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Global, regional and national burden of Parkinson's disease in people over 55 years of age: a systematic analysis of the global burden of disease study, 1991–2021

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Abstract

Background Parkinson's disease (PD) has emerged as a major global public health challenge. However, there is currently a lack of systematic analysis regarding the burden of PD and its long-term trends among people over 55 years of age.

Methods This study utilizes data from the Global Burden of Disease 2021 database to analyze the prevalence, incidence, disability-adjusted life years (DALYs), and mortality rates of PD in individuals aged 55 and older from 1990 to 2021. The annual percentage change was calculated to assess the temporal trends of the disease burden. Point estimates and their corresponding ranges were reported with 95% uncertainty intervals.

Results Globally, the prevalence, incidence, DALYs, and mortality rates of PD in individuals aged 55 and above significantly increased from 1990 to 2021, with all indicators being higher in males than in females. This trend was evident across all five Socio-Demographic Index (SDI) groups and in 21 regions worldwide. The number of prevalent cases, incident cases, DALYs, and deaths all showed significant increases and were positively correlated with SDI ($R=0.645$, $P<0.001$). Among 185 countries, the incidence rate increased, with DALY rates rising in 74 countries and mortality rates rising in 65 countries. Notably, in the population aged 95 years and older, the prevalence and incidence of PD showed particularly remarkable increases, at 735% and 505%, respectively. Furthermore, the greatest increase in prevalence was observed in the 55–59 age group, especially in countries with Middle SDI and High-middle SDI regions.

Conclusions This study indicates that the burden of PD in individuals aged 55 and above has significantly increased over the past three decades. This trend reflects the profound impact of global aging and socioeconomic development levels on the burden of PD, underscoring the urgency of addressing PD as a major global public health challenge.

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Keywords Parkinson's disease, Middle-aged and elderly populations, Global burden of disease, Socio-demographic index, Epidemiological trends

Introduction

Parkinson's disease (PD) is a chronic, progressive neurodegenerative disorder that primarily affects middle-aged and elderly populations. It is clinically characterized by motor symptoms such as tremor, rigidity, bradykinesia, and postural instability. As the disease progresses, patients may develop a range of non-motor symptoms including cognitive decline, mood disorders, sleep disturbances, and autonomic dysfunction, significantly impacting quality of life and increasing the burden of care [1, 2].

At the pathophysiological level, PD is primarily associated with the progressive degeneration of dopaminergic neurons in the substantia nigra pars compacta, leading to dopamine deficiency in the striatum. This disruption in basal ganglia circuitry impairs motor control and is believed to be influenced by complex interactions among genetic, environmental, and aging-related factors [3].

While PD is commonly associated with individuals aged 65 and older, mounting evidence suggests that those aged 55 and above also face a considerably elevated risk, with earlier onset leading to prolonged disease duration and cumulative disability [4, 5]. This age group represents a critical window for early diagnosis, intervention, and long-term disease management. Furthermore, aging populations globally are contributing to a marked rise in PD prevalence in individuals aged 55 and older, making this age group an increasingly important focus for public health planning. Defining this cohort enables more targeted analysis of aging-related disease dynamics and healthcare needs [6].

Despite growing awareness of Pd's impact on aging populations, few studies have comprehensively examined its long-term burden trends—particularly in individuals aged 55 and older—across different regions and sociodemographic contexts. Existing literature often overlooks gender disparities and regional heterogeneity in disease burden, leaving significant knowledge gaps in understanding the global distribution and determinants of PD.

This study utilizes Global Burden of Disease (GBD) 2021 data to quantify the global, regional, and national burden of PD among individuals aged 55 years and older from 1990 to 2021. It presents trends in prevalence, incidence, mortality, and disability-adjusted life years (DALYs), with stratified analyses by gender, region, and Socio-Demographic Index (SDI). The analysis highlights changes in disease burden over time, identifies disparities across demographic and geographic groups, and examines associations between disease burden and socioeconomic development.

The findings aim to support more targeted public health responses, including early screening initiatives, optimized resource allocation, and informed policy decisions to reduce the growing impact of PD in aging populations.

Methods

Data source and disease definition

This study utilized data from the GBD 2021 study to assess PD burden among individuals aged 55 years and older between 1990 and 2021 [7]. The latest available GBD 2021 dataset, providing more recent estimates up to the year 2021, thereby extending previous analyses.

The GBD 2021 database provides standardized estimates for 369 diseases and injuries across 204 countries and territories, grouped into 21 GBD regions [8]. All data are publicly available via the Global Health Data Exchange (https://ghdx.healthdata.org/gbd-2021/sources). Detailed methodology on data sources, modeling approaches, and estimation techniques is documented in prior GBD publications [9]. PD was defined according to the GBD as a progressive neurodegenerative disorder characterized by motor (tremors, rigidity, bradykinesia, gait instability) and non-motor symptoms (cognitive decline, mood disorders). PD classification followed the International Classification of Diseases 10th revision (ICD-10) codes: G20 (idiopathic PD) and G21 (secondary PD).

Data inclusion was restricted to available estimates from GBD 2021; no additional exclusion criteria were applied. Potential biases, such as misclassification and regional disparities in reporting quality, were addressed via GBD Bayesian meta-regression modeling (DisMod-MR), utilizing covariates and regional adjustments to estimate missing data and correct biases.

SDI

The SDI, defined by income per capita, educational attainment, and fertility rates, classifies countries into five groups: low, low-middle, middle, high-middle, and high. SDI influences healthcare access, disease awareness, and reporting quality. Hence, analyzing PD burden by SDI provides insights into the socioeconomic determinants influencing epidemiological trends.

DALYs

DALYs are used to quantify overall disease burden by summing the years of life lost (YLLs) due to premature mortality and the years lived with disability (YLDs). The formula is: DALYs = YLLs + YLDs. Disability weights for

PD were derived from population surveys conducted in multiple countries as part of the GBD methodology, reflecting public perceptions of disease severity. These weights vary by health state and disease phase and are detailed in GBD technical appendices. DALYs were estimated using 500 simulation draws; the 95% uncertainty interval (UI) was defined by the 2.5th and 97.5th percentiles.

Estimated annual percentage change and percentage change

To quantify temporal trends, we calculated the Estimated Annual Percentage Change (EAPC) in prevalence, incidence, and DALYs. A linear regression model was fitted to the natural logarithm of rates: $\ln(y) = \alpha + \beta x + \epsilon$, where y is the rate (e.g., prevalence), x is the calendar year, and β is the slope. EAPC was derived from β, with 95% confidence intervals (CIs) used to assess significance: an increasing trend was defined if the lower CI bound > 0, decreasing if the upper CI bound < 0, and stable if the CI included 0 [10]. Additionally, we computed the percentage change from 1990 to 2021 to capture net differences [11].

Death rate calculation

PD-related mortality was expressed as the death rate per 100,000 population, calculated as:

Death Rate = PD deaths / total population aged ≥ 55 × 100,000. Rates were stratified by year, sex, country, and GBD region.

Data analysis

Data cleaning, computation, and visualization analysis were performed using R software (version 4.3.1), with ggplot2 package for generating plots, and final editing was done in Adobe Illustrator (version CS5).

Results

Global level

From 1990 to 2021, the absolute number of prevalent PD cases among individuals aged 55 and older increased significantly, from 2.83 million in 1990 to 10.76 million in 2021 (an increase of 281%). Similarly, the absolute number of incident cases per year rose from 371,670 cases/year in 1990 to 1.18 million cases/year in 2021 (219% increase). PD-related deaths increased from 145,060 deaths/year to 382,950 deaths/year (165% increase), and DALYs increased from 2.68 million/year to 7.10 million/year (also a 165% increase) (Table 1; Fig. 1A).

