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Original Article

Life Expectancy in Asian Countries 1990–2021: A Subanalysis of Causes and Risk Factors from the Global Burden of Disease Study 2021

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Abstract:
Although global Life expectancy (LE) has been increasing for a long period of time, the post-2019 COVID-19 pandemic has led to a reversal of life expectancy trends in most regions. Asia is an ideal region to analyze health drivers due to its population diversity and significant health disparities. Based on the data from Global Burden of Disease Study 2021 (GBD 2021), this study analyzes the changes in LE, health-adjusted life expectancy (HALE), and life expectancy with disability (LED), and risk factor contributions in 34 countries in Asia from 1990-2021, aiming to reveal regional health trajectories and risk factors, and provide a foundation for the development of precise public health strategies. LE and HALE were calculated by standard life tables and Sullivan's method, combining age-specific mortality rates and disability-adjusted life years (YLDs). LED is the difference between LE and HALE. The contribution of 21 categories of causes of death to the change in LE was quantified by the age-cause-of-death decomposition method. Risk factor analyses encompassed the summary exposure values (SEVs) of 88 risk categories and their theoretical minimum exposure levels, with a focus on assessing the spatial and temporal trends of key upstream risks for cardiovascular diseases, respiratory infections and tuberculosis. LE and HALE in Asia showed growth from 1990 to 2021, but there were significant regional differences. Dietary improvement, cholesterol and blood pressure management contributed significantly to most Asian countries, while the negative impacts of air pollution and tobacco were relatively small. Additionally, there was significant regional heterogeneity in the burden of mortality and the effects of risk interventions in the Asian health transition. This study fills this gap by integrating life expectancy trajectories for 34 Asian countries from 1990-2021 and incorporating COVID-19 pandemic impacts, showing significant regional health differentiation in Asia.

Keywords Life expectancy, Health-adjusted life expectancy, Global burden of disease, Asia, COVID-19

1. Background

Life expectancy (LE) has been rising sharply around the world over the past few decades(1). In 2019-2021, there is a significant downward trend in life expectancy in all regions except Africa and Oceania(2). Disruption of health services due to the COVID-19 pandemic, and post-COVID-19 conditions and impacts on multiple organ systems, may still have a sustained impact on life expectancy(3). From a global perspective, Asia is the world's most populous, geographically extensive, and culturally rich and diverse region. It includes countries with large populations such as China, India, and Bangladesh, as well as countries with the longest LE such as Japan and Republic of Korea(4). Analyzing the geographic distribution and trends of LE and Health-adjusted

life expectancy (HALE) in Asia can reveal health disparities among different countries and regions, contributing to the understanding of the impact of various social, economic, and environmental factors on health.

The Global Burden of Disease Study 2021 (GBD 2021), using a harmonized and comparable methodology, provides an exhaustive analysis of the burden of disease for 371 diseases or injuries in 204 countries and territories worldwide, and systematically sorts out the attributable burden of disease for 88 risk factors, to provide good data support for exploring life expectancy in Asia(5,6). Therefore, the study compared the trends in life expectancy and the contribution of causes of death and risk factors to life expectancy in 34 countries in Asia from 1990 to 2021 using GBD 2021, aiming to identify trends in specific causes of death and risk factors associated with changes in life expectancy in particular countries or regions.

Methods

Overview

LE is a widely used health indicator that refers to the number of years a person is expected to live, estimated from the average age at death of the standard population(7). As an important generalized indicator of mortality, LE reflects the health status of all age groups(8). HALE is a summary indicator that estimates the average number of years a person at a given age expects to live in perfect health. HALE is more comprehensive than LE, because it takes into account both longevity and quality of life(9–11). Life expectancy with disability (LED), the difference between LE and HALE, directly reflects the duration of unhealthy survival of a population(12). LE, HALE, and LED cover multiple health dimensions, which are essential for exploring the health status of specific populations and enhancing health policy decisions.

From 1990 to 2021, the study estimated life expectancy, cause of death decomposition, summary exposure values (SEVs) of risk factors, and the contribution of specific risk factors to LE for 34 Asian countries (regions). Following the classification of Asian countries in GBD 2021, this study selected Central Asia (Armenia; Azerbaijan; Georgia; Kazakhstan; Kyrgyzstan; Mongolia; Tajikistan; Turkmenistan; Uzbekistan), high-income Asia-Pacific (Brunei Darussalam; Japan; Republic of Korea; Singapore), South Asia (Bangladesh; Bhutan; India; Nepal; Pakistan), East Asia (China; Democratic People's Republic of Korea; Taiwan (Province of China)), Southeast Asia (Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Maldives; Mauritius; Myanmar; Philippines; Seychelles; Sri Lanka; Thailand; Timor-Leste; Viet Nam). Considering that the COVID-19 pandemic had some impact on life expectancy in Asia, the study compared four time periods: 1990 to 1999, 1999 to 2009, 2009 to 2019, and 2019 to 2021 (1999, 2009, and 2019 were included at both the beginning and end of the time periods). The average annual change in life expectancy over these intervals was estimated, as well as a 95% uncertainty interval (UI) for individual life expectancy in each year.

Life Expectancy Decomposition

Life expectancy (LE) is calculated using age-specific mortality rates based on data from vital statistics registers, surveys and censuses and standard demographic methods. LE is calculated using standardized simplified life tables, with mortality rates and populations collected from GBD 2021 for each age group (1-4, 5-9, 10-14, up to 95+ years) in each country; HALE estimates are derived using Years lived with disability (YLDs) and age-specific mortality by location, age, sex, year, and cause(13), with mortality rates, YLDs, and populations for each age group in each country collected from GBD 2021 and calculated by the Sullivan method(14); LED is the difference between LE and HALE.

$$LE(x) = \frac{\sum_{i=1}^{n} X_i L_x}{l_x}$$

$$HALE(x) = \frac{\sum_{i=1}^{n} (1 - YLD_x) X_i L_x}{l_x}$$

n is the last set of ages in the life table, l_x is the number of survivors at age x, and L_x is the sum of the remaining lifespans of all individuals from age x to death.

Cause-specific mortality rates for 288 causes of death were estimated using the Cause of Death Ensemble model (CODEm), producing stable estimates of mortality rates across age, location, year, and sex(15). Inaccurate causes of death were reassigned to the most likely alternative causes of death.

Changes in life expectancy were attributed to changes in causes of death (which are categorized into 21 categories in GBD level 2) over time to determine the contribution of cause-specific changes to changes in life expectancy. Cause-specific life expectancy decomposition was used to quantify the contribution of country-specific causes of death using established decomposition methods(16). Age-specific life expectancy was calculated first, followed by the contribution of the 21 causes of death to changes in life expectancy within each age group. Finally, the age-specific contributions of the 21 causes of death were aggregated across age groups to produce the contribution of the 21 causes of death to the overall change in life expectancy.

Risk Factor Estimation

GBD 2021 provides epidemiologic estimates of 88 risk factors (divided into four tiers, with 20 risk factors in the second tier) and their associated health outcomes, with a total of 631 risk-outcome pairs. GBD 2021 estimates summary exposure value (SEVs) and theoretically minimal level of risk exposure (16). SEV is a measure of a population's exposure to a risk factor, considering the level of exposure at the risk level and the severity of that risk's contribution to the burden of disease (17). SEVs are measured on a 0-100 scale, with 100 indicating that the entire population is at maximum risk and 0 indicating that the population is at minimum risk. Theoretically minimal level of risk exposure is the lowest level of risk that could theoretically exist in the exposed population.

This study estimated the largest causes of death and their impact on life expectancy in Asian countries during 1990-2021. It also listed the upstream risk factors under cardiovascular diseases and respiratory infections and tuberculosis in 2021. Additionally, it detailed the SEVs of risk factors under cardiovascular diseases and respiratory infections and tuberculosis over time, as well as the extent of the impact of upstream risk factors on LE in Asian countries from 1990 to 2021.

All data used in this study were obtained from the GBD Results tool (https://vizhub.healthdata.org/gbd-results/). All statistical analyses were performed using R (version 4.4.1) and subsequently visualized using ggplot2.

Results

As shown in Table 1, the global LE and HALE showed an overall increasing trend over the period 1990-2021, but a decrease in 2019-2021. Specifically, global LE increased by 0.71 years and HALE increased by 1.28 years from 1990-1999; LE increased by 1.46 years and HALE increased by 2.83 years from 1999-2009; LE increased by 1.17 years and HALE increased by 2.46 years from 2009-2019; and from 2019-2021, LE decreased by 0.98 years and HALE decreased by 1.41 years. From 1990 to 2019, the increase in LE was less than the increase in HALE in all three time periods. However, both LE and HALE decreased from 2019 to 2021, with HALE showing a more significant decline.

