E-ISSN:2583-0074

Research Article

Old-age Dependency Ratio

Social Science Journal for Advanced Research

2026 Volume 6 Number 3 May

Publisher

Singh Publication

www.singhpublication.com

Old-Age Dependency Transition in Major World Economies: Ageing Burden, Economic Implications, and Lessons for India's Emerging Silver Economy

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DOI:10.54741/SSJAR/6.3.2026.356

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The old-age dependency ratio — defined as the number of people aged 65 and over per 100 people of working age (15-64) — is the most rapidly intensifying demographic pressure in the 21st century. This study presents a comprehensive comparative analysis of OADR trends between eleven of the world's most populous countries from 1950 to 2023 to be able to identify the speed and magnitude, pattern, and fiscal burden of population ageing. Japan's OADR increased from 8 in 1950 to 50 in 2023, a 525% increase and the most extreme ageing burden. China's OADR increased three times from 7 in 1970 to 21 in 2023, bringing significant pressure on its pension system. India's OADR increased slightly from 5 in 1950 to 10 in 2023, indicating a very favourable but rapidly narrowing window before rapid ageing. Nigeria and Ethiopia are the Sub-Saharan African countries with OADRs under 6, indicative of young population pyramids. Applying descriptive statistics, CAGR analysis, and regression modelling, this paper classifies ageing profiles across major economies and extracts policy implications for India's emerging challenge of demographic ageing.

Keywords: old-age dependency ratio, population ageing, silver economy, pension sustainability, demographic dividend, india elderly policy, ageing nations

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How to Cite this Article

Ankalam B, Srinivas KVR, Old-Age Dependency Transition in Major World Economies: Ageing Burden, Economic Implications, and Lessons for India's Emerging Silver Economy. Soc Sci J Adv Res. 2026;6(3):64-70.

Available From https://ssjar.singhpublication.com/index.php/ojs/article/view/356

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Manuscript Received	Review Round 1	Review Round 2	Review Round 3	Accepted
2026-04-11	2026-04-27			2026-05-16

Conflict of Interest	Funding	Ethical Approval	Plagiarism X-checker	Note
None	Nil	Yes	4.46	

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1. Introduction

Populations aged 60 years and above are projected to number 194 million by 2031 and 320 million by 2050: Elderly in India 2021 report, MoSPI, India The 60+ population in India is forecast to reach 194 million by 2031 and 320 million by 2050, as per India's Ministry of Statistics and Programme Implementation (MoSPI) one in the series of reports on Inequality in India - Ageing report N°15. The National Programme for Health Care of the Elderly (NPHCE), under the Government of India, recognises the need to prepare the existing health infrastructure to cater to the expanding elderly population, but it is still largely inadequately prepared to address this demographic transition. India's age dependency ratio of elderly (65+) is about 10 per 100 working-age people, one of the lowest globally, but it is climbing at an accelerating rate, and is highlighted in Economic Survey 2019–20. About 103.9 million aged people were enumerated by the 2011 Census of India (8.6% of population), while the Fertility declines and life expectancy at birth increases (67.9 years for males and 70.7 years for females) as demonstrated by the data of NFHS-5 (2019–21), which eventually is leading to the population ageing in India. The challenge becomes more pronounced when viewed in comparative context. Japan has suffered severe fiscal strain from an Old-Age Dependency Ratio (OADR) of 50 (2023): social security outlays account for more than 24% of Japan's national budget and pension obligations are over 220% of GDP. China's substantial increase in OADR from 12 (2010) to 21 (2023) — a rise of 75% in thirteen years — is a clear illustration of how quickly demographic configurations can change when fertility suppression policies are in place along with increasing longevity. Russia's post-communist transition period saw the increase of its OADR to 25 (2023), and Brazil's OADR has risen from 8 (1990) to 15 (2023), showing successful health transitions. For India, following these trajectories is not just an academic exercise – it's a critical policy priority. This study utilizes panel data for 11 major economies to equip India with evidence-based projections and actionable policy frameworks to manage the impending transition to the silver economy.

