Worldwide decline in the oldest old support ratio

F.R. Herrmann a,*, J.-P. Michel a, J.-M. Robinea,b

a Department of Rehabilitation and Geriatrics, Geneva University Hospitals and University of Geneva, 3, ch. Pont-Bochet, 1226 Thonex, Geneva, Switzerland
b CRLC, Inserm démographie et santé, 34298 Montpellier, France

ARTICLE INFO
Article history:
Received 3 November 2009
Accepted 23 January 2010
Available online 24 February 2010

Keywords:
Aged
Caregivers
Forecasting
Health services for the aged
Organization & administration
Trends

ABSTRACT

Purpose. – Increase in life expectancy will lead to a rapid expansion in the number of oldest old, of which a substantial proportion presents geriatric conditions or disability. Our aim is to globally forecast the potential availability of informal care resources using a new metric, and to assess whether it constitutes a new piece of information, not conveyed by existing indicators.

Materials and methods. – The UN population database allows the recently introduced oldest old support ratio, defined as the number of people aged 50–74 for each person aged ≥ 85, to be computed every five year from 1950 to 2050 for 192 countries. A multiple linear regression model is used to determine to which extent basic demographic indicators contribute to predict the value of the oldest old support ratio.

Results. – Worldwide, the oldest old support ratio decreased from 75.7 people aged 50–74 potentially available to care for each person aged ≥ 85 in 1950, to 32.0 in 2005 and 12.5 in 2050.

Discussion and conclusion. – Altogether 11 usual demographic indicators account for only 65% of its variance in 2005, leaving 35% unexplained. This suggests that the age structure of elderly groups, between youngest and oldest old, is independent to some degree from the other population features. Including the oldest old support ratio among the range of basic population indicators conveys additional information which illustrates the dramatic decline in informal care resources available to the oldest old. This inclusion should help the development of appropriate long-term care policies.

© 2010 Elsevier Masson SAS and European Union Geriatric Medicine Society. All rights reserved.

1. Introduction

The relationships between population ageing and national wealth are complex [1]. Economic population studies seldom consider the plurality of ages above age 65 but increase in life expectancy [2,3] leads to a rapid expansion in the number of oldest old, [4,5] of which a substantial proportion present geriatric conditions or disability [6] or poor vision [7], cognitive impairment and dementia [8], osteoporosis and fractures [9,10] and frailty [11]. No country can escape these changes [12]. Indeed, previous studies have suggested that the number of elderly people who need daily care will increase more in developing countries such as China and India than in established market economies [13].

Even if we could assume that frailty and disability might become preventable [14,15], providing long-term care (LTC) will remain the main response of societies for the coming decades, generating an LTC demand that is expected to outpace the supply of formal institutional care [16,17]. Increasing the use of assistive technology may partially help [18]. Developing home and community-based services may reduce institutional spending and entail long-term cost savings [19] but will not solve the scarcity of direct care workers. Beyond the complexity of the motivation of the migrant health workers, consumers and the many stakeholders [20], migration of qualified health staff, as well as low skilled workers, from lower to higher income countries does not appear to be a sustainable solution, neither worldwide nor at country level [21–26].

Turning to low-skilled workers is associated with a high turnover and discontinuity of care [27–32] and sometimes with illegal migration [33]. A large share of the burden of LTC for the oldest old rests on their spouse and children or other non-professional caregivers [34,35] with a possible risk of abuse [36,37].

Conventional studies of population ageing implicitly refer to a three age group population model – young people, those of working age, and elderly people. In this study we forecast the oldest old support ratio until 2050 for 192 countries worldwide. This recently proposed ratio [38] provides information on the number of people potentially available to care for each person aged ≥ 85. It is defined as the ratio of people aged 50–74 to those aged ≥ 85, with the sexes combined. Relating the oldest people to the youngest elderly provides an indicator enabling the future challenges of LTC to be quantified and understood. This ratio encapsulates in one statistic the challenge of caring for the oldest old.

* Corresponding author. Tel.: +41 22 305 6681; fax: +41 22 305 6115.
E-mail address: francois.herrmann@hcuge.ch (F.R. Herrmann).

doi:10.1016/j.eurger.2010.01.003

© 2019 Elsevier Masson SAS. Tous droits réservés - Document téléchargé le 02/02/2019 II est interdit et illégal de diffuser ce document.
2. Methods

In this demographic study, we analyse the long-term trends of the oldest old support ratio throughout the world, using the United Nations (UN) Population Database [39]. We also assess whether this indicator constitutes a new piece of information, not conveyed by existing demographic indicators, such as percent of population aged \( \geq 65 \) or life expectancy at birth, by analysing the correlations with the basic population indicators gathered for each country circa 2005 by the Population Reference Bureau (PRB) [40].

