

THE LANCET HIV

Supplementary appendix

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Life expectancy after 2015 of adults with HIV on long-term antiretroviral therapy in Europe and North America: a collaborative analysis of cohort studies

Supplementary materials

Cohorts included:

AHIVCOS, AMACS, ATHENA, Alberta, Aquitaine, CBC, CoRIS, DHK, ANRS CO4 FHDH (French Hospital Database on HIV), Frankfurt, HAVACS, ICONA, KP, PISCIS, SHCS, UAB, UK CHIC Study, UW, VACH, Vanderbilt.

See here for further information:

ART-CC: <http://www.bristol.ac.uk/art-cc/whoswho/>

UK CHIC: <https://www.ucl.ac.uk/global-health/research/z-research/uk-collaborative-hiv-cohort-uk-chic-study>

Life expectancy calculations

General population mortality rates and life expectancies were taken from mortality.org. Mortality rates were calculated for each country and weighted according to the proportion of PWH living in each country in our analysis. Sex-specific comparator data were used for the male and female life expectancy calculations among PWH. General population comparators are crucial as they are used in the calculation of life expectancy among PWH. This is because in the oldest age groups we are often lacking in follow-up time and events. We calculate the ratio of the mortality rates between PWH and the general population for each of the 5-year age-groups above 20 and then take the average of these rate ratios to produce an overall rate ratio for each ART start year group within each population group. Only the ratios from age-groups where the mortality rates among PWH are higher than among the general population are included in the overall rate ratio calculation. This rate ratio is used to multiply the general population mortality rate in the oldest age group (≥ 85 years). In the age-groups where the mortality rate estimates among PWH are less than among the general population the general population estimate is used instead.

These mortality rates are then entered into a life table that produces the estimates for the expected remaining years of life for each age group. An example of how the rate ratio is produced for females with suppressed viral load, no prior AIDS, that acquired HIV through heterosexual sex, started combination ART in 1996-2014 (surviving until 2015), and had a CD4 count of 350-499 in 2015 is in supplementary table 1. The average rate ratio of the yellow highlighted cells (excluding the ratio highlighted in red, as it is below 1) is taken: 3.65. As the ratio in the group of PWH aged 80-84 (highlighted red) is below 1, the mortality rate for this age-group in the life table will be replaced by the mortality rates in the corresponding general population age-group (highlighted pink). For the mortality rate in the 85+ age group of PWH, the corresponding general population mortality rates among females aged 85+ are taken (0.1239) and multiplied by the average rate ratio, giving a mortality rate of 0.4528. Supplementary table 2 gives an example of the rates and this ratio being applied to a life table for the life expectancy calculations also for this same population group.

Supplementary table 1: An example of calculating the rate ratio for PWH vs the general population, for females with suppressed viral load, no prior AIDS, that acquired HIV through heterosexual sex, started combination ART in 1996-2014 (surviving until 2015), and had a CD4 count of 350-499 in 2015

Age	PWH mortality rate	Gen-pop mortality rate	Rate ratio for PWH vs gen-pop
20-24	0.0017	0.0002	8.54
25-29	0.0020	0.0003	7.93
30-34	0.0025	0.0003	7.13
35-39	0.0029	0.0006	5.19
40-44	0.0032	0.0009	3.45
45-49	0.0038	0.0015	2.56
50-54	0.0046	0.0024	1.94
55-59	0.0057	0.0036	1.60
60-64	0.0079	0.0052	1.54
65-69	0.0109	0.0076	1.43
70-74	0.0177	0.0121	1.46
75-79	0.0223	0.0211	1.06
80-84	0.0323	0.0419	0.77

Supplementary table 2: An example of life table calculations for female persons with HIV with suppressed viral load, no prior AIDS, that acquired HIV through heterosexual sex, started combination ART in 1996-2014 (surviving until 2015), and had a CD4 count of 350-499 in 2015