2. Background of the Study

Population ageing, defined as the gradual increase in the proportion of older individuals in a population is the dominant global demographic trend of the late 20th and 21st centuries, albeit with varying speed and fiscal implications. The OADR is formally defined as: OADR = (Population 65+) / (Population 15–64) × 100. When OADR goes above 20, a country is considered to be advanced ageing, and when it goes above 35, a country should be considered as aged at a very high level or "hyper-ageing". Japan (OADR 50) is an exceptional case of hyper-ageing, while China (21) and Russia (25) are moving into advanced ageing. India remains in the early ageing stage (OADR 10), making for a significant strategic opportunity. The OADR and economic production growth dynamic has emerged as one of the defining macro-economic problems of the 21st century as the working-age population is increasingly called upon to support not only the consumption needs of the old but also the investment requirements to sustain growth.

3. Importance of Studying Old-Age Dependency Trends with Reference to India

India's demographic dividend is expected to transition into a demographic ageing challenge problem. The NITI Aayog's India@2047 report also concedes that India's elderly population will come close to 250 million by 2047 — a transformation is needed in healthcare systems, pension architecture and social protection regimes. A comparative study of the OADR trajectories of countries, lessons from countries such as Japan and China and Brazil offers India anticipatory insights to mitigate the fiscal and societal impact of swiftly increasing old-age dependency. Initial policy adjustments – if taken early (on the basis of international experience) – can bring down the ling-time fiscal cost by as much as 30–40%, as found in Nordic pension reform literature.

4. Review of Literature

Ogawa and Matsukura (2005) pointed out that social security systems Geared toward an OADR below 20 become destabilized when the OADR rises above 35, underscoring the fiscal risk facing rapidly ageing economies such as that of China.

Bongaarts (2004) showed that the pace at which fertility decline in developing countries promotes the pace of transitions in the OADR far exceeds the rate at which these transitions have occurred in Europe in the past, suggesting that countries such as India and China are witnessing highly compressed demographic timelines. Bloom, Canning, and Fink (2010) estimated that a 10 percentage point increase in the old-age dependency ratio decreases GDP growth by approximately 1.2 percentage points per year, a consequence of diminished saving, increased consumption, and declining capital formation in ageing economies. Drèze and Sen (2013): 39 also noted that India's elderly social protection continues to be weak, further highlighting the inadequacy of its public assistance schemes in reaching the burgeoning ranks of old people, presaging gaps of considerable policy proportion. Ito and Hoshi (2020) predicted that countries with sustained high OADR could potentially experience TFP declines of 0.3–0.8 percent per year without a set of policies incentivizing elderly labour force participation. Rajan and Mishra (2019), for example, documented notable interstate differentials in India's OADR, with the likes of Kerala nearing the aging profiles of developed areas, while Bihar retaining the regnant youthful ones, what this study emphasizes is the need for policy interventions tailored to each state.

5. Statement of the Problem

Although India's OADR is seen as one of the lowest among major nations at present, there is an acceleration in its path: increasing from 5 (in 1950) to 10 (in 2023), and it is projected to reach 20 by 2050. The policy community does not have a systematic international comparative framework from which to learn from countries that have already gone through high OADR transitions. This study bridges that evidence gap offering India focused comparative insights based on the experiences of eleven major economies.

6. Need for the Study

India's pension, healthcare, and eldercare systems were built around the needs of a young-population demographic. With the pace of OADR increasing, this misalignment between policy architecture and demographic reality will become even more pronounced. Lessons — from Japan, China, Russia, and Brazil, advanced OADR transitioning nations - offer a pathway for policy change. Understanding the pace, drivers, and implications of OADR growth in comparable major economies is key for India to take a leading rather than lagging role.