2.1. Data source

The UN population database allows the oldest old support ratio to be computed every five years from 1950 to 2050 [39]. Chronological series start in 1950 for 146 countries, which have population data for those above age 85 from the beginning. From 2000 on the oldest old support ratio may be computed for 172 countries, and by 2045 for all the 192 UN countries.

2.2. Definition

The oldest old support ratio is defined as the number of people aged 50–74 divided by the number of people aged \( \geq 85 \).

2.3. Statistical analysis

Poisson 95% confidence intervals were computed for the oldest old support ratio. To assess whether the oldest old support ratio provides a new piece of useful information, we compared it with 11 basic demographic variables, dimensionless according to population size because expressed as a rate or percentage, chosen among the macro indicators provided by the PRB 2006 world data sheet [40]. They are: Crude Birth Rate (CBR), Crude Death Rate (CDR), Rate of Natural Increase, Projected Population Change 2005–2050 in %, Infant Mortality Rate (IMR), Total Fertility Rate (TFR), Percent of Population of Age < 15, Percent of Population of Age \( \geq 65 \), Total Life Expectancy at Birth (LE), Male Life Expectancy at Birth, Female Life Expectancy at Birth. These PRB variables can be obtained for 189 UN countries for 2005, the year for which the oldest old support ratio can be computed for 174 countries. The strength of the associations was assessed by Pearson correlation coefficients (\( R \)). The proportion of the variance of each indicator observed among the countries, accounted for by each of the other indicators, was estimated by the coefficient of determination (\( R^2 \)). For each indicator, the maximum \( R^2 \) indicates the magnitude of the relation with the strongest associated indicator and the mean \( R^2 \) summarizes the level of correlation with all indicators. A multiple linear regression model was used to determine which of these 11 indicators (full model) contribute to predict the value of the oldest old support ratio and which part of the variance they account for (adjusted \( R^2 \), leading to a reduced model including only the indicators significantly associated with the oldest old support ratio using a stepwise backward procedure. Analyses were performed using Stata, release 10.1 (Stata Corporation, College Station, Texas, USA.) and \( P \) values below 0.05 were considered as statistically significant.

3. Results

3.1. Worldwide decline

At the global level, the oldest old support ratio decreased from 75.7 people aged 50–74 potentially available to care for each person aged \( \geq 85 \) in 1950, to 32.0 people in 2005, and is projected to reach 12.5 in 2050. At the national level, the lowest observed value decreased from 24.0 people aged 50–74 potentially available in Iceland in 1950 to 11.8 people in Sweden in 2005. By 2050, 122 countries are expected to fall below the 1950 Icelandic value, illustrating the emergence of the oldest old throughout the world as a significant part of the population. Fifty-eight countries could potentially fall below a ratio of 10, so that in these countries the numbers of oldest old would reach 10% of the size of the next youngest generation, aged from 50 to 74 years, who form their usual support group. Seventeen countries could fall below the ratio of 5, with Japan (as one of the first nations experiencing increased longevity) reaching the lowest ratio of 3.1 by 2050. Countries at the other extreme include Afghanistan, with a ratio of 801.0 people aged 50–74 potentially available to care for each person aged \( \geq 85 \) in 1950, Sierra Leone with a ratio of 292.5 people in 2005, and Niger with a projected 137.2 ratio in 2050. Countries which are not expected to reach the 1950 Icelandic ratio value of 24 by 2050 include the least developed countries of Africa and Asia as well as several Middle Eastern countries.

