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The role played by migration and fertility on Italy's aging trends: a provincial-level analysis

Il ruolo delle migrazioni e della fecondità nel processo di invecchiamento in Italia: un'analisi a livello provinciale

Thaís García-Pereiro and Anna Paterno

Abstract The main purpose of this paper is to quantify and compare the contributions made both by fertility and migration in the rapid aging process taking place in Italy at the provincial level. The relative variations of different indicators (concerning migration, fertility, mortality and age structure of the population) between 2011 and 2019 are analyzed in two differentiated empirical steps. In the first, through principal components factors analysis, both the relationships among variables under examination and the dynamics of their evolution at the provincial level are defined. In the second step, estimating a regression model, the roles of the determinants linked to fertility and migration on the evolution of the aging process are identified and quantified. Our results indicate the levels of fertility of Italian women as the most important decelerator of population aging, within a highly heterogeneous context at the provincial level.

Abstract *L'obiettivo di questo lavoro è quantificare e comparare tra loro i contributi forniti a livello provinciale sia dalla fecondità, sia dalle migrazioni nel processo di rapido invecchiamento in atto in Italia. A tal fine si osservano in due step differenziati le variazioni relative di diversi indicatori (riguardanti migrazioni, fecondità e mortalità e struttura per età della popolazione) verificatesi tra il 2011 e il 2019. Nel primo, attraverso un'analisi delle componenti principali, si definiscono le relazioni esistenti tra le variabili osservate e la loro evoluzione a livello provinciale. Nel secondo step, applicando un modello di regressione, si identificano e quantificano i ruoli delle determinanti connesse alla fecondità e alla migrazione sull'evoluzione del processo di invecchiamento. I risultati indicano il livello di fecondità delle donne*

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italiane come il più importante fattore nel decelerare l'invecchiamento della popolazione, all'interno di un contesto provinciale altamente eterogeneo.

Key words: aging, fertility, migration, Italy, provinces, demographic trends.

1 Introduction

Aging is one of the main long-term demographic challenges that most western countries are called to address within the near future because, given current trends, it might compromise the response capacity (in terms of both quantity and quality) of at least two important components of welfare systems: health and pension. As stated by Spijker and MacInnes (2013), population aging is hardly impacting the sustainability of health systems, and this will make essential for governments to deal with improving the relationship between morbidity and remaining life expectancy at older ages. Also the pension system is going to be well-overstressed due to the sharp combination of an increase of its recipients and a decline of its contributors (Bongaarts, 2004).

In Italy, the economically active population is progressively declining, which is also placing significant pressure on economic growth and public expenditures, given the boosted demand of public health-care related services and pensions, in terms of unbalance between actors involved (ISTAT, 2020). The country has become one of the worlds' oldest countries and, at the same time, hides important territorial differences (Dalla Zuanna and Righi, 1999; García-Pereiro, 2018), representing an interesting case of study.

It is well known that the population age-sex structure of any territory depends on three demographic components: fertility, mortality and international migration. Within the context of increasing population aging and considering that any *ad hoc* modifications on mortality are off-limits, only the increase of very-low fertility levels reached and/or of net migration can help slowing down the process.

Therefore, the main purpose of this paper is to assess whether and how fertility and migration trends have affected population aging during a recent interval of time (between 2011 and 2019). We are completely aware that there are other "solutions" to aging, but here we are only interested on those responding to changes on demographic components.

2 A brief review of the state of the art

A vast body of research has focused on the demographic determinants (mortality, fertility and migration) of population aging (Preston and Stokes, 2012; United Nations Department of Economic and Social Affairs, 2015; Murphy, 2017; Lee and Zhou, 2017). Most studies have indicated that the major responsible for population aging has been declining fertility (Boogarts, 2008; Bengtsson and Scott, 2011; Billari and

The role played by migration and fertility on Italy's aging trends: a provincial-level analysis

Dalla Zuanna, 2011; Bloom et al., 2015; Murphy, 2017). As Lee and Zhou (2017) have shown, population aging has been a direct consequence of fertility decline, independently of mortality trends.

Lee and Mason (2014) have stressed the important role played by fertility levels on a population age structure also highlighting that, in countries with very low fertility levels, increasing fertility will result on a moderate increase on the standards of living. A recent study on Poland by Fihel et al. (2018) has noticed that variations on age-specific growth rates were predominantly explained fertility fluctuations, second, mortality trends, and, last, international migration flows, in this order.