7. Objectives of the Study

1. To analyse and contrast the transitions in the old-age dependency ratio among the top eleven most populous nations from 1950 to 2023, describing the speed, shape and structural determinants of population ageing in a range of developmental contexts.
2. To analyze the fiscal and macroeconomic consequences of increasing old-age dependency ratios and draw evidence-based policy advice for India to manage its emerging demographic ageing transition by 2050 proactively.

8. Research Methodology and Statistical Tools

This research makes use of a quantitative, probabilistic panel design with data from six rounds of the National Family Health Survey of India (NFHS) and other sources including the Government of India, available at UN Population Division World Population Prospects 2024. The data contains OADR at 11 major economies from 1950 to 2023.

Statistical Tools Applied:

Descriptive Statistics: The average old-age dependency ratio (OADR) among the countries sampled in 2023: $\mu=17.5$, standard deviation $\sigma=14.8$, indicating a high level of cross-national variability. The OADR in Japan (50) lies 3.4 standard deviations above the mean.

OADR CAGR: Calculate as: CAGR = [(OADR_end / OADR_beginning)^(1/n)] – 1. China's 1990–2023 OADR CAGR: [(21/8)^(1/33)] – 1 = +2.9% per annum – the fastest rate of ageing among the largest economies.

Ageing Velocity Index (AVI): This is defined as absolute OADR increase every 10 years and is used as a measure to compare the speed of ageing between countries. Japan's AVI (2000–2023) = (50−26)/2.3 decades = 10.4 points per decade.

Linear Regression: OADR Year on Year Regression for each country The slopes of the trends. Japan: β = +0.74 per year (R^2 = 0.98); India: β = +0.07

per year (R^2 = 0.91), indicating a statistically significant positive trend in all countries.

9. Results

Old-Age Dependency Ratio (Per 100 Working-Age Persons) — Major Economies, 1950–2023

The information displayed in Table 1 reveals a striking divergence in the old-age dependency patterns across eleven leading world economies from the early 20th century until the end of the 1960s. Japan's OADR increased from 8 (1950) to 50 (2023) with a CAGR of 3.5% — the highest in all included countries. China's OADR increased from 8 (1950) to 21 (2023) at 2.9% CAGR, highlighting the combined effects of fertility suppression and rapidly improving longevity. India's OADR increased from 5 to 10 over 73 years, indicating an approximate...early-ageing scenario. Nigeria is the only country to have experienced a small fall in the OADR, from 6 (1970) to 5 (2023), due to high fertility (TFR ~ 5.1) which is maintaining a young populous so far. Russia's OADR was 25 (2023) post-Soviet fertility collapse. Brazil (15) and Mexico (12) are experiencing mild ageing. Pakistan and Bangladesh are less than 10, showing that the demographic transitions there are not yet complete and that youthful population structures remain the predominant feature of the national age profiles in.

Table 1: Old-Age Dependency Ratio (Per 100 Working-Age Persons) — Major Economies, 1950–2023

Country	1950	1970	1990	2000	2010	2020	2023	CAGR (1990–2023)
Japan	8	10	17	26	36	49	50	+3.5%
China	8	7	8	10	12	18	21	+2.9%
Russia	—	—	—	18	18	23	25	+1.1%
Brazil	4	5	7	8	10	14	15	+2.3%
India	5	7	7	7	8	10	10	+1.1%
Mexico	6	5	7	8	10	11	12	+1.7%
Indonesia	—	—	—	—	9	10	10	+0.7%
Bangladesh	7	6	7	6	7	9	10	+1.1%
Pakistan	3	5	6	7	6	7	7	+0.5%
Ethiopia	—	—	—	5	5	5	6	+0.6%
Nigeria	5	6	6	6	6	6	5	−0.6%

Source: https://unctadstat.unctad.org/datacentre

Absolute OADR Increase and Ageing Velocity (2000–2023)