Significant variations in LE and HALE changes across different regions of Asia were observed. For instance, the Central Asian region experienced a decline in LE of 0.31 years and a decrease in HALE of 0.65 years from 1990-1999. In the subsequent period (2009-2019), Central Asia again experienced a significant increase in LE and HALE. Among these countries, Azerbaijan demonstrated a notable increase in LE and HALE during 1990-2019, while Turkmenistan exhibited a comparatively modest growth.

In the high-income Asia-Pacific region, LE increased by 1.62 years and HALE by 1.88 years during 1990-1999. Republic of Korea experienced the largest increase in LE and HALE during 1990-2019, while Brunei Darussalam maintained an upward trend in LE and HALE during 2019-2021, although the increase in LE and HALE during 1990-2019 was relatively small.

From 1990 to 2019, South Asia experienced more stable growth in LE and HALE. In comparison to other South Asian countries, Pakistan presented comparatively lower growth in LE and HALE.

The overall trend of LE and HALE in East Asia showed an upward trajectory during the period between 1990 and 2021. China had a more significant increase in LE and HALE, with LE increasing by 0.13 years and HALE increasing by 0.1 years from 2019-2021. In East Asia, the increase in LE was generally lower than the increase in HALE.

LE and HALE in the Southeast Asia region showed an upward trend during 1990-2021, but the increase was relatively small. Laos was distinguished in the Southeast Asia region by its substantial growth in LE and HALE. In contrast, countries like Seychelles and Malaysia presented comparatively modest increases in LE and HALE.

Table 1. Annual changes in life expectancy (LE) and health-adjusted life expectancy (HALE) by time period

Location	1990-1999 changes, years		1999-2009 changes, years		2009-2019 changes, years		2019-2021 changes, years	
	LE	HALE	LE	HALE	LE	HALE	LE	HALE
Global	**0.71 (0.57 to 0.85)**	**1.28 (1.03 to 1.54)**	**1.46 (1.17 to 1.75)**	**2.83 (2.28 to 3.4)**	**1.17 (0.95 to 1.41)**	**2.46 (1.98 to 2.96)**	**-0.98 (-1.17 to -0.78)**	**-1.41 (-1.69 to -1.13)**
Central Asia	**-0.31 (-0.37 to -0.25)**	**-0.65 (-0.77 to -0.51)**	**1.22 (0.99 to 1.47)**	**2.36 (1.90 to 2.85)**	**1.37 (1.11 to 1.65)**	**2.85 (2.30 to 3.43)**	**-1.83 (-2.19 to -1.46)**	**-1.96 (-2.35 to -1.56)**
Armenia	-0.43 (-0.52 to -0.35)	1.11 (0.89 to 1.33)	0.73 (0.59 to 0.88)	1.75 (1.41 to 2.11)	1.82 (1.47 to 2.19)	2.48 (2 to 2.99)	-1.02 (-1.22 to -0.81)	-1.69 (-2.02 to -1.35)
Azerbaijan	0.87 (0.7 to 1.03)	0.23 (0.18 to 0.27)	1.25 (1 to 1.49)	2.7 (2.16 to 3.22)	0.65 (0.52 to 0.78)	2.5 (2 to 2.97)	-2.34 (-2.81 to -1.89)	-2.45 (-2.94 to -1.99)
Georgia	0.97 (0.77 to 1.17)	0.09 (0.07 to 0.11)	2.65 (2.11 to 3.19)	2.2 (1.75 to 2.65)	0.48 (0.39 to 0.58)	1.62 (1.29 to 1.95)	-3.25 (-3.91 to -2.58)	-2.68 (-3.23 to -2.13)
Kazakhstan	-1.84 (-2.23 to -1.49)	-2.36 (-2.85 to -1.91)	1.05 (0.83 to 1.25)	2.38 (1.89 to 2.83)	1.62 (1.28 to 1.93)	4.13 (3.28 to 4.92)	-2.02 (-2.43 to -1.63)	-2.62 (-3.16 to -2.11)
Kyrgyzstan	-0.06 (-0.07 to -0.05)	0.21 (0.17 to 0.25)	0.78 (0.63 to 0.93)	2.22 (1.78 to 2.63)	2.19 (1.76 to 2.6)	4.13 (3.32 to 4.9)	-1.11 (-1.33 to -0.9)	-1.68 (-2.01 to -1.37)
Mongolia	-0.45 (-0.54 to -0.36)	0.68 (0.55 to 0.81)	1.51 (1.21 to 1.8)	2.9 (2.33 to 3.45)	2.17 (1.75 to 2.59)	3.21 (2.58 to 3.82)	-0.42 (-0.51 to -0.34)	-0.54 (-0.64 to -0.43)
Tajikistan	-0.12 (-0.14 to -0.1)	0.21 (0.17 to 0.25)	0.14 (0.12 to 0.17)	2.65 (2.14 to 3.15)	2.77 (2.23 to 3.29)	3.27 (2.64 to 3.89)	-2.32 (-2.76 to -1.88)	-3.29 (-3.93 to -2.67)
Turkmenistan	0.04 (0.03 to 0.05)	-0.04 (-0.04 to -0.03)	2.39 (1.94 to 2.83)	2.38 (1.93 to 2.82)	-0.08 (-0.1 to -0.07)	1.45 (1.17 to 1.71)	-2.37 (-2.82 to -1.93)	-1.99 (-2.37 to -1.62)
Uzbekistan	-0.36 (-0.43 to -0.29)	-0.62 (-0.74 to -0.5)	0.31 (0.25 to 0.37)	1.7 (1.37 to 2.02)	1.48 (1.19 to 1.77)	2.44 (1.96 to 2.9)	-0.77 (-0.92 to -0.62)	-0.91 (-1.08 to -0.73)
High-income Asia Pacific	**1.62 (1.29 to 1.93)**	**1.88 (1.50 to 2.25)**	**1.04 (0.83 to 1.24)**	**2.02 (1.61 to 2.41)**	**0.73 (0.59 to 0.88)**	**1.61 (1.29 to 1.92)**	**0.1 (0.08 to 0.11)**	**-0.09 (-0.11 to -0.07)**

