C.H.A.I.N. REPORT

CHAIN 2016-2 Report

Predictors of Long-Term Survival for Persons Living with HIV:

A Literature Review and Empirical Study of the New York City CHAIN Cohort

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Key Findings

- This study assessed factors predicting long-term survival (LTS) for two New York City cohorts of persons diagnosed with HIV *prior to 1995* and followed through 2013.
- Forty-four percent (44%) of the study participants first interviewed in 1994 (the 1994 cohort)--before the introduction of efficacious antiretroviral medical regimens--were still alive as of the end of 2013.
- Sixty-three percent (63%) of the study participants first interviewed in 2002 (the 2002 cohort)—well into the era of efficacious antiretroviral medical regimens—were still alive as of the end of 2013.
- Based upon a review of the published research literature of LTS of persons living with HIV, we selected 26 variables collected at both the 1994 and the 2002 baseline interviews to assess their prediction of survival through 2013.
- The most robust predictors of long-term survival measured at baseline interviews were CD4 count greater than 200, better physical health functioning, female gender, same-sex sexual behaviors among men, current employment, and belief that one has control over one's health (health locus of control). Self-reported physical wasting at the time of baseline interviews predicted a lower rate of LTS.

Introduction

Among persons living with HIV (PLWH) today there is a subset of individuals who became infected in the years before the advent of highly active antiretroviral therapy (HAART). Research into the health-related determinants of long-term survival (LTS) is often limited to biological markers of health, such as CD4 count and viral load, and basic demographic characteristics. However, the World Health Organization has broadly defined health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity (WHO 1946)." In the spirit of this definition, we investigate a broad range of potential predictors of LTS for HIV-infected NYC residents that measure not only demographic and clinical characteristics, but also physical, psychological and social wellbeing and health-related behaviors such as smoking and substance use, specifically injection drug use.

Operational definitions of LTS for PLWH in the research literature range from as few as four to as many as 30 years of survival after HIV diagnosis. For this study, we define a long-term survivor as a person diagnosed before 1995, in the pre-HAART era, and surviving for at least 19 years through 2013. For the review of the research literature that follows, we include studies of the determinants of survival among PLWH, whether or not they explicitly refer to long-term survival.

Literature Review

HIV Clinical Characteristics. Survival is closely linked to several HIV clinical characteristics. There is a robust association between higher CD4 count and slower disease progression/longer survival time (Abioye, Soipe, Salako, et al., 2015; An, Song, Hernandez, & Hall 2015; Poorolajal, Molaiepoor, Mohraz, et al. 2015) whether CD4 is measured as of diagnosis (Chadborn, Baster, Delpech, et al. 2005), at study baseline (Hogg, 2001; Samji, Hogg, et al., 2013) or the nadir or lowest CD4 count measured (Cunningham, Crystal, Bozzette, &

Hays, 2005; Palella, Delaney, Moorman, et al., 1998). Furthermore, studies universally confirm that survival has improved dramatically following the introduction of effective antiretroviral therapies (An, Song, Hernandez, & Hall, 2015; Crum et al., 2006; Harrison et al., 2008; Lee, Karon, Selik, Neal, & Fleming, 2001; Sabin, 2013). Other HIV clinical characteristics associated with survival include viral suppression (Bradley, Hall, Wolitski, et al., 2014), medication adherence (An et al., 2015; Goulard, Sohier, Peyramond et al., 2003), early diagnosis (Linley, Prejean, An, Chen, Hall, 2012; Centers for Disease Control, 2013; Chadborn et al., 2005; Chadborn, Delpech, Sabin, et al., 2006; Grangeiro, Escuder, Menezes, Alencar, & Castilho, 2011), prophylaxis for opportunistic infections (Palella et al., 1998; McNaghten, Hanson, Jones et al. 1999; Jones, Hanson, Dworkin et al., 1999), [absence of] co-morbidities (Haydon, Flegg, Blair, Brettle, Burns, & Hayes, 1998; Crum, Riffenburgh, Wegner, et al., 2006; Moore, Keruly, & Chaisson, 2004), and access to care (Palacio, Shinboski, & Yelin, 1999; Crum et al., 2006).