Table 1 presents the 10 countries with the smallest and largest oldest old support ratios in 2005, showing the contrast between aged Europe and young Africa. Fig. 1 displays trends by continents, observed from 1950 to 2005 and forecasted until 2050. Africa apart, all continents converge to values below 15.0. Fig. 2 details these trends for the 12 most populous countries in 2005, showing that by 2050, five of the largest countries will exhibit an oldest old support ratio well above the world average, with a value of 65.1 in Nigeria, 38.0 in Bangladesh, 29.7 in Pakistan, 24.8 in Indonesia and 19.0 in India. Fig. 3 shows world maps displaying ratio details at country level in 1950, 2000 and 2050. The colour key on a logarithmic scale allows changes in the oldest old support ratio to be appreciated throughout the world over a century of population growth.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sweden</td>
<td>9.1</td>
<td>2533</td>
<td>215</td>
<td>11.78</td>
<td>11.77–11.80</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Norway</td>
<td>4.7</td>
<td>1165</td>
<td>98</td>
<td>11.89</td>
<td>11.87–11.91</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Martinique (F)</td>
<td>0.4</td>
<td>88</td>
<td>7</td>
<td>12.57</td>
<td>12.49–12.65</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>United Kingdom</td>
<td>60.5</td>
<td>15681</td>
<td>1212</td>
<td>12.94</td>
<td>12.93–12.94</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Switzerland</td>
<td>7.5</td>
<td>1996</td>
<td>152</td>
<td>13.13</td>
<td>13.11–13.15</td>
<td></td>
</tr>
<tr>
<td>170</td>
<td>Gambia</td>
<td>1.5</td>
<td>169</td>
<td>1</td>
<td>169.00</td>
<td>[168.20–169.81]</td>
<td></td>
</tr>
<tr>
<td>171</td>
<td>Afghanistan</td>
<td>1.1</td>
<td>2568</td>
<td>14</td>
<td>183.43</td>
<td>[183.20–183.65]</td>
<td></td>
</tr>
<tr>
<td>172</td>
<td>Kuwait</td>
<td>2.7</td>
<td>224</td>
<td>1</td>
<td>224.00</td>
<td>[223.07–224.93]</td>
<td></td>
</tr>
<tr>
<td>173</td>
<td>Niger</td>
<td>4.4</td>
<td>974</td>
<td>4</td>
<td>243.50</td>
<td>[243.02–243.98]</td>
<td></td>
</tr>
<tr>
<td>174</td>
<td>Sierra Leone</td>
<td>5.7</td>
<td>585</td>
<td>2</td>
<td>292.50</td>
<td>[291.75–293.25]</td>
<td></td>
</tr>
</tbody>
</table>
3.2. Variance explained

The oldest old support ratio and 11 other basic demographic indicators can be correlated with each other, as shown in the Pearson correlation (R) matrix (Table 2) with all two-tailed P values below 0.001. Among the 11 other indicators, only the Crude Death Rate (CDR) and the “Rate of Natural Increase” are not significantly correlated (P = 0.180), though the correlation between the CDR and the “% Population of Age 65+” is marginally significant (P = 0.0496). The CDR is distinct from the other

Fig. 1. Trends of the oldest old support ratio by continents observed from 1950 to 2005 and forecasted until 2050, using population estimates from the UN 2004 World Population Prospects [39].

Fig. 2. Trends of the oldest old support ratio for the 12 most populous countries in 2005 observed from 1950 to 2005 and forecasted until 2050, using population estimates from the UN 2004 World Population Prospects [39].
indicators since a high number of deaths can result from two opposite situations: a low mortality level in an old population or a high mortality level in a young population. This indicator apart, the oldest old support ratio is the indicator the least correlated with any of the others, as shown by the mean and the maximum R² values (Table 3). The strongest R² for the oldest old support ratio, which occurs with infant mortality (IMR), reaches the comparatively low value of 0.56, while the strongest correlations for the other indicators are all above 0.80 and exceed 0.95 for six of them. Multiple linear regression shows that only IMR (regression coefficient ($\beta$) = 0.656, $p < 0.001$), fertility (TFR) ($\beta$ = 24.821, $p = 0.023$), “Percent of Population of Age < 15” ($\beta$ = −5.214, $p < 0.001$) and “Percent of Population of Age ≥ 65” ($\beta$ = −7.955, $p < 0.001$) out of the 11 basic demographic indicators contained in the PRB datasheet are significantly associated with the oldest old support ratio. The full model, as well as a reduced model comparing only the four significant demographic indicators, accounts for 65% of the variance in the oldest old support ratio, leaving 35% unaccounted for.

4. Discussion

The worldwide decline in the oldest old support ratio, observed from 1950 to 2005 and projected for the coming four decades, is striking. By 2050, Africa as a whole should reach the level attained by North America in 1950. Less than 50 people aged 50–74 are likely to be potentially available in Africa in 2050 to care for each person aged ≥ 85, three times fewer than one century earlier. The convergence among the other continents is spectacular. By 2050 values are expected to range from 14.1 in Asia to 6.0 in Europe.