The arrival of individuals to a territory implies short-term changes on its population size and structure but also long-term variations because, if individuals remain at destination, they might contribute to local fertility (increasing the number of births) (Mussino and Strozza, 2012; Giannantoni and Strozza, 2015).

Concerning migration, international literature has reported mixed results. Part of these studies has shown a rejuvenating effect of migration inflows on aged populations (Alho, 2008; Chen, 2015; Fihel et al., 2018), while others have stressed that effect of the presence of foreigners on populations' age structures is negligible (Goldstein, 2009; Bengtsson and Scott, 2010; Murphy, 2017). Projection-based studies (UN 2000, Bijak et al., 2008; Bijak, et al., 2013; Kupiszewski, 2013; Craveiro et al., 2019) have found that the number of immigrants necessary to contrast population aging must be excessively large, profiling unrealistic forecasts.

Several studies have focused on the Italian case (Billari and Dalla Zuanna, 2011; De Santis, 2011; Gesano and Strozza, 2011; Paterno, 2011; Gesano and Strozza, 2019) concluding that immigration alone will not be enough to deal with populating aging, especially if fertility levels remain low, but might help by slowing it down for a while. Authors also highlighted the need to consider that the effects of fertility and migration on aging vary greatly at local levels, given their particular combinations of demographic trends.

3 Data and methods

Data were drawn from demographic statistics available at the provincial level (107 provinces) (NUTS3) from the Italian National Institute of Statistics (ISTAT) for the interval of time between 2001 and 2019. Data is referred not only to the total resident population in Italy, but also to the resident foreign population.

Our dependent variable, signalling population aging, is mean age (Mean Age). We chose this indicator among others (Old Age Dependency Ratio, etc.) based on Murphy (2017) results showing no significant variation when interpreting aging determinants using different measures. Other indicators included in our analyses are: Total Fertility Rate of Italian women (TFR_it), to account for the role of fertility trends; Total Fertility Rate of foreign women (TFR_for), to consider the contribution of foreign fertility to national levels; life expectancy at birth of males (Lexp M) and females (Lexp F), to take into account longevity; the share of foreigners among total population (Foreigners), to weight for the stock of individuals coming from foreign

countries, net migration rates (NetMigR), to control for interprovincial migration flows, and, finally, the mean age of foreigners (Mean Age_for) to evaluate their particularly young age-structure.

All these variables are analyzed in terms of relative variations (computing the ratio between the absolute variation during the interval and the value registered at the first year of the interval). These allowed us to make more accurate the comparison of indicators using different units of measurement.

Our empirical strategy follows two well differentiated steps. In the first, after performing descriptive analysis, we conduct principal components factor analysis to better describe relationships among demographic components of population change throughout a reduction of information while highlighting similarities/dissimilarities across provinces. In the second, we estimate a linear regression model on provincial data to identify the determinants of aging of the resident population in Italy in the last decade. Thus, the dependent variable is continuous and measures variations in the mean age of the resident population between 2011 and 2019. As independent variables, model includes the values of demographic components considered (TFR of Italian women, incidence of foreigners, life expectancy at birth for males and females, net interprovincial migration rate, TFR of migrant women, mean age of foreigners) at the beginning of the period (2011) together with their respective absolute variations during the period under observation (between 2011 and 2019) plus the mean age of resident population in 2011.

4 Main findings

The first part of this section is dedicated to a description of the evolution of aging, fertility and migration trends between 2011 and 2019 at the provincial level. Figures shown here only plot the ranking of the top 5 (highest and lowest variations) of the mean age of the resident population, of TFR of Italian women and the share of foreigners among total resident population.

Between 2011 and 2019, the mean age of the resident population increased the most (around 6-7%) in two provinces of Puglia (Barletta–Andria-Trani, and Bari) and three of Sardegna (Sud Sardegna, Cagliari, Oristano). Instead, those provinces where the increase was the lowest (1-2%) were located in the North, in particular, three in Emilia Romagna (Bologna, Parma and Piacenza), one in Liguria (La Spezia) and the last one in Friuli-Venezia-Giulia (Trieste).

Regarding relative variations of TFR of Italian women (Figure 2), most provinces experimenting declining fertility are in Central (Massa Carrara, Roma and Grosseto) and Northern (Valle d'Aosta, Verbano) regions, with relative variations that oscillate between 18.9% and 25%. There are only three provinces that register increases on their fertility levels: Isernia (8.3%), Bolzano (5.3%) and Crotone (4.5%), while at Consenza and Vibo Valentia, fertility remain almost unvaried.