Brunei Darussalam	1.31 (1.05 to 1.55)	2.07 (1.65 to 2.45)	0.81 (0.65 to 0.96)	1.73 (1.38 to 2.04)	-0.02 (-0.03 to -0.02)	0.2 (0.16 to 0.24)	0.31 (0.25 to 0.37)	0.02 (0.02 to 0.03)
Japan	1.48 (1.19 to 1.75)	1.38 (1.12 to 1.63)	0.81 (0.65 to 0.95)	1.61 (1.29 to 1.9)	0.63 (0.51 to 0.75)	1.45 (1.16 to 1.71)	0.14 (0.11 to 0.17)	-0.04 (-0.05 to -0.04)
Republic of Korea	1.76 (1.44 to 2.1)	3.29 (2.68 to 3.92)	2.36 (1.92 to 2.81)	3.49 (2.85 to 4.17)	1.54 (1.26 to 1.84)	2.29 (1.87 to 2.73)	-0.11 (-0.13 to -0.09)	-0.25 (-0.3 to -0.2)
Singapore	1.31 (1.06 to 1.55)	2.71 (2.18 to 3.21)	1.69 (1.36 to 2)	2.93 (2.35 to 3.46)	1.78 (1.43 to 2.11)	2.53 (2.03 to 2.99)	-0.26 (-0.31 to -0.21)	-0.07 (-0.08 to -0.06)
South Asia	**1.39 (1.12 to 1.67)**	**2.57 (2.06 to 3.07)**	**1.34 (1.08 to 1.6)**	**3.13 (2.51 to 3.75)**	**1.04 (0.83 to 1.24)**	**2.78 (2.23 to 3.33)**	**-1.53 (-1.83 to -1.23)**	**-1.57 (-1.88 to -1.26)**
Bangladesh	1.41 (1.12 to 1.68)	5.14 (4.1 to 6.13)	1.52 (1.21 to 1.81)	3.74 (2.99 to 4.46)	2.28 (1.82 to 2.72)	3.91 (3.12 to 4.67)	-1.17 (-1.41 to -0.95)	-1.36 (-1.63 to -1.1)
Bhutan	2.55 (2.04 to 3.05)	4.69 (3.77 to 5.62)	2.01 (1.62 to 2.41)	4.49 (3.6 to 5.37)	0.7 (0.56 to 0.84)	2.4 (1.93 to 2.87)	-0.14 (-0.17 to -0.12)	-0.02 (-0.02 to -0.01)
India	1.69 (1.36 to 2.02)	2.5 (2.02 to 2.99)	1.23 (1 to 1.47)	3.17 (2.56 to 3.79)	0.95 (0.77 to 1.14)	2.92 (2.36 to 3.49)	-1.47 (-1.75 to -1.18)	-1.53 (-1.82 to -1.23)
Nepal	3.02 (2.4 to 3.58)	5.58 (4.43 to 6.61)	1.76 (1.4 to 2.09)	3.9 (3.1 to 4.62)	0.33 (0.26 to 0.39)	2.26 (1.79 to 2.68)	-2.32 (-2.8 to -1.89)	-2.52 (-3.04 to -2.05)
Pakistan	-0.5 (-0.6 to -0.4)	-0.04 (-0.05 to -0.03)	1.09 (0.88 to 1.31)	2.1 (1.69 to 2.51)	1.13 (0.91 to 1.35)	1.98 (1.6 to 2.37)	-2.22 (-2.65 to -1.79)	-1.87 (-2.23 to -1.5)
East Asia	**1.22 (0.98 to 1.46)**	**2.33 (1.87 to 2.78)**	**1.53 (1.23 to 1.82)**	**3.42 (2.74 to 4.08)**	**1.6 (1.28 to 1.9)**	**2.24 (1.79 to 2.66)**	**0.12 (0.1 to 0.14)**	**0.10 (0.08 to 0.12)**
China	1.33 (1.06 to 1.57)	2.59 (2.07 to 3.06)	1.43 (1.15 to 1.69)	3.3 (2.65 to 3.91)	1.62 (1.3 to 1.92)	2.25 (1.81 to 2.67)	0.13 (0.1 to 0.15)	0.1 (0.08 to 0.11)
Democratic People's Republic of Korea	-3.4 (-4.05 to -2.75)	-6.63 (-7.91 to -5.37)	3.62 (2.93 to 4.32)	7.4 (5.98 to 8.82)	1.19 (0.96 to 1.42)	1.95 (1.57 to 2.32)	0.19 (0.15 to 0.23)	0.25 (0.21 to 0.3)
Taiwan (Province of China)	1.13 (0.91 to 1.36)	1.37 (1.1 to 1.64)	2.71 (2.18 to 3.24)	2.27 (1.82 to 2.71)	0.55 (0.44 to 0.66)	1.06 (0.86 to 1.27)	-0.1 (-0.12 to -0.08)	0.09 (0.07 to 0.11)
Southeast Asia	**1.39 (1.12 to 1.67)**	**2.20 (1.76 to 2.61)**	**0.76 (0.61 to 0.9)**	**2.30 (1.84 to 2.73)**	**1.21 (0.97 to 1.43)**	**2.02 (1.61 to 2.39)**	**-1.28 (-1.53 to -1.04)**	**-1.40 (-1.68 to -1.15)**
Cambodia	1.2 (0.97 to 1.43)	2.25 (1.83 to 2.69)	2.38 (1.94 to 2.85)	5.58 (4.54 to 6.68)	0.94 (0.77 to 1.13)	2.86 (2.33 to 3.42)	-0.9 (-1.07 to -0.72)	-0.87 (-1.04 to -0.7)
Indonesia	0.95 (0.75 to 1.14)	2.68 (2.13 to 3.22)	0.21 (0.17 to 0.26)	1.89 (1.5 to 2.27)	0.84 (0.66 to 1.01)	2.08 (1.65 to 2.5)	-1.32 (-1.59 to -1.05)	-1.53 (-1.84 to -1.22)

Lao People's Democratic Republic	2.25 (1.82 to 2.7)	4.42 (3.57 to 5.29)	3 (2.42 to 3.59)	5.79 (4.68 to 6.93)	1.66 (1.34 to 1.98)	4.01 (3.24 to 4.8)	-0.84 (-1 to -0.67)	-0.68 (-0.81 to -0.55)
Malaysia	-1.28 (-1.51 to -1.02)	0.14 (0.12 to 0.17)	0.05 (0.04 to 0.06)	1.7 (1.39 to 2.05)	0.5 (0.4 to 0.6)	0.51 (0.42 to 0.61)	-1.48 (-1.75 to -1.18)	-1.57 (-1.86 to -1.25)
Maldives	2.56 (2.05 to 3.07)	5.2 (4.16 to 6.23)	2.32 (1.85 to 2.78)	5.22 (4.17 to 6.25)	1.39 (1.11 to 1.67)	2.31 (1.84 to 2.76)	-0.78 (-0.94 to -0.63)	-1.05 (-1.26 to -0.84)
Mauritius	1.42 (1.15 to 1.71)	1.3 (1.05 to 1.56)	1.68 (1.36 to 2.02)	1.39 (1.13 to 1.67)	0.24 (0.19 to 0.29)	0.42 (0.34 to 0.5)	-1.13 (-1.34 to -0.9)	-0.84 (-1.01 to -0.68)
Myanmar	1.33 (1.07 to 1.58)	2.73 (2.18 to 3.24)	2.61 (2.09 to 3.1)	5.04 (4.04 to 5.98)	2.01 (1.61 to 2.39)	4.38 (3.51 to 5.2)	-1.24 (-1.48 to -1.01)	-1.18 (-1.42 to -0.96)
Philippines	1.41 (1.14 to 1.69)	2.06 (1.66 to 2.46)	-0.19 (-0.22 to -0.15)	0.19 (0.15 to 0.22)	0.48 (0.39 to 0.57)	0.83 (0.67 to 0.99)	-2.6 (-3.1 to -2.1)	-2.57 (-3.06 to -2.07)
Seychelles	0.39 (0.32 to 0.47)	0.96 (0.77 to 1.15)	0.09 (0.07 to 0.11)	0.84 (0.68 to 1.01)	0.34 (0.27 to 0.4)	0.04 (0.04 to 0.05)	-0.3 (-0.36 to -0.24)	-0.09 (-0.11 to -0.07)
Sri Lanka	1.23 (0.99 to 1.46)	1.44 (1.16 to 1.71)	0.55 (0.44 to 0.65)	1.36 (1.09 to 1.61)	1.78 (1.42 to 2.1)	3.29 (2.63 to 3.88)	-0.58 (-0.7 to -0.48)	-0.82 (-0.98 to -0.67)
Thailand	0.26 (0.22 to 0.32)	0.22 (0.18 to 0.27)	1.64 (1.35 to 1.98)	3.77 (3.1 to 4.54)	1.41 (1.15 to 1.69)	1.42 (1.17 to 1.71)	-1.04 (-1.22 to -0.83)	-0.91 (-1.07 to -0.73)
Timor-Leste	0.13 (0.11 to 0.16)	-1.49 (-1.77 to -1.19)	3.42 (2.78 to 4.09)	10.08 (8.19 to 12.06)	0.02 (0.01 to 0.02)	1.18 (0.96 to 1.41)	-1.24 (-1.47 to -0.99)	-1.28 (-1.52 to -1.03)
Viet Nam	0.86 (0.68 to 1.03)	2.43 (1.92 to 2.92)	0.21 (0.17 to 0.25)	0.95 (0.75 to 1.14)	0.65 (0.51 to 0.78)	1.32 (1.04 to 1.58)	-0.37 (-0.45 to -0.3)	-0.37 (-0.45 to -0.3)

As illustrated in Figure 1, LE and HALE demonstrated a consistent upward trend across all regions from 1990 to 2019, with the most notable increases observed in East Asia and high-income Asia-Pacific. However, starting in 2019, LE and HALE began to decrease in Central, South, and Southeast Asia. There was no significant change in LE and HALE in high-income Asia-Pacific over the 2019-2021 period, while an upward trend was observed in LE and HALE in East Asia. Overall, growth in HALE between 1990 and 2021 exceeded LE, resulting in a decrease in LED. East Asia and the high-income Asia-Pacific region showed more consistent growth rates in LE and HALE, with smaller reductions in LED and lower LED overall compared to other regions. South and Southeast Asia, however, demonstrated the most significant reduction in LED and an overall high LED.

As illustrated in Figure 2, in most Central Asian countries, such as Kazakhstan and Uzbekistan, LE and HALE exhibited a relatively stable upward trend during the period 1990-2019. However, Tajikistan was noteworthy for its unique experience with the LE. While the LE increased overall, it underwent fluctuations, with an upward trend that decelerated or even decreased slightly in 1993, followed by a subsequent rise. For HALE, Tajikistan's increase was comparatively modest among other Central Asian countries.

Other South Asian countries, including Bangladesh and India, showed a steady rise in LE

and HALE. However, Bhutan experienced a particularly notable increase in these metrics, while Pakistan's progress was more gradual.

There were some differences in the trends of LE and HALE in Democratic People's Republic of Korea compared to China in East Asia. China's LE and HALE showed a more stable linear increase, while Democratic People's Republic of Korea 's LE and HALE fell in 1995 and remained stable during 1996-2002 before rebounding rapidly in 2003.

Southeast Asian countries such as the Philippines, Seychelles, and Vietnam showed a steady trend in LE and HALE over the period 1990-2021, while Laos illustrated the most pronounced increasing trend in LE and HALE. Myanmar, Sri Lanka, and Timor-Leste presented a steeper, more moderate upward trend, with steeper decreases in 1999, 2004, and 2008, respectively, and then a rapid rebound in the following year.