Out of the set of basic demographic indicators contained in the PRB datasheet, only IMR, TFR, and age structure indicators (i.e. % Population < 15 or ≥ 65) contribute to predicting the oldest old support ratio. High IMR, high TFR and a large percentage of population below 15 are three features of the young populations in the least developed countries where the oldest old are comparatively few, leading to a high oldest old support ratio even if the number of people aged 50–74 is not so large. On the other hand, low IMR and a large percentage of population above 65 are two
characteristics of the populations of the most developed countries where the oldest old are relatively numerous, leading to a low oldest old support ratio even if the number of people aged 50–74 is large. The role of fertility is obviously more complex, as a relatively high TFR is observed today in some of the most developed countries. Altogether, these basic indicators of the population age structure, or strongly associated ones (IMR and TFR), account for only 65% of the variance of the oldest old support ratio observed throughout the world in 2005, leaving 35% unexplained. This suggests that the age structure of elderly groups, between youngest (50–74) and oldest old (> 85), is independent to some degree from the whole population age structure considered as three age groups, the young, the middle aged and the old people. Whereas societies in most developed countries expect to encounter difficulties in coping with the increasing number of oldest old, a large proportion of this group currently receiving LTC due to loss of physical and/or cognitive autonomy [35,38], the convergence of developing countries towards the same low values in oldest old support ratio implies dramatic economic adjustments. Developing countries today have relatively low retirement ages today by the presence of an oldest old parent but this situation will may quickly outpace the supply [19,38,42,45,46]. Social norms may change over time and differ across societies as well as allocation of time between paid work, care for grandchildren so that their children, particularly daughters, can fully participate in the labour force. Thirdly, they will have to provide informal care to their ageing parents. Choice between formal and informal LTC for the oldest old is not only a question of simple alternative since in most developing countries care in collective or institutional housing is not yet socially accepted.

Children are not the sole caregivers. Spouses provide an essential part of LTC as long as they remain able to provide such help and this part could even increase in the coming years as the likely rise in divorce rates will be more than counterbalanced by the strong decline in widowhood brought by the fall of old age mortality [42]. The need for LTC depends more on the individual functional level than strictly on the individual age. The level of old age disability may decline in the future although an OECD study has demonstrated that the old age disability decline observed in the United States [43] may be less universal than expected in other OECD countries [44]. Growth in wealth combined with increased aspiration for independence may lead to greater than before purchase of supportive devices, favoured by technical advances. Social norms may change over time and differ across societies as well as allocation of time between paid work, care for grandchildren so that their children, particularly daughters, can fully participate in the labour force. Thirdly, they will have to provide informal care to their ageing parents. Choice between formal and informal LTC for the oldest old is not only a question of simple alternative since in most developing countries care in collective or institutional housing is not yet socially accepted.

Table 2
Pearson correlation (R) matrix of the oldest old support ratio (OOSR) with a set of basic demographic indicators, circa 2005, N = 174 countries. All two-sided P values in the column OOSR are below 0.001.

