# Global, regional, and national burden of HIV and other sexually transmitted infections in older adults aged 60–89 years from 1990 to 2019: results from the Global Burden of Disease Study 2019

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## Summary

**Background** Sexually active older adults are often more susceptible to HIV and other sexually transmitted infections (STIs) due to various health conditions (especially a weakened immune system) and low use of condoms. We aimed to assess the global, regional, and national burdens and trends of HIV and other STIs in older adults from 1990 to 2019.

**Methods** We retrieved data from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 on the incidence and disability-adjusted life-years (DALYs) of HIV and other STIs (syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes) for older adults aged 60–89 years in 204 countries and territories from 1990 to 2019. Estimated annual percentage changes in the age-standardised incidence and DALY rates of HIV and other STIs, by age, sex, and Socio-demographic Index (SDI), were calculated to quantify the temporal trends. Spearman correlation analysis was used to examine the relationship between age-standardised rates and SDI.

**Findings** In 2019, among older adults globally, there were an estimated 77 327 (95% uncertainty interval 59 443 to 97 648) new cases of HIV (age-standardised incidence rate 7·6 [5·9 to 9·6] per 100 000 population) and 26 414 267 (19 777 666 to 34 860 678) new cases of other STIs (2607·1 [1952·1 to 3440·8] per 100 000). The age-standardised incidence rate decreased by an average of 2·02% per year (95% CI –2·38 to –1·66) for HIV and remained stable for other STIs (–0·02% [–0·06 to 0·01]) from 1990 to 2019. The number of DALYs globally in 2019 was 1 905 099 (95% UI 1 670 056 to 2 242 807) for HIV and 132 033 (95% UI 83 512 to 225 630) for the other STIs. The age-standardised DALY rate remained stable from 1990 to 2019, with an average change of 0·97% (95% CI –0·54 to 2·50) per year globally for HIV but decreased by an annual average of 1·55% (95% CI –1·66 to –1·43) for other STIs. Despite the global decrease in the age-standardised incidence rate of HIV in older people from 1990 to 2019, many regions showed increases, with the largest increases seen in eastern Europe (average annual change 17·84% [14·16 to 21·63], central Asia (14·26% [11·35 to 17·25]), and high-income Asia Pacific (7·52% [6·54 to 8·51]). Regionally, the age-standardised incidence and DALY rates of HIV and other STIs decreased with increases in the SDI.

**Interpretation** Although the incidence and DALY rates of HIV and STIs either declined or remained stable from 1990 to 2019, there were regional and demographic disparities. Health-care providers should be aware of the effects of ageing societies and other societal factors on the risk of HIV and other STIs in older adults, and develop age-appropriate interventions. The disparities in the allocation of health-care resources for older adults among regions of different SDIs should be addressed.

**Funding** Natural Science Foundation of China, Fujian Province's Third Batch of Flexible Introduction of High-Level Medical Talent Teams, Science and Technology Innovation Team (Tianshan Innovation Team) Project of Xinjiang Uighur Autonomous Region, Cure Alzheimer's Fund, Helse Sør-Øst, the Research Council of Norway, Molecule/VitaDAO, NordForsk Foundation, Akershus University Hospital, the Civitan Norges Forskningsfond for Alzheimers Sykdom, the Czech Republic-Norway KAPPA programme, and the Rosa Sløyfe/Norwegian Cancer Society & Norwegian Breast Cancer Society.



*Lancet Healthy Longev* 2024; 5: e17–30

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## Introduction

According to WHO, the number of people over the age of 60 is expected to almost double, from 12% to 22%, between 2015 and 2050.[1] As adults age, their quality of health typically decreases, with weakening of the immune system and increased prevalence of multimorbidity, leading to increased susceptibility to infection.[2] Studies suggest that the burden of HIV and other sexually transmitted infections (STIs) is substantial in older adults in both high-income and low-income countries.[3,4] The US

## Research in context

### Evidence before this study

We used the key words "human immunodeficiency virus", "HIV", "sexually transmitted infection", "STI", "sexually transmitted disease", "STD", "syphilis", "gonorrhea", "chlamydia", "trichomoniasis", "genital herpes", "global burden" and "older adults" to search PubMed and Web of Science from database inception to Feb 12, 2023. Several recent studies have shown that older adults are engaging in sexual activity at higher rates than in previous decades, leading to an increase in sexually transmitted infections (STIs) and HIV infection in this population. To date, there has been no analysis of global burden and trends in HIV and other STIs among older adults. The UN General Assembly declared 2021–30 the UN Decade of Healthy Ageing to foster longer and healthier lives for older adults. One of the key actions is to deliver person-centred integrated care and primary health services responsive to older people. However, available national-level STI surveillance data are sparse and of varying quality.

### Added value of this study

This study is the first to analyse the global trends in the incidence, prevalence, mortality, and disability-adjusted life-years (DALYs) of HIV and other STIs (syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes) among older adults aged 60–89 years in 204 countries and territories from 1990 to 2019 by sex, age, and Socio-demographic Index. This study offers valuable insights into evidence-based health-care planning and resource allocation for addressing the burden of HIV and other STIs among older adults, fostering a more comprehensive approach to screening, prevention, and care tailored to this demographic group.

### Implications of all the available evidence

HIV and other STIs among older adults pose a global public health challenge. Although the age-standardised incidence rate of HIV decreased worldwide from 1990 to 2019, it increased in many regions, most highly in eastern Europe, central Asia, and high-income Asia Pacific. Additionally, despite global trends in the incidence of HIV and other STIs declining or remaining stable from 1990 to 2019, regional and demographic disparities exist. Health-care providers should be aware of the effects of ageing societies and other societal factors on the risk of HIV and other STIs in older adults and should develop age-appropriate interventions.

For the **GHDx results tool** see http://ghdx.healthdata.org/gbd-results-tool

Centers for Disease Control and Prevention reported that people older than 50 years accounted for 17% of new HIV diagnoses in the USA in 2016.[5] A modelling study estimated that the proportion of adults with HIV infection aged 50 years or older in the Netherlands would increase from 28% in 2010 to 73% in 2030.[4]

The increasing incidence of HIV and STIs among older adults is a concerning trend that can be attributed to several factors, including increased numbers of new partners due to longer life expectancy, improved health, and higher divorce rates.[6,7] Additionally, a lack of awareness among health-care professionals about sexuality and sexual activity in older adults leads to inadequate communication to older people regarding sexual health and HIV risk. Moreover, older individuals are often excluded from STI prevention and health promotion programmes, leading to reduced condom use and fewer STI tests compared with younger age groups. The widespread use of erectile dysfunction medications for sexual enhancement and the ease of foreign travel to countries with accessible sex industries further contribute to this complex landscape. In addition, the increased prevalence of HIV and STIs among this demographic group is partly due to longer life expectancy.[8] Advances in therapeutic modalities for HIV and STIs have enabled people to live longer with these conditions.

For the **GHDx data input sources tool** see https://ghdx.healthdata.org/gbd-2019/data-input-sources

## Methods

### Study population and data collection

We obtained data on HIV and other STIs from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 using the Global Health Data Exchange (GHDx) results tool. GBD 2019 provided estimates of the global burden of 369 diseases and injuries in 204 countries and territories from 1990 to 2019.[9] We defined the study population as older adults aged 60–89 years. The other STIs we included were syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes due to herpes simplex virus 2. The choice of STIs for this study depended on the availability of STI data in the GBD 2019 database; GBD 2019 only provided estimates of the burden of disease for these five common STIs and HIV.

GBD 2019 used several main data sources to extract STI data from the literature: case notification, antenatal and community surveillance data, cross-sectional studies, health insurance claims data, inpatient hospital data, and any additional data from the GBD collaborator network. Sources were excluded if the sample population was drawn exclusively from a group at higher risk of HIV and STI acquisition, such as people with HIV, men who have sex with men, and sex workers. The data sources for HIV in GBD 2019 can be found through the GHDx data input sources tool, and mainly included household seroprevalence surveys, data from countries (antenatal care data or health and human services data; incidence and prevalence estimates; and data on intervention coverage reported to UNAIDS, including for antiretroviral therapy [ART], prevention of vertical transmission, and ART eligibility), GBD demographic inputs, and vital registration data.[9]

Data on the incidence, prevalence, mortality, and disability-adjusted life-years (DALYs) of HIV and other

STIs (syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes) were extracted from the GBD 2019. In this study, ages in the range 60–89 years were divided into six GBD age groups at 5-year intervals. Incidence estimates of HIV for people older than 80 years were not included in GBD 2019, because HIV infection is relatively rare in this age group compared with younger age groups. Details of the estimated incidence, prevalence, mortality, and DALYs of HIV and other STIs are presented in the appendix of the GBD 2019 capstone paper.[9] An overview of the disease model is provided in the appendix (p 2); the specific disease modelling method has been described in previous studies.[9–11]

The Socio-demographic Index (SDI) is calculated in GBD 2019 to represent the combined level of health-related social and economic conditions in each region. The SDI is the geometric mean of 0–1 indices of the total fertility rate in females younger than 25 years, mean education (years of schooling) in people aged 15 years and older, and the country's lag-distributed income per capita.[9] The 204 countries in GBD 2019 are grouped into quintiles (low, low-middle, middle, high-middle, and high) based on country-level estimates of SDI in 2019.