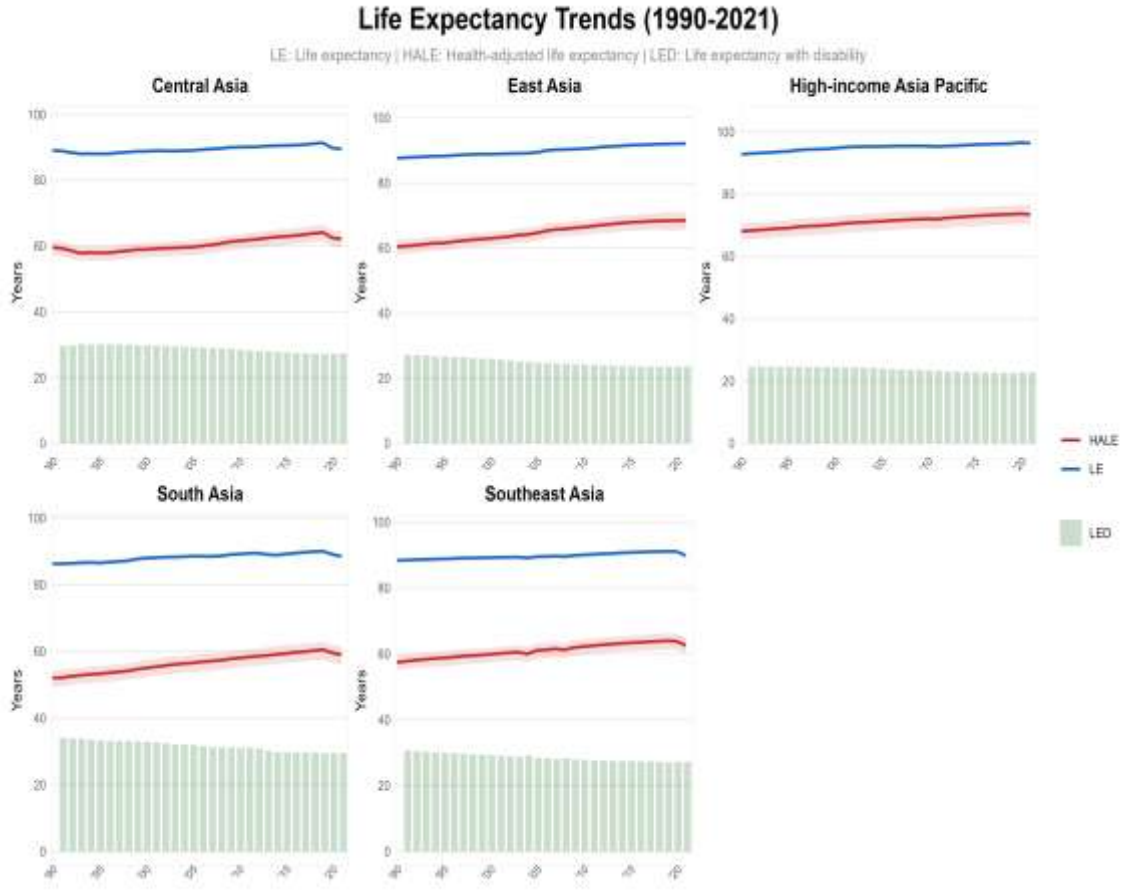

Figure 1. Trends of LE, HALE and LED in five subregions of Asia during 1990-2021

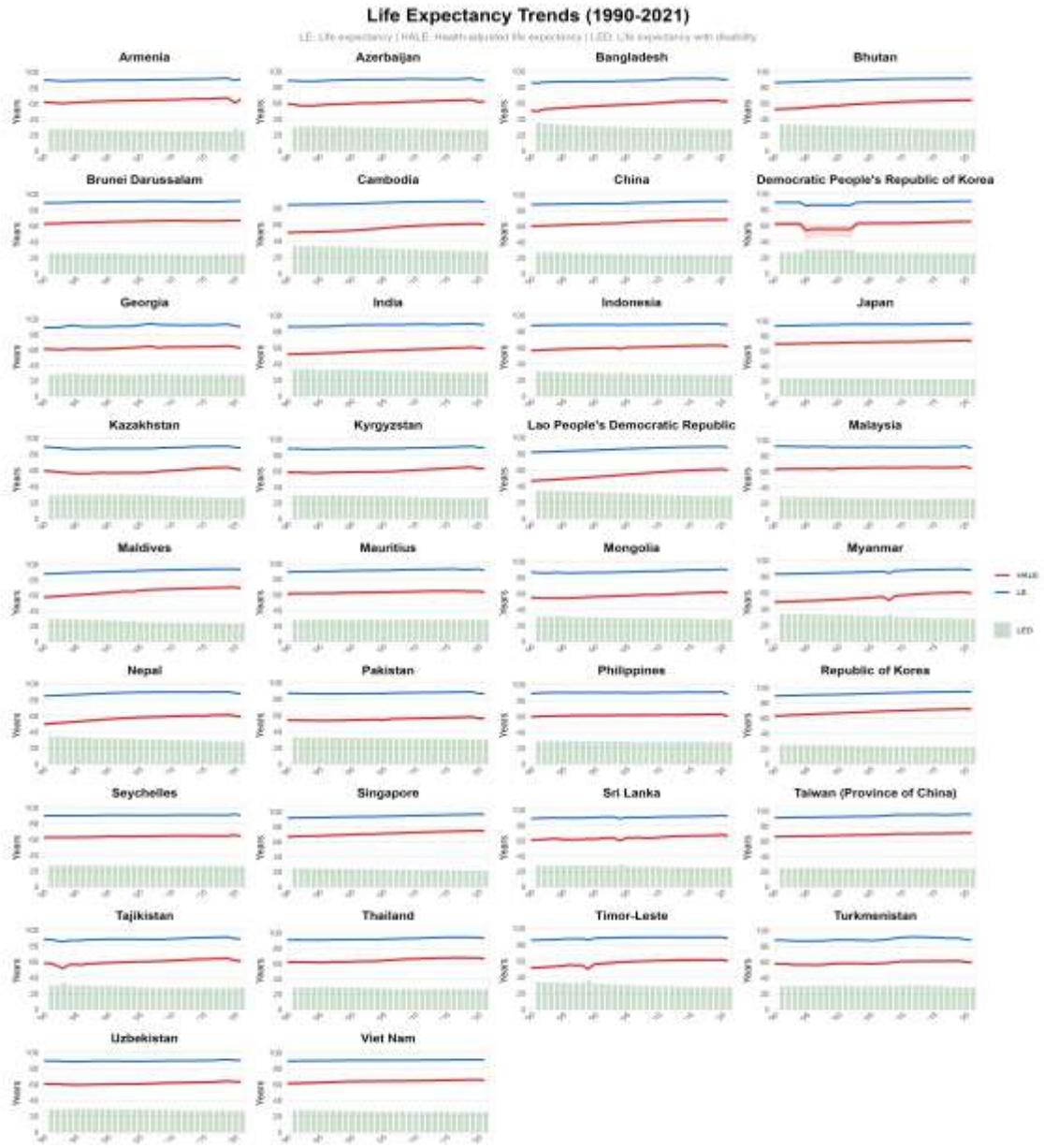

Figure 2. Trends of LE, HALE and LED in 34 Asian countries during 1990-2021

As illustrated in Figure 3, cardiovascular diseases, chronic respiratory diseases, and transport injuries primarily impacted LE in Central Asian countries during the 1990s. Kazakhstan was the most severely affected, with its LE being impacted by cardiovascular diseases (-9.94 years), self-harm and interpersonal violence (-12.47 years), and unintentional injuries (-4.5 years). From 1999 to 2019, cardiovascular diseases, respiratory infections and tuberculosis, and unintentional injuries had the greatest impact on LE in Central Asian countries. From 1990 to 2009, Georgia experienced a significant increase in LE, primarily due to a decline in cardiovascular disease mortality. Similarly, in 2009, cardiovascular diseases were the leading cause of death in Kazakhstan, Kyrgyzstan, and Mongolia, with ages of 8.92, 10.52, and 9.56 years, respectively. Beginning in 2019, the primary factors influencing LE in Central Asian countries shifted to respiratory infections and tuberculosis, and neoplasms.

LE in the high-income Asia-Pacific region for the period 1990-2021 was chronically affected by cardiovascular diseases and neoplasms. The most significant improvement in cause of death for LE in Republic of Korea was neoplasms (6.6 years) from 1990 to 1999, while cardiovascular diseases demonstrated the most significant improvement from 1999 to 2009 (10.82 years).