Age	Unadjusted mortality rate among PWH	General population mortality rate	Rate ratio used	Adjusted mortality rate among PWH	Probably of dying between one age group and the next	Probability of surviving between one age group and the next	Number aging through a synthetic cohort of 1000 PWH	Number dying between each age-group	The number of person years lived in each age-group	Cumulative person years between each age and death	Remaining years of life estimate
							SYNTHETIC COHORT OF 1000 PWH				
20	0.0017	0.0002	1	0.0017	0.0084	0.9916	1,000	8	4,979	57,808	57.8
25	0.0020	0.0003	1	0.0020	0.0102	0.9898	992	10	4,933	52,829	53.3
30	0.0025	0.0003	1	0.0025	0.0122	0.9878	982	12	4,878	47,896	48.8
35	0.0029	0.0006	1	0.0029	0.0142	0.9858	970	14	4,813	43,018	44.4
40	0.0032	0.0009	1	0.0032	0.0157	0.9843	956	15	4,741	38,204	40.0
45	0.0038	0.0015	1	0.0038	0.0190	0.9810	941	18	4,659	33,463	35.6
50	0.0046	0.0024	1	0.0046	0.0228	0.9772	923	21	4,562	28,804	31.2
55	0.0057	0.0036	1	0.0057	0.0283	0.9717	902	26	4,446	24,242	26.9
60	0.0079	0.0052	1	0.0079	0.0389	0.9611	876	34	4,297	19,796	22.6
65	0.0109	0.0076	1	0.0109	0.0530	0.9470	842	45	4,100	15,499	18.4
70	0.0177	0.0121	1	0.0177	0.0848	0.9152	798	68	3,819	11,400	14.3
75	0.0223	0.0211	1	0.0223	0.1057	0.8943	730	77	3,457	7,581	10.4
80	0.0419	0.0419	1	0.0419	0.1895	0.8105	653	124	2,955	4,124	6.3
85	0.1239	0.1239	3.7	0.4528	1.0000	0.0000	529	529	1,169	1,169	2.2

The pink highlighted cells in supplementary table 2 are the general population mortality rates that are higher than the corresponding age-group rates among PWH (highlighted red). The rate in pink is multiplied by the rate ratio (highlighted green) calculated in supplementary table 1 for the highest age group, whilst the general population rate is taken for younger age groups. This produces the adjusted rates for PWH that are highlighted blue. Further standard life table calculation steps are used to produce the estimate for the remaining years of life expectancy at age 40 in the yellow highlighted cell. Extra steps are required to produce uncertainty bounds around this estimate using the standard errors, which are not shown here.

Supplementary table 3: Outputs from the Poisson model used to calculate the life expectancy estimates.

Variable	Coefficient	95% Confidence Interval
Age group		
20-24	1	
25-29	1.22	(0.66, 2.26)
30-34	1.47	(0.81, 2.64)
35-39	1.71	(0.96, 3.05)
40-44	1.88	(1.06, 3.35)
45-49	2.29	(1.29, 4.05)
50-54	2.75	(1.55, 4.87)
55-59	3.42	(1.93, 6.06)
60-64	4.73	(2.67, 8.39)
65-69	6.49	(3.65, 11.52)
70-74	10.57	(5.94, 18.79)
75-79	13.30	(7.44, 23.80)
80-84	19.25	(10.66, 34.74)
85+	30.76	(16.85, 56.16)
Sex		
Male	1	
Female	0.80	(0.75, 0.86)
ART start year		
1996-2014	1	
2015-2019	0.59	(0.52, 0.67)
HIV acquisition route		
MSM	1	
IDU	3.25	(3.03, 3.50)
Heterosexual	1.14	(1.06, 1.22)
Missing	1.29	(1.16, 1.43)
CD4 cells/ μ L		
0-49	5.62	(4.74, 6.67)
50-99	4.70	(3.98, 5.54)
100-199	3.29	(2.95, 3.66)
200-349	2.09	(1.92, 2.26)
350-499	1.37	(1.27, 1.48)
500+	1	
Missing	1.82	(1.64, 2.02)
HIV-1 viral load unsuppressed		
No	1	
Yes	1.42	(1.32, 1.53)
Missing	1.80	(1.63, 2.00)
AIDS at follow-up start		
No	1	
Yes	1.68	(1.59, 1.78)
Model constant term	0.0013352	(0.0007558, 0.0023588)

Supplementary table 4: Estimates of remaining years of life expectancy for females at exact age 20, stratified by HIV mode of acquisition, ART start year, and viral load (VL) suppression (<50 cells/ml), prior AIDS, and CD4 count (cells/ μ L) at follow-up start (2015 onwards).

