Population & development in Africa with special regards to ageing.

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Abstract

Background: Population ageing is a global trend of the 21st century, with huge socioeconomic implications. Yet Africa's population ageing is not fully understood. Africa is often characterized as a homogenous region which is not useful in terms of policy formulation.

Data and methods: The purpose of this study is to examine regional population ageing differentials and similarities in Africa. Selected indicators and determinants of population ageing were taken from World Population Prospects (2017) for periods 1995-2000, 2010-2015 and 2025-2030.

Findings: We applied k-means clustering method to selected indicators and grouped the countries according to their heterogeneity and homogeneity. Three clusters were identified with high, medium and low population ageing.

Conclusion: Northern and Southern African countries formed a relatively homogeneous spatial unit with the highest ageing. Each cluster forms a spatial unit in which appropriate policy measures on population development and ageing can be formulated, implemented and shared as recommended by Agenda 2030, for Sustainable Development Goals (SDGs).

Keywords: demographic revolution, regional differences, clustering

Introduction

The world has been ageing at an unprecedented rate since the 21st Century. Globally, thenumber of people aged 60 years and over is projected to increase by 56 percent (1.4 billion from 0.9 billion) between 2015 and 2030(UN 2017).Moreover, a significant body of literature has shown that globally, the share of the elderly (60 years and over) is growing fastest than all the other age groups (Harper 2016, Pillay and Maharaj 2013). However, the growth of the elderly has not been uniform across the world regionsbetween 2015 and 2100.Although, Africa is the last region to experience demographic revolution, its growth of the elderly is at a faster pace and magnitude in comparison to other world regions.It is clear that the number is increasing in Africa(Pillay andMaharaj 2013, UN 2017), yet the magnitude, extent, and differentiation of this phenomenon remained unexplored.Few fragmented studies in Africa have looked on different aspects of ageing, mainly at country levels or subregions e.g. Sub-Saharan Africa(Suntoo 2012, Cohen andMenken 2006, Apt 2002, Kinsella 1992, Nair 2014, Aboderin and Beard 2015, Kyobutungi et al. 2009, Ferreira and Kowal 2006, Dhemba and Dhemba, 2015).

In addition, inadequate research on ageing in Africa is compounded by the lack of quality and reliable data on the elderly that enables comparability across countries. Data on elderly Africans is limited in scope and accuracy(Randall and Coast 2016). Thereis a misconception and generalization that the African continent is ageing in a homogeneous manner(Bloom et al. 2016, Kinsella and Wan 2009, Dyson 2013).Undeniably, such generalization is not useful in terms of ageing policy formulation and programming on a large and diverse continent.Undoubtedly, most African governments have other more pressing problems such as economic crises, infant and child mortality, HIV and AIDS, rapid population growth, rapid urbanization, youth unemployment and conflicts, which they are focusing on(Aboderin 2012, Pillay and Maharaj 2013).Thus, rapid population ageing without socioeconomic improvement might mean that the human development needs of the elderly are compromised.Population ageing is highlighted in the Agenda 2030, for Sustainable Development Goals (SDG), which emphasize paying attention to the human development needs of the vulnerable population groups including the elderly and leaving no one behind(Kudo, Mutisya and Nagao 2015). To ensure its success, the agenda must remain of the people, by the people and for the people committing the world to global action as from 2015-2030 (UN 2017).

The age structural transformation towards more elderly ages has huge health and socioeconomic implications. In countries burdened with HIV/AIDS pandemic,ageing creates skipped-generation households and feminization of ageing as HIV/AIDS kills more young adults and men than elderly and women respectively (Nabalamba and Chikoko 2011).Moreover,ageingincreasesold-age dependency ratios, social security costs,non-communicable diseases, changes in living arrangements. This is a challenge as Africa is already the world's poorest continent(Harper 2016, Kinsella and Wan, 2009). Unlike Europe, Africa's rapid population ageing does not give time to reap a demographic dividend, which might alleviate the continent's poverty (Groth and May 2017)andtime to prepare and adjust socio-economically.This means Africa may get demographically old before getting socioeconomically developed.For example, a fertility transition to replacement level fertility, which took Sweden about 100 years (Dyson 2013), was achieved in Tunisia in less than 40 years (UN 2017).

There is therefore the need for empirical evidence across Africa countries to understand the population ageing dynamics as well as its differential demographic nuances that may be important for policy considerations.This study aims to provide more evidence, which will assist in understanding population development andageing in Africa. The specific objectives of the study are to (1) examine countries' differentials and similarities in terms of determinants and selected population ageing indicators from 2000, 2015 and 2030 and (2) do countries clustering based on the aforementioned indicators. The understanding of population ageing will enable countries that share similar demography profiles to share experiences and learn from each other. Furthermore, such endeavors will help in meeting Sustainable Development Goals(SDGs) 1 and 3 of ending poverty in all its forms everywhere and ensuring healthy lives and promoting well-being for all at all ages respectively.

Literature review

Although the demographic transition in Africa began later as compared to other regions, its ageing process is happening at a faster pace and magnitude than elsewhere (Pillay and Maharaj 2013). The demographic transition is defined as the movement from high to low mortality and fertility regimes accompanied by age structural changes due to socioeconomic developmentTabutin et al. 2004).Africa is still regarded as the youngest continent, even though spatial ageing variations have been noted between and within countries and regions (Nabalamba and Chikoko 2011, Pillay and Maharaj 2013).For example, in 2000, 2015, and 2030 projections Northern countries had the highest percentage of thepopulation aged 60 years and over of (6.8%; 8%; 11%) respectively, followed by Southern Africa with almost similar values, whilst Western, Central and Eastern experienced a slight increase with an average of 5% for respective periods. However, exponential increases in absolute numbers of elderly were recorded in all regions (UN 2017). Various studies have revealed that not only are there more elderly females than males but, also a significant number of the elderly population resides in rural than urban areas, although in future more elderly people will be urbanites than rural(Nabalamba and Chikoko 2011, Pillay and Maharaj 2013).Further, population ageing is accompanied by an increases in the median ages, old age dependency ratio and a simultaneous decrease in the child dependency ratios of the population.

The determinants of population ageing in Africa like everywhere else are rooted in the fertility and mortality decline processes. Migration effect has been found to be insignificant on population ageing(Nabalamba and Chikoko 2011, Dyson 2013).Most importantly, the overlapping processes are causally related to each other, a fact which explains why they always occur relatively sequentially i.e., mortality decline-population growth- fertility decline–population ageing(Dyson 2013).Even though mortality and fertility remain high and variable in Africa as compared to other world regions, the rapid decline of mortality especially infant mortality with sustained high fertility has created unprecedented rates of natural increases (RNI) which is still above 2.5% per annum in 2015 (UN 2017). In this context, it is possible to hypothesize that such high RNI creates a future elderly population, given that from the 1950-2015 probability of survival to 60 years old increased from 0.44 to 0.64 respectively with simultaneous declining fertility levels.