<table>
<thead>
<tr>
<th>OOSR</th>
<th>v6</th>
<th>v7</th>
<th>v8</th>
<th>v11</th>
<th>v12</th>
<th>v13</th>
<th>v14</th>
<th>v15</th>
<th>v16</th>
<th>v17</th>
<th>v18</th>
</tr>
</thead>
<tbody>
<tr>
<td>v6</td>
<td>0.50</td>
<td>0.18</td>
<td>0.37</td>
<td>0.39</td>
<td>0.56</td>
<td>0.50</td>
<td>0.42</td>
<td>0.40</td>
<td>0.43</td>
<td>0.41</td>
<td>0.44</td>
</tr>
<tr>
<td>v7</td>
<td>0.50</td>
<td>0.27</td>
<td>0.81</td>
<td>0.77</td>
<td>0.82</td>
<td>0.98</td>
<td>0.92</td>
<td>0.63</td>
<td>0.70</td>
<td>0.67</td>
<td>0.72</td>
</tr>
<tr>
<td>v8</td>
<td>0.37</td>
<td>0.81</td>
<td>0.01</td>
<td>0.10</td>
<td>0.46</td>
<td>0.30</td>
<td>0.16</td>
<td>0.02</td>
<td>0.68</td>
<td>0.70</td>
<td>0.65</td>
</tr>
<tr>
<td>v11</td>
<td>0.39</td>
<td>0.77</td>
<td>0.10</td>
<td>0.74</td>
<td>0.55</td>
<td>0.82</td>
<td>0.67</td>
<td>0.44</td>
<td>0.38</td>
<td>0.35</td>
<td>0.40</td>
</tr>
<tr>
<td>v12</td>
<td>0.56</td>
<td>0.82</td>
<td>0.46</td>
<td>0.51</td>
<td>0.55</td>
<td>0.51</td>
<td>0.81</td>
<td>0.70</td>
<td>0.45</td>
<td>0.79</td>
<td>0.78</td>
</tr>
<tr>
<td>v13</td>
<td>0.50</td>
<td>0.98</td>
<td>0.30</td>
<td>0.77</td>
<td>0.82</td>
<td>0.81</td>
<td>0.86</td>
<td>0.54</td>
<td>0.68</td>
<td>0.65</td>
<td>0.70</td>
</tr>
<tr>
<td>v14</td>
<td>0.42</td>
<td>0.92</td>
<td>0.16</td>
<td>0.84</td>
<td>0.67</td>
<td>0.70</td>
<td>0.86</td>
<td>0.79</td>
<td>0.65</td>
<td>0.61</td>
<td>0.67</td>
</tr>
<tr>
<td>v15</td>
<td>0.40</td>
<td>0.63</td>
<td>0.02</td>
<td>0.73</td>
<td>0.44</td>
<td>0.45</td>
<td>0.54</td>
<td>0.79</td>
<td>0.43</td>
<td>0.39</td>
<td>0.45</td>
</tr>
<tr>
<td>v16</td>
<td>0.43</td>
<td>0.70</td>
<td>0.68</td>
<td>0.31</td>
<td>0.38</td>
<td>0.79</td>
<td>0.68</td>
<td>0.65</td>
<td>0.43</td>
<td>0.99</td>
<td>0.99</td>
</tr>
<tr>
<td>v17</td>
<td>0.41</td>
<td>0.67</td>
<td>0.70</td>
<td>0.28</td>
<td>0.35</td>
<td>0.78</td>
<td>0.65</td>
<td>0.61</td>
<td>0.39</td>
<td>0.99</td>
<td>0.97</td>
</tr>
<tr>
<td>v18</td>
<td>0.44</td>
<td>0.72</td>
<td>0.65</td>
<td>0.34</td>
<td>0.40</td>
<td>0.80</td>
<td>0.70</td>
<td>0.67</td>
<td>0.45</td>
<td>0.99</td>
<td>0.97</td>
</tr>
<tr>
<td>Mean R²</td>
<td>0.42</td>
<td>0.71</td>
<td>0.32</td>
<td>0.52</td>
<td>0.51</td>
<td>0.66</td>
<td>0.69</td>
<td>0.66</td>
<td>0.48</td>
<td>0.64</td>
<td>0.62</td>
</tr>
<tr>
<td>Max R²</td>
<td>0.56</td>
<td>0.98</td>
<td>0.70</td>
<td>0.84</td>
<td>0.82</td>
<td>0.82</td>
<td>0.98</td>
<td>0.82</td>
<td>0.79</td>
<td>0.99</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Table 3
Coefficient of determination (R²) matrix of the oldest old support ratio (OOSR) with a set of basic demographic indicators, circa 2005, N = 174 countries.

| OOSR | v6 | v7 | v8 | v11 v12 v13 v14 v15 v16 v17 v18 |
|------|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| v6   | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v7   | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v8   | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v11  | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v12  | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v13  | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v14  | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v15  | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v16  | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v17  | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |
| v18  | 0.41 | 0.66 | 0.77 | 0.39 | 0.32 | 0.59 | 0.42 | 0.40 | 0.43 | 0.41 | 0.44 |

F.R. Herrmann et al. / European Geriatric Medicine 1 (2010) 3–8
policies regarding the needs and welfare of the oldest old and their caregivers should urgently be developed and implemented by all governments and international agencies. It is one of the challenges of improving the quality of a longer life [47].

Down the road, is the oldest old support ratio truly a valid measure of the gap in informal care resources at the population level? Future studies, possibly limited to OECD countries where more macro data are available, should show precisely how the oldest old support ratio evolves with more detailed measures of informal and formal care use. Several refinements could be considered such as taking into account genders on both sides of the ratio. In the meantime, taking into account the ease of its calculation and the wide availability of necessary data, it is worth using it to heighten the awareness of the global emergence of the oldest old [48] before the economic and personal costs of inaction become too important [49].

Conflict of interest statement

All authors declare that they all participated in the writing of the manuscript and that they have seen and approved the final version. They declare that they have no competing interest. FRH and JMR took care of the data preparation and analysis. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication. No need for ethical approval as this study is based on publicly available data. No funding source.

References