### Statistical analysis

Age-standardised rates per 100 000 people were extracted from the GBD database. The formula for calculating age-standardised rate was

$$\frac{\sum_{i=1}^{N}\alpha_i W_i}{\sum_{i=1}^{N} W_i}$$

where $a_i$ is the age-specific rate in the $i$th age group and $w_i$ represents the number of people (or the weight) in the same age group among the GBD standard population. $N$ is the number of age groups. 95% uncertainty intervals (UIs) were defined as the 25th and 975th values of the ordered 1000 draws.

The estimated annual percentage change in age-standardised rate was calculated to evaluate the average changing trends over a specified time interval, and was widely used in secondary analysis based on GBD studies.[12] The natural logarithm of age-standardised rate is assumed to fit the linear regression model $y=\alpha+\beta x+\varepsilon$, where $y$ is equal to ln(age-standardised rate), and $x$ refers to the calendar year. Then, the estimated annual percentage change is equal to $100\times(e^{\beta}-1)$. 95% CIs of estimated annual percentage change were estimated using the linear regression model.

An age-standardised rate was determined to represent an increasing or decreasing trend over time if both the estimated annual percentage change and its 95% CI were above or below 0, respectively. When the 95% CI included 0, the change in age-standardised rate was considered statistically non-significant, meaning that the observed trend was not statistically different from no change.

Smoothing splines models were used to evaluate the relationship between the burdens of HIV and other STIs among older adults and SDI for the 21 regions and 204 countries and territories. The expected values were determined through a calculation that takes into account the SDI and disease rates across all locations. We fitted smooth splines using the Locally Weighted Scatterplot Smoothing method, which automatically determines the degree, number, and location of nodes (knots) on the basis of the data and the span parameter. Spearman correlation analysis was used to estimate the $r$ indices and p values for the association of age-standardised rate with SDI. $p<0\cdot05$ was considered statistically significant.

See Online for appendix

All data analysis and mapping were done with R software (version 3.6.0).

### Role of the funding source

The funders of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report.

## Results

Globally, an estimated 77 327 (95% UI 59 443 to 97 648) new HIV cases among older adults aged 60–79 years were reported in 2019, with an age-standardised incidence rate of 7·6 cases (95% UI 5·9 to 9·6) per 100 000 population (table 1). The age-standardised incidence rate of HIV decreased by an average of –2·02% (95% CI –2·38 to –1·66) per year globally between 1990 and 2019. The number of DALYs due to HIV globally in 2019 was 1 905 099 (95% UI 1 670 056 to 2 242 807), with an age-standardised rate of 188·0 DALYs (95% UI 164·8 to 221·4) per 100 000 population. The age-standardised DALY rate of HIV remained stable from 1990 to 2019, with an average change of 0·97% (95% CI –0·54 to 2·50) per year globally.

In 2019, the number of new cases of five other common STIs (excluding HIV) reported among older adults aged 60–89 years was 26 414 267 (95% UI 19 777 666 to 34 860 678), with an age-standardised incidence rate of 2607·1 cases (95% UI 1952·1 to 3440·8) per 100 000 population (table 1). The age-standardised incidence rate of STIs remained stable, with an average change of –0·02% (95% CI –0·06 to 0·01) per year globally from 1990 to 2019. The number of DALYs for STIs globally was 132 033 (95% UI 83 512 to 225 630) in 2019, with an age-standardised rate of 13·0 DALYs (95% UI 8·2 to 22·3) per 100 000. The age-standardised rate of DALYs due to STIs decreased by an annual average of 1·55% (95% CI –1·66 to –1·43) globally from 1990 to 2019.

In 2019, regions of sub-Saharan Africa (central, eastern, southern, and western) had the highest age-standardised incidence rates (per 100 000 population) of HIV (table 1; figure 1A). Between 1990 and 2019, the largest increases in age-standardised incidence rate of HIV occurred in eastern Europe (average annual change 17·84% [95% CI 14·16 to 21·63]), central Asia (14·26% [11·35 to 17·25]), and high-income Asia Pacific (7·52% [6·54 to 8·51];

| | Incidence | | | | | DALYs | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number of cases, 1990 | Age-standardised rate per 100 000 population, 1990 | Number of cases, 2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 | Count, 1990 | Age-standardised rate per 100 000 population, 1990 | Count, 2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 |
| **HIV** | | | | | | | | | | |
| Global | 54 277 (42 486 to 68 134) | 11·3 (8·8 to 14·2) | 77 327 (59 443 to 97 648) | 7·6 (5·9 to 9·6) | −2·02% (−2·38 to −1·66)* | 391 963 (290 331 to 516 178) | 81·6 (60·5 to 107·5) | 1 905 099 (1 670 056 to 2 242 807) | 188·0 (164·8 to 221·4) | 0·97% (−0·54 to 2·50) |
| **Sex** | | | | | | | | | | |
| Male | 29 948 (22 972 to 38 369) | 13·8 (10·6 to 17·7) | 43 464 (32 701 to 55 353) | 9·2 (6·9 to 11·7) | −1·99% (−2·35 to −1·63)* | 218 527 (163 186 to 286 242) | 100·9 (75·3 to 132·2) | 1 032 408 (896 555 to 1 245 866) | 218·5 (189·7 to 263·6) | 0·91% (−0·35 to 2·19) |
| Female | 24 329 (19 028 to 30 870) | 9·2 (7·2 to 11·7) | 33 863 (25 599 to 43 254) | 6·3 (4·7 to 8·0) | −2·09% (−2·47 to −1·71)* | 173 436 (125 250 to 234 663) | 65·8 (47·5 to 87·9) | 872 691 (756 947 to 1 021 207) | 161·4 (140·0 to 188·9) | 1·02% (−0·75 to 2·82) |
| **Region** | | | | | | | | | | |
| East Asia | 1233 (690 to 2679) | 1·2 (0·7 to 2·6) | 5880 (2695 to 8764) | 2·2 (1·0 to 3·3) | 3·38% (0·51 to 6·33)* | 9839 (3509 to 13 966) | 9·4 (3·4 to 13·4) | 195 700 (149 737 to 247 694) | 74·4 (56·9 to 94·1) | 6·60% (6·09 to 7·11)* |
| Southeast Asia | 1839 (1345 to 2883) | 6·4 (4·7 to 10·0) | 6959 (3659 to 12 555) | 9·8 (5·2 to 17·7) | 1·95% (1·50 to 2·41)* | 2790 (1978 to 4295) | 9·7 (6·9 to 14·9) | 126 911 (91 897 to 209 565) | 178·8 (129·5 to 295·3) | 6·01% (3·33 to 8·76)* |
| Oceania | 6 (1 to 25) | 1·9 (0·4 to 7·7) | 220 (12 to 750) | 30·1 (1·7 to 102·4) | 5·60% (2·54 to 8·75)* | 25 (5 to 128) | 7·7 (1·6 to 39·3) | 6384 (2633 to 17 018) | 872·1 (359·6 to 2324·7) | 16·21% (12·40 to 20·14)* |
| Central Asia | 7 (4 to 10) | 0·1 (0·1 to 0·2) | 284 (81 to 539) | 3·4 (1·0 to 6·4) | 14·26% (11·35 to 17·25)* | 167 (155 to 180) | 3·0 (2·8 to 3·2) | 1197 (986 to 1494) | 14·3 (11·8 to 17·9) | 4·33% (3·61 to 5·06)* |
| Central Europe | 25 (21 to 34) | 0·1 (0·1 to 0·2) | 139 (62 to 231) | 0·5 (0·2 to 0·8) | 3·37% (2·21 to 4·55)* | 1466 (1353 to 1575) | 7·7 (7·1 to 8·2) | 1854 (1630 to 2173) | 6·5 (5·7 to 7·6) | −0·37% (−0·78 to 0·05) |
| Eastern Europe | 49 (23 to 84) | 0·1 (0·1 to 0·2) | 2675 (839 to 4724) | 5·9 (1·8 to 10·4) | 17·84% (14·16 to 21·63)* | 3454 (3317 to 3647) | 9·5 (9·1 to 10·0) | 17 348 (15 802 to 19 137) | 38 (34·7 to 42·0) | 5·20% (4·56 to 5·86)* |
| High-income Asia Pacific | 113 (71 to 183) | 0·4 (0·3 to 0·7) | 1986 (847 to 3259) | 3·7 (1·6 to 6·1) | 7·52% (6·54 to 8·51)* | 707 (659 to 772) | 2·8 (2·6 to 3·1) | 7005 (5051 to 9800) | 13·0 (9·4 to 18·2) | 4·98% (4·10 to 5·86)* |
| Australasia | 34 (21 to 50) | 1·1 (0·7 to 1·6) | 74 (44 to 117) | 1·2 (0·7 to 1·9) | −1·73% (−2·98 to −0·46)* | 546 (512 to 586) | 18·0 (16·8 to 19·3) | 763 (607 to 957) | 12·4 (9·8 to 15·5) | −2·86% (−3·64 to −2·07)* |
| Western Europe | 789 (649 to 1064) | 1·1 (0·9 to 1·4) | 1705 (1191 to 2321) | 1·6 (1·1 to 2·1) | 1·41% (0·85 to 1·98)* | 16 515 (15 793 to 17 415) | 22·1 (21·2 to 23·4) | 23 701 (19 502 to 28 864) | 21·6 (17·8 to 26·4) | −1·16% (−1·81 to −0·51)* |
| Southern Latin America | 224 (151 to 420) | 3·8 (2·6 to 7·2) | 365 (279 to 488) | 3·5 (2·7 to 4·7) | −0·90% (−1·48 to −0·32)* | 2624 (2500 to 2757) | 45·1 (42·9 to 47·3) | 8718 (7890 to 9956) | 83·6 (75·7 to 95·5) | 2·17% (1·61 to 2·74)* |
| High-income North America | 1323 (786 to 1780) | 2·9 (1·7 to 3·9) | 4119 (719 to 8114) | 5·1 (0·9 to 10·1) | 2·08% (1·19 to 2·99)* | 35 517 (34 002 to 37 667) | 78·7 (75·4 to 83·5) | 74 078 (55 360 to 100 146) | 92·4 (69·1 to 124·9) | 0·08% (−0·52 to 0·69) |
| Caribbean | 1302 (801 to 2076) | 41·0 (25·3 to 65·4) | 878 (558 to 1301) | 14·1 (8·9 to 20·8) | −3·00% (−3·55 to −2·45)* | 6495 (4457 to 10 139) | 204·7 (140·5 to 319·6) | 22 479 (18 362 to 27 780) | 359·7 (293·8 to 444·6) | −0·73% (−2·17 to 0·73) |