In 2015, the middle-income countries of Northern and Southern Africa's fertility had declined to 3.3 and 2.6 respectively, whilst the Central and Western countries were in the early stages of fertility decline (UN 2017).However, in the period 2000-2015, a significant number of countries have experienced fertility stalling or stagnation midway of fertility transition(Goujon, Lutz and Samir 2015, Garenne 2013, Bongaarts 2006), which might delay population ageing. Generally in Africa, life expectancy at birth was found to be 3-6 years higher for females than males (Pillay and Maharaj 2013, Muhwava, Rutaremwa, 2016),even though recent study by Muhwava and Rutaremwa (2016) found that in Swaziland and Mali, men had slightly higher life expectancy at birth than females. The outbreak of

HIV/AIDS pandemic has since created life expectancy at birth gaps between North Africa and Southern Africa (Pillay & Maharaj2013). Thus, from 1990-2005, South Africa, Botswana, Lesotho, Malawi, Swaziland and Zimbabwe, life expectancy at birth fell from about 60 to almost 40 years in less than 15 years, whilst Northern Africa experienced a continued increase in life expectancy at birth of about 5 yearsTabutin et al. 2004, Nabalamba and Chikoko 2011). HIV/AIDS-induced mortality kills more sexually active young adults than the elderly and children, therefore initially speeds-up ageing process (Nabalamba and Chikoko, Pillay and Maharaj 2013). Socially, it creates young adult- skipped generation households. In Southern Africa, over 60% of orphans were reported to be living with grandparents (Nabalamba and Chikoko 2011). Increased caring responsibilities are placed on grandparents, despite such grandparents being already health and socioeconomically vulnerable and in need of supporting themselves.

Data and methods

Datawere extracted from World Population Prospects (2017) Revision on global and regional population estimates from 2000-2017 and a medium variant of population projections from (2015-2030) was used (UN 2017). The rationale for selecting the data source emanates from its comparability across all African countries. This is important given the scarcity of reliable and accurate data on ageing personsin Africa(Randall and Coast 2016).

The study selected 48 out of 58 countries with a total population of more than 1million people in 2017. Countries that wereexcluded had less than 1million population in 2017(Comoros, Djibouti, Mayotte, Seychelles, Reunion, Sao Tome,and Principe, Western Sahara, and Cape Verde). This is because errors have been found to be greater for populations that are smaller than bigger populations (UN 2017, Randall and Coast 2016). In addition, Mauritius (with the highest proportion of the old aged population at 10% in Africa), was also excluded because, being an island, it is demographically and socio-economically an outlier (Nair 2014), therefore affects clustering. The study adopted the following five regional classifications of Africa with a specific number of countries: Southern (5), Northern (6), Central Africa (8), Eastern (14) and Western (15) regions (UN 2017).

The following years 1995-2000, 2010-2015 and2025-2030 were used to create cluster analysis (Analysis 1,Analysis 2 and Analysis 3) respectively. Table 1;shows selected seven demographic indicators for the respective periods namely;total fertility rate (TFR), rate of natural increase (RNI), Median age, percentage aged 60 years plus, infant mortality rate (IMR),childdependency ration (CDR) and total dependency ratios (TDR).We used K-means clustering analysis in our research. K-means clustering is a method of classifying objects or subjects into K-groups, where K is defined as the number of prechosen groups (Jain, 2010). K-means was deemed most appropriate because it considers homogeneity and heterogeneity of spatial units and clusters them into groups. Clustering was done by minimizing the sum of squared distances (Euclidean distances) between items and corresponding centroid. A centroid is the mass of a geometric object of uniform density or also means vectors.

The method is appropriate when you have a large number of objects. Moreover, the method chooses the initial clusters means by randomly choosing values within the same range as the highest and the lowest in the data values (Jain, 2010). The chosen data sets have different measurement units, therefore they were standardized into z-scores of +3 to -3 on a continuum line using SPSS version 21 (Yüceşahin and Tulga, 2017). Moreover, Post hoc analysis (Turkey's HSD test) was computed to compare the internal differences and similarities of the cluster analysis.

Analyses were done by trying various clustering alternatives, between 2-5 clusters based on the means of the selected demographic variables. Only 3 clusters result for each analysis period produced acceptable results. Two cluster analysis was found to be too simplistic, whilst 4 and 5 clusters produced only one or two countries in some of the clusters, therefore the three cluster results were inherently chosen to be the appropriate method findings.

Table 1. Determinants and selected indicators of population ageing (1995–2000; 2010–2015; 2025–2030)

	Country /region	Median age 2000	Median age 2015	Median age 2030	TFR 1995-2000	TFR 2010-2015	TFR 2025-2030	IMR 1995-2000	IMR 2010-2015	IMR 2025-2030	RNI 1995-2000	RNI 2010-2015	RNI 2025-2030
Eastern	Burundi	15.3	17.6	18.6	7.2	6.0	4.8	102.7	77.9	53.6	28.6	31.7	26.7
	Eritrea	17.1	18.9	21.7	5.6	4.4	3.4	71.2	45.0	19.4	23.0	26.7	21.8