Physical Wellbeing. Better physical health functioning is also linked with longer survival (Cunningham et al., 2005; Jacobson, Wu, & Feinberg, 2003; Kolk et al., 2010; Mathews & May, 2007). Caution should be taken when interpreting these results, as physical health functioning may be a consequence rather than a cause of HIV disease progression. In addition, inadequate nutrition and physical wasting (e.g. more than 10% involuntary weight loss, chronic diarrhea or weakness, and fever for at least one month) also contribute to poorer health outcomes and increased risk of death (Erlandson, Li, Abraham, et al., 2015).

Psychological Wellbeing. Although physical wellbeing is important to LTS, it does not paint the whole picture; psychological wellbeing, specifically a positive outlook on life, may also be crucial to LTS among PLWH (Balbin, Ironson, & Solomon, 1999; Littlewood, Vanable, Carey, & Blair, 2008). For example, Littlewood et al., (2008) reported a relationship between

"benefit finding"—the effort to look for positive aspects of life while experiencing stressful conditions such as an HIV diagnosis—and several potential antecedents to longer life: fewer depressive symptoms, stronger social support and greater physical activity, but no relationship to medication adherence and substance use. A second cross-sectional study found that individuals who had lived four or more years with an AIDS defining symptom, the long-term survivor group, when compared to a demographically matched HIV-seropositive comparison group, who had yet to experience an AIDS defining symptom, had higher levels of emotional expression and depth processing (finding meaning and involvement in life) (O'Cleirigh, Ironson, Antoni, et al., 2003).

Another aspect of psychological disposition that may be predictive of LTS is health locus of control (HLOC). It refers to beliefs regarding the control of one's condition(s) and its eventual outcome(s). The more internal an individual's HLOC, the stronger one believes he or she is in control of his or her health. The more external one's HLOC, the stronger one believes that others, such as doctors, are in control of one's health or that health is a matter of chance, fate or luck (Wallston, Wallston, & DeVellis, 1978). No consensus has yet to emerge about how HLOC relates to LTS among PLWH. The available evidence is almost entirely indirect, and is further weakened by research designs that cannot disentangle the causal sequence between HLOC and other measures of health. We found no quantitative study that attempted to measure a direct association between HLOC and LTS. However, one study based on in-depth interviews with HIV positive individuals reported that a sense of control was an important factor in LTS (Stowers, Johansen & Kohli, 2012). Studies investigating the relationship between HLOC and physical health were mixed, finding associations that were both positive (King & Orel, 2012; Preau et al., 2005), and negative (Ruffin, Ironson, Fletcher, Balbin & Schneiderman, 2012). Two studies investigating HLOC and mental health found no relationship (Burns, Maniss, Young, &

Gaubatz, 2005; Preau et al., 2005). Generalization of findings from these studies was further limited as study samples were often small and unrepresentative of the general HIV+ population.

Religiosity and spirituality may also contribute to long-term survival. Belief in a god, prayer/meditation, sense of peace, and compassion towards others have been found to be correlated with LTS (Ironson, Solomon, Balbin et al., 2002; Stowers Johansen & Kohli, 2012).

Demographic Characteristics. Gender has a strong, if contextually bounded, association with mortality risk. A comprehensive meta-analysis of 115 studies of gender and disease progression and mortality in HIV populations throughout the world (Abioye et al., 2015) found that men had a higher risk than women of *all-cause* mortality among those who had taken HAART adherently and lived in lower- and middle-income countries. However, gender was unrelated to mortality among those not taking HAART and those who lived in high-income countries. There was no gender difference in AIDS-related mortality, but men had slightly faster HIV disease progression than women. An analysis restricted to males found that across all races/ethnicities, men who have sex with men (MSM) experienced lower death rates compared with men who did not engage in same-sex sexual behaviors (Azfar-e-Alam, Hu, & Hall, 2015).