Age-standardized rates (per 100,000 population per year) also showed significant increases. Specifically, prevalence rates increased with an EAPC of 1.73 (95% CI: 1.68–1.77), incidence rates increased with an EAPC of 1.22 (95% CI: 1.18–1.26), DALY rates with an EAPC of 0.60 (95% CI: 0.51–0.69), and mortality rates with an EAPC of 0.65 (95% CI: 0.54–0.75) (Table 1, 2; Fig. 1B).

Both absolute numbers and standardized rates indicate a substantial global increase in PD burden among older adults.

SDI regional level

Across SDI groups, the absolute number of PD cases significantly increased. Specifically, from 1990 to 2021, Andean Latin America showed the largest absolute increase in prevalence (465%), while East Asia recorded the highest increase in annual incident cases (445% increase). The High-income Asia Pacific region showed the highest absolute increase in annual deaths (283%).

When considering age-standardized rates per 100,000 population, the Middle SDI region exhibited the greatest increase in prevalence rates (EAPC: 2.58, 95% CI: 2.51–2.65) and incidence rates (EAPC: 1.78, 95% CI: 1.75–1.81). High SDI regions had the largest increases in DALY rates (EAPC: 0.89, 95% CI: 0.80–0.98) and mortality rates (EAPC: 1.10, 95% CI: 0.99–1.20) (Table 1; Figs. 1G–J).

PD burden increased across all SDI regions, with Middle and High SDI regions experiencing particularly rapid increases in standardized rates.

GBD regional level

All 21 GBD regions demonstrated significant increases in absolute PD burden from 1990 to 2021. East Asia experienced the largest increase in absolute prevalent cases (702%) and absolute incident cases per year (445%). Andean Latin America recorded the highest increase in absolute DALYs (251%), while High-income Asia Pacific had the greatest increase in absolute mortality (283%) (Table 1; Fig. 2A and C).

Age-standardized rate analysis revealed East Asia again had the fastest rising prevalence rates (EAPC: 3.54, 95% CI: 3.41–3.68) and incidence rates (EAPC: 2.56, 95% CI: 2.51–2.61). The High-income Asia Pacific region showed the greatest increase in DALY rates (EAPC: 1.85, 95% CI: 1.74–1.97) and mortality rates (EAPC: 2.46, 95% CI: 2.35–2.58) (Table 1; Fig. 2B and D).

The East Asia and High-income Asia Pacific regions emerged as hotspots for rapid increases in PD burden, as confirmed by both absolute and standardized measures.

Countries level

From 1990 to 2021, nearly all 185 countries analyzed showed increased absolute numbers of PD cases. Only Niue reported decreases in all PD metrics. Georgia showed reductions in absolute prevalence and incidence numbers, and Tokelau had a decrease in absolute deaths per year.

Notably, Qatar showed the highest increases in absolute prevalence and incidence numbers, while Djibouti

Table 1 Global and regional prevalence, incidence, dalys, and mortality rates of PD among individuals aged 55 and older, 1990–2021

location	Prevalent cases			Prevalent rates		
	1990 (in thousands) (95%UI)	2021 (in thousands) (95%UI)	percentage Change (100%)	1990 per 100,000 (95%UI)	2021 per 100,000 (95%UI)	EAPC (95% CI)
Global	2825.06 (2441.51-3270.99)	10757.5 (9480.91-12341.39)	2.81	420.76 (363.63-487.17)	723.93 (638.02-830.52)	1.73 (1.68–1.77)
High-middle SDI	877.32 (761.08-1016.77)	3192.07 (2759.5-3715.96)	2.64	508.52 (441.14-589.34)	920.76 (795.99-1071.88)	1.84 (1.76–1.92)
High SDI	976.35 (860.9-1106.36)	2712.17 (2497.17-2949.66)	1.78	523.61 (461.7-593.34)	786.11 (723.79-854.94)	1.27 (1.2–1.34)
Low-middle SDI	292.04 (244.99-348.11)	1043.2 (887.2-1232.3)	2.57	289.72 (243.04-345.34)	432.71 (368.01-511.15)	1.42 (1.38–1.45)
Low SDI	90.65 (75.52-108.21)	265.21 (225.38-310.58)	1.93	242.98 (202.42-290.04)	323.2 (274.66-378.49)	0.99 (0.95–1.04)
Middle SDI	585.47 (492.04-700.97)	3537.89 (3024.13-4176.16)	5.04	337.33 (283.5-403.88)	752.97 (643.63-888.81)	2.58 (2.51–2.65)
Andean Latin America	13.63 (11.49–16.2)	77.01 (64.38–91.96)	4.65	406.11 (342.52-482.77)	777.42 (649.91-928.29)	2.14 (2.09–2.2)
Australasia	15.24 (12.7-17.59)	48.59 (41.45–58.37)	2.19	386.97 (322.37-446.55)	549.97 (469.14-660.75)	0.97 (0.91–1.02)
Caribbean	11.74 (10.06–13.57)	34.63 (30.35–39.7)	1.95	272.3 (233.37-314.85)	374.06 (327.78-428.79)	0.97 (0.9–1.04)
Central Asia	30.22 (25.22–35.55)	54.99 (46.91–63.57)	0.82	377.81 (315.29-444.44)	377.97 (322.42–436.9)	0.19 (-0.01-0.38)
Central Europe	120.15 (105.51-135.31)	220.47 (196.08-241.59)	0.83	453.03 (397.86-510.23)	595.42 (529.55-652.44)	0.78 (0.68–0.88)
Central Latin America	42.12 (36.93–48.67)	207.48 (182.51-238.55)	3.93	310.38 (272.11-358.65)	485.16 (426.76-557.79)	1.15 (1-1.29)
Central Sub-Saharan Africa	7.72 (6.15–9.64)	21.88 (17.53–27.23)	1.83	205.43 (163.6-256.45)	242.43 (194.29-301.76)	0.46 (0.4–0.52)
East Asia	593.27 (486.63-717.62)	4756.22 (4003.12-5649.76)	7.02	398.29 (326.7-481.78)	1212.95 (1020.89-1440.82)	3.54 (3.41–3.68)
Eastern Europe	231.71 (192.57-278.52)	315.13 (262.13-374.42)	0.36	473.91 (393.85-569.65)	507.63 (422.25-603.14)	0.15 (0.05–0.25)
Eastern Sub-Saharan Africa	25.73 (21.41–30.67)	68.43 (57.9-79.19)	1.66	211.5 (175.97-252.11)	253.08 (214.16–292.9)	0.56 (0.53–0.58)
High-income Asia Pacific	114.66 (95.82-136.56)	280.76 (241.28-326.22)	1.45	327.89 (274.03-390.54)	398.22 (342.22–462.7)	1.29 (1.09–1.48)
High-income North America	313.77 (262.23–371.3)	818.28 (760.06–881.4)	1.61	541.65 (452.69-640.97)	727.13 (675.4-783.23)	0.57 (0.44–0.7)
North Africa and Middle East	82.57 (68.89–96.88)	349.61 (297.66–405.5)	3.23	292.14 (243.72-342.75)	458.6 (390.45-531.92)	1.56 (1.5–1.62)
Oceania	1.46 (1.18–1.75)	4.16 (3.4–4.93)	1.85	303.19 (244.53-364.65)	337.07 (275.79-399.47)	0.27 (0.17–0.38)
South Asia	270.69 (222.02–325)	1088.42 (899.52-1310.62)	3.02	285.11 (233.85-342.31)	438.36 (362.28-527.85)	1.59 (1.52–1.65)
Southeast Asia	122.37 (104.31-142.79)	444.96 (386.91-515.74)	2.64	289.01 (246.36-337.23)	388.42 (337.75-450.21)	0.96 (0.89–1.02)
Southern Latin America	40.03 (35.11–44.06)	94.36 (81.02-111.26)	1.36	505.29 (443.21-556.23)	641.22 (550.53-756.07)	0.83 (0.69–0.97)
Southern Sub-Saharan Africa	11.33 (9.5–13.5)	29.12 (24.52–34.34)	1.57	256.07 (214.71-305.14)	299.12 (251.89-352.73)	0.38 (0.34–0.43)
Tropical Latin America	46.72 (38.58–56.29)	196.99 (164.5-233.84)	3.22	308.56 (254.82-371.79)	444.7 (371.34-527.88)	1.02 (0.91–1.14)
Western Europe	691.32 (628.28-762.15)	1545.87 (1390.77-1703.67)	1.24	711.88 (646.97-784.81)	1036.56 (932.56-1142.37)	1.12 (0.99–1.25)
Western Sub-Saharan Africa	38.63 (32.36–45.09)	100.13 (85.8-116.58)	1.59	267.59 (224.19-312.35)	311.52 (266.94-362.69)	0.55 (0.49–0.61)