According to the data in Table 2, China has seen the largest percentage increase in its OADR among the selected countries from 2000 to 2023. to 21 during only 23 years, compressed by its one-child policy legacy as working-age population shrunk while elderly longevity simultaneously improved. Japan increased its OADR by 24 absolute points (from a already high base of 26 in 2000), reaching 50 in 2023, a rise of 92.3%, with a Ageing Velocity Index of 10.4 points/decade the highest rate of ageing in the world. The OADR in Brazil increased from 8 to 15 (an increase of 87.5%), and the increase in India of 42.9% (from 7 to 10) indicates a rather slow ageing path. Pakistan experienced no absolute change, stagnating at an OADR of 7, marking the slowest ageing shift in the leading economies. The old-age dependency ratio or OADR for Mexico and Bangladesh increased at a modest pace of 1.7 points per decade for each country which indicates on the one hand manageable but on the other accelerating pressures on old-age dependency with a major shift in pension and healthcare policies anticipated in the next two decades.

Table 2: Absolute OADR Increase and Ageing Velocity (2000–2023)

Country	OADR 2000	OADR 2023	Absolute Increase	% Increase	AVI (points/decade)
Japan	26	50	+24	+92.3%	10.4
China	10	21	+11	+110.0%	4.8
Brazil	8	15	+7	+87.5%	3.0
India	7	10	+3	+42.9%	1.3
Mexico	8	12	+4	+50.0%	1.7
Russia	18	25	+7	+38.9%	3.0
Bangladesh	6	10	+4	+66.7%	1.7
Pakistan	7	7	0	0.0%	0.0

Source: https://unctadstat.unctad.org/datacentre

OADR as Percentage of Total Dependency Ratio (Ageing Share of Total Burden, 2023)

The data in Table 3 indicates that the share of ageing contributing to the total dependency burden differs substantially between the world's largest economies, suggesting that there are very different underlying demographic structures hiding behind what seem to be fairly similar aggregate TDR values. Japan is at the far end, where OADR makes up 71.4% of the total dependency ratio — a testament to the hyper-aged classification where elderly dependents grossly outnumber child dependents and the old-age DR (50) is over two and a half times that of the child DR (20).

Russia (48.1%) and China (46.7%) may be categorized as "aged" countries, with old-age and child dependency ratios that are almost equal. Brazil (34.1%) and Mexico (24.5%) are considered as the intermediate ageing groups and the old-age dependency ratio is rising. India's OADR accounts for a mere 21.3% of the TDR, substantiating that it is in the early-ageing stage – the dependency structure is still dominated by child dependency (78.7%). Pre-ageing profiles of Nigeria (6.3%) and Pakistan (10.0%) where child dependency too dominates are indicative of high-fertility demographic patterns with old-age dependency staying fiscally negligible and structurally immaterial in case of both nations.

Table 3: OADR as Percentage of Total Dependency Ratio (Ageing Share of Total Burden, 2023)

Country	TDR 2023	OADR 2023	OADR as % of TDR	Ageing Dominance Classification (by author)
Japan	70	50	71.4%	Hyper-Aged
Russia	52	25	48.1%	Advanced Ageing
China	45	21	46.7%	Advanced Ageing
Brazil	44	15	34.1%	Moderate Ageing
India	47	10	21.3%	Early Ageing
Mexico	49	12	24.5%	Early Ageing
Bangladesh	53	10	18.9%	Early Ageing
Pakistan	70	7	10.0%	Pre-Ageing
Nigeria	80	5	6.3%	Pre-Ageing

Source: Prepared by author from the data, https://unctadstat.unctad.org/datacentre

Regression Coefficients for OADR Trend (Year as Predictor, 1990–2023)

The results in Table 4 indicate that the linear regression models confirm statistically significant increasing trends in the OADR for all major economies analysed, with all R^2 values above 0.90 this means that the year solely explains more than 90% of the variance in the trajectories of the OADR and confirms the predictability of this demographic momentum of ageing. Japan has the largest slope in the regression trend ($\beta = +0.74$ per year, $R^2 = 0.98$), estimating that its OADR will attain around 63 by 2040 — a startling fiscal course suggesting that there will be more than two elderly dependents for every three working-age individuals. OADR for China ($\beta = +0.39$, $R^2 = 0.97$) is estimated to rise to 28 in 2040, which significantly increases demands for pension and healthcare spending.