(Table 1 continues on next page)

| | Incidence | | | | | DALYs | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number of cases, 1990 | Age-standardised rate per 100 000 population, 1990 | Number of cases, 2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 | Count, 1990 | Age-standardised rate per 100 000 population, 1990 | Count, 2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 |
| (Continued from previous page) | | | | | | | | | | |
| Andean Latin America | 64 (36 to 200) | 2·7 (1·5 to 8·5) | 627 (239 to 1177) | 9·4 (3·6 to 17·7) | 5·20% (4·29 to 6·12)* | 1218 (732 to 3383) | 52·1 (31·3 to 144·6) | 7965 (4953 to 16 572) | 119·7 (74·4 to 248·9) | 2·84% (2·22 to 3·47)* |
| Central Latin America | 440 (371 to 570) | 4·6 (3·9 to 6·0) | 2723 (1503 to 3862) | 9·7 (5·3 to 13·7) | 4·42% (3·89 to 4·96)* | 6793 (6589 to 7025) | 71·2 (69·1 to 73·7) | 33 344 (29 735 to 37 529) | 118·4 (105·6 to 133·2) | 1·56% (1·13 to 1·99)* |
| Tropical Latin America | 281 (246 to 323) | 2·6 (2·3 to 3·0) | 6219 (2651 to 10 116) | 21·1 (9·0 to 34·3) | 7·21% (6·06 to 8·37)* | 6266 (5966 to 6678) | 58·8 (56·0 to 62·7) | 59 920 (53 732 to 67 402) | 203·4 (182·4 to 228·8) | 3·75% (3·33 to 4·17)* |
| North Africa and Middle East | 141 (38 to 379) | 0·7 (0·2 to 1·9) | 1276 (520 to 3472) | 2·6 (1·1 to 7·2) | 3·87% (3·48 to 4·26)* | 1231 (496 to 3164) | 6·3 (2·5 to 16·1) | 17 893 (9802 to 39 740) | 36·9 (20·2 to 81·9) | 5·50% (4·60 to 6·40)* |
| South Asia | 536 (334 to 1095) | 0·9 (0·5 to 1·7) | 2981 (933 to 6887) | 1·8 (0·6 to 4·1) | 2·61% (2·08 to 3·14)* | 1548 (759 to 4928) | 2·5 (1·2 to 7·9) | 70 829 (42 313 to 154 747) | 42·4 (25·3 to 92·6) | 8·40% (5·65 to 11·22)* |
| Central sub-Saharan Africa | 3587 (2396 to 5077) | 141·9 (94·8 to 200·8) | 1867 (1202 to 2754) | 33·7 (21·7 to 49·8) | −4·74% (−5·12 to −4·35)* | 28 325 (18 951 to 41 904) | 1120·2 (749·5 to 1657·3) | 60 432 (47 269 to 78 966) | 1092·4 (854·5 to 1427·5) | −1·68% (−2·86 to −0·49)* |
| Eastern sub-Saharan Africa | 27 976 (20 592 to 35 937) | 334·2 (246·0 to 429·3) | 11 529 (8325 to 15 965) | 66·0 (47·7 to 91·4) | −5·85% (−6·08 to −5·62)* | 204 326 (134 950 to 286 471) | 2441·0 (1612·2 to 3422·3) | 420 261 (343 803 to 530 182) | 2406·5 (1968·7 to 3035·9) | −2·28% (−3·85 to −0·69)* |
| Southern sub-Saharan Africa | 6706 (3056 to 11 767) | 210·1 (95·7 to 368·6) | 18 118 (13 986 to 23 534) | 275·1 (212·4 to 357·3) | −1·21% (−2·48 to 0·07) | 17 467 (7956 to 36 192) | 547·2 (249·2 to 1133·7) | 457 950 (394 690 to 543 843) | 6953·1 (5992·6 to 8257·2) | 5·83% (2·68 to 9·07)* |
| Western sub-Saharan Africa | 7604 (5117 to 10 954) | 75·9 (51·1 to 109·3) | 6699 (5347 to 8521) | 33·3 (26·6 to 42·4) | −4·33% (−4·88 to −3·77)* | 44 642 (28 583 to 69 441) | 445·6 (285·3 to 693·1) | 290 367 (245 414 to 347 127) | 1443·3 (1219·9 to 1725·4) | 1·71% (−0·05 to 3·51) |
| **Other STIs†** | | | | | | | | | | |
| Global | 12 600 659 (9 483 900 to 16 613 300) | 2623·8 (1974·8 to 3459·4) | 26 414 267 (19 777 666 to 34 860 678) | 2607·1 (1952·1 to 3440·8) | −0·02% (−0·06 to 0·01) | 92 003 (67 361 to 137 622) | 19·2 (14·0 to 28·7) | 132 033 (83 512 to 225 630) | 13·0 (8·2 to 22·3) | −1·55% (−1·66 to −1·43)* |
| **Sex** | | | | | | | | | | |
| Male | 7 294 849 (5 462 153 to 9 746 829) | 3368·3 (2522·1 to 4500·4) | 15 424 938 (11 463 719 to 20 503 369) | 3263·8 (2425·7 to 4338·4) | −0·12% (−0·15 to −0·10)* | 31 438 (21 866 to 45 019) | 14·5 (10·1 to 20·8) | 34 476 (21 484 to 60 363) | 7·3 (4·5 to 12·8) | −2·81% (−3·06 to −2·55)* |
| Female | 5 305 810 (4 015 497 to 6 995 184) | 2012·3 (1522·9 to 2653·0) | 10 989 328 (8 294 987 to 14 560 250) | 2032·9 (1534·5 to 2693·5) | 0·05% (0·00 to 0·11)* | 60 565 (42 007 to 93 600) | 23·0 (15·9 to 35·5) | 97 557 (61 908 to 166 843) | 18·0 (11·5 to 30·9) | −0·95% (−1·01 to −0·89)* |