had the greatest absolute increases in DALYs and mortality numbers. When examining age-standardized incidence rates per 100,000/year, Italy showed the greatest decrease (EAPC: -1.16), whereas Norway had the highest increase (EAPC: 5.06). Similarly, DALY rates decreased in 74 countries and mortality rates in 65 countries, with Qatar demonstrating the most substantial rate declines, while Japan showed significant increases in both rates (Figs. 3A–H).

Country-level analysis highlights significant global heterogeneity in PD burden changes, with standardized rates providing deeper insights beyond absolute number changes.

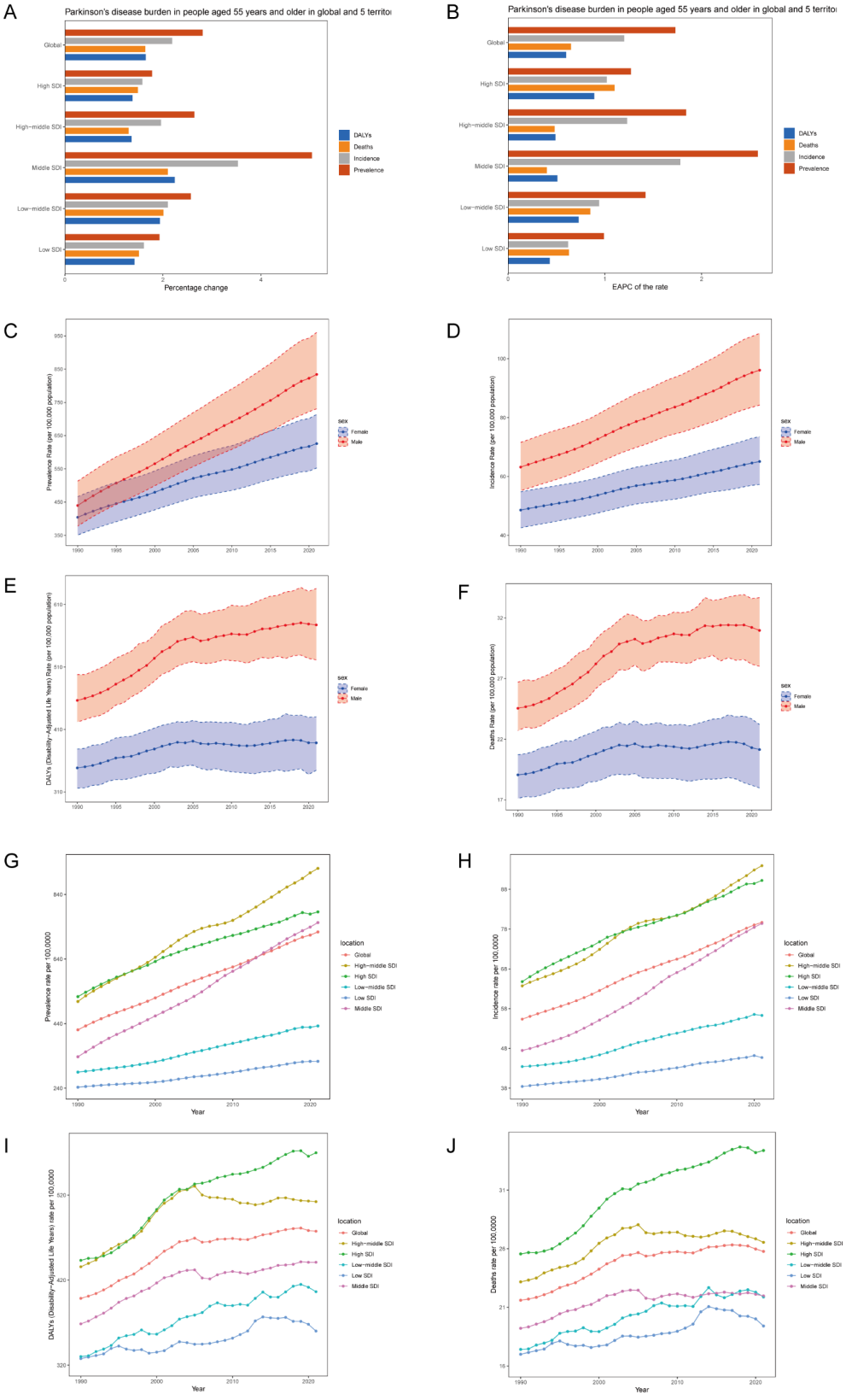

Fig. 1 Temporal trend of PD burden in people over 55 years of age in global and 5 territories. **(A).** Percentage change in cases of prevalence, incidence, DALYs, and Deaths in 1990 and 2021. **(B).** The EAPC of prevalence, incidence, and DALY rates from 1990 to 2021. **(C-F).** The rates of prevalence, incidence, DALYs, and Deaths for men and women. **(G-J).** The rates of prevalence, incidence, DALYs, and Deaths

Table 2 Global prevalence, incidence, dalys, and death rates and trends of Parkinson's disease burden in people over 55 years of age, 1990 to 2021

Sex	Prevalent cases			Prevalent rates		
	1990 (in thousands) (95%UI)	2021 (in thousands) (95%UI)	percentage Change (100%)	1990 per 100,000 (95%UI)	2021 per 100,000 (95%UI)	EAPC (95% CI)
Female (Prevalence)	Global	1.46 (1.26–1.68)	4.92 (4.35–5.61)	2.37 (2.45–2.34)	404.32 (350.67-466.19)	625.97 (552.86-713.79)
Male (Prevalence)	Global	1.37 (1.18–1.6)	5.83 (5.11–6.72)	3.26 (3.33–3.2)	439.75 (378.02-513.04)	834.07 (730.61–960.7)
Female (Incidence)	Global	0.17 (0.15–0.2)	0.51 (0.45–0.58)	2 (2-1.9)	48.58 (42.55–54.78)	65.08 (57.27–73.52)
Male (Incidence)	Global	0.2 (0.17–0.22)	0.67 (0.59–0.76)	2.35 (2.47–2.45)	63.19 (55.17–71.59)	96.09 (84.26-108.61)
Female (Death)	Global	68.59 (61.62–74.57)	166.3 (141.4-182.55)	1.42 (1.29–1.45)	19.06 (17.12–20.72)	21.15 (17.98–23.21)
Male (Death)	Global	76.46 (70.72–83.15)	216.65 (195.98–235.6)	1.83 (1.77–1.83)	24.55 (22.7–26.7)	30.97 (28.02–33.68)