South Asian countries were affected by a variety of infectious diseases, including respiratory infections and tuberculosis, enteric infections, and other infectious diseases. From 1990 to 1999, while other countries had improvements in LE due to a decrease in cardiovascular diseases, enteric infections, and respiratory infections and tuberculosis, Pakistan's increase in LE was stifled due to these causes of death.

LE in East Asia was primarily influenced by two major factors: cardiovascular diseases and respiratory infections and tuberculosis. The causes of death in China that led to an improvement in its LE during 1990-2019 were cardiovascular diseases and neoplasms.

Southeast Asian countries also experienced a high prevalence of respiratory infections and tuberculosis, and cardiovascular diseases from 1990 to 2019. Since 2019, there has been an uptick in transport injuries, unintentional injuries, and self-harm and interpersonal violence.

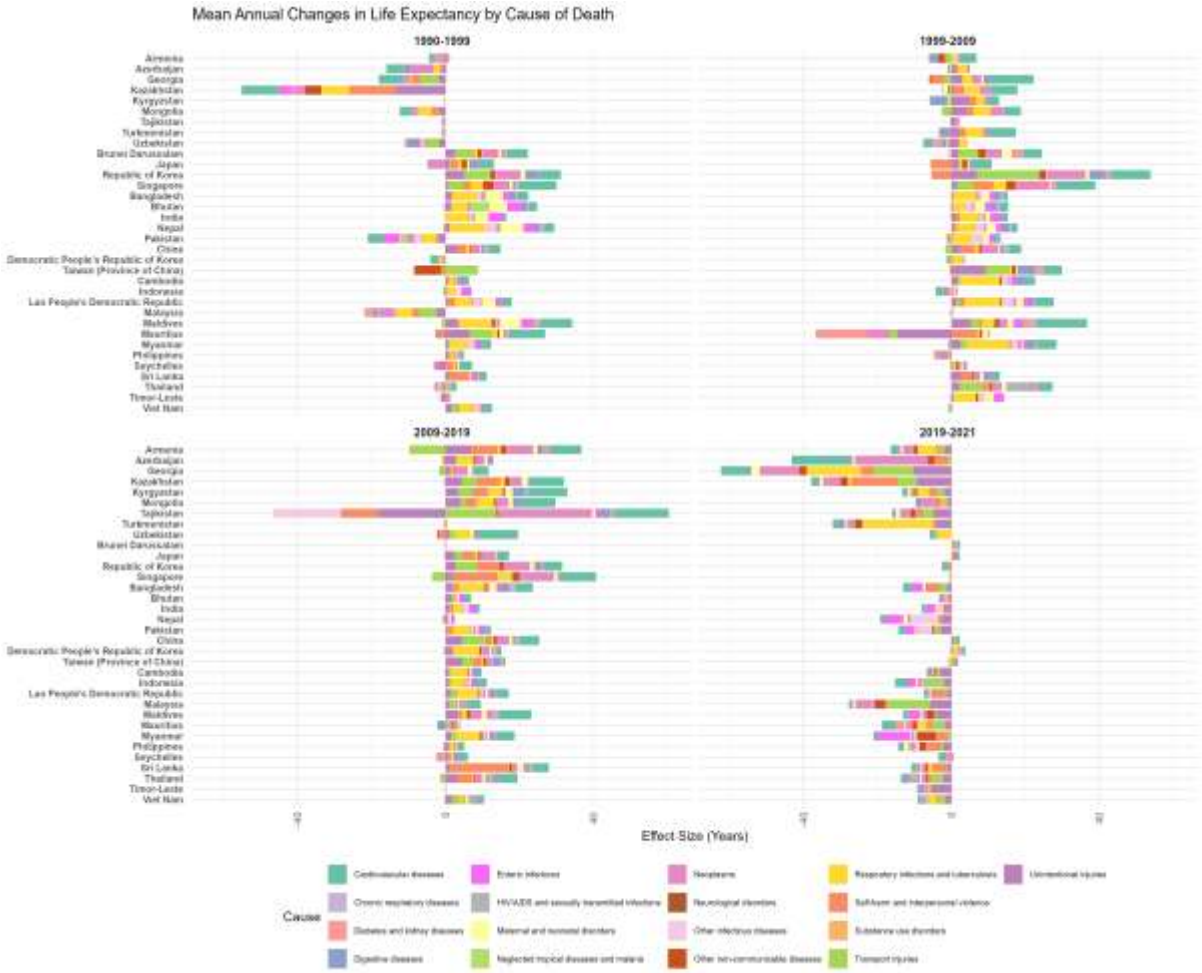

Figure 3. Extent of impact of cause of death on life expectancy, 1990-2021

As shown in Table 2, the causes of death with the greatest impact on LE in Asian countries were indicated, as well as the extent of their impact. In Central Asia, the primary causes of death that had the greatest impact on LE shifted from cardiovascular diseases (1990-2019) to respiratory infections and tuberculosis (2019-2021). The leading causes of death that significantly impact LE in high-income Asia-Pacific countries remained consistent, with cardiovascular diseases and neoplasms being the predominant factors. For South Asian countries, the most impactful causes of death in the 1990-2019 period were respiratory infections and tuberculosis, but during 2019-2021, the leading causes shifted to other infectious diseases. The leading causes of death in East Asia remained the same (cardiovascular diseases, respiratory infections and tuberculosis). In Southeast Asia, the leading causes of death shifted from cardiovascular diseases and respiratory infections and tuberculosis (1990-2019) to transport injuries (2019-2021).

Table 2. Top causes of death and their impact on life expectancy in Asian countries, 1990-2021

Location	Period							
	1990-1999		1999-2009		2009-2019		2019-2021	
	Cause	Effect	Cause	Effect	Cause	Effect	Cause	Effect
Central Asia								
Armenia	Cardiovascular diseases	-1.6	Cardiovascular diseases	4.48	Transport injuries	-9.78	Respiratory infections and tuberculosis	-5.16
Azerbaijan	Neoplasms	-6.41	Respiratory infections and tuberculosis	2.48	Respiratory infections and tuberculosis	4.76	Neoplasms	-19.68
Georgia	Cardiovascular diseases	-6.4	Cardiovascular diseases	11.91	Cardiovascular diseases	3.68	Respiratory infections and tuberculosis	-14.7
Kazakhstan	Unintentional injuries	-13.66	Cardiovascular diseases	7.12	Cardiovascular diseases	8.92	Self-harm and interpersonal violence	-12.31
Kyrgyzstan	Chronic respiratory diseases	-0.2	Unintentional injuries	4.81	Cardiovascular diseases	10.52	Respiratory infections and tuberculosis	-3.36
Mongolia	Respiratory infections and tuberculosis	-3.44	Respiratory infections and tuberculosis	4.66	Cardiovascular diseases	9.56	Neoplasms	-3.54
Tajikistan	Chronic respiratory diseases	-0.52	Unintentional injuries	1.03	Neoplasms	25.45	Unintentional injuries	-4.87
Turkmenistan	Transport injuries	-0.28	Cardiovascular diseases	7.56	Self-harm and interpersonal violence	0.28	Respiratory infections and tuberculosis	-19.19
Uzbekistan	Transport injuries	-3.39	Cardiovascular diseases	-2.57	Cardiovascular diseases	10.31	Respiratory infections and tuberculosis	-3.87
High-income Asia Pacific								
Brunei	Cardiovascul	5.59	Transport	5.09	Chronic	-0.2	Neoplasms	0.78

Darussalam	ar diseases		injuries		respiratory diseases			
Japan	Neoplasms	-4.91	Self-harm and interpersonal violence	-5.63	Neoplasms	4.03	Neoplasms	0.85
Republic of Korea	Neoplasms	6.6	Transport injuries	17	Neoplasms	7.13	Cardiovascular diseases	-0.84
Singapore	Cardiovascular diseases	10.1	Cardiovascular diseases	10.51	Self-harm and interpersonal violence	12.25	Cardiovascular diseases	-0.2
South Asia								
Bangladesh	Respiratory infections and tuberculosis	6.9	Respiratory infections and tuberculosis	6.23	Respiratory infections and tuberculosis	7.04	Self-harm and interpersonal violence	-3.09
Bhutan	Neglected tropical diseases and malaria	5.31	Respiratory infections and tuberculosis	3.29	Unintentional injuries	1.66	Unintentional injuries	-0.78
India	Respiratory infections and tuberculosis	6.11	Respiratory infections and tuberculosis	5.17	Respiratory infections and tuberculosis	2.17	Enteric infections	-2.28
Nepal	Respiratory infections and tuberculosis	9.43	Respiratory infections and tuberculosis	4.93	Enteric infections	0.79	Other infectious diseases	-7.84
Pakistan	Enteric infections	-4.14	Respiratory infections and tuberculosis	5.25	Respiratory infections and tuberculosis	4.51	Other infectious diseases	-4.2
East Asia								
China	Cardiovascular diseases	3.16	Neoplasms	4.58	Transport injuries	6.51	Cardiovascular diseases	0.7
Democratic People's Republic of	Cardiovascular diseases	-1.98	Respiratory infections and tuberculosis	2.63	Respiratory infections and tuberculosis	7.1	Respiratory infections and tuberculosis	1.34