	Ethiopia	16.6	18.6	22.6	6.8	4.6	3.1	96.7	45.8	22.9	30.3	26.1	20.4
	Kenya	17.0	19.0	22.5	5.4	4.1	3.3	70.3	39.4	8.	28.1	26.8	21.9
	Madagascar	17.3	18.7	21.2	5.8	4.4	3.6	77.7	36.8	19.1	31.5	27.2	24.4
	Malawi	16.5	17.4	19.9	6.3	4.9	3.8	115.5	66.5	49.8	28.3	29.8	26.7
	Mozambique	17.4	17.2	19.1	5.9	5.5	4.5	114.1	67.3	50.2	27.9	29.2	26.9
	Rwanda	17.3	19.4	22.9	5.9	4.2	3.2	122.0	44.0	30.3	25.4	26.7	20.0
	Somalia	16.5	16.5	17.7	7.7	6.6	5.2	105.1	79.5	55.9	33.7	32.1	30.0
	South Sudan	17.6	18.6	20.6	6.4	5.2	4.0	113.9	77.7	49.2	27.7	25.3	22.8
	Uganda	15.2	15.8	17.9	6.9	5.9	4.6	96.2	60.2	43.4	31.7	34.5	30.0
	Tanzania	17.2	17.3	19.0	5.8	5.2	4.3	89.0	44.0	31.9	27.6	31.9	28.7
	Zambia	16.6	17.1	19.0	6.1	5.2	4.4	101.2	53.8	36.2	26.7	30.5	28.3
	Zimbabwe	17.8	19.0	21.8	4.2	4.0	3.1	64.8	46.5	35.3	19.1	26.0	19.5
Central	Angola	16.2	16.4	18.1	6.8	6.0	4.9	134.0	65.4	49.2	29.9	34.4	30.2
	Cameroon	17.3	18.3	20.4	5.8	5.0	4.0	101.9	67.5	45.9	25.9	27.1	23.5
	CAR	18.6	17.8	20.3	5.6	5.1	4.0	115.4	93.5	65.6	21.2	22.0	22.7
	Chad	15.6	16.1	18.1	7.4	6.3	4.9	114.2	91.2	64.9	33.2	31.2	26.8
	Congo	19.0	18.9	20.5	5.1	4.9	4.0	84.6	46.5	31.3	25.0	28.5	25.2
	DRC	17.2	16.8	18.2	6.8	6.4	5.0	112.9	73.2	50.5	29.3	33.1	29.0
	Equatorial G	19.6	22.2	22.7	5.9	5.0	3.8	99.3	70.0	48.4	26.6	25.3	21.6
	Gabon	19.4	2.6	24.3	4.8	4.0	3.2	59.0	40.8	28.3	23.4	22.9	17.5
Northern	Algeria	21.7	27.5	31.8	2.9	3.0	2.3	41.9	27.7	16.2	16.3	20.5	10.8
	Egypt	21.2	24.7	26.6	3.4	3.4	2.8	36.7	18.9	11.9	19.2	22.4	14.7
	Libya	22.1	27.2	32.5	3.2	2.4	1.9	29.6	24.3	16.5	18.0	16.1	8.9
	Morocco	22.7	27.9	33.0	3.0	2.6	2.2	44.0	28.1	13.3	16.7	16.1	10.2
	Sudan	17.9	18.9	21.6	5.7	4.8	3.9	70.1	48.7	36.5	29.4	26.6	22.7
	Tunisia	25.1	31.1	36.2	2.3	2.3	2.0	28.6	18.5	10.8	13.2	12.8	6.8
Southern	Botswana	20.1	24.4	28.7	3.7	2.9	2.3	73.2	35.2	21.4	16.3	17.0	12.6
	Lesotho	18.7	21.3	23.7	4.4	3.3	2.6	81.2	59.8	36.1	20.0	15.1	12.7
	Namibia	19.5	21.0	23.8	4.3	3.6	2.9	60.3	36.4	23.0	23.5	22.1	17.7
	South Africa	22.8	26.1	29.6	3.0	2.6	2.2	55.7	36.5	24.8	15.2	10.9	8.2
	Swaziland	17.2	20.4	23.5	4.5	3.3	2.6	80.7	56.3	33.2	22.3	19.4	15.0
Western	Benin	17.3	18.2	20.1	6.2	5.2	4.2	93.4	67.7	51.6	30.2	28.7	24.9
	Burkina Faso	16.4	17.0	19.0	6.7	5.6	4.5	99.5	64.8	38.9	30.5	31.2	27.4
	Côte d'Ivoire	18.0	18.3	19.6	6.1	5.1	42	99.2	71.6	3.3	25.2	4.3	23.6
	Gambia	16.8	17.0	19.1	6.0	5.6	4.6	67.1	49.8	38.2	33.4	32.6	26.8
	Ghana	18.8	20.4	22.8	5.0	4.2	3.4	66.9	46.5	31.5	25.7	24.0	19.2
	Guinea	17.8	18.4	20.4	6.2	5.1	4.0	111.7	65.7	30.2	28.4	27.0	24.5
	Guinea-Bisau	17.1	18.9	21.0	6.0	4.9	3.9	109.1	80.4	53.2	27.7	27.0	22.0
	Liberia	18.1	18.6	20.9	6.0	4.8	3.9	128.7	59.0	27.7	29.1	27.1	24.5
	Mali	16.6	16.0	17.8	7.0	6.4	5.0	121.3	78.5	47.5	29.3	33.1	29.9
	Mauritania	18.2	19.7	21.8	5.6	4.9	4.0	76.2	68.0	55.1	29.3	27.4	22.4
	Niger	15.9	14.9	15.7	7.7	7.4	6.4	102.6	65.8	42.4	35.6	38.5	37.1
	Nigeria	17.9	17.9	19.2	6.2	5.7	4.7	118.6	76.3	47.1	25.1	27.0	24.7
	Senegal	17.3	18.3	20.2	5.7	5.0	4.1	68.3	43.9	21.6	28.9	31.0	25.4
	Sierra Leone	17.5	18.3	21.2	6.5	4.8	3.5	148.7	94.4	59.6	19.9	23.3	18.8
	Togo	17.9	18.9	21.2	5.5	4.7	3.8	80.2	55.7	41.3	26.7	26.5	22.2

Table 1 (Continued)

	Country/region	CDR1995-2000	CDR 2010-2015	CDR 2025-2030	% aged ≥60 years 1995-2000	% aged ≥60 years2010-2015	% aged ≥ 60years2025-2030	TDR 1995-2000	TDR2010-2015	TDR 2025-2030
Eastern	Burundi	106.8	87.7	87.7	4.5	4.2	4.2	116.6	96.0	88.7
	Eritrea	89.4	80.8	60.4	5.4	5.3	5.2	100.3	90.9	69.2
	Ethiopia	95.4	78.3	58.4	4.8	5.2	6.0	105.2	88.1	68.6
	Kenya	88.7	75.8	58.9	4.0	4.1	5.6	96.5	83.3	68.4