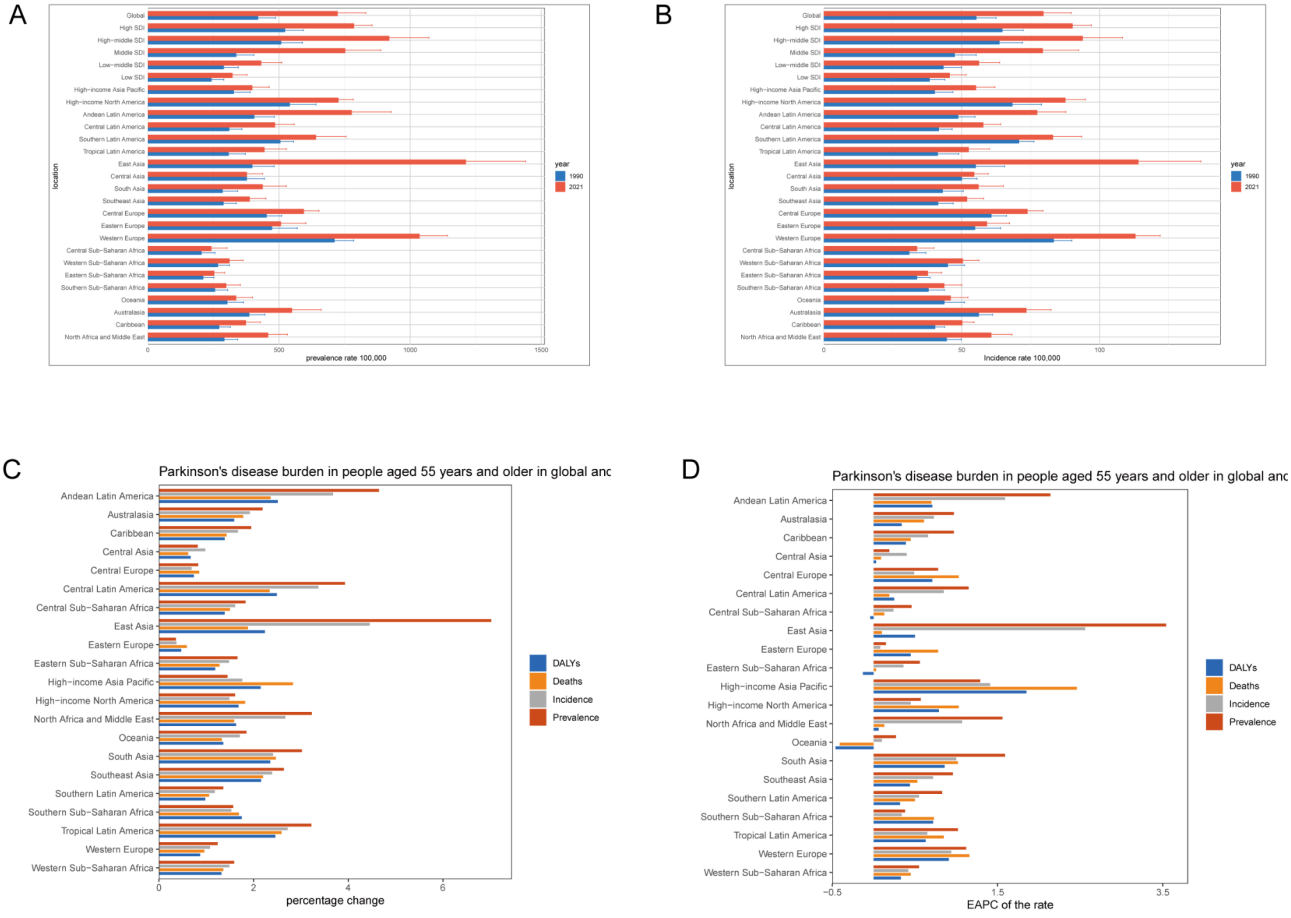

Fig. 2 Temporal trend of PD burden in people over 55 years of age in regions. **(A-B).** Prevalence and incidence rate per 100,000 population in 1990 and 2021. **(C).** Percentage change in cases of prevalent, incident, DALYs, and Deaths in 1990 and 2021. **(D).** EAPC of rates of prevalent, incident, DALYs, and Deaths from 1990 to 2021

Age patterns

Between 1990 and 2021, absolute PD cases increased most notably among individuals aged 95 and older (735% globally). The Middle SDI region showed a striking absolute increase of 1540% in this age group. In terms of age-standardized prevalence rates per 100,000 population, the 55–59 age group had the highest EAPC globally (1.83, 95% CI: 1.69–1.97).