Brazil's ($\beta = +0.23$) exceptionalising ageing classification presupposes going beyond OADR 20 threshold by 2040. Russia ($\beta = +0.21$) is projected at 29 by 2040. India's relatively shallow slope ($\beta = +0.07$, $R^2 = 0.91$) estimates OADR of about 12 in 2040, which is still sustainable, but it will require immediate institutional preparedness so as to avoid degeneration of policy implications leading to losses that could have been prevented in the fiscal and social domains on a national level like Japan.

Table 4: Regression Coefficients for OADR Trend (Year as Predictor, 1990–2023)

Country	Regression Slope (β)	R^2	Projected OADR 2040
Japan	+0.74	0.98	~63
China	+0.39	0.97	~28
Brazil	+0.23	0.99	~20
Russia	+0.21	0.95	~29
India	+0.07	0.91	~12
Mexico	+0.15	0.98	~18
Bangladesh	+0.10	0.93	~13

Source: https://unctadstat.unctad.org/datacentre

China also had the fastest growth among major economies in its OADR from 2000 to 2023 (+110.0%), as the legacy of its one-child policy contracted the working-age cohort and life expectancy rose. Japan's AVI of 10.4 points per 10 years is an unparalleled speed internationally. India's OADR is expected to reach 12 by 2040 (regression $\beta = +0.07$, $R^2 = 0.91$), although it is rising at a relatively modest +1.1% CAGR (1990–2023), and it is expected to accelerate more as its fertility declines further. Nigeria's OADR also is uniquely steady at 5–6, as extremely high fertility continually replenishes a youthful population core. The ageing transition — in terms of OADR for Pakistan, remaining at 7 (2000 to 2023) — is the slowest ever, a testament to high fertility (TFR ~3.5) and relatively low life expectancy at birth (~67 years). Russia's OADR (25) illustrates the distinctive dual burden of drastically declining fertility in the post-1990 era and increasing longevity for the elderly.

10. Discussion

Different countries facing ageing crises and those still with youthful demographics are starkly separated in the global view of old-age dependence.

The path of Japan — with a OADR increase from 8 to 50 over 73 years — is the most extreme demographic shift in modern history and takes up over 24% of the national budget in social security spending. China's acceleration in OADR (+110% since 2000) will likely bring about similar fiscal pressure within two decades, especially considering the structurally under-developed nature of China's private pension system. India with an OADR of just 10 in 2023 has strategic assets: time, size of workforce, and a policy learning from Japan, China and Brazil. Yet regression estimates suggest india's oadr will be close to 12 in 2040 and over 20 in 2055. The experience of Brazil suggests that a proactive scaling up of pension reform, universal health coverage and conditional social transfers can blunt the fiscal impact of a rising OADR. And the fundamental policy insight for India is that the ageing transition should be anticipated, not followed —a lesson Japan learnt too late.

11. Conclusion

This paper demontrates that the old age dependency presents the largest demographic challenge of the 21st century for the biggest world economies, despite extremely different paths associated with the history of fertility, improvement in longevity, and policy options. Japan's hyper-ageing population (OADR 50) and China's rapidly rising OADR (+110% since 2000) are the twin alarm bells for developing countries nearing demographic maturity. Being in the early ageing stage with OADR at 10 (2023), India has a window of opportunity that has to be translated into institutional preparedness. The National Social Assistance Programme, NPHCE, and Atal Pension Yojana are to the silver economy in India, very tentative responses, answerable to coming, rather than present, need. Both Brazil's managed pension transition and Japan's costly delay offer the same lesson: that India's financial viability over the long run hinges on proactive old-age dependency management — i.e., by way of expanded pension coverage, healthy ageing investments, elderly labour force participation policies, and state-level tailoring — is non-negotiable for India's long-term financial sustainability. Aging transition for countries like Nigeria and Ethiopia is further ahead, but demographic dividends must be reinvested to build eldercare capacity before the transition.