	Madagascar	89.8	77.5	66.5	6	4.6	5.9	98.9	86.2	76.8
	Malawi	96.2	87.5	70.3	4.4	4.3	4.4	105.3	95.9	78.1
	Mozambique	89.7	90.5	76.3	4.8	4.8	4.9	99.3	100.1	85.5
	Rwanda	86.2	74.8	56.5	4.3	4.6	6.5	94.6	83.3	67.5
	Somalia	97.1	95.2	86.0	4.3	4.3	4.5	105.9	104.1	94.7
	South Sudan	89.3	79.7	68.4	4.9	5.1	5.7	99.1	89.5	78.5
	Uganda	106.7	99.6	82.0	3.8	3.3	3.6	114.9	106.5	88.9
	Tanzania	89.4	90.1	77.0	4.4	4.6	5.1	98.2	99.4	86.4
	Zambia	93.8	89.1	76.2	4.1	3.7	4.1	102.0	96.4	83.7
	Zimbabwe	81.2	76.4	58.7	4.6	4.2	4.6	89.9	84.2	66.4
Central	Angola	97.4	96.1	82.5	3.9	3.9	4.6	105.3	104.1	91.3
	Cameroon	90.2	82.5	68.3	5.2	4.8	5.1	100.6	91.6	77.4
	CAR	81.2	86.1	68.8	5.9	5.5	5.3	92.6	96.9	78.3
	Chad	104.6	98.2	81.1	4.5	4.0	4.0	114.1	106.4	88.6
	Congo	78.3	80.8	69.1	5.4	5.1	6.2	88.5	90.5	80.4
	DRC	91.6	94.6	82.1	4.7	4.7	5.0	101.1	104.1	91.6
	Equatorial G	75.7	64.5	57.9	5.7	4.6	4.2	86.4	72.4	64.8
	Gabon	80.1	61.8	54.1	8.3	6.4	7.7	96.5	72.9	66.9
Northern	Algeria	57.8	45.9	39.8	6.4	8.9	13.3	68.5	60.2	61.2
	Egypt	65.0	56.0	48.6	7.2	7.7	9.9	77.8	69.0	64.9
	Libya	56.0	44.0	33.8	5.7	6.5	11.0	65.4	54.0	50.3
	Morocco	57.1	44.3	38.4	7.7	10.0	15.7	70.2	60.3	64.2
	Sudan	85.2	78.1	64.5	4.8	5.4	6.5	94.4	88.2	75.9
	Tunisia	48.6	36.7	35.2	9.6	11.7	17.7	64.4	54.7	64.3
Southern	Botswana	65.2	51.2	41.7	4.7	6.1	8.6	73.3	61.0	55.0
	Lesotho	79.0	61.9	53.5	6.5	6.7	5.9	91.5	73.6	63.1
	Namibia	74.2	64.3	55.1	4.9	5.4	6.8	83.3	73.6	66.5
	South Africa	55.9	46.9	40.3	6.3	8.0	10.5	66.4	59.7	56.8
	Swaziland	87.4	65.4	53.3	4.7	4.8	5.4	96.5	73.7	62.1
Western	Benin	90.5	82.7	71.2	5.0	5.0	5.6	100.5	92.3	81.4
	Burkina Faso	95.6	90.1	75.4	4.3	3.8	4.4	104.5	97.7	83.5
	Côte d'Ivoire	84.2	81.2	39.2	4.6	4.7	10.2	93.0	90.3	82.8
	Gambia	92.2	90.3	75.1	4.1	3.8	4.5	100.3	97.7	83.4
	Ghana	78.2	69.3	58.3	8	5.2	6.5	87.2	78.7	69.4
	Guinea	87.8	81.6	69.4	5.4	5.1	5.6	98.5	91.3	79.4
	Guinea-Bissau	89.8	78.1	65.4	4.5	4.9	5.3	98.8	87.2	74.5
	Liberia	83.5	80.3	67.3	5.0	4.8	5.7	93.2	89.5	77.3
	Mali	96.1	99.8	83.3	5.0	4.0	4.0	106.4	108.1	90.9
	Mauritania	83.0	73.4	63.9	4.9	4.9	6.2	92.5	82.4	74.7
	Niger	100.8	109.9	102.3	4.0	4.1	4.2	109.2	119.0	111.1
	Nigeria	84.3	85.8	75.3	4.7	4.5	4.8	93.4	94.5	84.1
	Senegal	89.2	82.4	68.8	5.0	4.7	5.3	99.2	91.3	78.2
	Sierra Leone	86.9	80.4	62.7	4.2	4.1	4.7	95.1	88.2	70.7
	Togo	83.4	78.6	64.7	4.6	4.5	5.4	92.1	87.1	74.1

Source: (UN 2017)

Results

Table 2: shows the results of the three cluster analysis; Analysis 1 (1995-2000), Analysis 2 (2010-2015), Analysis 3 (2025-2030) and show country membership grouped into 3 clusters, represented by numbers 1 (low); 2 (medium); and 3 (high) for the demographic determinants and selected ageing indicators in Africa.Furthermore, the heterogeneity and homogeneity of countries were clustered using z-score averages (final cluster centres), as shown in Table 3. In addition, the z-score averages shown in Table 3 have been converted to bar graphs in Figure 1 in order to demonstrate the differences between the determinants and indicators of population ageing in clusters for the respective periods visually. Moreover, the list of country cluster membership in Table 2, have been imputed into the geographical map as shown in Figure 3 to demonstrate the changing regional and geographical spatial clustering of the mentioned demographic variables of population ageing in Africa (Table 3). Final cluster centres result from cluster Analysis (1) 1995-2000; (2) 2010-2015; (3) 2025-2030 (n=48)

In Analysis 1 (1995-2000) the results show that 6 out of 48 countries, mainly north African countries and South Africa were clustered in 3/1 with high (positive z-score) median age and percentage aged 60 plus and low (negative z-score) for TFR, RNI, IMR, CDR and TDR compared to other clusters. Cluster 2/1 had 14 countries with very low (positive z-score) median age and percentage above 60 plus and low (negative z-score) for TFR, RNI, IMR, child and total dependency ratios. The majority of the countries belonged to cluster 1/1 with 28 countries with very low (negative z-scores) median and percentage aged 60 plus and low positive z-scores TFR, RNI, IMR, child and total dependency ratios. This implies that in 1995-2000, clusters 1/1; 2/1 and 3/1 (58; 29 and 13 percent) were in the early, middle and later stages of fertility decline respectively.

Table 2. Cluster membership of African results from Analysis 1 (1995–2000); Analysis 2 (2010–2015) and Analysis 3 (2025–2030)

	Country/region	Analysis 1Cluster Membership (1995-2000)	Analysis 2 Cluster Membership (2010-2015)	Analysis 3 Cluster Membership (2025-2030)
Eastern	Burundi	1	1	1
	Eritrea	2	2	2
	Ethiopia	1	2	2
	Kenya	1	2	2
	Madagascar	1	2	2
	Malawi	1	1	2
	Mozambique	1	1	1
	Rwanda	1	2	2
	Somalia	1	1	1
	South Sudan	1	2	2
	Uganda	1	1	1
	Tanzania	1	1	1
	Zambia	1	1	1
	Zimbabwe	2	2	2
Central	Angola	1	1	1
	Cameroon	1	2	2
	CAR	2	1	2
	Chad	1	1	1
	Congo	2	2	2
	DRC	1	1	1
	Equatorial G	2	2	2
	Gabon	2	2	2
Northern	Algeria	3	3	3
	Egypt	3	3	3
	Libya	3	3	3
	Morocco	3	3	3
	Sudan	2	2	2
	Tunisia	3	3	3
Southern	Botswana	2	3	3
	Lesotho	2	2	2
	Namibia	2	2	2
	South Africa	3	3	3
	Swaziland	2	2	2
Western	Benin	1	1	1
	Burkina Faso	1	1	1
	Côte d'Ivoire	1	2	2
	Gambia	1	1	1
	Ghana	2	2	2
	Guinea	1	2	2
	Guinea-Bissau	1	2	2
	Liberia	1	2	2