(Table 1 continues on next page)

| | Incidence | | | | | DALYs | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number of cases, 1990 | Age-standardised rate per 100 000 population, 1990 | Number of cases, 2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 | Count, 1990 | Age-standardised rate per 100 000 population, 1990 | Count, 2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 |
| (Continued from previous page) | | | | | | | | | | |
| **Region** | | | | | | | | | | |
| East Asia | 3 059 067 (2 308 428 to 4 042 618) | 2930·9 (2211·7 to 3873·2) | 7 268 933 (5 423 027 to 9 615 966) | 2762·3 (2060·8 to 3654·2) | −0·19% (−0·24 to −0·13)* | 17 174 (12 098 to 26 504) | 16·5 (11·6 to 25·4) | 25 692 (14 460 to 47 159) | 9·8 (5·5 to 17·9) | −1·75% (−2·04 to −1·45)* |
| Southeast Asia | 892 849 (678 279 to 1 172 566) | 3099·8 (2354·9 to 4070·9) | 2 132 694 (1 600 920 to 2 801 319) | 3004·9 (2255·7 to 3947·0) | −0·11% (−0·15 to −0·06)* | 4736 (2980 to 7815) | 16·4 (10·3 to 27·1) | 9212 (5119 to 16 853) | 13·0 (7·2 to 23·7) | −0·88% (−0·95 to −0·82)* |
| Oceania | 13 990 (10 472 to 18 270) | 4279·7 (3203·5 to 5589·1) | 30 507 (22 866 to 40 026) | 4167·4 (3123·6 to 5467·7) | −0·01% (−0·06 to 0·04) | 87 (49 to 149) | 26·5 (15·1 to 45·6) | 183 (99 to 324) | 25·0 (13·5 to 44·3) | −0·09% (−0·18 to 0·00) |
| Central Asia | 160 808 (122 141 to 210 779) | 2888·8 (2194·1 to 3786·4) | 248 281 (188 271 to 323 183) | 2972·2 (2253·8 to 3868·9) | −0·04% (−0·17 to 0·08) | 1112 (812 to 1622) | 20·0 (14·6 to 29·1) | 1016 (621 to 1773) | 12·2 (7·4 to 21·2) | −2·44% (−2·77 to −2·11)* |
| Central Europe | 465 757 (353 815 to 609 958) | 2436·4 (1850·9 to 3190·8) | 669 137 (502 814 to 885 178) | 2348·0 (1764·3 to 3106·0) | −0·14% (−0·21 to −0·08)* | 1672 (1033 to 2909) | 8·7 (5·4 to 15·2) | 1846 (957 to 3567) | 6·5 (3·4 to 12·5) | −0·88% (−0·98 to −0·77)* |
| Eastern Europe | 756 619 (569 611 to 995 139) | 2079·4 (1565·5 to 2735·0) | 934 167 (702 934 to 1 229 277) | 2048·5 (1541·4 to 2695·6) | −0·15% (−0·28 to −0·03)* | 6422 (4619 to 9792) | 17·7 (12·7 to 26·9) | 4978 (2827 to 9205) | 10·9 (6·2 to 20·2) | −3·51% (−4·24 to −2·77)* |
| High-income Asia Pacific | 548 876 (407 490 to 726 046) | 2187·0 (1623·7 to 2893·0) | 1 105 377 (822 572 to 1 465 504) | 2054·8 (1529·1 to 2724·2) | −0·23% (−0·25 to −0·21)* | 2744 (1736 to 4725) | 10·9 (6·9 to 18·8) | 4740 (2756 to 8606) | 8·8 (5·1 to 16·0) | −0·60% (−0·67 to −0·53)* |
| Australasia | 61 971 (45 941 to 82 366) | 2039·4 (1511·8 to 2710·5) | 123 851 (93 035 to 166 032) | 2006·2 (1507·0 to 2689·4) | 0·04% (0·00 to 0·09)* | 367 (242 to 597) | 12·1 (8·0 to 19·7) | 437 (227 to 877) | 7·1 (3·7 to 14·2) | −1·56% (−1·85 to −1·26)* |
| Western Europe | 1 278 453 (956 003 to 1 703 921) | 1714·6 (1282·2 to 2285·2) | 1 859 111 (1 390 974 to 2 462 042) | 1697·9 (1270·3 to 2248·5) | −0·01% (−0·03 to 0·02) | 7973 (5426 to 13 017) | 10·7 (7·3 to 17·5) | 7667 (4188 to 14 927) | 7·0 (3·8 to 13·6) | −1·30% (−1·43 to −1·16)* |
| Southern Latin America | 127 917 (95 254 to 170 686) | 2196·5 (1635·7 to 2931·0) | 224 569 (168 729 to 295 409) | 2153·5 (1618·0 to 2832·8) | −0·04% (−0·08 to 0·00) | 998 (648 to 1638) | 17·1 (11·1 to 28·1) | 1320 (747 to 2507) | 12·7 (7·2 to 24·0) | −0·90% (−1·04 to −0·76)* |
| High-income North America | 1 112 814 (823 185 to 1 496 536) | 2466·4 (1824·5 to 3316·8) | 2 034 529 (1 509 147 to 2 731 503) | 2538·2 (1882·8 to 3407·7) | 0·20% (0·13 to 0·27)* | 7979 (5250 to 13 186) | 17·7 (11·6 to 29·2) | 10 558 (6358 to 18 695) | 13·2 (7·9 to 23·3) | −1·17% (−1·26 to −1·08)* |
| Caribbean | 112 127 (83 778 to 147 038) | 3534·5 (2640·9 to 4635·0) | 214 824 (159 462 to 286 214) | 3437·8 (2551·8 to 4580·2) | −0·03% (−0·06 to −0·01)* | 786 (470 to 1304) | 24·8 (14·8 to 41·1) | 1352 (843 to 2254) | 21·6 (13·5 to 36·1) | −0·36% (−0·51 to −0·22)* |
| Andean Latin America | 74 519 (55 608 to 100 213) | 3185·5 (2377·1 to 4283·8) | 202 357 (150 232 to 267 517) | 3039·8 (2256·8 to 4018·7) | −0·17% (−0·19 to −0·15)* | 500 (315 to 856) | 21·4 (13·5 to 36·6) | 1108 (614 to 2098) | 16·6 (9·2 to 31·5) | −0·81% (−0·87 to −0·75)* |
| Central Latin America | 381 090 (284 327 to 501 762) | 3996·0 (2981·3 to 5261·3) | 1 091 796 (815 022 to 1 442 621) | 3876·1 (2893·5 to 5121·6) | −0·09% (−0·11 to −0·07)* | 2144 (1374 to 3667) | 22·5 (14·4 to 38·5) | 5460 (3239 to 9906) | 19·4 (11·5 to 35·2) | −0·22% (−0·40 to −0·04)* |
| Tropical Latin America | 394 707 (293 948 to 528 284) | 3705·9 (2759·8 to 4960·0) | 1 048 146 (779 343 to 1 399 568) | 3557·3 (2645·0 to 4750·0) | −0·12% (−0·15 to −0·08)* | 2581 (1573 to 4580) | 24·2 (14·8 to 43·0) | 6488 (3684 to 11 989) | 22·0 (12·5 to 40·7) | −0·25% (−0·29 to −0·21)* |

(Table 1 continues on next page)

table 1; figure 1B). In the same period, the largest increases in age-standardised DALY rates were found in Oceania (16·21% [12·40 to 20·14]), and south Asia (8·40% [5·65 to 11·22]; table 1).

In 2019, eastern sub-Saharan Africa, southern sub-Saharan Africa, and western sub-Saharan Africa had the highest age-standardised incidence rates of STIs (table 1; figure 1C). An increase in the age-standardised incidence rate of STIs was found only in high-income North America (average change 0·20% per year [0·13 to 0·27]) and Australasia (0·04% [0·00 to 0·09]; figure 1D). In the same period, all GBD regions showed a decreasing trend in age-standardised DALY rates.

In 2019, the age-standardised incidence and DALY rates of HIV were highest in the 60–64 years age group and decreased with increasing age (table 2). Globally, the largest decrease in HIV incidence between 1990 and 2019 was observed in those aged 70–74 years old (average annual change −3·27% [95% CI −3·81 to −2·73]). The largest increase in the age-standardised rate of DALYs due to HIV was observed in the 85–89 years age group (2·76% [1·12 to 4·43]). Globally, the largest increase in incidence of other STIs between 1990 and 2019 was observed in people aged 80–84 years (0·13% [0·10 to 0·17]). For the same period, the age-standardised rate of DALYs due to other STIs decreased in all age groups (table 2).

From 1990 to 2019, the incidence rate of HIV declined by an average of 1·99% per year (95% CI −2·35 to −1·63) among men and by 2·09% per year (−2·47 to −1·71) among women (table 1). The incidence rate of other STIs declined by an average of 0·12% per year (−0·15 to −0·10) among men, but increased by an average of 0·05% per year (0·00 to 0·11) among women. The age-standardised DALY rates of HIV in men and women were stable from 1990 to 2019, while other STIs showed decreases in age-standardised DALY rates in men (annual average −2·81% [−3·06 to −2·55]) and women (−0·95% [−1·01 to −0·89]).

At the regional level, the age-standardised incidence and DALY rates of HIV decreased exponentially with increases in SDI (figure 2A, C). Southern sub-Saharan Africa and eastern sub-Saharan Africa had higher-than-expected age-standardised incidence rates based on their SDI between 1990 and 2019. Age-standardised incidence rate ($r$=−0·520 [95% CI −0·584 to −0·458], p<0·0001) and age-standardised DALY rate ($r$=−0·545 [−0·608 to −0·482], p<0·0001) were negatively correlated with SDI among regions.