LTS differs, as well, by race and ethnicity. Harrison, Ling, Song, & Hall (2008) found that Whites and Latinos in the United States had five-year survival rates of 89.9 and 90.1 percent, respectively; whereas, African Americans and American Indians/Alaskan Natives had slightly lower five-year survival rates, at 86.5 and 83.9 percent, respectively. Several other studies have confirmed that LTS is lower for African Americans than other racial and ethnic groups in the United States (Arnold, Hsu, Pipkin, McFarland, & Rutherford, 2009; Azfar-e-Alam et al., 2015; Jain, Schwarcz, Katz, Gulati, & McFarland, 2006).

Socioeconomic Status. Several studies have reported a positive association between survival and increased educational attainment (Cunningham et al., 2000; Cunningham, Hays, et

al., 2005; McMahon, Wanke, Terrin, Skinner, & Knox, 2011). In an ecological analysis of county-level data, CDC researchers reported that survival after HIV diagnosis was worse for both men and women living in counties with larger portions of the population living below the federal poverty line (Harrison et al., 2008).

The research literature has yet to establish a direct link between employment and LTS, although Rueda et al. (2011) found an association between employment and better physical and mental health quality of life among people living with HIV, after controlling for clinical and demographic covariates. They concluded that both selection and causation processes may explain these findings. On the one hand, diminished cognitive functioning and physical health related to HIV may impair ability to continue working; on the other, the health-related benefits of employment found in the general population may extend to PLHW. Several studies have reported a positive association between employment and adherence to antiretroviral therapy (Burch, Smith, Phillips, Johnson, & Lampe, 2016; Duggan et al., 2009; Johnson, Elliott, Neilands, Morin, & Chesney, 2006; Kyser et al., 2011).

Another aspect of disadvantaged social status, unstable housing, may also contribute to increased risk of death (Erlandson et al., 2015). A review by Aidala and colleagues (2015) reported that homelessness and unstable or inadequate housing are associated with poorer health outcomes, including unsuppressed viral load, reduced CD4 count, and increased mortality risk.

Social Wellbeing. Strong social support has been associated with slower progression from HIV to AIDS, fewer HIV-related symptoms, slower CD4 cell decline, better adherence to ART, and higher rates of survival (Ironson & Hayward, 2008; Johnson, Dilworth, Taylor, & Neilands, 2011; Leserman et al., 1999). One study has directly linked social isolation and fragmented social networks to an increased risk of mortality for an HIV+ population (Greysen et al., 2013). Another study has linked social support to a slower CD4 count decline. However

social support also exposes PLWH to greater risk for adverse social consequences such as rejection, abandonment, or physical harm (Kalichman, DiMarco, Austin, Luke, & DiFonzo, 2003). According to Kalichman and colleagues (2003, p. 316), "disclosure decisions must balance the need for social support specific to coping with HIV-AIDS against the potential loss of what could otherwise be generally supportive relationships."

Healthcare and Health-Related Behaviors. The healthcare provider-patient relationship represents another dimension of social well-being. LTS among PLWH may be associated with a positive relationship with one's physician (Balbin et al., 1999).

Drug use—especially injection drug use—is consistently associated with lower rates of survival in HIV populations (Azfar-e-Alam et al., 2015; Cohn et al., 2011; Kipp, Desruisseau, & Qian, 2011; Kyser et al., 2011; Meade, Conn, Skalski, & Safren, 2011; Quach et al., 2008; Samji et al., 2013). Smoking cigarettes is associated with premature mortality, with current smokers experiencing higher rates of mortality than former smokers (Pines, Koutsky, & Buskin, 2011; Poorolajal et al., 2015). A recent study from the Danish HIV Cohort reported that smoking may contribute to more life-years lost than HIV itself (Helleberg et al., 2013).

Treatment of substance use, particularly injection drug use, through modalities such as methadone maintenance therapy, buprenorphine treatment, and other harm reduction strategies, is associated with improved HIV related outcomes including use of HAART, viral load suppression, and higher CD4 count. (Clarke et al., 2003; Moatti et al., 2000; Palepu et al., 2006; Palepu, Horton, Tibbetts, Meli, & Samet, 2004; Sambamoorthi, Warner, Crystal, & Walkup, 2000; Stowers Johansen & Kohli, 2012; Wolfe, Carrieri, & Shepard, 2010; Wood et al., 2005).