Mali	1	1	1
Mauritania	2	2	2
Niger	1	1	1
Nigeria	1	1	1
Senegal	1	2	2
Sierra Leone	1	2	2
Togo	2	2	2

Notes; Cluster number 1, 2 and 3 = low, medium and high respectively
Source: (UN 2017) and Own Calculations

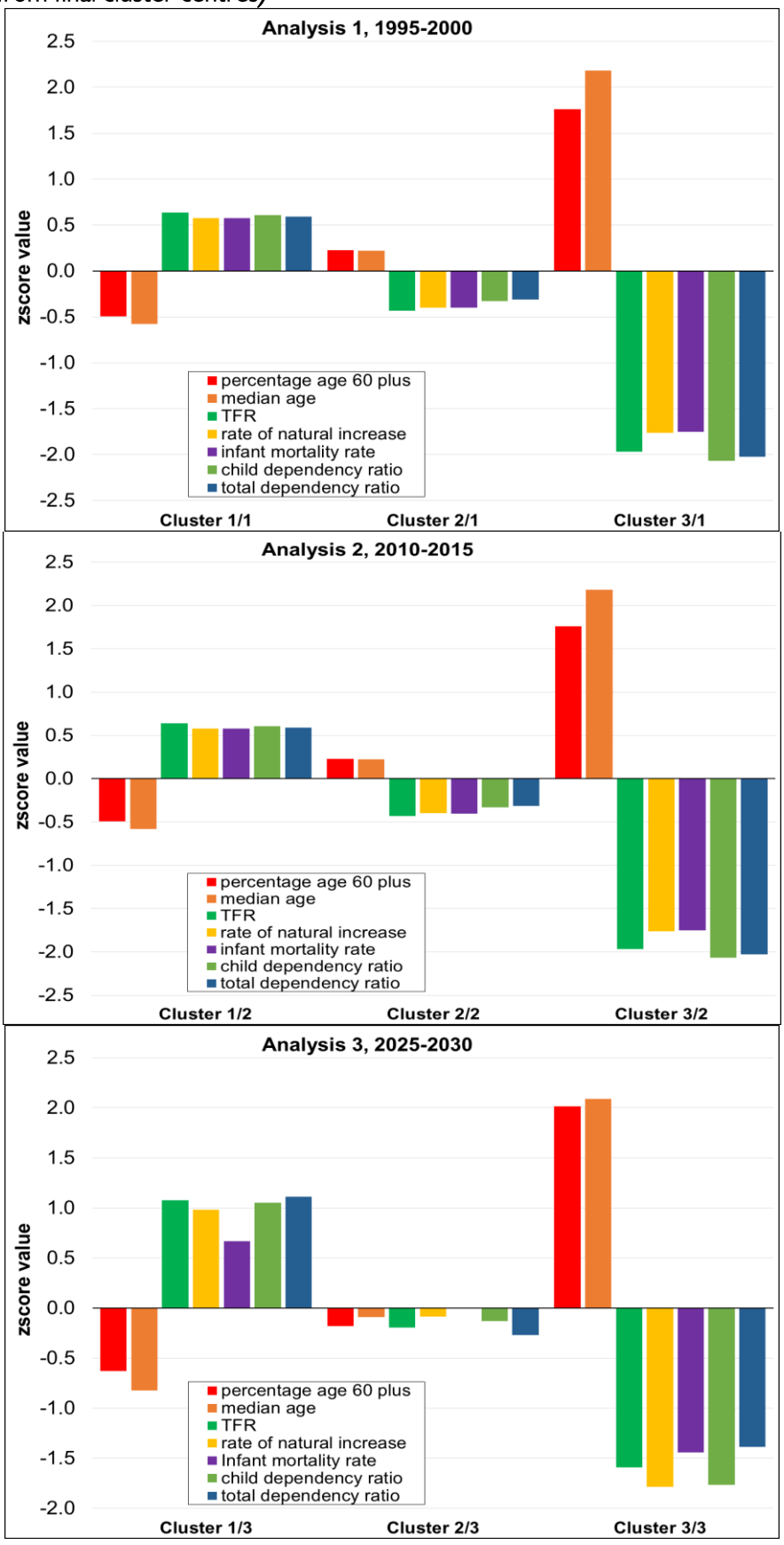
Table 3. Final cluster centres result from cluster Analysis (1) 1995–2000; (2) 2010–2015; (3) 2025–2030 (n=48)

		Demographic Indicator	Child Dependency Ratio	Median Age	Total Fertility Rate	Rate of Natural Increase	% aged ≥ 60 years	Total Dependency Ratio	Infant Mortality Rate	Countriesin cluster
Analysis 1 (1995–2000)	z–score	Cluster 1/1	0.61	–0.58	0.64	0.58	–0.49	0.59	0.58	26
		Cluster 2/1	–0.33	0.22	–0.43	–0.40	0.23	–0.31	–0.40	14
		Cluster 3/1	–2.07	2.18	–1.97	–1.76	1.76	–2.03	–1.75	6
	Anova Test	F–value	89.62	103.12	85.03	40.38	28.14	71.77	39.61	
		P	****	****	****	****	***	****	****	
Analysis 2 (2010–2015)	z–score	Cluster 1/2	0.93	–0.77	0.95	0.86	–0.59	0.96	0.66	17
		Cluster 2/2	–0.11	–0.06	–0.17	–0.13	–0.15	–0.15	–0.02	24
		Cluster 3/2	–1.88	2.08	–1.70	–1.63	1.96	–1.80	–1.53	7
	Anova Test	F–value	122.00	145.94	74.96	46.69	54.35	104.06	23.09	
		P	****	****	****	****	**	****	**	
Analysis 3 (2025–2030)	z–score	Cluster 1/3	1.05	–0.82	1.08	0.98	–0.63	1.11	0.67	15
		Cluster 2/3	–0.13	–0.09	–0.19	–0.08	–0.18	–0.27	0.00	26
		Cluster 3/3	–1.76	2.09	–1.59	–1.79	2.01	–1.39	–1.44	7
	Anova Test	F–value	107.66	150.19	74.97	82.52	66.77	58.74	18.53	
		P	****	****	****	****	**	****	**	

Significance; levels **** P<0.001, ***P< 0.01, **P <0.05
Source: UN, (2017) and Own Calculations