Southern sub-Saharan Africa, western sub-Saharan Africa, Oceania, tropical Latin America, central Latin America, the Caribbean, and high-income North America had higher-than-expected age-standardised incidence rates of other STIs based on their SDIs (figure 2B, D). Southern sub-Saharan Africa, central sub-Saharan Africa, tropical Latin America, the Caribbean, central Latin America, eastern Europe, and high-income North America had higher than expected

| | Incidence | | | | | DALYs | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number of cases, 1990 | Age-standardised rate per 100 000 population, 1990 | Number of cases, 2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 | Count, 1990 | Age-standardised rate per 100 000 population, 1990 | Count, 2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 |
| (Continued from previous page) | | | | | | | | | | |
| North Africa and Middle East | 560 177 (421 775 to 743 810) | 2855·1 (2149·7 to 3791·0) | 1 327 916 (996 252 to 1 748 349) | 2736·7 (2053·2 to 3603·2) | −0·21% (−0·26 to −0·16)* | 1896 (1058 to 3572) | 9·7 (5·4 to 18·2) | 4360 (2268 to 8157) | 9·0 (4·7 to 16·8) | −0·21% (−0·37 to −0·05)* |
| South Asia | 1 404 033 (1 050 551 to 1 857 142) | 2242·8 (1678·2 to 2966·7) | 3 479 883 (2 597 815 to 4 641 118) | 2083·2 (1555·1 to 2778·3) | −0·29% (−0·31 to −0·27)* | 20 774 (15 526 to 27 603) | 33·2 (24·8 to 44·1) | 30 769 (22 299 to 43 069) | 18·4 (13·3 to 25·8) | −2·30% (−2·45 to −2·15)* |
| Central sub-Saharan Africa | 96 705 (71 313 to 127 587) | 3824·6 (2820·4 to 5046·0) | 203 575 (150 480 to 266 890) | 3680·0 (2720·2 to 4824·6) | −0·12% (−0·19 to −0·06)* | 2450 (765 to 4967) | 96·9 (30·3 to 196·4) | 2675 (1146 to 5073) | 48·4 (20·7 to 91·7) | −2·47% (−2·57 to −2·36)* |
| Eastern sub-Saharan Africa | 500 812 (376 664 to 653 618) | 5982·9 (4499·8 to 7808·4) | 1 022 345 (761 595 to 1 339 078) | 5854·1 (4361·0 to 7667·8) | −0·06% (−0·09 to −0·03)* | 5496 (3161 to 9121) | 65·7 (37·8 to 109·0) | 6442 (4105 to 9877) | 36·9 (23·5 to 56·6) | −2·20% (−2·31 to −2·09)* |
| Southern sub-Saharan Africa | 144 250 (108 273 to 191 739) | 4518·7 (3391·7 to 6006·3) | 295 624 (222 055 to 392 361) | 4488·5 (3371·5 to 5957·3) | −0·03% (−0·08 to 0·02) | 1478 (961 to 2354) | 46·3 (30·1 to 73·7) | 2152 (1370 to 3681) | 32·7 (20·8 to 55·9) | −1·31% (−1·52 to −1·09)* |
| Western sub-Saharan Africa | 453 119 (338 210 to 598 383) | 4522·7 (3375·8 to 5972·6) | 896 645 (672 040 to 1 185 381) | 4456·9 (3340·5 to 5892·1) | −0·07% (−0·09 to −0·05)* | 2634 (1591 to 4212) | 26·3 (15·9 to 42·0) | 3577 (1919 to 6924) | 17·8 (9·5 to 34·4) | −1·59% (−1·79 to −1·39)* |

Values in parentheses are 95% uncertainty intervals (for counts and rates) or 95% CIs (for estimated annual percentage change). Estimated annual percentage change is based on age-standardised rates. DALY=disability-adjusted life-year. STI=sexually transmitted infection. *Estimated annual percentage change is statistically significant at the 5% α level. †Other STIs comprised syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes.

***Table 1:*** **Incidence and DALYs of HIV and other STIs in older adults (aged 60–89 years) in 1990 and 2019, and estimated annual percentage changes from 1990 to 2019**

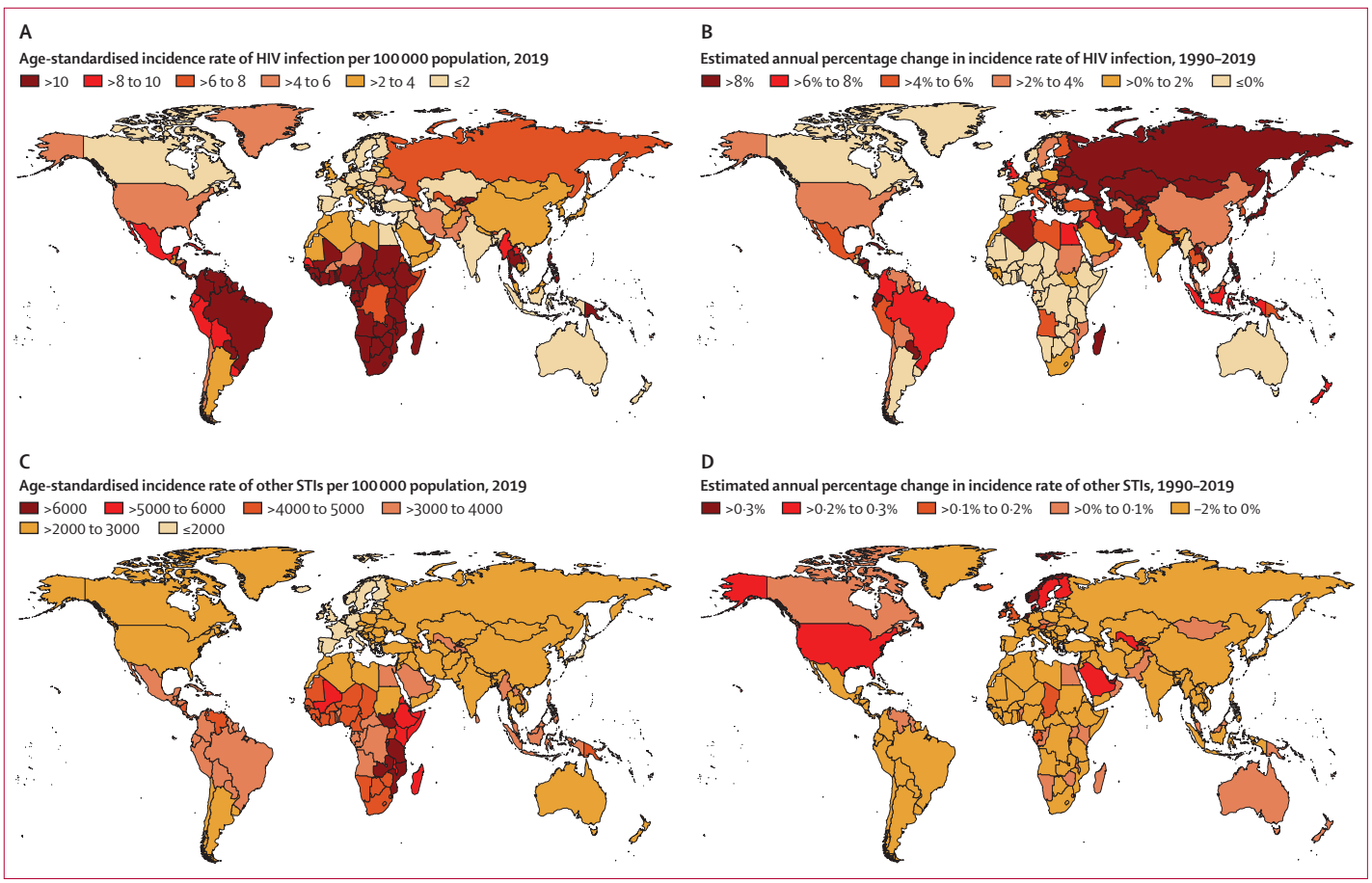



***Figure 1:*** **Age-standardised incidence rates in 2019, and estimated annual percentage changes in incidence rates from 1990 to 2019 for HIV and other STIs, by country**
Age-standardised rate (A) and estimated annual percentage change in rate (B) of the incidence of HIV. Age-standardised rate (C) and estimated annual percentage change in rate (D) of the incidence of other STIs (syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes). STI=sexually transmitted infection.

age-standardised DALY rate of other STIs, based on their SDI. Negative correlations were also found between age-standardised incidence rate and SDI ($r$=–0·728 [95% CI –0·771 to –0·676], p<0·0001) and between DALYs rate and SDI ($r$=–0·738 [–0·778 to –0·698], p<0·0001).

