/statistics/publications/strategic-communication-framework-statistical-institutions
WHO. 2002. Active ageing. A policy framework. In *Second United Nations World Assembly on Ageing*, Madrid, https://iris.who.int/handle/10665/67215

Vito Fabio BELLAFIORE, Istat, vibellaf@istat.it
Donatella CANGIALOSI, Istat, donatella.cangialosi@istat.it
Giuseppe LANCIONI, Istat, giuseppe.lancioni@istat.it