Korea								
Taiwan (Province of China)	Transport injuries	8.68	Unintentional injuries	9.24	Unintentional injuries	4.49	Neoplasms	0.71
South east Asia								
Cambodia	Respiratory infections and tuberculosis	1.63	Respiratory infections and tuberculosis	10.66	Respiratory infections and tuberculosis	4.69	Unintentional injuries	-3.02
Indonesia	Enteric infections	2.41	Cardiovascular diseases	-1.95	Respiratory infections and tuberculosis	3.69	Transport injuries	-5.17
Lao People's Democratic Republic	Respiratory infections and tuberculosis	4.48	Respiratory infections and tuberculosis	9.62	Respiratory infections and tuberculosis	5.86	Self-harm and interpersonal violence	-2.87
Malaysia	Transport injuries	-4.88	Other non-communicable diseases	0.19	Cardiovascular diseases	3.41	Transport injuries	-11.9
Maldives	Respiratory infections and tuberculosis	9.1	Cardiovascular diseases	13.75	Cardiovascular diseases	8.8	Unintentional injuries	-3.96
Mauritius	Cardiovascular diseases	9.79	Unintentional injuries	-14.56	Digestive diseases	-2.16	Cardiovascular diseases	-3.7
Myanmar	Respiratory infections and tuberculosis	4.96	Respiratory infections and tuberculosis	11.61	Respiratory infections and tuberculosis	6.51	Enteric infections	-8.96
Philippines	Respiratory infections and tuberculosis	1.28	Diabetes and kidney diseases	-1.79	Cardiovascular diseases	1.54	Self-harm and interpersonal violence	-4.01
Seychelles	Cardiovascular diseases	3.28	Digestive diseases	0.71	Diabetes and kidney diseases	-2.45	Cardiovascular diseases	-1.95

Sri Lanka	Self-harm and interpersonal violence	4.98	Self-harm and interpersonal violence	3.02	Self-harm and interpersonal violence	15.59	Self-harm and interpersonal violence	-3.79
Thailand	Cardiovascular diseases	1.38	HIV/AIDS and sexually transmitted infections	7.07	Cardiovascular diseases	5	Transport injuries	-3.37
Timor-Leste	Neoplasms	1.18	Respiratory infections and tuberculosis	6.01	Enteric infections	0.09	Unintentional injuries	-4.76
Viet Nam	Respiratory infections and tuberculosis	3.81	Cardiovascular diseases	-0.32	Transport injuries	2.13	Transport injuries	-2.13

Based on the data in GBD 2021, the mortality rates due to risk factors under cardiovascular diseases, respiratory infections and tuberculosis in the five subregions of Asia were ranked and summed. According to the different disease classifications, the numbers of the mortality rate ranking results of the five subregions were similarly summed to form the Total Rank in Asia, with the smaller Total Rank indicating that the corresponding risk factors contributed more to the mortality rates of the five subregions.

According to the importance of risk factors under cardiovascular diseases and respiratory infections and tuberculosis as shown in Figure 4, air Pollution, dietary disks, high systolic blood pressure, tobacco, and high LDL cholesterol had higher Total Ranks and contributed more to the mortality rates.

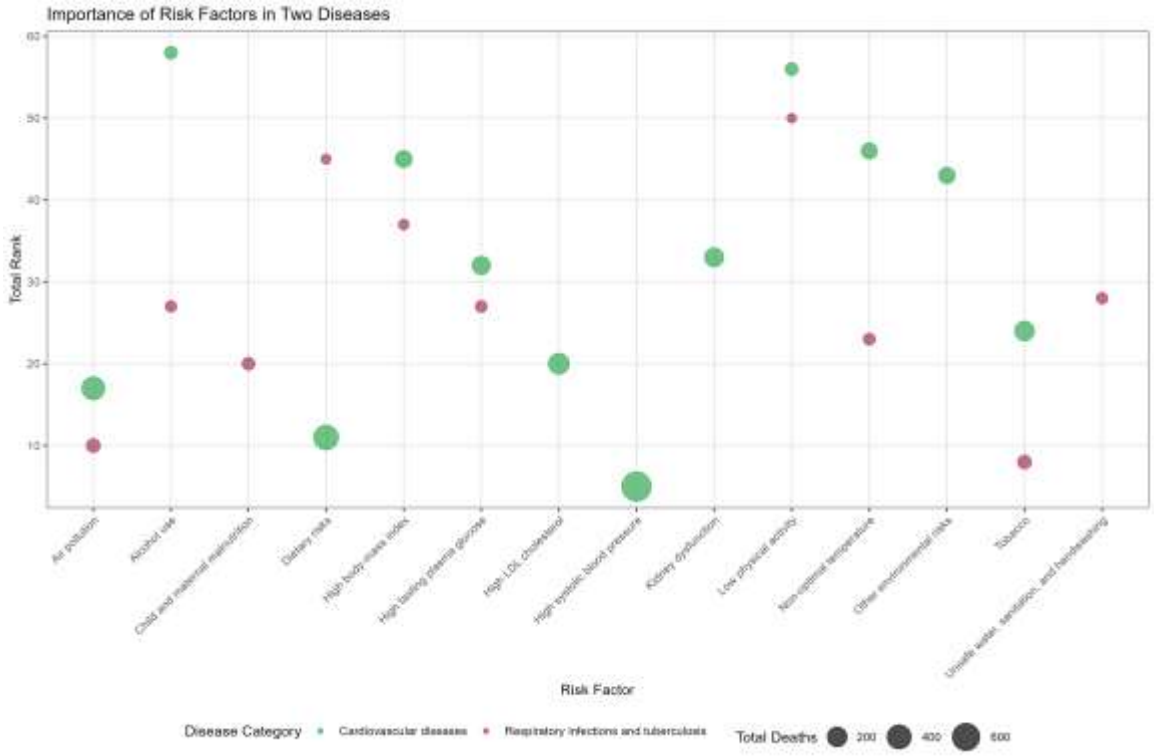

Figure 4. Importance of risk factors under cardiovascular diseases and respiratory infections and tuberculosis (2021)

As shown in Figure 5, the SEVs for the top five risk factors for cardiovascular disease and respiratory infections and tuberculosis showed some consistent patterns over time from 1990-2021. Dietary risk and high LDL cholesterol were consistently high population risks, with exposure to dietary risk steadily decreasing and exposure to high LDL cholesterol steadily increasing in all Asian countries. Around 2020, exposure to air pollution began to reverse after decreasing to its lowest value in most countries. For exposure to high systolic blood pressure, most Asian countries showed a decreasing and then increasing trend over the period 1990-2021, with trend reversals generally occurring in the period 2000-2010. Tobacco was at a higher exposure value from 1990 to 2021, with an overall steady decreasing trend, except for Uzbekistan and Georgia, which showed a significant upward trend.

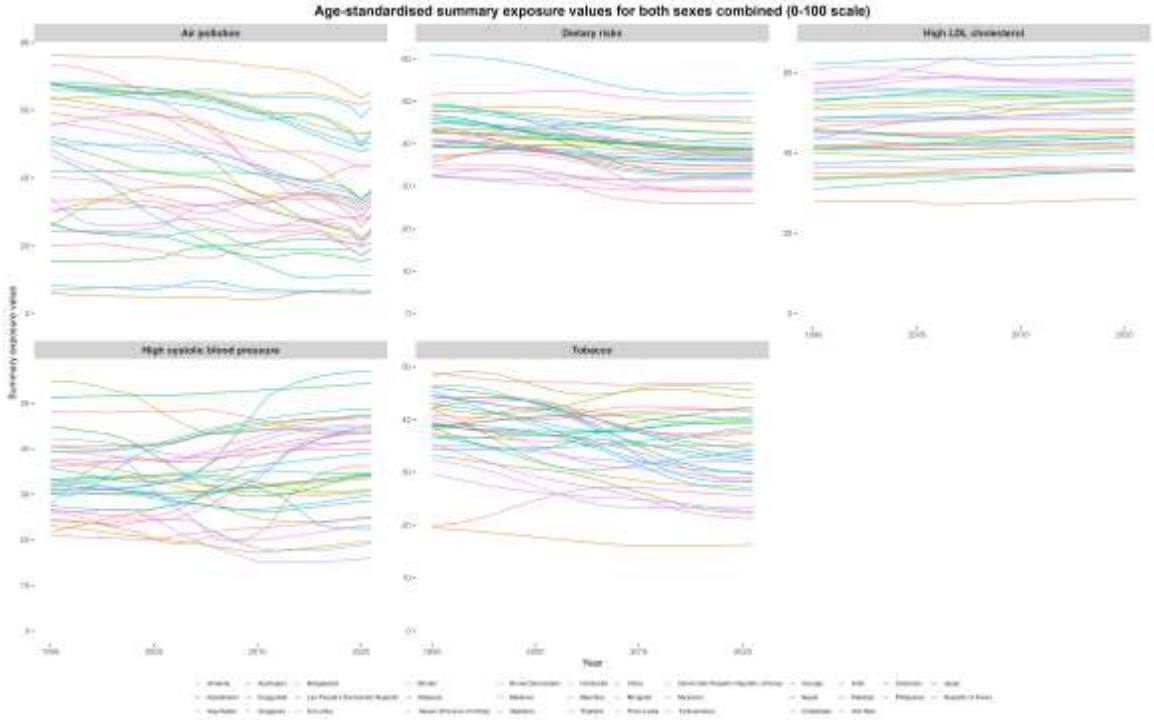

Figure 5 Summary of age-standardized exposure values for major risk factors for cardiovascular disease and respiratory infections and tuberculosis, 1990-2021 (scale 0-100)