The age-standardised incidence and DALY rates of specific STIs among older adults varied by geographical region in 2019 (figure 3A, B). The highest incidence rate of syphilis occurred in central sub-Saharan Africa (10·2 per 100 000 population), of chlamydial infection occurred in central Asia (180·1), of gonococcal infection occurred in southern sub-Saharan Africa (161·2), of trichomoniasis occurred in eastern sub-Saharan Africa (5593·4), and of genital herpes occurred in central Asia (110·5). In 2019, trichomoniasis constituted the highest proportion of all incident cases of STIs, while HIV accounted for the highest proportion of DALYs of STIs in all regions (figure 3C, D).

## Discussion

Although the age-standardised incidence rate of HIV among older adults decreased worldwide from 1990 to 2019, a significant increase in the incidence rate of HIV among older adults was observed in many regions from 1990 to 2019, especially in eastern Europe, central Asia, and high-income Asia Pacific. Similarly, many studies of the aforementioned regions have documented increasing trends in HIV incidence among older adults. Data from the European Surveillance System showed that notification rates for new HIV diagnoses in older adults increased significantly in central and eastern European countries during 2004–15.[13] Increases in the number and prevalence of HIV infections among older adults have also been found in several epidemiological studies in China,[14–16] and the prevalence of HIV infection has been shown to be significantly higher in older adults (2·1%) than in the general population (0·05%).[17]

In eastern Europe, HIV infection is increasing among older people because of several factors, including an increase in injection drug use and sexual practices without condom use, as well as social and economic factors such as poverty and social exclusion. The collapse of the Soviet Union in the early 1990s led to a rise in drug use and sex work, which contributed to the spread of HIV in the region.[18]

| | Incidence | | Prevalence | | Death | | DALYs | |
|---|---|---|---|---|---|---|---|---|
| | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 | Age-standardised rate per 100 000 population, 2019 | Estimated annual percentage change, 1990–2019 |
| **HIV** | | | | | | | | |
| 60–64 years | 12·2 (8·8 to 15·8) | −1·24% (−1·56 to −0·92)* | 444·5 (393·7 to 501·3) | 5·59% (5·07 to 6·12)* | 10·0 (8·8 to 11·7) | 1·06% (−0·61 to 2·75) | 321·7 (283·0 to 244·5) | 1·31% (−0·30 to 2·95) |
| 65–69 years | 9·4 (7·3 to 11·9) | −1·93% (−2·27 to −1·59)* | 329·2 (285·7 to 375·0) | 5·44% (4·96 to 5·94)* | 7·5 (6·7 to 8·7) | 0·82% (−0·70 to 2·37) | 208·3 (182·8 to 244·5) | 1·12% (−0·34 to 2·61) |
| 70–74 years | 6·0 (4·9 to 7·3) | −3·27% (−3·81 to −2·73)* | 242·9 (209·8 to 276·5) | 4·46% (4·00 to 4·93)* | 5·3 (4·6 to 6·2) | 0·06% (−1·48 to 1·62) | 124·8 (107·8 to 148·0) | 0·43% (−1·02 to 1·91) |
| 75–79 years | 3·0 (2·4 to 3·8) | −2·51% (−3·59 to −1·42)* | 175·7 (153·2 to 200·2) | 4·17% (3·75 to 4·60)* | 3·9 (3·4 to 4·6) | −0·15% (−1·85 to 1·59) | 75·8 (65·0 to 90·9) | 0·27% (−1·30 to 1·87) |
| 80–84 years | .. | .. | 74·4 (62·6 to 90·0) | 6·86% (5·90 to 7·81)* | 1·7 (1·4 to 2·1) | 2·01% (0·19 to 3·86)* | 27·8 (22·1 to 35·2) | 2·52% (0·81 to 4·26)* |
| 85–89 years | .. | .. | 66·9 (56·6 to 79·2) | 7·14% (6·25 to 8·04)* | 1·3 (1·1 to 1·5) | 2·02% (0·22 to 3·85)* | 18·1 (14·3 to 23·0) | 2·76% (1·12 to 4·43)* |
| **Other STIs†** | | | | | | | | |
| 60–64 years | 3·6 × 10³ (2·7 to 4·7) | 0·04% (0·03 to 0·05)* | 23·7 × 10³ (20·6 to 27·3) | −0·05% (−0·09 to 0·00) | 0·2 (0·1 to 0·2) | −3·29% (−3·51 to −3·08)* | 14·1 (8·6 to 24·7) | −1·54% (−1·67 to −1·40)* |
| 65–69 years | 2·8 × 10³ (2·1 to 3·7) | 0·05% (0·04 to 0·06)* | 22·1 × 10³ (19·1 to 25·6) | −0·11% (−0·15 to −0·08)* | 0·2 (0·2 to 0·3) | −2·72% (−2·84 to −2·59)* | 13·2 (8·2 to 22·7) | −1·34% (−1·42 to −1·26)* |
| 70–74 years | 2·2 × 10³ (1·6 to 3·0) | 0·06% (0·04 to 0·09)* | 20·7 × 10³ (17·8 to 24·0) | −0·18% (−0·22 to −0·14)* | 0·2 (0·2 to 0·3) | −2·88% (−3·01 to −2·74)* | 12·2 (7·7 to 20·6) | −1·51% (−1·61 to −1·40)* |
| 75–79 years | 1·8 × 10³ (1·3 to 2·4) | 0·08% (0·06 to 0·10)* | 19·5 × 10³ (16·7 to 22·8) | −0·25% (−0·30 to −0·19)* | 0·4 (0·3 to 0·4) | −3·26% (−3·50 to −3·01)* | 12·3 (8·2 to 20·1) | −1·93% (−2·10 to −1·75)* |
| 80–84 years | 1·3 × 10³ (1·0 to 1·8) | 0·13% (0·10 to 0·17)* | 18·3 × 10³ (15·6 to 21·4) | −0·25% (−0·30 to −0·21)* | 0·5 (0·4 to 0·5) | −2·62% (−2·86 to −2·37)* | 11·7 (7·9 to 18·5) | −1·60% (−1·74 to −1·46)* |
| 85–89 years | 0·9 × 10³ (0·7 to 1·3) | 0·12% (0·09 to 0·15)* | 17·3 × 10³ (14·7 to 20·4) | −0·24% (−0·30 to −0·19)* | 0·8 (0·6 to 1·0) | −2·42% (−2·64 to −2·21)* | 12·8 (9·0 to 18·7) | −1·63% (−1·76 to −1·49)* |

Values in parentheses are 95% uncertainty intervals (for rates) or 95% CIs (for estimated annual percentage change). Incidence estimates of HIV in people older than 80 years were not included in GBD 2019 as HIV infections rarely occur in this age group. DALY=disability-adjusted life-year. STI=sexually transmitted infection. *Estimated annual percentage change is statistically significant at the 5% α level. †Other STIs comprised syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes.

***Table 2:*** **Incidence, prevalence, death, and DALY rates of HIV and other STIs in older adults (aged 60–89 years) by age group in 1990 and 2019, and estimated annual percentage changes from 1990 to 2019**

We found that the sub-Saharan African regions remain the region with the largest HIV burden in terms of incidence and DALY rates among older adults. This finding could be attributed to a combination of factors: high HIV prevalence, insufficient access to HIV prevention and treatment services, and lack of targeted HIV prevention messages for older adults.[19] Negin and colleagues[20] reported that older adults in Africa had low levels of HIV-related knowledge and awareness and were less likely to have been tested for HIV compared with young adults. Moreover, older adults in sub-Saharan Africa face multiple barriers to accessing HIV prevention and treatment services.[21] The high burden of STIs, including HIV, in sub-Saharan Africa is often accompanied by a high prevalence of other comorbidities, including tuberculosis, malaria, malnutrition, and non-communicable diseases (eg, cardiovascular disease and diabetes).[22] The presence of these comorbidities, coupled with limited health-care infrastructure and resources, poses significant challenges to healthy ageing and longevity. HIV interventions are increasingly reaching older populations in sub-Saharan Africa through a variety of approaches, including strengthening health-care systems, improving access to HIV testing and treatment, promoting prevention strategies, addressing social and economic disparities, and prioritising comprehensive care for older adults living with HIV.[21]

Our study also found that the age-standardised rates of DALYs due to HIV among older adults increased significantly in all Asian regions and Oceania from 1990 to 2019. Although people with HIV are living longer as a result of effective antiretroviral drugs, ageing people with HIV are more susceptible to non-communicable diseases.[4] Yuan and colleagues reported that people with HIV had increased incidence and mortality for a wide spectrum of non-AIDS-defining cancers, including anal cancer, Hodgkin lymphoma, and liver cancer.[23] HIV has been associated with accelerated ageing.[24] This phenomenon is thought to be partly due to chronic inflammation and immune activation caused by HIV infection. These factors contribute to increased rates of cardiovascular disease, osteoporosis, kidney disease, liver disease, and certain cancers in people with HIV.[25] HIV can also have significant effects on brain health, including neurocognitive impairment, peripheral neuropathy, and Alzheimer's disease.[26] It is believed that chronic inflammation and