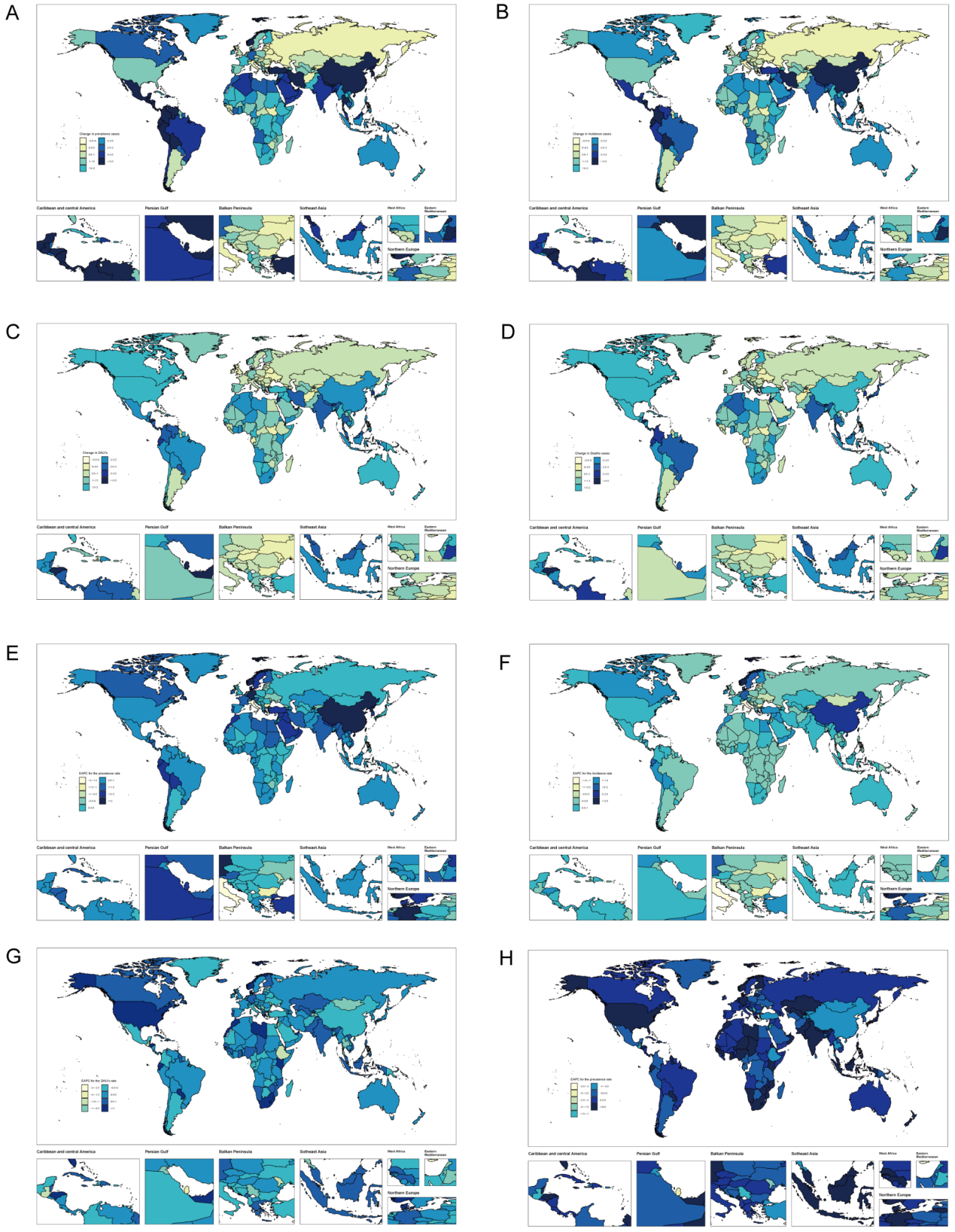

Fig. 3 Temporal trend of PD burden in people over 55 years of age globally. **(A-D).** Percentage change in prevalence, incidence, DALYs, and Deaths cases across 204 countries in 1990 and 2021. **(E-H).** EAPC in prevalence, incidence, DALYs, and Deaths rates across 204 countries in 1990 and 2021

Regarding incidence, the absolute number of cases per year among those aged 95 + rose significantly (505% globally; 780% in Middle SDI regions). For DALYs and mortality, the 90–94 age group showed the highest age-standardized rate increases (DALYs EAPC: 0.69, 95% CI: 0.64–0.73; Mortality EAPC: 0.56, 95% CI: 0.50–0.61). Meanwhile, standardized mortality rates among younger elderly groups (55–74) declined significantly (EAPC: -0.60 for age 55–59) (Table 3; Figs. 4A–D).

Older age groups showed the fastest increases in both absolute numbers and standardized PD rates, highlighting increased vulnerability among the oldest elderly populations.

The association between PD burden and SDI

Globally, there was a significant positive correlation between SDI and age-standardized PD prevalence rates ($R = 0.645$, $P < 0.001$), incidence rates ($R = 0.665$), DALY rates ($R = 0.703$), and mortality rates ($R = 0.755$) (Figs. 5A–D). Regions with higher SDI values, such as East Asia and Western Europe, had notably higher prevalence and incidence rates, while lower-SDI regions (Central and Southern Sub-Saharan Africa) had lower standardized rates.

Higher socioeconomic development correlates positively with PD burden, suggesting demographic aging and healthcare factors significantly influence PD epidemiology.

Discussion

The results of this study indicate a marked global increase in PD cases, incidence, mortality, and DALYs among individuals aged 55 and older from 1990 to 2021. This rising burden can be attributed to several key factors. Primarily, global aging significantly contributes to PD's growing prevalence; the United Nations reports continued rapid expansion of elderly populations worldwide, especially individuals over 60, thus substantially increasing chronic disease incidence, including PD [12, 13]. Epidemiological studies consistently indicate a substantial rise in PD incidence, especially among those aged 80 and above [14]. Furthermore, improved diagnostic techniques have allowed increased identification of early-stage PD cases, also contributing to rising prevalence.

This study observed upward trends in age-standardized prevalence, incidence, DALYs, and mortality rates of PD. Although medical advancements have improved symptom management and quality of life, current therapies, including dopamine replacement and deep brain stimulation, do not halt or significantly alter disease progression. The limited efficacy in modifying underlying neurodegeneration explains why treatment advancements have not effectively reduced overall disease burden.

Gender disparities in PD burden were evident, with significantly higher prevalence, incidence, and mortality observed among men compared to women. Globally, epidemiological research estimates that males have approximately a 1.5-fold higher relative risk of developing PD compared to females. Potential mechanisms behind this gender difference include protective effects of estrogen in women and increased androgen levels and genetic susceptibilities in men [15]. Potential mechanisms behind this gender difference include protective effects of estrogen in women and increased androgen levels and genetic susceptibilities in men [16, 17].

Additionally, emerging evidence suggests sex-specific differences in neuroinflammation and mitochondrial dysfunction significantly contribute to PD pathology. Studies report greater neuroinflammatory responses and mitochondrial impairment in males, highlighting biological vulnerabilities potentially exacerbating PD progression in men. This study also found significant regional variability in PD burden, positively correlated with the SDI. Regions with middle and high SDI displayed pronounced increases in PD prevalence and incidence, likely driven by demographic aging, improved healthcare access, and enhanced diagnostic capabilities. Developed countries, such as the United States and those in Western Europe, have well-established PD diagnostic infrastructures, contributing to higher documented prevalence and disease reporting [18, 19]. High SDI regions exhibited substantial increases in DALY rates and mortality, reflective of aging societies where chronic neurodegenerative disorders increasingly dominate disease burdens [20]. Conversely, lower SDI regions, although having lower documented PD burdens, may underestimate true disease impact due to limited healthcare resources, delayed diagnoses, and incomplete surveillance systems.

Country-specific differences further highlight the role of demographic and healthcare factors. Countries like Qatar experienced notable increases in PD burden due to rapid socioeconomic development, aging populations, and improved healthcare systems. In contrast, smaller countries like Niue and Georgia saw declines or stability in PD cases, likely reflecting smaller elderly populations and robust public health infrastructures. These disparities underline the importance of healthcare resources, demographic transitions, and national policy frameworks in shaping PD burden.

Age-stratified analyses confirmed the greatest increases in PD burden among the oldest age groups, especially individuals aged 95 and older, consistent with established research highlighting aging as a fundamental risk factor for neurodegeneration [21'23].

Genetic mutations, cumulative environmental exposure, mitochondrial dysfunction, and increased neuroinflammation during aging collectively contribute to this elevated PD risk in the elderly population.

Table 3 The prevalence of Parkinson's disease burden in people over 55 years of age in global and 5 cases and rates, and the trends in age patterns from 1990 to 2021