12. Major Findings

1. Japan experienced the largest increase in its old-age dependency ratio among all major world economies, from 8 in 1950 to 50 in 2023, an increase of 525% over 73 years — this raised the burdens that Japan's shrinking working-age population had to bear to an unsustainable level.
2. China had the largest OADR increase (2000–2023) among the three countries with 110% an increase from 10 to 21 in just 23 years, and this increase was attributable to both a shrinking working-age population due to the legacy of the one-child policy and an increasing elderly population because of longer life expectancy.
3. India experienced a slight growth in its OADR from 5 (1950) to 10 (2023) with a CAGR of 1.1 % (1990–2023), which places India at the "early ageing" stage with a strategic window of about 15–20 years before ageing takes off in its full throttle.
4. Between 2000 and 2023, Russia's OADR climbed from 18 to 25 as a result of decreased fertility following the post-Soviet transition and enhanced longevity placing it into the "advanced ageing" tier and escalating pension system fiscal stress at over 8% of GDP much more severe than that seen in other high income countries.
5. It is interesting to note that Nigeria is the only exception in which the old-age dependency ratio did not increase but rather decreased. (6 in 1970 to 5 in 2023) suggesting that persistent high fertility rates (TFR ~5.1) are still dominant and shaping a youthful population structure capable of supporting a low old-age dependency.
6. Brazil's OADR rose by more than two-thirds from 7 in 1990 to 15 in 2023, yet Brazil's forward-looking pension reforms and Bolsa Família programme exemplify that fiscal management of increasing old-age dependency ratios ×r is possible with early institutional preparation.
7. Regression analysis confirms significant positive trends for OADR in all selected countries (R^2 > 0.90), with Japan's slope (β = +0.74/year) being approximately 10 times larger than that of India (β = +0.07/year), estimating Japan's OADR at ~63 at 2040.
8. Ageing Velocity Index analysesญ for 2000–2023 reveal that Japan's OADR increases by 10.4 points per decade, while that of India increases by 1.3 points per decade — however, India's rate of acceleration is expected to increase once TFR goes below replacement fertility at the national level.

9. The OADR in Pakistan stagnated at 7 per 100 working-age people from 2000 to 2023, as it underwent the slowest aging transition among the major economies for decades because of consistently high fertility and a comparatively young population with a median age of 22.
10. Country classifications based on cross-national d evelopment → reveals a battery of three aging type: hyper-aged (Japan, OADR >35), advanced aging (Russia, China, OADR 20–35), early aging (India, Brazil, Mexico, OADR 10–20), and pre-aging (Nigeria, Pakistan, Ethiopia, OADR <10) which each demands its own unique policy rubric.

13. Policy Implications and Suggestions for Future Research

1. Indian government should focus on scaling up Atal Pension Yojana and National Pension System coverage for workers in the unorganised sector covering 80% of elderly population by 2035 by leveraging Brazil's contributory pension universalisation experience to mitigate old-age poverty risk.
2. Japan and China need to adopt comprehensive "active ageing" labour market policies to encourage work beyond 65 years of age, as raising the elderly labour force participation by just 5% can mitigate 15-20% of fiscal drag stemming from increasing old-age dependency ratios.
3. India's state governments, especially Kerala, Tamil Nadu and Himachal Pradesh, OADR which crosses 17 is in need of state-level geriatric care infrastructure that is unique to this demographic including district level dementia centres and community-based eldercare networks after the model of Japan's Long-Term Care Insurance scheme.
4. It will also require future studies to use the NTA method to measure net economic transfer from the working-age to the elderly population for the leading economies to have a more refined fiscal impact indicator than using the aggregated OADR measure.
5. Developing countries — especially Ethiopia and Nigeria — ought to weave old-age preparedness into existing demographic dividend investment plans, creating contributory pension schemes and health care infrastructure while their populations are young and fiscal space isn’t so constrained by massive dependency costs.

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