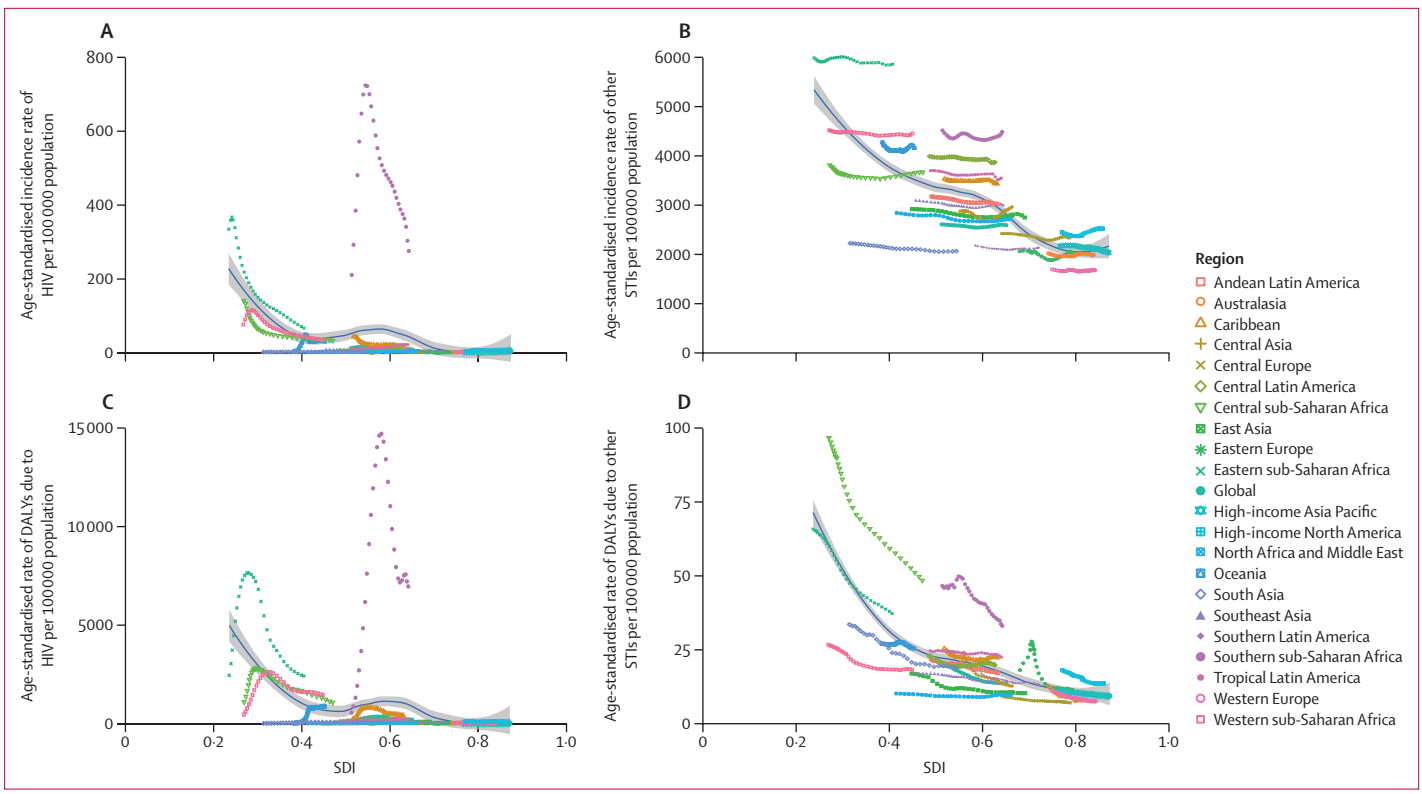
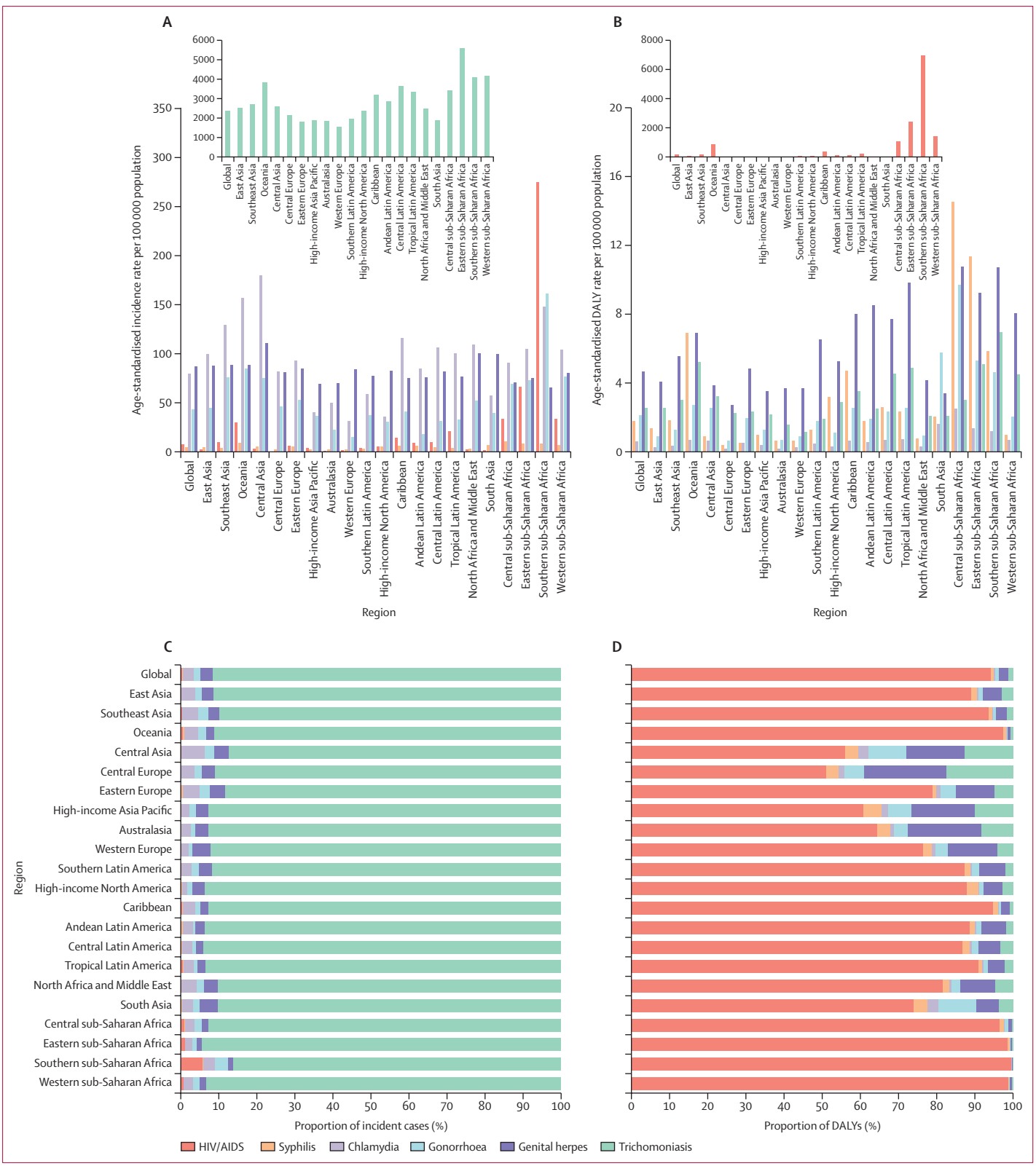



***Figure 2:*** **Age-standardised incidence and DALY rates of HIV and other STIs, globally and for 21 GBD regions, by SDI, 1990–2019**
Expected values, based on SDI and disease rates in all locations, are shown as a solid line; expected values based on a calculation accounting for the SDI and disease rates across all locations. 30 points are plotted for each region and show the observed age-standardised incidence or DALY rates for each year from 1990 to 2019 for that region. The shaded area indicates the 95% CI of the expected values. Points above the solid line represent a higher-than-expected burden, and those below the line show a lower-than-expected burden. Other STIs comprised syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes. DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. SDI=Socio-demographic Index. STI=sexually transmitted infection.

immune dysfunction associated with HIV contribute to the development or progression of these conditions.[26] The rising incidence of non-communicable comorbidities with HIV poses a major challenge to health systems in many countries, particularly low-income and middle-income countries (LMICs), where technical and financial constraints exist and communicable disease prevention and control has focused on younger people, while HIV care for older adults has been neglected. The HIV epidemic in Asia started later than in other parts of the world and many countries in this region have inadequate systems of care for older adults living with HIV.[27] Integration of comprehensive geriatric assessment and screening for non-communicable comorbidities into HIV care systems is essential to improve the wellbeing and healthy ageing of older adults living with HIV and reduce the disease burden.