This study assessed the potential impact of LTS predictors identified in the above literature review on predictors of survival for HIV-positive CHAIN participants. A subset of CHAIN participants infected with HIV before the advent of HAART forms the study sample.

Although CHAIN is an ongoing longitudinal study, this analysis is restricted to data collected at initial interviews for two NYC CHAIN cohorts. The first cohort completed baseline interviews in 1994 and 1995, just prior to the advent of HAART. The second cohort completed baseline interviews in 2002 and 2003, at a time well into the HAART era.

Methodology

Recruiting the Study Sample

The study sample is a subset of New York City CHAIN participants.[1] We followed a two-stage sampling procedure to recruit CHAIN participants. We first formed an exhaustive list of NYC medical and social service providers who cared for twenty or more HIV-positive clients and then sampled listed sites proportional to an estimate of HIV-positive caseload. Next, we selected HIV-positive patients/clients from sampled sites to participate in CHAIN through one of two methods based upon the anticipated daily volume of HIV-positive clients/patients visiting a site. We implemented on-site sequential enrollment for "large volume" sites and list-based recruitment for sites where the numbers of patients/clients with scheduled visits on any day was small. To protect patient/client confidentiality, staff of the participating recruitment agencies always made the initial approach to their patients/clients to secure their permission for subsequent contact by CHAIN staff.

For on-site enrollment, we scheduled one or more days when CHAIN staff would be present at a recruitment site. A recruitment-agency staff member briefly described the CHAIN project to HIV-positive patients/clients visiting the agency for any reason on a recruitment day. The agency recruiter referred patients/clients, who expressed an interest in learning more about the CHAIN project, to the onsite CHAIN staff, who completed the enrollment process. CHAIN

[1] We excluded CHAIN participants residing in Westchester, Rockland and Putnam Counties from this study, as the CHAIN study was not expanded to counties outside of NYC until 2000.

staff made repeated visits to a site until they recruited a predetermined number of patient/clients, approximately proportionate to the size of the agency's HIV-positive caseload. We assigned patients/clients to a CHAIN interviewer, who would then schedule a date and place for a baseline interview.

For list based recruitment, a recruitment-agency liaison prepared a list of anonymous IDs for HIV-positive clients with active cases within the last year (agency liaisons but not CHAIN staff were able to link the client IDs to contact information). CHAIN staff randomized the anonymous ID list and returned a small number of anonymous IDs from the top of the list to the agency liaison, who attempted to contact the patients/clients associated with these IDs by phone or other contact information on file, or intercepting patients/clients when onsite at the agency for any reason (e.g. at meal program). The agency recruiter passed along the name and contact information to CHAIN of sampled patient/client, who gave initial permission to contact. CHAIN interviewers followed-up; scheduling a date and place for a baseline interview. CHAIN staff sent small numbers of additional IDs from the randomized list until we recruited a pre-determined number of clients or the list of IDs was exhausted.

Overall, the number of CHAIN participants recruited per site typically ranged between ten and thirty. In New York City, we recruited CHAIN participants from 54 agencies in 1994 and 39 in 2002 located in all five boroughs. The sample for this study included NYC CHAIN cohort members who reported a date before 1995 when asked, "You said you first became aware that you were HIV positive on __[Month/Year]" A total of 685 of 700 individuals from the 1994 cohort[2] and 409 of 693 individuals from the 2002 cohort met the study inclusion criterion.

[2] Recruitment of the 1994 cohort continued through 1995, which accounts for the small number of individuals diagnosed in 1995, and therefore excluded from this study.