As shown in Figure 6, the five major risk factors of dietary risk, high LDL cholesterol, air pollution, high systolic blood pressure, and tobacco had a significant negative impact on life expectancy in Central Asian countries in the 1990s. For Uzbekistan in particular, the negative contribution of tobacco to its LE was as high as 25.24%. Over the period of 1999-2019, the five major risk factors contributed to the improvement of LE in Central Asia with varying degrees of contribution. Air pollution and tobacco exposure negatively affected life expectancy to varying degrees in Azerbaijan and Uzbekistan during the 2019-2021 period.

During 1990-2021, each of the five risk factors contributed in varying degrees to improvements in LE in high-income Asia-Pacific countries. Compared to other regions, the five risk factors contributed less to improvements in LE in South Asia and more to improvements in Southeast Asia. Dietary risk, high LDL cholesterol and high systolic blood pressure contributed positively to LE in the majority of countries, while air pollution and tobacco contributed less negatively to LE in the majority of countries.

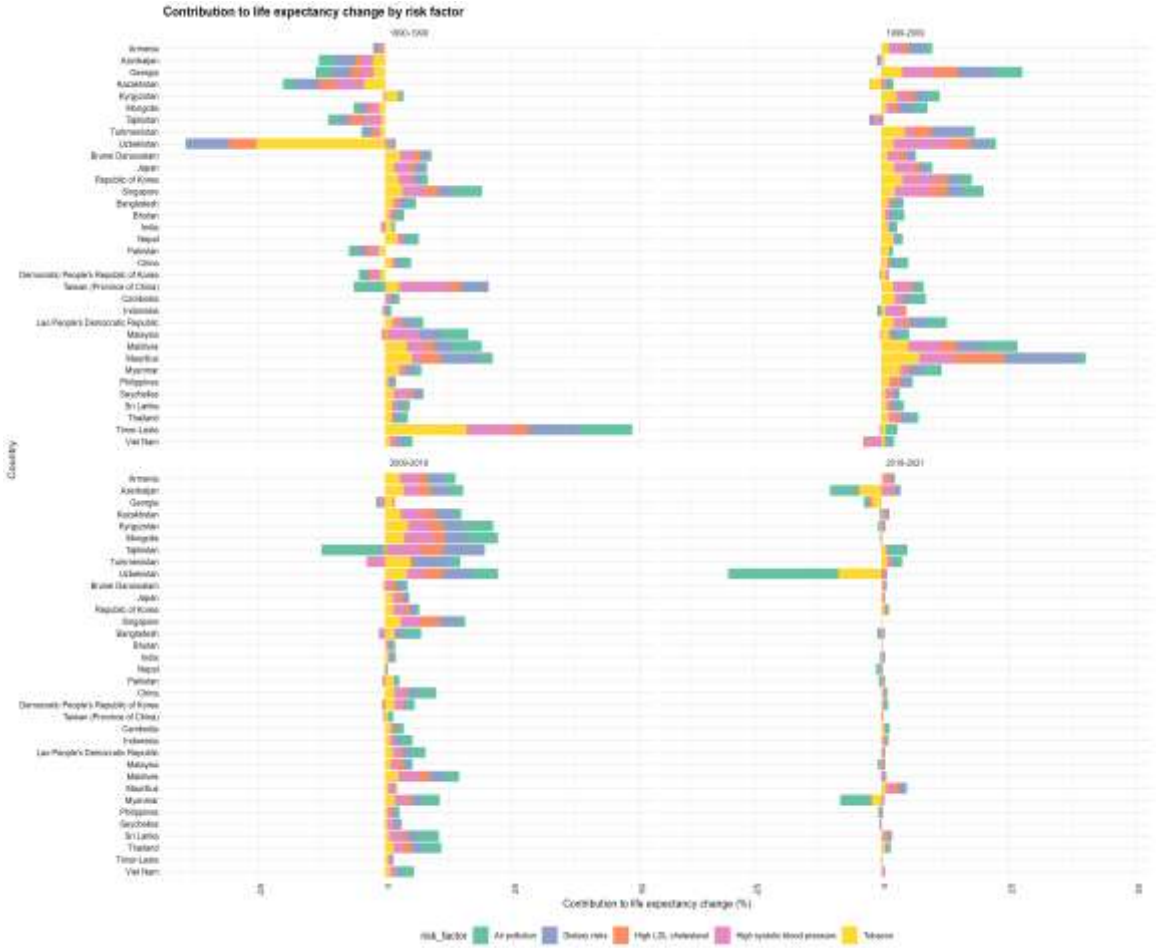

Figure 6. Extent of contribution of risk factors to life expectancy, 1990-2021

Discussion

Overall Trends in LE and HALE

Global LE and HALE showed an overall upward trend during 1990-2021, but a decline in 2019-2021. This finding aligns with those of previous studies (2,12,18). From 1990 to 2019, the rise in LE was less significant than that of HALE, suggesting that the rate of enhancement in HALE is rapid on a global scale, leading to an increase in lifespan and improved health among the population. However, the decline in both LE and HALE from 2019-2021 may be related to the impact of global public health events on health status, suggesting that the rate of improvement in health status may be slowed or reversed by epidemics despite people living longer(19).

In the high-income Asia-Pacific region, there was an increase in both LE and HALE from 1990 to 1999, a result similar to that of previous work related to the study of the Global Healthcare Access and Quality Index (HAQ), which confirms that the Asia-Pacific region experienced a greater increase in the HAQ index between 1990 and 2019, suggesting that the region achieved better health improvement results at an earlier stage(20). Republic of Korea had the largest increase in LE and HALE between 1990 and 2019, and its rapid increase in life expectancy was likewise the fastest among the Organization for Economic Cooperation and Development (OECD) countries(21). This may be due to Republic of Korea's sustained economic prosperity from the late 20th century to the early 21st century. Its 88-fold increase in GDP over the 40-year period (1970-2010) made it a country that has experienced economic and human development in a very short period of time(22).

The growth of LE and HALE in South Asia has been relatively stable over the period 1990-2019. The relatively low growth in LE and HALE in Pakistan compared to other South Asian countries may be due to the fact that Pakistan has a higher Inequality-adjusted Human Development Index (IHDI) and educational deprivation rate than other South Asian countries, limiting its life expectancy gains(23).

The overall upward trend in LE and HALE in East Asia over the period 1990-2021 reflected the region's positive progress in terms of improved healthcare, economic development, and the promotion of healthy lifestyles. China's growth in LE and HALE during this period was more pronounced. Its LE and HALE increased at the same rate as that of high-middle income countries between 2000 and 2019, which can be partly attributed to declining mortality rates for chronic respiratory diseases and certain cancers (liver and stomach cancers)(24). In East Asia, the increase in LE was lower than the increase in HALE, suggesting that the region was striving to increase healthy longevity along with life expectancy(25–27).

From 1990 to 2021, LE and HALE in Southeast Asia demonstrated an upward trend, though the growth was modest, likely due to the scarcity of medical resources and health education in some Southeast Asian countries. This limited the effectiveness of preventing, controlling, and treating chronic diseases, which in turn affected the growth of LE and HALE(13). Laos is distinguished in Southeast Asia with a notable increase in LE and HALE, potentially attributable to the nation's recent economic growth, increased government investment in public health, advancements in healthcare infrastructure, and strengthened capacity for disease prevention and control(28).

East Asia and high-income Asia-Pacific regions demonstrated more stable growth in LE and HALE, with modest declines in LED. Notably, East Asia exhibited a lower rate of LED compared to other regions, which can be ascribed to advancements in reducing deaths and disease burden. These developments may positively influence HALE(13). Conversely, South and Southeast Asia exhibited the most substantial decline in LED and a higher LED overall compared to other regions. This may be attributable to the ongoing rise in the prevalence of chronic diseases, such as heart failure (HF) in Southeast Asia, and the significant health inequalities in health outcomes in South Asia(29,30).