The geographical pattern of other STIs among older adults in this study was similar to previous findings among the general population, that sub-Saharan Africa, Latin America, and Oceania had the highest burden in terms of DALY rates of STIs.[12] We also found a negative correlation between the burden of STIs and SDI. WHO estimated that more than 90% of new STI cases in 2016 were in LMICs, possibly due to poor financial ability, poor medical insurance services, low sexual health awareness, inadequate screening, and low treatment rates.[28] In these countries, STI case management largely relies on syndromic management for patients with symptoms, which lacks specificity and leads to overtreatment with antibiotics, and does not interrupt transmission in asymptomatic patients.[29] Untreated or poorly managed STIs can lead to complications such as pelvic inflammatory disease, infertility, increased risk of HIV transmission, and an increased likelihood of developing some types of cancer. Although decreasing trends were seen in age-standardised incidence and DALY rates of other STIs in most regions from 1990 to 2019, the numbers of incident infections and DALYs

***Figure 3:*** **Age-standardised incidence and DALY rates of HIV, syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes, and proportions of incident cases and DALYs contributed by each infection, globally and for 21 GBD regions, 2019**
Age-standardised incidence rates (A) and DALY rates (B) of each infection. Proportions of incident cases (C) and DALYs (D) accounted for by each infection. DALY=disability-adjusted life-year. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.


A
Age-standardised incidence rate per 100 000 population
Region
B
Age-standardised DALY rate per 100 000 population
Region
C
Region
Proportion of incident cases (%)
D
Proportion of DALYs (%)
HIV/AIDS
Syphilis
Chlamydia
Gonorrhoea
Genital herpes
Trichomoniasis

increased globally. In addition, increased screening efforts and precision in laboratory diagnostic methods in many countries are contributing to the detection of more cases globally.[29]

It is intriguing to observe that some countries, including Australia, Sweden, and China, showed better-than-expected performance in mitigating the burden of STIs among older adults in 2019 (appendix p 47). Australia has a comprehensive national STI strategy that includes targeted interventions for older adults. These interventions include HIV testing campaigns, education and awareness programmes, and outreach services to reach older adults who might not have access to health care.[30] Sweden has been noted for its comprehensive sexual health education and services that are designed to be inclusive of all age groups. Initiatives like age-friendly health centres and educational campaigns have contributed to open discussions on sexual health among older adults.[31] In China, the better-than-expected performance could be attributed to its comprehensive health-care system, which has enabled robust preventive measures and health promotion campaigns that span all age groups.[32] These examples highlight the evolving efforts of several countries to promote sexual health services for older individuals. However, challenges persist, even in these countries.

Of the STIs included in this study, trichomoniasis was the most prevalent among older adults worldwide. By addressing STIs in this demographic group, public health initiatives can contribute to healthier ageing and the broader goal of disease prevention and control within communities.

The emergence of the COVID-19 pandemic prompted changes in health-care delivery models, including the suspension or reduction of non-essential services. These disruptions might have hindered older adults' access to sexual health services, including testing, counselling, and treatment. Delayed or missed care can amplify the risk of undiagnosed and untreated STIs in this population, especially in older adults living with HIV.[33] Lockdowns, physical distancing measures, and concerns about virus transmission might have led to changes in sexual behaviour, reducing the frequency of sexual encounters.[34] However, reduced contact with health-care facilities might also mean fewer opportunities for STI testing and prevention counselling. This complex interplay warrants a closer examination of potential shifts in STI risk behaviours.

Our study has several limitations. First, the estimation of the burden of HIV and other STIs depends on the availability and quality of the primary data in GBD 2019. Raw data in GBD 2019 are not available in some countries, especially LMICs. Second, our study only describes the burdens of HIV and five common STIs (syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes) among older adults, and did not include other STIs. Third, our study only analysed data based on binary sexes as GBD 2019 did not provide data on gender minorities. Fourth, diagnosis and detection of HIV and other STIs might have been inconsistent across countries and over time, which might affect the comparability of results. Trends in the burden of HIV and other STIs among older adults identified in this study should be interpreted with caution because of uncertainties in the raw data. Fifth, chlamydia is a largely asymptomatic infection and reported incidence is highly dependent on testing rates, particularly among asymptomatic individuals at risk for infection, which might affect the accuracy of the GBD estimates. Additionally, we recognise that an exclusive focus on significance tests can overshadow the clinical significance of our findings. To address this limitation, we advocate for the development and application of diverse analytical methods that extend and validate the results of this study.

Notably, the estimation of STI burden within older adults presents unique challenges, distinct from those encountered when analysing other age groups. STI data often predominantly focus on younger age groups, potentially leading to under-representation of the burden in older individuals. In addition, older adults might have different risk factors and sexual behaviours than younger populations, potentially influencing the transmission dynamics of STIs. These differences might not be fully captured by existing modelling approaches, which are often tailored to younger age groups. Adapting modelling frameworks to account for age-specific risk profiles and behaviours is essential for more accurate estimation. The dynamics of health-care seeking behaviour in older adults for STI-related services might differ from that in younger age groups. The underestimation of STI cases due to reduced health-seeking behaviours in this demographic group presents a challenge that needs to be acknowledged and addressed in future estimation models.

Although there is a scarcity of comprehensive surveillance information regarding STIs and HIV infection among older adults, this study's findings are supported by other data. First, the incidence and prevalence of HIV calculated by GBD aligns with UNAIDS estimates.[35] Nonetheless, some minor differences in incidence emerge in GBD due to the distinct data sources and methodologies used.[11] Furthermore, the study presents a regional overview of STI burden within the older population, which is consistent with WHO's 2016 assessment relying on the Spectrum-STI model.[28] Although WHO's assessment pertains to individuals aged 15–49 years, it offers a valuable glimpse into the broader regional burden. Additionally, regional estimates[13] and existing surveillance data[36] support our study's findings. Due to the absence of comparable incidence and prevalence data, the results of this study need further validation.

HIV and STIs among older adults pose a global public health challenge. Although the incidence of HIV decreased worldwide from 1990 to 2019, increases occurred in many regions. Globally, trends in incidence of HIV and STIs have declined or stabilised from 1990 to 2019, although regional and demographic disparities exist. Health-care providers should be aware that ageing societies can lead to increased numbers of older adults at risk of HIV and other STIs, should be aware of societal factors that can increase this risk, and should develop age-appropriate interventions.

#### Contributors

HZ conceived the study and designed the protocol with LF. LF, TT, and BW analysed the GBD data. LF and TT contributed to statistical analysis and interpretation of data. LF, TT, BW, EFF, NH, and HZ drafted the manuscript, and all authors critically revised the manuscript. HZ had access to all the data in the study and had final responsibility for the decision to submit for publication. HZ, LF, TT, and BW accessed and verified the data.

#### Declaration of interests

EFF has a material transfer agreement with LMITO Therapeutics (South Korea), a cooperative research and development agreement with ChromaDex (USA), and a commercialisation agreement with Molecule AG/VitaDAO, and is a consultant to Aladdin Healthcare Technologies (UK and Germany), the Vancouver Dementia Prevention Centre (Canada), Intellectual Labs (Norway), and MindRank AI (China). All other authors declare no competing interests.

#### Data sharing

The GBD 2019 data used in this study are freely available for download from the GHDx website at http://ghdx.healthdata.org/gbd-results-tool. All data used in this study will also be made available on request to the corresponding author. Proposals will be reviewed and approved by the sponsor, investigator, and collaborators on the basis of scientific merit. After approval of a proposal, data will be shared through a secure online platform after the signing of a data access agreement.

#### Acknowledgments

This study was funded by the Natural Science Foundation of China Excellent Young Scientists Fund (grant number 82022064), Natural Science Foundation of China International/Regional Research Collaboration Project (72061137001), Fujian Province's Third Batch of Flexible Introduction of High-Level Medical Talent Teams (TD202307), Science and Technology Innovation Team (Tianshan Innovation Team) Project of Xinjiang Uighur Autonomous Region (2022TSYCTD0013), National Natural Science Foundation of China (81971327), Cure Alzheimer's Fund (282952), Helse Sør-Øst (2020001, 2021021, 2023093), the Research Council of Norway (262175, 334361), Molecule/VitaDAO (282942), NordForsk Foundation (119986), Akershus University Hospital (269901, 261973, 262960), the Civitan Norges Forskningsfond for Alzheimers Sykdom (281931), the Czech Republic-Norway KAPPA programme (with Martin Vyhnálek, TO01000215), and the Rosa Sløyfe/Norwegian Cancer Society & Norwegian Breast Cancer Society (207819). We acknowledge the Institute for Health Metrics and Evaluation (University of Washington), the GBD Diseases and Injuries Collaborators, and all staff who shared their data needed for this study.

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