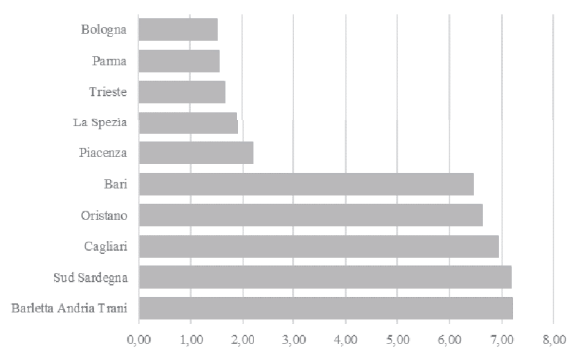


Figure 1: Relative variations in the mean age of resident population between 2011 and 2019 by provinces, lowest 5 and highest 5 values.

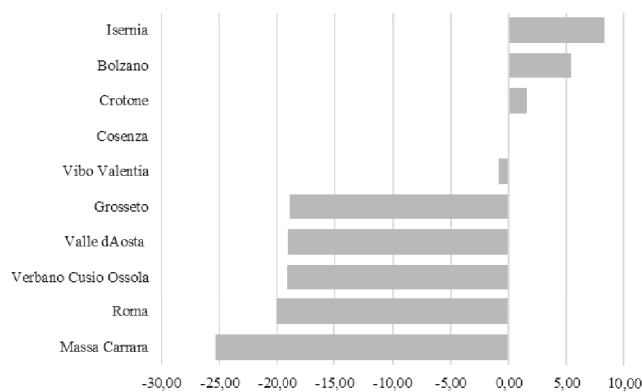


Figure 2: Relative variations in the Total Fertility Rate of Italian women between 2011 and 2019 by provinces, lowest 5 and highest 5 values.

Figure 3 illustrates changes on the share of foreigners among total population under the period interval under study. Out of 107 provinces, only 13 experience a decrease on the stock of foreigners. Those with the highest negative values are in North (Vicenza, Treviso, Brescia) and Center (Macerata, Pesaro and Urbino) of the

country. In contrast, the highest values (around 6 and 7%) are registered in Southern provinces (Crotona, Trapani, Benevento, Campobasso and Cagliari).

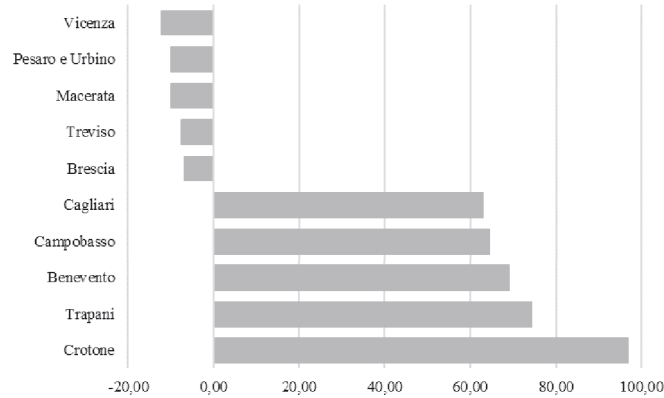


Figure 3: Relative variations in the share of foreigners among total resident population between 2011 and 2019 by provinces, lowest 5 and highest 5 values.

In following multivariate analysis, we summarize relationships observed at the provincial level among observed variables.

The components matrix resulting from principal components factor analysis (Table 1) allows us to identify four factors explaining 76.82% of the total variability of provincial data. The first factor absorbs 31.16% of the total variance and summarize positive variations of the mean age of resident population (in contrast with foreigners mean age variations) and the presence of foreigners. The second factor, explaining 19.12% of the total variance, is associated to negative variations of fertility of both Italian and foreign women. The third factor (covering 14% of total variance), is tied to the increase in life expectancies at birth of males and females, while the fifth fully represented period variations on inter-provincial net migration.

Table 1: Matrix of components resulting from principal components factor analysis. Rotation method: Varimax with Kaiser normalization.