ART start: 1996-2014		CD4 count:	0-49	50-99	100-199	200-349	350-499	≥ 500
Acquisition route: Injecting drug use (IDU)	VL suppressed, no prior AIDS		25.5 (23.8, 27.3)	28.1 (26.4, 29.9)	33.5 (31.8, 35.1)	40.3 (38.9, 41.7)	46.2 (45.1, 47.4)	50.2 (49.3, 51.2)
	VL suppressed, prior AIDS		18.7 (16.8, 20.5)	20.9 (19.1, 22.7)	25.8 (24.0, 27.6)	32.5 (30.8, 34.1)	38.8 (37.4, 40.2)	43.4 (42.1, 44.7)
	VL unsuppressed, no prior AIDS		20.8 (18.9, 22.6)	23.1 (21.3, 25.0)	28.2 (26.5, 29.9)	35.0 (33.4, 36.6)	41.3 (39.9, 42.6)	45.7 (44.6, 46.9)
	VL unsuppressed, prior AIDS		14.7 (12.9, 16.5)	16.6 (14.8, 18.5)	21.0 (19.2, 22.8)	27.2 (25.5, 29.0)	33.5 (31.9, 35.1)	38.2 (36.8, 39.7)
Acquisition route: Heterosexual sex	VL suppressed, no prior AIDS		41.1 (39.8, 42.5)	43.7 (42.5, 45.0)	48.5 (47.5, 49.6)	53.8 (53.0, 54.6)	57.8 (57.2, 58.4)	60.1 (59.7, 60.6)
	VL suppressed, prior AIDS		33.3 (31.7, 34.9)	36.1 (34.5, 37.6)	41.4 (40.0, 42.7)	47.7 (46.6, 48.8)	52.7 (51.9, 53.6)	56.0 (55.3, 56.6)
	VL unsuppressed, no prior AIDS		35.9 (34.3, 37.4)	38.6 (37.1, 40.0)	43.8 (42.5, 45.0)	49.8 (48.8, 50.8)	54.6 (53.8, 55.3)	57.5 (56.9, 58.1)
	VL unsuppressed, prior AIDS		28.1 (26.3, 29.8)	30.7 (29.1, 32.4)	36.1 (34.6, 37.7)	42.9 (41.6, 44.1)	48.5 (47.5, 49.6)	52.3 (51.5, 53.2)
Standardised	Overall: 52.3 (51.7, 52.9)		30.0 (28.9, 31.2)	35.5 (34.5, 36.6)	41.7 (40.7, 42.7)	49.5 (48.7, 50.2)	54.7 (54.2, 55.3)	58.1 (57.7, 58.5)
ART start: 2015-19		CD4 count:	0-49	50-99	100-199	200-349	350-499	≥ 500
Acquisition route: Injecting drug use (IDU)	VL suppressed, no prior AIDS		33.3 (31.7, 34.9)	36.0 (34.5, 37.5)	41.3 (40.0, 42.7)	47.6 (46.5, 48.7)	52.7 (51.8, 53.5)	55.9 (55.3, 56.6)
	VL suppressed, prior AIDS		25.6 (23.8, 27.4)	28.2 (26.5, 29.9)	33.5 (31.9, 35.1)	40.4 (39.0, 41.7)	46.3 (45.2, 47.4)	50.3 (49.4, 51.3)
	VL unsuppressed, no prior AIDS		28.0 (26.3, 29.8)	30.7 (29.0, 32.4)	36.1 (34.5, 37.6)	42.8 (41.5, 44.1)	48.5 (47.5, 49.5)	52.3 (51.4, 53.1)
	VL unsuppressed, prior AIDS		20.8 (19.0, 22.7)	23.2 (21.4, 25.0)	28.3 (26.5, 30.0)	35.1 (33.5, 36.6)	41.3 (40.0, 42.7)	45.4 (44.2, 46.6)
Acquisition route: Heterosexual sex	VL suppressed, no prior AIDS		48.4 (47.3, 49.4)	50.6 (49.6, 51.5)	54.6 (53.8, 55.3)	58.7 (58.2, 59.2)	60.7 (60.3, 61.1)	61.7 (61.4, 62.1)
	VL suppressed, prior AIDS		41.2 (39.9, 42.6)	43.8 (42.5, 45.0)	48.6 (47.5, 49.6)	53.9 (53.1, 54.7)	57.9 (57.3, 58.4)	60.1 (59.7, 60.6)
	VL unsuppressed, no prior AIDS		43.6 (42.4, 44.9)	46.1 (45.0, 47.3)	50.6 (49.7, 51.6)	55.6 (54.9, 56.3)	59.1 (58.6, 59.6)	60.6 (60.2, 61.0)
	VL unsuppressed, prior AIDS		36.0 (34.4, 37.5)	38.7 (37.2, 40.1)	43.9 (42.6, 45.1)	49.9 (48.9, 50.8)	54.6 (53.9, 55.4)	57.5 (56.9, 58.1)
Standardised	Overall: 56.6 (56.2, 57.1)		37.8 (36.8, 38.9)	43.2 (42.3, 44.1)	48.7 (47.9, 49.5)	55.3 (54.7, 55.8)	58.9 (58.5, 59.3)	60.7 (60.4, 61.0)