In Central Asia, most countries, including Kazakhstan and Uzbekistan, demonstrated a relatively stable upward trend in both LE and HALE from 1990 to 2019. However, Tajikistan was noteworthy for its unique experience, where while the LE increased overall, it underwent fluctuations, with the upward trend decelerating or even regressing slightly in 1993, followed by a subsequent rise after 1993. This phenomenon can be attributed to the significant fluctuations in life expectancy caused by the economic collapse, political disintegration, and civil wars that occurred in Tajikistan during the 1990s(31). In terms of HALE, the relatively small increase in Tajikistan may be attributed to the low diagnosis rate of hypertensive patients, weak primary care capacity, and inadequate control of chronic diseases in Tajikistan(32).

There are some differences in the trends of LE and HALE in the Democratic People's Republic of Korea compared to China. While China's LE and HALE demonstrated a more stable and linear upward trend, Democratic People's Republic of Korea's LE and HALE decreased in 1995 and remained stable during 1996-2002 before rebounding rapidly in 2003. The decline in life expectancy during the mid-1990s can be attributed to the country's economic challenges, including widespread hunger and economic hardship(33). Its economic recovery through economic cooperation such as the Kaesong Industrial Complex after 2003 may have indirectly improved its HALE(34).

Factors Influencing LE

During the 1990s, cardiovascular diseases, chronic respiratory diseases, and transportation injuries were the primary contributors to life expectancy in Central Asia. Moving into the 1999-2019 period, the dominant factors evolved into cardiovascular diseases, respiratory infections and tuberculosis, while the negative impact of unintentional injuries increased significantly. Since 2019, the disease burden of respiratory infections and tuberculosis has increased further. Neoplasms have become an additional core risk, reflecting the severe impact of Covid-19 epidemic on the health of Central Asian populations(35,36).

From 1990 to 2021, cardiovascular diseases and tumors have consistently been the primary drivers of life expectancy constraints in the high-income Asia-Pacific region. In the Republic of Korea, for instance, there was a 6.6-year increase in life expectancy due to oncology prevention and treatment from 1990 to 1999. Additionally,

cardiovascular disease management contributed to a 10.82-year increase in life expectancy from 1999 to 2009, underscoring the synergistic effect of precision medicine and public health policies(37,38).

The South Asian region has long been confronted with a significant burden of communicable diseases, including respiratory infections and tuberculosis, and intestinal infections. While other South Asian countries have achieved improvements in health through the control of cardiovascular and communicable diseases from 1990 to 1999, Pakistan's growth in life expectancy has been hindered by the same causes of death. Pakistan's health indicators lag significantly behind those of neighboring countries and countries with a similar socio-demographic index. The burden of non-communicable diseases continues to increase. The challenges posed by communicable and non-communicable diseases represent a dual burden for Pakistan. The ongoing economic instability and political unrest in the country have placed significant strain on its healthcare system(39).

Cardiovascular diseases are a significant contributor to the overall mortality rate in East Asia, along with respiratory infections and tuberculosis. Despite the significant strides made in medical technology, cardiovascular diseases remain the foremost cause of mortality. This is largely attributable to the aging population and the heightened risk of chronic diseases(29,40).

From 1990 to 2019, the most prevalent health risks in Southeast Asia were respiratory infections and tuberculosis, and cardiovascular disease. After 2019, the impact of transport injuries, unintentional injuries, and violence-related deaths rose significantly. Road traffic mortality rates in Southeast Asia far exceeded global averages, leading to healthcare resource constraints and a surge in health expenditures(41).

Risk factors for cardiovascular diseases and respiratory infections and tuberculosis

Dietary risk and high LDL cholesterol are consistently high population risks, and it is possible that changes in dietary composition have had a significant impact on lipid levels(42). Around 2020, exposure to air pollution began to reverse after decreasing to a minimum in most countries, which may be directly related to the 2020 pandemic closure measures. However, long-term improvements will need to rely on sustained emission reduction policies(43,44). Nevertheless, air pollution remains a significant health threat in Asia, with considerable health implications(45,46). For the exposure value of high systolic blood pressure, most Asian countries exhibited a decreasing and then an increasing trend during 1990-2021, with a trend reversal generally occurring during 2000-2010. This may be related to population aging, lifestyle changes, and an increase in the rate of treatment for hypertension-related illnesses(47,48). During 1990-2021, tobacco demonstrated a high exposure value, exhibiting an overall stable downward trend, with the notable exceptions of Uzbekistan and Georgia, where a clear upward trend was observed. This may be attributable to changes in tobacco consumption policies or socioeconomic factors in these countries or regions(49).

Strengths and limitations

The GBD 2021 is a reliable and consistent source of data on mortality, causes of death, and risk factors. It is well-regarded in the field for its rigorous research methods and consistent results. However, the accuracy of GBD estimates is constrained by the quality and availability of national vital registration systems. For many countries with limited raw data, GBD estimates are highly dependent on the modeling process, predictive covariates, past trends, or trends in neighboring countries, leading to uncertainty. Additionally, we were unable to explore the impact of various risk factors and co-morbidities on life expectancy due to a lack of relevant data. Therefore, it is essential to interpret our findings with caution and to conduct additional practical studies to validate our results.

Implications for policy

A variety of factors can contribute to a decline in LE, and multisectoral coordination is necessary to address this population health issue. Numerous studies have demonstrated a correlation between socio-economic levels and fluctuations in LE. This underscores the imperative for economic recovery strategies to prioritize enhancing basic health facility coverage, chronic disease management services, social security networks, and health informatics, particularly for the most economically disadvantaged and marginalized

segments of society(50–52). Some countries with declining LE could benefit from the experiences of nations that have effectively implemented healthcare and public health strategies.

Based on the heterogeneity of disease burden and effectiveness of risk interventions in different regions of Asia, different regions should make appropriate policy improvements according to their own actual situations. Cardiovascular diseases and neoplasms have always been the major factors limiting life expectancy in high-income Asia-Pacific, which should focus on early prevention and control of cardiovascular diseases and neoplasms, and strengthen accurate screening(53,54). The South Asian region has long been plagued by high-burden infectious diseases. It is recommended that priority be given to improving public health infrastructure, establishing joint mechanisms for the prevention and control of infectious diseases, and strengthening primary health care response capacity(55). Accidental injuries have recently had a serious impact on health in Southeast Asia, and emphasis should be placed on strengthening accidental injury prevention and emergency medical care systems to reduce the rate of death and disability from sudden health threats(56–58). Overall, the Asian Region should focus on key health risks based on regional differences in disease burden and systematically improve the Region's health protection capacity by strengthening preventive measures, improving the public health system and promoting inter-sectoral collaboration.

Non-communicable disease prevention and control and infection risk management need to be strengthened synergistically during the COVID-19 epidemic. Studies have shown that in societies with unequal distribution of health care resources, infectious diseases are more likely to accelerate in high-density living environments. Hospital mortality rates increase as a result of the superimposition of underlying diseases(59,60). Meanwhile, epidemic prevention policies have compounded the impact on low-income communities(61). Therefore, there is a need to strengthen primary care and optimize the allocation of resources across time. Such systemic interventions can reduce the long-term health impact of major crises, such as global economic downturns or emerging infectious diseases. (62–64).

Conclusion

The study finds an overall increase in LE and HALE in Asia from 1990 to 2021, but with significant regional differences: while East Asia and high-income Asia-Pacific continue to grow and maintain low levels of LED, South Asia, Southeast Asia and Central Asia experience declines in LE and HALE after 2019, and despite large declines in LED, their absolute levels are still high. Cardiovascular diseases and respiratory infections were the leading causes of death affecting LE in Asian countries. Among risk factors, dietary risk and tobacco exposure continued to decline, while high LDL cholesterol levels were steadily increasing; air pollution and high systolic blood pressure risk were at inflection points in the 2020s and 2000s, respectively. Southeast Asia significantly improved LE through risk factor control, with limited improvement in South Asia. In particular, dietary optimization, cholesterol control, and blood pressure management contributed significantly to LE gains in most countries, while air pollution and tobacco had relatively small negative effects. The study highlights the variability in disease burden and effectiveness of risk interventions in different regions of Asia, providing a basis for targeted public health strategies.

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Authors' Contributions

Pengcheng Liu conceived the initial research idea and designed the study protocol. Tianqi Sun performed the statistical analysis and wrote the first draft of the manuscript. Xueyan Luo provided data, participated in the analysis, reviewed the findings, and contributed to the interpretation. All authors agreed with the final version of the paper for submission.

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Not applicable.

Data Availability

To download the data used in the present study, please visit the Global Health Data Exchange GBD 2021 website.

Declarations

Competing Interests

The authors declare no competing interests.

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