Relative variations	Factor1	Factor2	Factor3	Factor4
Mean Age	0.712	-0.508	-0.008	0.062
TFR_it	0.425	0.525	-0.267	-0.309
TFR_for	0.057	0.805	-0.038	0.312
Lexp M	-0.156	-0.192	0.746	0.195
Lexp F	0.176	0.079	0.807	-0.288
Foreigners	0.937	0.065	0.025	0.049
NetMigR	0.100	0.156	-0.048	0.892
Mean Age_for	-0.852	-0.368	0.009	-0.036
Variance exp.	76.82%	31.16%	19.12%	14%

The role played by migration and fertility on Italy's aging trends: a provincial-level analysis

Figure 4 plots factor scores of the first two factors for each province. Following a counter-clockwise order, we find, in the upper-right quadrant, provinces showing positive values with respect to increasing population aging and contrasted by growing shares of foreigners -which are also growing older- (Factor 1), and less accentuated or even positive variations on fertility (Factor 2). Most of these provinces are situated in the South, for example, Isernia in Molise, Trapani in Sicilia and Benevento and Avellino in Campania, share high values in both factors.

The second quadrant, with positive values on Factor 1 and negative ones in Factor 2, comprises provinces that are predominantly located in the South and Islands, with the Sardinian ones (i.e.: Cagliari, Sud Sardegna) showing the highest combination of values. Here, increases in the mean age and share of foreigners, characterizing positive values of Factor 1, are illustrated in contrast to high negative variations on TFR of foreign women.

The third quadrant comprises provinces with negative figures of both factors and is predominantly represented by northern provinces (i.e.: Reggio nell'Emilia, Rovigo, Viterbo, Brescia e Bergamo). In these provinces both the aging pace (Factor 1) and TFR variations for Italian women (Factor 2) are less pronounced.

The last quadrant, illustrating positive values on the horizontal semiaxis and negative ones on the vertical semiaxis, also includes provinces located in northern areas of the country (such as: Piacenza, Parma, Bologna, Livorno). They share the lowest positive variations on mean age and on the percentage of foreign residents (Factor 1), in opposition to negative variations on fertility, smaller in terms of its magnitude (Factor 2).

Figure 4 is underpinning the deep North-South gap regarding the recent evolution of observed dynamics, which is clearly evident on the net division of the quadrants.

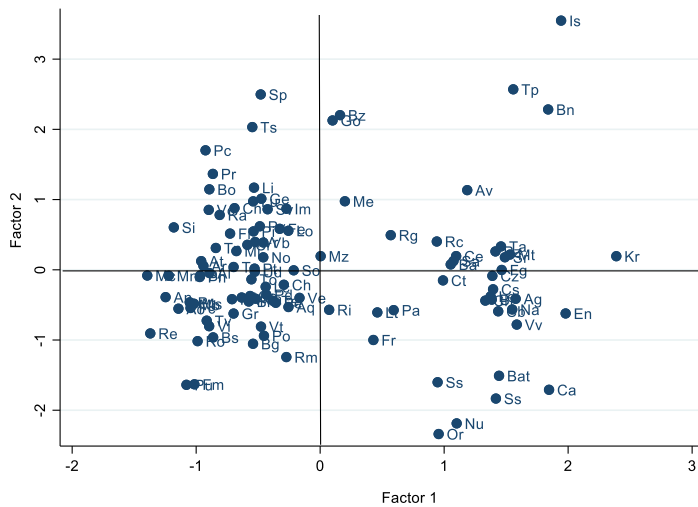


Figure 4: Positions of provinces on the factor plane (first and second factor) resulting from principal components factor analysis.

The last step of our analyses regards results coming from a linear regression model on provincial data (Table 2) on the determinants of mean age variations¹. Our findings show that provinces in which the increase in mean age is larger between 2011 and 2019 are those where the TFR of Italian women was lower both at the beginning of the observation period ($\beta = -0.476$), and when considering its evolution over the observation period ($\beta = -0.490$). Also the presence of foreigners acts shielding against population aging, even if having a weaker impact on it respect to natives fertility. In fact, mean age increases are smaller in provinces with the highest shares of foreigners both in 2011 ($\beta = -0.222$) and successively ($\beta = -0.289$). The third determinant showing a negative relationship is inter-provincial net migration, which also explain mean age variations but to a lesser extent ($\beta = -0.065$) and only in 2011.

Regarding female life expectancy at birth, positive coefficients for its values in 2011 ($\beta = 0.236$) and between years of observations ($\beta = 0.227$), indicate the existence of a direct relation with mean age variation at the province level.

Table 2: Determinants of the absolute variation of the mean age of the population resident in Italy between 2011 and 2019 from linear regression model with provincial-level data.