Measures

Long-term survival. We collected information about deceased CHAIN members during annual cohort follow-up efforts. Typically, we discovered deaths through contact with family members of the deceased cohort member. In addition, CHAIN staff periodically checked for deaths of CHAIN participants searching the Social Security Death Index (SSDI)—most recently during the spring of 2016. We also took this opportunity to confirm the dates of death for individuals, whose deaths relatives had reported. The SSDI delays entering new deaths by three years. Based upon this reporting delay, long-term survivors are CHAIN participants not known to have died as of December 2013.

LTS Predictors. The literature review informed the selection of 26 LTS predictors constructed from the same baseline interview questions asked of both the 1994 and 2002 cohorts. The potential predictors of LTS clustered into the eight conceptual domains used to organize the literature review: 1) HIV clinical characteristics, 2) physical wellbeing, 3) psychological wellbeing, 4) demographic characteristics, 5) socioeconomic status, 6) social wellbeing, 7) health care and 8) health-related behavior.

To assess HIV clinical characteristics, we included CD4 count (200 or less/above 200) at time of baseline interview and age at HIV diagnosis. We also asked participants if a medical provider ever told them they had wasting syndrome defined in the interview schedule as severe unexplained weight loss.

We measured physical wellbeing using the physical component summary (PCS) scale of the SF-36 health survey (Ware, Kosinski, & Dewey, 2001) and a four-item vitality scale developed for the CHAIN survey. The PCS scale has a theoretical range from 0 to 100, with higher values indicating better health. The scale is standardized for the general U.S. population, with a mean of 50 and standard deviation of 10. Estimates of internal consistency reliability,

measured by Cronbach's alpha, have been reported for both the general population and subpopulations, including people infected with HIV. All reported reliabilities exceed the accepted standards for measures used in group comparisons, with the median of the reliability coefficients across studies of the general population exceeding 0.80 and ranging from 0.85 to 0.86 among PLWH (Bing, Hays, Jacobson, Chen, Gange, Kass & Zucconi 2000; Ware, Kosinski, & Dewey, 2001). The items forming the vitality scale are reproduced in the appendix to this report, and the reliability for the vitality scale for the study sample was 0.82.

Variables related to psychological wellbeing included measures of mental health functioning, HLOC, cognition, self-efficacy and religiosity. We measured mental health functioning using the mental component summary (MCS) scale of the SF-36 health survey (J. Ware, Kosinski, Turner-Bowker, & Gandek, 2002). The details of this scale are identical to those described above for the PCS—except that the SF-36 items are weighted differently so as to yield a valid measure of mental health functioning. Other variables were adapted from scales previously developed in the research literature. We measured HLOC using a 4-item scale (reliability=0.26). Cognition was a 3-item scale (reliability-=0.65) that asked about difficulties in reasoning and memory problems. We measured self-efficacy using a six-item scale (reliability=.67) with questions regarding belief in control over the direction of one's life.[3] We calculated the religiosity/spirituality scale by summing six-point ordinal measures of the frequency of prayer/meditation and attendance at religious/spiritual services and a 4-point ordinal measure of the importance of religion/spirituality (not at all important to very important).

[3] See appendix for the wording of items included in the vitality, HLOC, self-efficacy and cognition scales.

Demographic variables included age at interview, sex at birth, race (White, Black, Latino, other), and same-sex sexual behavior among men and women. Socioeconomic variables were educational attainment (less than high school, high school, more than high school), employment status(employed full or part-time/not employed), and housing status. Participants described their living situation during the six months prior to the baseline interview. Their housing situations were grouped into homeless (street, public place, shelter, drop-in center, SRO), unstable (doubled-up, temporary/transitional housing such as drug treatment, mental health treatment, hospital, nursing home, hospice), or stable (house, apartment, room).

For social wellbeing, we assessed the strength of an individual's social support network by tallying all non-cohabitating relatives and friends. The size of one's disclosure network was a count of the number of relatives and friends to whom CHAIN participants had disclosed their HIV status.