location	Age (year)	Prevalent cases			Prevalent rates		
		1990 (in thousands) (95%UI)	2021 (in thousands) (95%UI)	percentage Change (100%)	1990 per 100,000 (95%UI)	2021 per 100,000 (95%UI)	EAPC (95% CI)
Global	55–59 years	201.73 (151.57-257.92)	836.71 (651.21-1066.13)	3.15 (3.3–3.13)	108.92 (81.84-139.27)	211.44 (164.56-269.41)	1.83 (1.69–1.97)
Global	55 + years	2825.06 (2441.51-3270.99)	10757.5 (9480.91-12341.39)	2.81 (2.88–2.77)	420.76 (363.63-487.17)	723.93 (638.02-830.52)	1.73 (1.68–1.77)
Global	60–64 years	308.18 (236.47-399.77)	1060.26 (825.63-1366.79)	2.44 (2.49–2.42)	191.88 (147.24-248.91)	331.28 (257.97-427.06)	1.77 (1.67–1.88)
Global	65–69 years	450.62 (364.84-557.11)	1676.42 (1383.24-2060.68)	2.72 (2.79–2.7)	364.55 (295.16-450.71)	607.75 (501.46-747.05)	1.6 (1.57–1.63)
Global	70–74 years	528.92 (422.29-653.76)	1999.45 (1630.85-2417.05)	2.78 (2.86–2.7)	624.75 (498.79-772.21)	971.36 (792.3-1174.24)	1.42 (1.4–1.44)
Global	75–79 years	606.25 (505.86-722.88)	1950.77 (1630.16-2305.02)	2.22 (2.22–2.19)	984.88 (821.8-1174.36)	1479.15 (1236.05-1747.76)	1.38 (1.35–1.41)
Global	80–84 years	456.09 (370.24-548.06)	1732.59 (1427.65-2076.02)	2.8 (2.86–2.79)	1289.26 (1046.59-1549.24)	1978.22 (1630.05-2370.34)	1.42 (1.38–1.47)
Global	85–89 years	205.77 (169.43-247.82)	1017.29 (848.11-1200.13)	3.94 (4.01–3.84)	1361.74 (1121.21-1639.98)	2224.95 (1854.94-2624.86)	1.56 (1.54–1.59)
Global	90–94 years	55.05 (44.31–68.61)	380.06 (311.9-467.03)	5.9 (6.04–5.81)	1284.68 (1034.09-1601.04)	2124.52 (1743.48-2610.64)	1.66 (1.63–1.69)
Global	95 + years	12.45 (9.13–16.92)	103.94 (80.21-134.14)	7.35 (7.79–6.93)	1223.16 (897.15-1661.69)	1907.07 (1471.73-2461.22)	1.54 (1.48–1.59)
Low SDI	55–59 years	9.58 (7.01–12.47)	24.8 (18.35–32.1)	1.59 (1.62–1.57)	81.92 (60-106.68)	97.9 (72.42–126.7)	0.58 (0.52–0.63)
Low SDI	55 + years	90.65 (75.52-108.21)	265.21 (225.38-310.58)	1.93 (1.98–1.87)	242.98 (202.42-290.04)	323.2 (274.66-378.49)	0.99 (0.95–1.04)
Low SDI	60–64 years	12.54 (9.48–16.38)	32.77 (24.84–42.65)	1.61 (1.62–1.6)	134.41 (101.54-175.46)	166.21 (126-216.33)	0.72 (0.65–0.78)
Low SDI	65–69 years	16.92 (13.25–20.88)	46.5 (37.41–56.84)	1.75 (1.82–1.72)	243.36 (190.48-300.33)	308.41 (248.16-376.99)	0.82 (0.75–0.9)
Low SDI	70–74 years	19.45 (14.61–24.99)	54.93 (42.98–68.72)	1.82 (1.94–1.75)	411.41 (309.07-528.51)	529.64 (414.47-662.63)	0.86 (0.79–0.94)
Low SDI	75–79 years	17.24 (13.58–21.29)	52.46 (42.29–63.11)	2.04 (2.11–1.96)	635.56 (500.56-784.85)	817.05 (658.64-982.97)	0.88 (0.81–0.95)
Low SDI	80–84 years	10.5 (8.09–13.39)	35.6 (27.9-43.97)	2.39 (2.45–2.28)	808.75 (622.62-1030.76)	1055.31 (827.08-1303.62)	0.95 (0.88–1.03)
Low SDI	85–89 years	3.51 (2.63–4.51)	14.1 (10.9-17.64)	3.02 (3.14–2.91)	770.77 (577.18-990.02)	1056.35 (816.64-1321.29)	1.12 (1.03–1.21)
Low SDI	90–94 years	0.75 (0.55–1.02)	3.38 (2.54–4.43)	3.51 (3.62–3.34)	663.66 (485.46-906.39)	943.13 (708.73-1235.15)	1.22 (1.09–1.35)
Low SDI	95 + years	0.15 (0.09–0.23)	0.68 (0.43–1.02)	3.53 (3.78–3.43)	626.99 (377.93-950.01)	892.19 (570.99-1336.87)	1.16 (1.02–1.29)
Low-middle SDI	55–59 years	30.64 (22.98–39.52)	94.04 (71.36-120.63)	2.07 (2.11–2.05)	98.54 (73.9-127.09)	135.39 (102.73-173.66)	1.04 (1-1.07)
Low-middle SDI	55 + years	292.04 (244.99-348.11)	1043.2 (887.2-1232.3)	2.57 (2.62–2.54)	289.72 (243.04-345.34)	432.71 (368.01-511.15)	1.42 (1.38–1.45)
Low-middle SDI	60–64 years	40.78 (31.19–53.5)	128.33 (98.06-166.17)	2.15 (2.14–2.11)	161.11 (123.24–211.4)	224.49 (171.54-290.67)	1.08 (1.05–1.12)
Low-middle SDI	65–69 years	52.28 (41.12–64.86)	176.27 (141.35-218.94)	2.37 (2.44–2.38)	287.72 (226.33-356.94)	397.36 (318.64-493.55)	1.11 (1.06–1.16)
Low-middle SDI	70–74 years	58.77 (44.59–74.62)	207.18 (162.09-260.38)	2.53 (2.64–2.49)	478.31 (362.93-607.34)	658.81 (515.45–828)	1.15 (1.09–1.22)
Low-middle SDI	75–79 years	54.71 (43.49–68.57)	201.77 (163.07-242.93)	2.69 (2.75–2.54)	721.8 (573.87-904.76)	1004.86 (812.16-1209.86)	1.2 (1.14–1.27)
Low-middle SDI	80–84 years	37.07 (28.19–48.04)	147.86 (116.68-181.84)	2.99 (3.14–2.79)	890.71 (677.36-1154.15)	1285.72 (1014.6-1581.18)	1.31 (1.25–1.38)

Table 3 (continued)