Independent variables	Coeff	SE	Sig.
Mean Age 2011	-0.480	0.037	***
TFR_it 2011	-0.476	0.624	***
TFR_for 2011	0.292	0.283	
Lexp M 2011	-0.123	0.091	
Lexp F 2011	0.236	0.104	**
Foreigners 2011	-0.222	0.025	***
NetMigR 2011	-0.065	0.028	**
Mean Age_for 2011	-0.016	0.046	
AV TFR_it (2001-2019)	-0.390	0.717	***
AV TFR_for (2001-2019)	0.151	0.238	
AV Lexp_M (2001-2019)	-0.035	0.114	
AV Lexp_F (2001-2019)	0.227	0.112	**
AV Foreigners (2001-2019)	-0.289	0.058	***
AV NetMigR (2001-2019)	0.038	0.031	
AV Mean Age_for (2001-2019)	0.099	0.073	
<i>Constant</i>	<i>22.168</i>	<i>7.397</i>	<i>**</i>
R ²	90.45%		
N	107		

Notes: * p<0.1; ** p<0.05; *** p<0.001

¹ Independent variables include in the model are both values at 2011 of mean age (Mean Age 2011), TFR of Italian (TFR_it 2011) and foreign women (TFR_for 2011), life expectancy at birth of males (Lexp M 2011) and females (Lexp F 2011), share of foreigners (Foreigners 2011), interprovincial net migration rate (NMigR 2011) and mean age of foreigners (Mean Age_for 2011); and absolute variations of TFR of Italian (AV TFR_it 2001-2019) and foreign women (AV TFR_for 2001-2019), life expectancy of males (AV Lexp_M 2001-2019) and females (AV Lexp_F 2001-2019), percentage of foreigners (AV Foreigners 2001-2019), net migration rates (AV NetMigR 2001-2019) and mean age of foreigners (AV Mean Age_for 2001-2019). Significant and negative coefficients (in order of magnitude) were found for the level of fertility of Italian women, the share of foreigners and the net inter-provincial migration rate (p-value <0.001), and a positive one for female life expectancy at birth (p-value <0.05).

5 Brief discussion

This paper was aimed at providing a description of whether and how fertility and migration trends (international and internal) have affected population aging in Italy between 2011 and 2019 at the provincial level.

When summarizing relationships observed among variables included in this study, we found that there are two factors explaining more than half of total variability. The first deals with increases on the mean age of resident population (which is contrasted with a younger age structure of foreigners) and the increasing share of foreigners in Italian provinces. The second factor is linked to decreasing fertility trends of both Italian and foreign women.

Results on the determinants of recent population aging (measured through the relative variation of the mean age of the resident population between 2011 and 2019) indicate both fertility of Italian women and the presence of foreigners as important decelerators of population aging, but the first has exerted the greatest impact. This finding is in line with previous research on the subject stressing the predominant role that fertility has had (over longevity and migration) as main responsible for population aging (Boogarts, 2008; Bengtsson and Scott, 2011; Bloom et al., 2015; Murphy, 2017; Lee and Zhou, 2017; Fihel et al., 2018). According to our estimations, provinces more efficaciously contrasting their increasing mean age were those with higher levels of fertility, both at the beginning of the interval analysed (2011) and when considering the evolution measured up to 2019.

As the effects of fertility and migration on aging might considerably vary at local levels when considering their specific demographic profiles (Billari and Dalla Zuanna, 2011; De Santis, 2011; Gesano and Strozza, 2011; Paterno, 2011), further research should consider testing whether and how the contribution of these population components of change on slowing down aging have differed according to the magnitude already achieved at the beginning of the period under analysis.

References

1. Alho, J. Migration, fertility, and aging in stable populations. *Demography* 45(3): 641–650. doi:10.1353/dem.0.0021 (2008)
2. Bengtsson, T. and Scott, K. The ageing population. In: Bengtsson, T. (ed.). *Population ageing: A threat to the welfare state?* Berlin: Springer: 7–22. doi:10.1007/978-3-642-12612-3_2 (2010)
3. Bengtsson, T. and Scott, K. Population aging and the future of the welfare state: the example of Sweden. *Population and Development Review* 37(1): 158–170. doi:10.1111/j.1728-4457.2011.00382.x (2011)
4. Bijak, J., Kupiszewska, D., and Kupiszewski, M. Replacement migration revisited: Simulations of the effects of selected population and labor market strategies for the aging Europe, 2002–2052. *Population Research and Policy Review* 27(3): 321–342. doi:10.1007/s11113-007-9065-2 (2008)
5. Bijak, J. and Kupiszewski, M. International migration trends in Europe prior to 2002. In: Kupiszewski, M. (ed.). *International migration and the future of populations and labour in Europe*. Dordrecht: Springer: 57–74. doi:10.1007/978-90-481-8948-9_4 (2013)
6. Billari, F. C., and Dalla-Zuanna, G. Is replacement migration actually taking place in low fertility countries?. *Genus*, 67(3), 105-123 (2011)