Supplementary table 5: Estimates of remaining years of life expectancy for males at exact age 20, stratified by HIV mode of acquisition, ART start year, and viral load (VL) suppression (<50 cells/ml), prior AIDS, and CD4 count (cells/μL) at follow-up start (2015 onwards).

ART start: 1996-2014		CD4 count:					
		0-49	50-99	100-199	200-349	350-499	≥500
Acquisition route: Men having sex with men (MSM)	VL suppressed, no prior AIDS	39.9 (38.5, 41.3)	42.5 (41.2, 43.8)	47.5 (46.4, 48.6)	53.0 (52.2, 53.9)	56.0 (55.4, 56.6)	57.3 (56.7, 57.8)
	VL suppressed, prior AIDS	32.0 (30.4, 33.7)	34.7 (33.2, 36.3)	40.1 (38.7, 41.5)	46.6 (45.5, 47.8)	51.9 (51.0, 52.8)	55.0 (54.3, 55.7)
	VL unsuppressed, no prior AIDS	34.6 (33.0, 36.1)	37.3 (35.8, 38.8)	42.6 (41.3, 43.9)	48.9 (47.8, 49.9)	53.7 (52.9, 54.5)	55.8 (55.2, 56.5)
	VL unsuppressed, prior AIDS	26.8 (25.1, 28.6)	29.4 (27.7, 31.2)	34.8 (33.3, 36.4)	41.6 (40.3, 43.0)	47.5 (46.4, 48.6)	51.5 (50.6, 52.4)
Acquisition route: Injecting drug use (IDU)	VL suppressed, no prior AIDS	22.5 (20.7, 24.4)	25.0 (23.2, 26.8)	30.2 (28.5, 31.9)	37.0 (35.5, 38.5)	43.3 (42.0, 44.5)	47.6 (46.6, 48.7)
	VL suppressed, prior AIDS	16.1 (14.3, 17.9)	18.2 (16.4, 20.0)	22.8 (20.9, 24.6)	29.2 (27.5, 30.9)	35.5 (34.0, 37.1)	40.3 (38.9, 41.7)
	VL unsuppressed, no prior AIDS	18.1 (16.2, 19.9)	20.3 (18.5, 22.1)	25.1 (23.3, 26.9)	31.7 (30.1, 33.4)	38.1 (36.6, 39.5)	42.7 (41.4, 44.0)
	VL unsuppressed, prior AIDS	12.5 (10.8, 14.3)	14.3 (12.5, 16.1)	18.3 (16.4, 20.1)	24.2 (22.4, 26.0)	30.2 (28.5, 31.9)	35.0 (33.4, 36.5)
Acquisition route: Heterosexual sex	VL suppressed, no prior AIDS	37.9 (36.4, 39.4)	40.6 (39.2, 42.0)	45.7 (44.6, 46.9)	51.6 (50.7, 52.5)	55.3 (54.6, 56.0)	56.8 (56.2, 57.4)
	VL suppressed, prior AIDS	30.1 (28.4, 31.8)	32.8 (31.1, 34.4)	38.2 (36.7, 39.6)	44.8 (43.6, 46.0)	50.4 (49.5, 51.4)	53.9 (53.1, 54.7)
	VL unsuppressed, no prior AIDS	32.6 (31.0, 34.2)	35.3 (33.8, 36.9)	40.7 (39.3, 42.1)	47.1 (46.0, 48.3)	52.4 (51.5, 53.2)	55.1 (54.4, 55.8)
	VL unsuppressed, prior AIDS	25.0 (23.2, 26.8)	27.5 (25.8, 29.3)	32.8 (31.2, 34.5)	39.7 (38.3, 41.1)	45.8 (44.6, 46.9)	50.0 (49.0, 51.0)