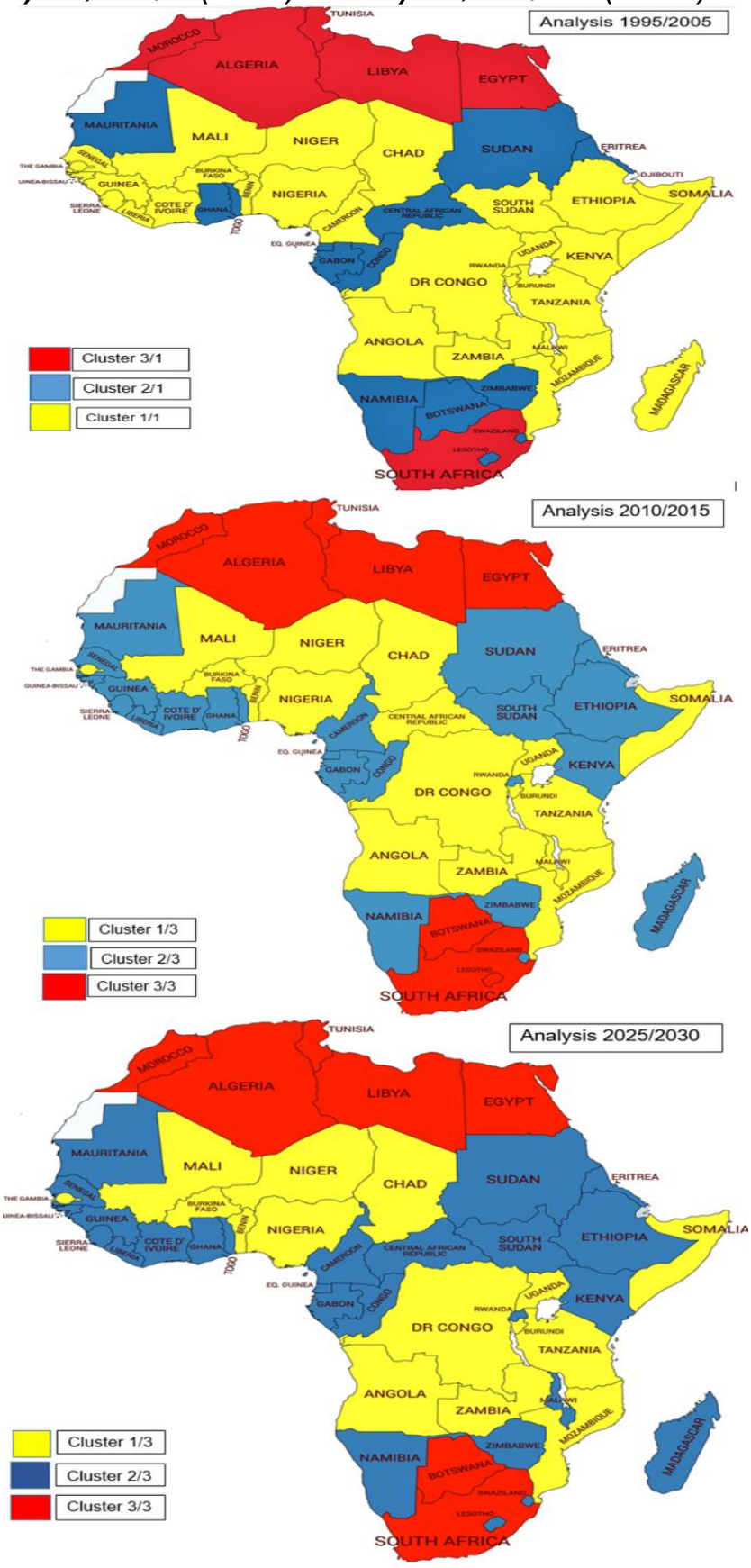
In Analysis 2 (2010-2015),7 (15%) countries out of 48 belonged to cluster 3/2; all North African countries (except the Sudan), plus Botswana, and South Africa with high median age and percentage above 60 plus and low (negative z-score) for TFR, RNI, IMR, child and total dependency ratios. In addition, in Analysis 2, about 24 (50%) countries out of 48 belonged to cluster 2/2 with low negative z-score values for all indicators. The remaining 17 (35%) countries were assigned to cluster 1/2 with very low (negative) median age and percentage above 60 plus and low (positive z-score) for TFR, RNI, IMR, child and total dependency ratios.

Figure 11. Z–score bar graphs Analysis 1 (1995–2000); Analysis 2 (2010–2015) and Analysis 3 (2025–2030) respectively (made from final cluster centres)



Source: UN 2017, own Calculations

Figure 2. Clustering of countries and final cluster centres of demographic indicators in Analysis 1, 1995/2000 (Top); Analysis 2, 2010/15 (middle) and Analysis 3, 2025/2030 (bottom)



Source: UN (2017) and own Calculations.

Again in Analysis 3 (2025-2030),Cluster 3/3 had 7 (15%) out of 48 countries comprises of North African countries, (except Sudan) plus Botswana and South Africa). Nevertheless,cluster 3/3 was characterised with very high positive z-score for median age and percentage above 60 plus and very low (negative z-score) for TFR, RNI, IMR, child and

total dependency ratios. Cluster 2/3 had the bulk of 26 (54%) countries with low negative z-score values for all indicators. The remaining 17(31%) countries were assigned to cluster 1/3 with very low (negative z-score) median age and percentage above 60 plus and low (positive z-score) TFR, RNI, IMR, child and total dependency ratios.

The results inTable 3further reveals that in cluster Analysis 1(1995-2000),the most important factor for the differentiation of the demographic profile and ageing in cluster 1/1 wasTFR with positivez-score of 0.64.The highTFRkeeps the median age and percentage above 60 plus negative. This showsthe cluster had a youthful population structure.Furthermore,Table 3 shows that cluster 1/1 in relation to other clusters 2.1 and 3.1 had the highest TFR. Also, cluster 1/1had the majority of 28 countries mainly from Eastern, Central and Western Africa in 1995-2000. Cluster 3/1 had the highest negative z-score TFR of all the clusters of -1.97 compared to all other clusters. The RNI, IMR, child and total dependency ratios z-scores had the highest negative z-scores to all other clusters. On the contrary, cluster 1/1 had higher positive z-scores for (TFR,RNI, IMR, child) and lower negative z-scores for total dependency ratios, median age and percentages above 60 plus than other to clusters 2/1 and 3/1 for this period. The Median age and percentage above 60 hadpositive highestz-score for the analysis period as compared to other clusters. Cluster 3/1 had the highest median age and percentage above 60 plus and a corresponding lowest TFR,RNI, IMR, child and total dependency ratios. This cluster consisted of Algeria, Egypt, Libya,Morocco, Tunisia,andSouth Africa (see Table 2). Cluster 2/1 was sandwiched between clusters 1/1.