7. Bloom, D. E., Canning, D., & Lubet, A. Global population aging: Facts, challenges, solutions & perspectives. *Daedalus*, 144(2), 80-92 (2015)
8. Bongaarts, J. Population aging and the rising cost of public pensions. *Population and Development Review*, 30(1), 1-23 (2004)
9. Bongaarts, J. What can fertility indicators tell us about pronatalist policy options?. *Vienna yearbook of population research*, 39-55 (2008)
10. Chen, C.-Y. The effect of migration on the mean age of population: An application of Preston's mean age of population improvement model. *Journal of Family History* 40(1): 92–110. doi:10.1177/0363199014562711 (2015)
11. Craveiro, D., De Oliveira, I. T., Gomes, M. S., Malheiros, J., Moreira, M. J. G., and Peixoto, J. Back to replacement migration. *Demographic research*, 40, 1323-1344 (2019)
12. Dalla Zuanna, G., and Righi A. Nascere nelle cento Italie. Analisi territoriale del comportamento riproduttivo nelle province italiane. *Argomenti* (18), Istat, Roma (1999)
13. De Santis, G. Can immigration solve the aging problem in Italy? Not really.... *Genus*, 67(3), 37-64 (2011)
14. Fihel, A., Janicka, A., and Kloc-Nowak, W. The direct and indirect impact of international migration on the population ageing process: A formal analysis and its application to Poland. *Demographic Research*, 38, 1303-1338 (2018)
15. García-Pereiro, T. Aging and pensions in Italy: highlighting regional disparities. *Rivista Italiana di Economia Demografia e Statistica*, 72(3), 17-28 (2018)
16. Gesano, G., and Strozza, S. Foreign migrations and population aging in Italy. *Genus*, 67(3), 83-104 (2011)
17. Gesano, G., and Strozza, S. Fecondità delle italiane e immigrazione straniera in Italia: due leve alternative o complementari per il riequilibrio demografico?. *la Rivista delle Politiche Sociali*, 4, 119-140 (2019)
18. Giannantoni P., Stozza S. Foreigners' contribution to the evolution of fertility in Italy: a re-examination on the decade 2001-2011. *Rivista Italiana di Economia Demografia e Statistica*, vol. LXIX, n. 2, 129-140 (2015) ISTAT. Invecchiamento attivo e condizione di vita degli anziani in Italia. ISTAT, Roma (2020)
19. Kupiszewski, M. *International migration and the future of populations and labour in Europe*. Dordrecht: Springer Science and Business Media. doi:10.1007/978-90-481-8948-9 (2013)
20. Lee, R. and Zhou, Y. Does fertility or mortality drive contemporary population aging? The revisionist view revisited. *Population and Development Review* 43(2): 285-301 (2017)
21. Lee, R., Mason, A. Is low fertility really a problem? Population aging, dependency, and consumption. *Science*, 346(6206), 229-234 (2014)
22. Murphy, M. Demographic determinants of population aging in Europe since 1850. *Population and Development Review*, 43(2), 257–283. doi:10.1111/padr.12073 (2017)
23. Mussino, E., & Strozza, S. The fertility of immigrants after arrival: The Italian case. *Demographic research*, 26, 99-130 (2012)
24. Paterno, A. Is immigration the solution to population aging?. *Genus*, 67(3), 65-82 (2011)
25. Preston, S. H. and Stokes, A. Sources of population aging in more and less developed countries. *Population and Development Review*, 38(2), 221-236 (2012)
26. Spijker, J. and MacInnes, J. Population Ageing: The Timebomb that Isn't?. *British Medical Journal* (BMJ), vol. 347, 6598 <https://doi.org/10.1136/bmj.f6598> (2013)
27. United Nations. *Replacement Migration: Is it a Solution to Declining and Ageing Populations?*, Population Division, Department of Economic and Social Affairs, United Nations Secretariat, New York (2000)
28. United Nations, Department of Economic and Social Affairs, Population Division. *World population Prospects: Key findings and advanced tables. The 2015 revision*. UN, New York (2015)