location	Age (year)	Prevalent cases			Prevalent rates		
		1990 (in thousands) (95%UI)	2021 (in thousands) (95%UI)	percentage Change (100%)	1990 per 100,000 (95%UI)	2021 per 100,000 (95%UI)	EAPC (95% CI)
Low-middle SDI	85–89 years	13.85 (10.51–17.97)	63.98 (50.3–79.7)	3.62 (3.79–3.44)	837.48 (635.66-1086.51)	1280.36 (1006.65-1594.96)	1.52 (1.45–1.59)
Low-middle SDI	90–94 years	3.19 (2.33–4.31)	18.37 (14.13–23.58)	4.76 (5.06–4.47)	723.35 (528.39–976.4)	1134.89 (873.03-1457.1)	1.57 (1.47–1.67)
Low-middle SDI	95 + years	0.75 (0.47–1.12)	5.4 (3.7–7.76)	6.2 (6.87–5.93)	743.96 (468.62-1108.04)	1189.96 (815.65-1710.28)	1.56 (1.49–1.64)
Middle SDI	55–59 years	58.22 (43.45–74.67)	348.67 (270.37-447.17)	4.99 (5.22–4.99)	109.5 (81.72-140.45)	252.76 (196-324.17)	2.08 (1.82–2.35)
Middle SDI	55 + years	585.47 (492.04-700.97)	3537.89 (3024.13-4176.16)	5.04 (5.15–4.96)	337.33 (283.5-403.88)	752.97 (643.63-888.81)	2.58 (2.51–2.65)
Middle SDI	60–64 years	78.62 (59.58-103.28)	385.32 (296.62-505.53)	3.9 (3.98–3.89)	183.56 (139.11-241.13)	378.57 (291.43-496.67)	2.23 (2.02–2.44)
Middle SDI	65–69 years	105.8 (84.06-135.08)	612.15 (491.38-767.56)	4.79 (4.85–4.68)	331.99 (263.76-423.88)	686.76 (551.26-861.11)	2.33 (2.27–2.38)
Middle SDI	70–74 years	121.12 (92.48-158.05)	664.52 (522.25–824.7)	4.49 (4.65–4.22)	554.15 (423.1-723.12)	1078.28 (847.41-1338.18)	2.29 (2.23–2.35)
Middle SDI	75–79 years	111.2 (87.54-139.84)	627.12 (501.02-764.57)	4.64 (4.72–4.47)	831.68 (654.67-1045.82)	1600.55 (1278.72-1951.35)	2.31 (2.23–2.39)
Middle SDI	80–84 years	72.87 (54.92–93.01)	505.71 (392.22-628.52)	5.94 (6.14–5.76)	1051.55 (792.41-1342.17)	2122.99 (1646.54-2638.57)	2.42 (2.36–2.48)
Middle SDI	85–89 years	29.45 (22.67–37.31)	276.28 (219.18-340.34)	8.38 (8.67–8.12)	1079.57 (831.08-1367.54)	2409.16 (1911.24-2967.77)	2.67 (2.61–2.73)
Middle SDI	90–94 years	6.65 (4.94–8.82)	93.04 (71.77-121.75)	12.99 (13.53–12.8)	1003.95 (746.59-1332.69)	2413.13 (1861.54-3157.94)	2.96 (2.87–3.06)
Middle SDI	95 + years	1.53 (1-2.25)	25.09 (18.52–34.3)	15.4 (17.52–14.24)	1043.36 (683.82-1532.78)	2411.5 (1780.34-3297.1)	2.76 (2.63–2.89)
High-middle SDI	55–59 years	55.63 (41.49–71.7)	260.22 (199.61-335.94)	3.68 (3.81–3.69)	119.66 (89.24-154.23)	289.34 (221.94-373.53)	2.46 (2.27–2.65)
High-middle SDI	55 + years	877.32 (761.08-1016.77)	3192.07 (2759.5-3715.96)	2.64 (2.63–2.65)	508.52 (441.14-589.34)	920.76 (795.99-1071.88)	1.84 (1.76–1.92)
High-middle SDI	60–64 years	95.04 (72-124.52)	326.51 (248.52-429.43)	2.44 (2.45–2.45)	220.79 (167.25-289.27)	447.68 (340.75-588.79)	2.26 (2.14–2.38)
High-middle SDI	65–69 years	139.21 (113.53-172.75)	516.38 (419.45-647.59)	2.71 (2.69–2.75)	441.59 (360.14-547.97)	777.63 (631.65-975.23)	1.82 (1.76–1.88)
High-middle SDI	70–74 years	160.86 (130.2-196.11)	586.41 (471.88-724.32)	2.65 (2.62–2.69)	778.95 (630.46-949.66)	1200.46 (966.01-1482.79)	1.4 (1.32–1.48)
High-middle SDI	75–79 years	201.13 (169.3-238.94)	543.99 (447.76-650.54)	1.7 (1.64–1.72)	1208.33 (1017.14-1435.52)	1821.31 (1499.12-2178.03)	1.22 (1.16–1.28)
High-middle SDI	80–84 years	146.84 (121-176.08)	502.43 (400.28–604)	2.42 (2.31–2.43)	1577.64 (1299.99-1891.81)	2301.34 (1833.45-2766.54)	1.16 (1.09–1.23)
High-middle SDI	85–89 years	61.72 (50.98–74.09)	309.85 (252.16-374.16)	4.02 (3.95–4.05)	1650.45 (1363.28-1981.22)	2723.44 (2216.34-3288.66)	1.41 (1.31–1.52)

Despite leveraging comprehensive global data from the GBD database, this study has inherent limitations. Variability in diagnostic criteria and reporting practices across regions may cause data heterogeneity. Moreover, reliance on existing surveillance systems, which may be weaker in low-resource or remote areas, potentially results in underestimated PD burdens in these populations.

Future research should prioritize elucidating PD pathogenesis, emphasizing interactions between genetic predisposition, environmental exposure, mitochondrial dysfunction, neuroinflammation, and aging. Additionally, as healthcare infrastructures and socioeconomic conditions evolve globally, it will be imperative to evaluate how emerging therapeutic strategies—including alpha-synuclein targeted therapies, neuroprotective agents, mitochondrial modulators, immunotherapies, and precision medicine approaches—can effectively reduce PD progression and burden. Integrating early screening

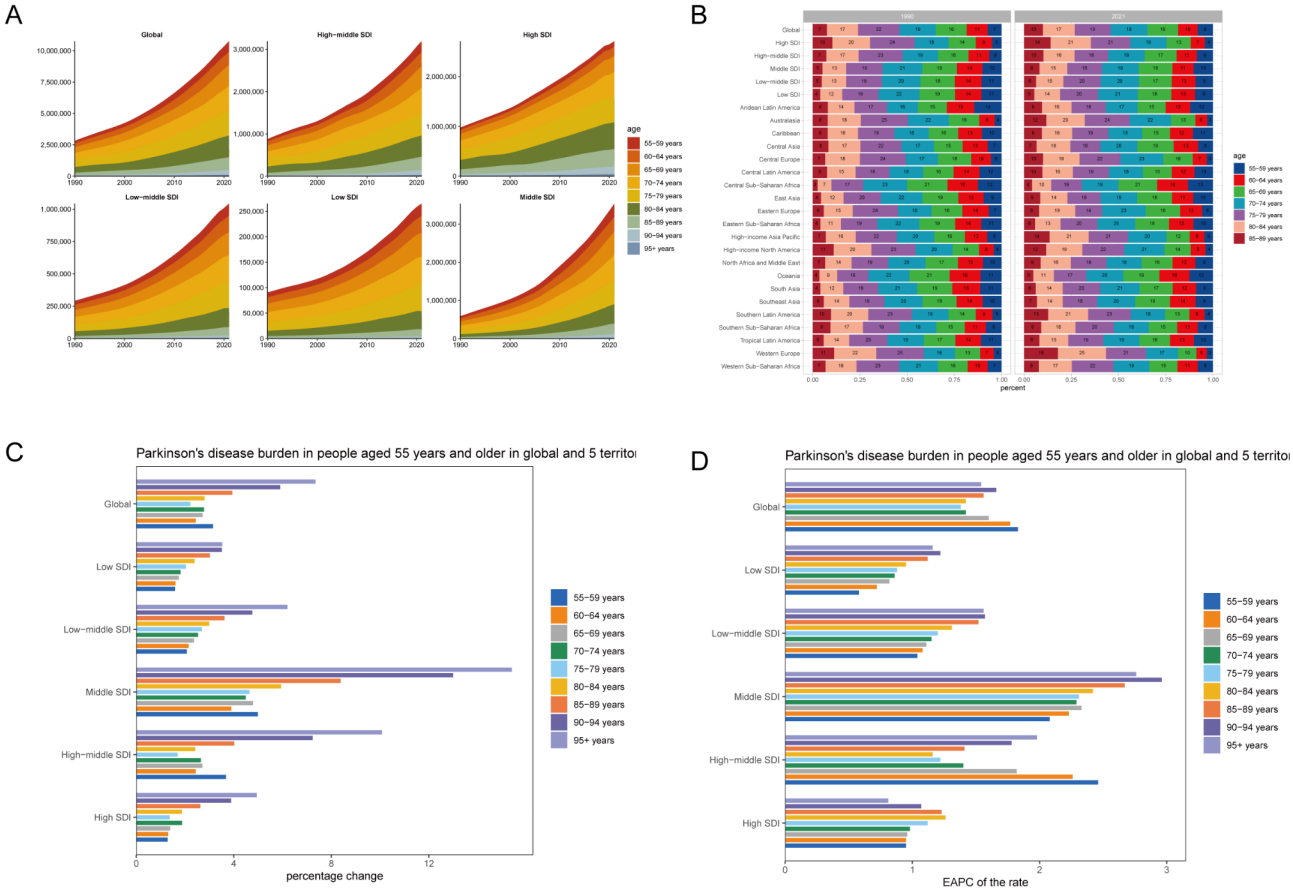

Fig. 4 Temporal trend of PD burden in people over 55 years of age by age pattern in different regions. **(A).** Prevalent cases of 9 age groups (55–95 years, 5-year intervals) from 1990 to 2021 globally and in 5 territories (low to high SDI). **(B).** The distribution of prevalent cases across 9 age groups as percentages globally, in 5 territories, and 21 GBD regions in 1990 and 2021. **(C).** Percentage change in prevalent cases of 9 age groups globally and in 5 territories in 1990 and 2021. **(D).** EAPC of prevalent rates of 9 age groups globally and in 5 territories from 1990 to 2021

programs and targeted health policies with novel therapies may substantially alleviate the global PD impact.