The results indicate thatAnalysis 1 (1995-2000);(top panels in Table 3, Figure 1 and 4) cluster 3/1 have experienced significant fertility decline which had causedthe rate of natural increase, child dependency and total dependency ratio to be negative whilst median age and percentages aged 60plus increased. This pattern wassimilar tocluster 2/1 to a slight extent.

In summary, cluster 1.1 was the opposite of 2/1 and 3/1 because it is in the early stages of fertility decline whilst the 2/1 and 3/1were in the middle and advanced stages ofthe demographic revolution respectively.Consequently, this suggest the that majority of the countries (58%)were in analysis 1 and cluster 1/3, had a predisposition towards youthfulpopulation age structures whilst, 30% and 13%of total countries in cluster 2/1 and cluster 3/1, respectively,had experienced significant fertility decline(see Table 1 with indicators in absolute terms).

Furthermore, analysis2 (2010-2015) depicts thespatial demographic determinants, and ageing indicators for Africa was differentiated into three clusters namely 1/2, 2/2, and 3/2 (See Middle panels in Table 3, Figure 1 and 2).The positive TFRz-score in the cluster showed that it was the most important variable. The positive TFR z-score keptRNI, IMR, child and total dependency ratios also high and positive. High TFR also kept median age and percentage of aged 60 plus negative. Table 2 shows the group consistedof Central, Eastern and Western African countries.Cluster 3/2 was the opposite of 1/2 with high negative TFRz-score of -1.70. The TFR negative z-score keptRNI, child and total dependency ratios also negative, whilst median age and percentage above 60 plus were positive (highest) as compared to other clusters. In this cluster, 3/2, Algeria, Egypt, Libya, Morocco, Tunisia, South Africa were joined by Botswana (Table 2).In Cluster 2/2TFRwas slightly negative, which made all the variables to be negative and the cluster2/2 wassandwiched between cluster 1/2 and 1/3. Furthermore,the results showthat some countries shifted in clustering from cluster 1/1 (1995-2000) to 2/2 (2010-2015). Consequently, nine countries shifted, and the number of countries increased from 14 to 24 inthe respective periods. Whilst Botswana moved out of cluster 2/1 in 1995-2000 to cluster 3/2 in 2010-2015. Due to fertility decline, cluster 2/2was in the third stage of the demographic revolution. The number of countries in cluster 2/2 increased asmore countries experienced furthersignificant fertility declines from analysis 1 (1995-2000) cluster 1/1.

Countries in clusters 3/2 had experienced significant fertility decline which caused other demographic variables to change, causing a maturing of population age structure- which was predominated by young adults (demographic dividend period).Countries in cluster 2/2 were in the middle of fertility decline with 50% of the countrieswhilst 35% of countries in cluster 1/2 were in the early stages of fertility decline(dominated by more children and few elderly). Cluster 1/1 had a young age structure whilst cluster 2/1 had a predominance of population ageing *(*See Table2, Table 3 andFigure 1).

Analysis 3 (2025-2030),shows countries were clustered into three 3 groups representing theirgeo-demographic determinants and ageingindicators (Middle panels in Table 3; Figure 1 and 2). Cluster 3/3 had the highest negative z-score TFR of -1.59 compared to other clusters. This negative z-score TFR causes the rate of natural increase, infant mortality rate, child and total dependency ratios also to have very high negative z-scores whilst the median age and percentages above 60 was very high (positive z-score) compared to other clusters. The cluster

consisted of 7 countries, Algeria, Egypt, Libya, Morocco, Tunisia, Botswana, and South Africa. Cluster membership countries did not change from analysis 2010-2015, cluster 3/2.

An interesting observation wasthat cluster 1/3 wasthe opposite of 3/3.It had a declining high TFR which contributed to high rate of natural increase, infant mortality rate, child and total dependency ratios and lowest (negative z-score) median age and percentages above 60 plus compared to other clusters. In this cluster, membership decreased by two countries as Cameron and Malawi movedinto cluster 2/3resulting inthe number of countries increasingfrom 24 to 26. Cluster 2/3 wascharacterisedbyslightly negative / or near zero scores, which causes all the other demographic variables to be slightly negative near zero.Two more countries, Malawi and Cameroon joined cluster 2/3 from analysis 2 (2010-2015), and its member countries increased from 24 to 26.

In summary, it is projected that from 2025-2030 countries in cluster 3/3 will be on their way to complete the demographic revolution with at or near replacement fertility level and maturing of the population age structure. Countries in the cluster 2/3 will be passing into the middle fertility transition.Lastly, countries in cluster 1/3 would be in the early stages of fertility decline and still experiencing high fertility.

Looking at the F-value in cluster Analysis 1(1995-2000) in Table 3, the most important variables contributing to the spatial clustering regarding demographic variables contributing to population ageing of the African region were medianage (103.12), child dependency ratio (89.62), (TFR, 85.03), total dependency ratio (71.77), rate of natural increase (40.38), infant mortality rate (39.61) and percentage aged 60 years and over (28.14). All the variables made a significant contribution to the spatial clustering with regards to demographic indicators of the countries except forthe percentage of the population aged 60 plus which contributed the least (28.14) because during this period the majority of countries had young population age structures.

According to F values inCluster Analysis 2(2000-2015),it can be observed that infant mortality contributed the least (23.09) as compared to the other determinants and demographicindicators of population ageing in Africa.However, the percentage aged 60 plusalmost doubled between Analysis 1, (1995-2000) to Analysis 2, (2010-2015)thus showing the rapid changing of population ageing.According to F-values in Analysis 3 (2025-2030), indicate a slight change in the variables which contributed to geographicalspatial clustering for the period 2010-2015 and 2025-2030. However, a significant difference is noted in the F-values for the above mentioned periods for total dependency ratio (104.06 and 58.74) andthe rate of natural increase (46.69 and 82.52) respectively.

This implies that the rate of transition in Africa is not the same. For instance,the rate of natural increase and the total dependency ratio almost doubles from cluster analysis 2 and 3. Therefore, the countries in Cluster 3/3 analysis (2025-2030), were in the last stages of the demographic revolution(ageing) characterised by very high median age and percentage above 60 plus and a concomitantly low TFR (near/at replacement rate Table 2, Figure 1 and Table 1 with indicators), very low rate of natural increase, low child and total dependency ratios, and infant mortality rates. In analysis 3, Cluster analysis 2/3 (2025-2030)was characterised by countries with a young population age structure and a preponderance towards ageing. Lastly, cluster 1/3 shows 15 countries that are clearly lagging in their demographic profiles and ageing, with very young population age structures and very small percentages of elderly.