Standardised	Overall: 50.8 (50.1, 51.4)	28.4 (27.3, 29.6)	32.7 (31.6, 33.9)	39.6 (38.5, 40.6)	47.5 (46.7, 48.3)	53.0 (52.4, 53.6)	55.6 (55.1, 56.2)
ART start: 2015-19		CD4 count:					
		0-49	50-99	100-199	200-349	350-499	≥500
Acquisition route: Men having sex with men (MSM)	VL suppressed, no prior AIDS	47.4 (46.3, 48.5)	49.7 (48.7, 50.7)	53.7 (52.9, 54.5)	56.5 (55.9, 57.1)	57.9 (57.4, 58.4)	58.8 (58.3, 59.3)
	VL suppressed, prior AIDS	40.0 (38.6, 41.4)	42.6 (41.3, 43.9)	47.6 (46.5, 48.7)	53.1 (52.2, 53.9)	56.0 (55.4, 56.7)	57.3 (56.8, 57.8)
	VL unsuppressed, no prior AIDS	42.4 (41.1, 43.7)	45.0 (43.8, 46.2)	49.8 (48.8, 50.8)	54.7 (53.9, 55.4)	56.7 (56.1, 57.3)	57.8 (57.3, 58.3)
	VL unsuppressed, prior AIDS	34.6 (33.1, 36.2)	37.4 (35.9, 38.8)	42.7 (41.4, 44.0)	48.9 (47.9, 50.0)	53.8 (53.0, 54.5)	55.8 (55.2, 56.5)
Acquisition route: Injecting drug use (IDU)	VL suppressed, no prior AIDS	30.0 (28.3, 31.7)	32.7 (31.1, 34.3)	38.1 (36.6, 39.6)	44.8 (43.6, 46)	50.4 (49.4, 51.4)	53.8 (53.0, 54.6)
	VL suppressed, prior AIDS	22.6 (20.8, 24.4)	25.1 (23.3, 26.9)	30.3 (28.6, 31.9)	37.1 (35.6, 38.6)	43.3 (42.1, 44.6)	47.7 (46.6, 48.8)
	VL unsuppressed, no prior AIDS	24.9 (23.1, 26.7)	27.5 (25.7, 29.2)	32.8 (31.2, 34.4)	39.6 (38.2, 41.1)	45.7 (44.5, 46.9)	49.9 (48.9, 50.9)
	VL unsuppressed, prior AIDS	18.1 (16.3, 20.0)	20.3 (18.5, 22.2)	25.1 (23.4, 26.9)	31.8 (30.1, 33.4)	38.1 (36.7, 39.6)	42.8 (41.5, 44.1)
Acquisition route: Heterosexual sex	VL suppressed, no prior AIDS	45.6 (44.4, 46.8)	48.0 (46.9, 49.1)	52.4 (51.5, 53.3)	55.9 (55.2, 56.5)	57.6 (57.0, 58.1)	58.5 (58.0, 59.0)
	VL suppressed, prior AIDS	38.0 (36.5, 39.5)	40.7 (39.3, 42.1)	45.8 (44.6, 47.0)	51.7 (50.7, 52.6)	55.4 (54.7, 56.1)	56.8 (56.2, 57.4)
	VL unsuppressed, no prior AIDS	40.5 (39.1, 41.9)	43.1 (41.9, 44.4)	48.1 (47.0, 49.2)	53.5 (52.6, 54.3)	56.2 (55.6, 56.8)	57.4 (56.9, 58.0)
	VL unsuppressed, prior AIDS	32.7 (31.0, 34.3)	35.4 (33.8, 36.9)	40.8 (39.4, 42.1)	47.2 (46.1, 48.3)	52.4 (51.6, 53.3)	55.2 (54.5, 55.9)
Standardised	Overall: 54.5 (54.0, 55.1)	36.1 (35.1, 37.2)	40.5 (39.5, 41.5)	46.9 (46.1, 47.7)	53.4 (52.8, 54.0)	56.3 (55.8, 56.8)	57.8 (57.3, 58.3)