Conclusion

Through a systematic analysis of global and regional epidemiological data from 1990 to 2021, this study demonstrates a substantial increase in the PD burden among individuals aged 55 and older. Between 1990 and 2021, global PD prevalence increased by 281%, incidence by 219%, and DALYs by 165%, with statistically significant upward trends across all age-standardized rates. The PD burden was particularly pronounced among men, in high-income regions, and in the elderly population, highlighting the influence of gender, socio-economic development, and aging on disease dynamics. As global populations continue to age, the PD burden is expected to rise further. This underscores the urgency of implementing targeted public health responses. Recommended strategies include establishing community-based early screening programs for older adults, improving training for primary care providers to enhance early diagnosis, ensuring equitable allocation of healthcare resources in aging societies, and integrating PD management into national chronic disease frameworks. These interventions will be crucial for mitigating the long-term societal and economic impact of PD worldwide.

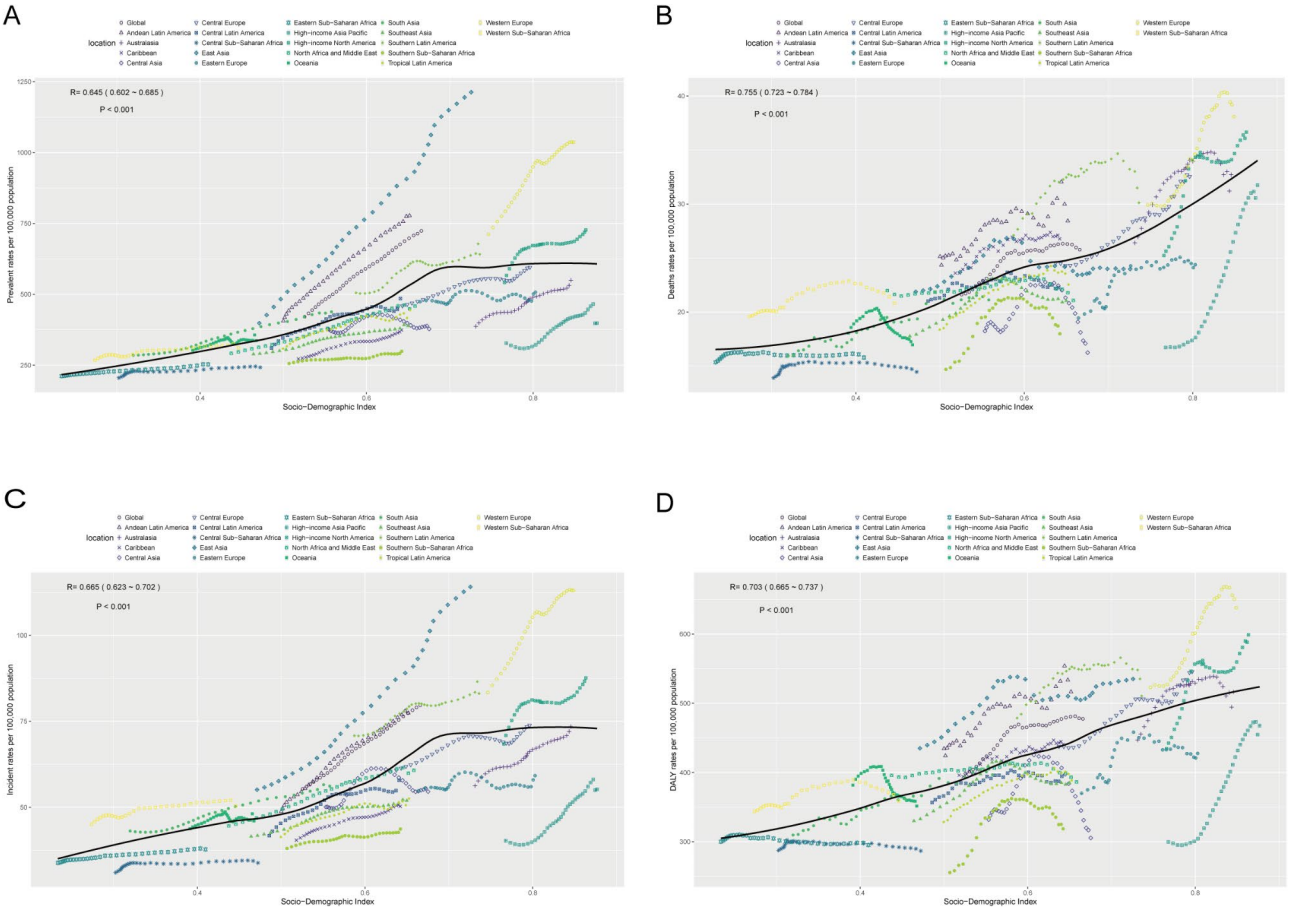

Fig. 5 The associations between the SDI and prevalence, incidence, DALYs and deaths rates per 100,000 population of PD burden in people over 55 years of age across 21 GBD regions

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12883-025-04191-8.

Supplementary Material 1: Supplementary Table 1 The incidence of PD burden in people over 55 years of age in global and 5 cases and rates, and the trends from 1990 to 2021

Supplementary Material 2: Supplementary Table 2 The DALYs of PD burden in people over 55 years of age in global and 5 cases and rates, and the trends from 1990 to 2021

Supplementary Material 3: Supplementary Table 3 The deaths of PD burden in people over 55 years of age in global and 5 cases and rates, and the trends from 1990 to 2021

Supplementary Material 4: Supplementary Table 4 The prevalence of PD burden in people over 55 years of age in 1990 and 2021 across 204 countries, and the trends from 1990 to 2021

Supplementary Material 5: Supplementary Table 5 The incidence of PD burden in people over 55 years of age in 1990 and 2021 across 204 countries, and the trends from 1990 to 2021

Supplementary Material 6: Supplementary Table 6 The DALYs of PD burden in people over 55 years of age in 1990 and 2021 across 204 countries, and the trends from 1990 to 2021

Supplementary Material 7: Supplementary Table 8 The incidence of PD burden in people over 55 years of age in global and 5 cases and rates, and the trends in age patterns from 1990 to 2021

Supplementary Material 8: Supplementary Table 9 The DALY of PD burden in people over 55 years of age in global and 5 cases and rates, and the trends in age patterns from 1990 to 2021

Supplementary Material 9: Supplementary Table 10 The deaths of PD burden in people over 55 years of age in global and 5 cases and rates, and the trends in age patterns from 1990 to 2021

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Author contributions

This study was designed by KL and XW. SP and PL contributed to the data collection and analysis. SP wrote the first draft of the paper. KL revised the article. All authors read and approved the final manuscript.

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Data availability

All data are freely accessible through the Global Health Data Exchange (https://ghdx.healthdata.org/gbd-2021/sources).

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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