Discussion and conclusion

The findings from this study suggest that determinants and indicators ofageing in Africa can be divided into three clusters for each analysis period:1995-2000, 2010-2015 and 2025-2030. The number of countries in the first cluster decreased (early phase of fertilitytransition), as thenumberof countries in the second cluster increased (middle phase fertility transition) from 1995-2000 to2010-2015, respectively. The last and smallest cluster 3 (last phase of transition) stays relatively the same number of countriesinthe periods under study.Majority of countries were stagnated in the middlecluster and failed to move to cluster three.The fertility and mortality in African countries decline at different intensities creating different ageing profiles and show regional variation. This is in line with other studies in Africa (Pillay and Maharaj 2013, Bloom, Mitgang and Osher, 2016, Nabalamba and Chikoko 2011).However, middle-income countries of North Africa and Sothern Africa (in cluster 3) are ahead in the demographic revolution, and least developed countries of Sub Saharan Africa are trailing behind. This suggests that in a way, regional and socioeconomic development is related to the demographic revolution.

In Africa (2010-2015) there are about three distinct clusters of determinants and profiles of population ageing based on the demographic revolution theory. The first group with about 35% of countries had a predominance of young children, low median ages, high TFR, IMR, total dependency ratios

and percentages above 60 and over. This group of countries just entered the second stage of the demographic revolutioncharacterised by the early stage of fertility decline and rapid population growth. There made upabout 60%; 35% and 31% of total countries in 1995-2000, 2010-2015 and 2025-2030 respectively, which meanta significant number of countries experienced further fertility and mortalitydecline and moved out into the second cluster in 2010-2015 and 2020-2030. Also, fertility and mortality decline was accompanied by a concomitant upward age structural change increase. This is typical and consistent of the demographic revolution as postulated by demographic transition theory(Notestein 1945, Dyson 2013)

As expected, the second cluster's share of countries grew significantly from 29%; 50% and 54% from the periods under discussion respectively. This is consistent with Notestein's (1945; 1953) formulation that countries reduce mortality and fertility as they develop.

Lastly, the third cluster's share of countries remained stagnant at about 7% for the respective periods. Only Botswana moved from cluster 2(1995-2000) to cluster 3 in (2010-2015).The presence of Botswana and South Africa in this cluster and absence of Sudan is not consistent with other studies revealing North African countries as a homogeneous group and distinctly different from sub-Saharan Africa(Yüceşahin and Tulga 2017, Ferreira and Kowal 2006, Velkoff and Kowal 2006, Nair 2014). Lack of movement by all countries in the second cluster to the third cluster might be related to fertility stalling ina significant number of sub-Saharan Africa countries (Garenne 2013, Goujon, Lutz and Samir, 2015, Bongaarts 2006). Although the causes of fertility stalling are beyond the scope of this paper, and we recommend further investigation with appropriate demographic techniques.However, plausible causes of fertility stalling have included impact of HIV/AIDS through increased child mortality, lower priority assigned to family planning as funds were directed to HIV/AIDS pandemic and slower trends socioeconomic development(Goujon, Lutz & Samir, 2015, Garenne 2013, Bongaarts 2006, Lutz et al., 2015)

Cluster 3 (North Africaregion, South Africa and Botswana), are characterisedby countries with predominant young adults and elderly populations are already in need of efficient policies that cover the needs of current elderly and an emerging predominant elderly population by 2030. However currently, there is a need to reap the benefits of the demographic dividend and at the same time, take care of the elderly. In contrast to the European experience, the North African countries' failure to meet the needs and expectations of an ever-growing young adult population in terms of employment, housing, and health (Groth and May 2017). Consequently, around 2010, North African countries experienced revolts and social upheavals commonly referred as the ''*Arab springs/Awakening*'' in academic literature and the popular mass and social media(Yüceşahin and Tulga 2017, Groth and May 2017)

In 2010-2015most Africancountries were in the second cluster (middle stage of the demographic revolution), although the majority of countries has experienced fertility stalling, the risk of population ageing is very real considering the tempo and magnitude of population ageing in Africa (Pillay and Maharaj 2013). The countries are likely to be simultaneously faced with the twin burden of a youthful and ageing population at the same time.Most sub-Saharan countries (in cluster 2 and 3) have faced increased mortality due to the HIV and AIDS pandemic. Age-specific mortality patterns of HIV and AIDS kill more young adults than the elderly. This age-specific mortality pattern initially makes the population to appear aged (Pillay and Maharaj 2013).It means developing countries affected by HIV and AIDS mightface a double burden of infectious diseases and non-communicable diseases simultaneously. Developed countries never experienced such a double burden. However, sharing regional knowledge and experiences can enable and enhance governments' preparedness to take care of the increased number of orphans and the elderly.

Moreover, 85% of countries which are in clusters 1 and 2 (early and middle stages of fertility decline) are still experiencing population growth, and high mortality from infectious diseases (Omran 2005). Interestingly, the United Nations (2012) Report on Population Ageing and non–communicable diseases using non-communicable standardised deaths rates has highlighted that non-communicable diseases deaths are now higher in Africa than in developed countries. Non-communicable diseases are chronic and expensive for developingcountries. This means developing countries in the early stages might face a double burden of diseases: non-communicable and communicable,simultaneously. The situation will be exacerbated by population ageing.

Countries in cluster 1 and 2 have higher mortality and fertility rates than countries in cluster 3. High mortality rates especially infant mortality rates, are related to high TFR through child replacement and hoarding (Pavlík, 1980). Infant mortality decline to lower levels should theoretically lead to fertility decline in the least developed countries.

Bongaarts (2014) though, has argued that even in the least developed countries, women might not necessarily want a high number of children but lack

access to family planning. Women have a high unmet need for contraceptives. Family planning programmes have also been noted to create demand for contraception through diffusion-innovation and adoption of contraceptive behaviours even in poor countries and drive fertility down (Cleland and Wilson 1987, Cleland 2001, Bongaarts 2014). Maybe there is mutual interaction of fertility determinants. It might befeasible that ageing in cluster I will happen at low socioeconomic development levels.

In conclusion, given that fertility has a strong effect on population ageing andmost of the countries are experiencing fertility stalling, we recommend that countries should invest more on determinants of fertility stalling/decline including access to family planning, women empowerment,andsocio-economicdevelopment to achieve further fertility decline to replacement level. Moreover, since the demographic window of opportunity is short countries need to prepare to avoid demographic disaster.Therefore, countries within a classification can share knowledge and experiences to meet the human development needs of the elderly. However, further research is needed to look at intra country and gender differentials of population ageing and their policy implications.

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