For health care, we measured both medical care and drug treatment. A provider-patient encounter scale measured the quality of the patient-provider interaction with their primary care provider. Summative scale items measured waiting time, overall satisfaction with provider, participant's perception of time provider spent with patient, provider understanding of patient's needs and questions, and provider's attention to patient's concerns. We asked each participant to indicate the importance to them of treatment for drug problems (not at all important versus slightly to extremely important), and if they had received substance abuse treatment during the six months prior to the interview. We asked all participants the "drug treatment importance" question. Not surprisingly, few non-drug using participants, 13%, thought drug treatment was important to them, but many more former drug users, 52%, and current drug users, 70%, attributed some importance to drug treatment.

For health-related behaviors, we measured use of heroin, cocaine, and/or crack on five or more occasions or problem alcohol use as determined by the 4-item CAGE questionnaire (Ewing 1984)[4]. We categorized problem substance use as current (past 12 months), former, or no history and smoking as current (smoking now), past (smoked at least 100 cigarettes). We also measured any history of injection drug use.

Statistical Analysis

We estimated logistic regression models to determine statistically significant baseline predictors of LTS. We started by fitting models separately to the 1994 and 2002 cohorts. To strengthen the statistical power of the regression analysis, we next estimated models that pooled data for the 1994 and 2002 cohorts. We first estimated a pooled main-effects model that included all the study variables and a control variable for cohort membership. We next estimated a pooled model that included interaction terms with cohort membership for each variable where 1) its coefficient was statistically significant at the $p<0.1$ level in one but not both cohort-specific models, or 2) its cohort-specific model coefficients indicated associations in opposite directions.

Results

By construction, members of both the 1994 and 2002 NYC CHAIN cohorts eligible for this study "first learned" that they were infected with HIV prior to 1995.[5] Consequently, despite the eight years that elapsed between baseline interviews, the two study cohorts were similar with

[4] When assessed separately from other substances, problem drinking was unrelated to LTS. Consequently, we decided not to include problem drinking as a separate variable.

[5]Small percentages of both cohorts reported that they "first learned" that they were HIV-positive earlier than 1985 when antibody testing first became available: three percent of the 1994 cohort and eight percent of the 2002 cohort. CHAIN interviewers did not ask directly for a date of initial diagnosis, although this was the intent of the question. These very "early" infections may raise concern about the reliability of this question to elicit an accurate date of diagnosis, particularly among individuals whose infection occurred many years before the interviews. However, we are confident that this question served its intended purpose: not to pin down a specific date of infection, but to screen out individuals who became infected after the advent of HAART.

respect to the year they "first learned" they were infected. The median year was 1991 for the 1994 cohort and 1990 for the 2002 cohort. Approximately half the members of each cohort first learned they were infected between 1989 and 1992.

Trends in Survival

Forty-five (45) percent of the 1994 NYC CHAIN cohort and 63 percent of the 2002 cohort were not known to have died prior to 2014. They constitute the study sample's long-term survivors. Those still alive through the end of the study period had lived a minimum of 19 years with the virus. Figure 1 displays the relative frequency of annual deaths by study cohort. Figure 2 displays cohort-specific survival curves. Taken together, these figures depict a sharp divergence in the temporal pattern of cohort-specific survival. Figure 2 shows that about half the 18 percent difference in LTS between the two cohorts resulted from differences in mortality in the period immediately following baseline interviews: 80 percent of the 1994 cohort compared to 89 percent of the 2002 cohort were still alive two years after baseline interviews. The relatively large number of deaths experienced by the 1994 cohort within two years of their baseline interviews undoubtedly reflected this cohort's recruitment during the pre-HAART era. The sharp decline in annual mortality after 1996 coincided with the widespread introduction of HAART, (see Figure 1).

By contrast, the annual number of deaths experienced by the 2002 cohort--recruited well into the HAART era--was more evenly distributed from the time of the initial interview through 2013 (setting aside the anomalously large number of deaths in 2006). After the short-term divergence in survival trends, Figure 2 shows that the annual decline in survival was similar for the two cohorts, during year 3 through year 11 post-baseline interviews. We attribute the remaining 11 percent of the cohort difference in LTS to the eight additional years that we followed the 1994 cohort.

Figure 1: Annual Distribution of Deaths by Study Cohort

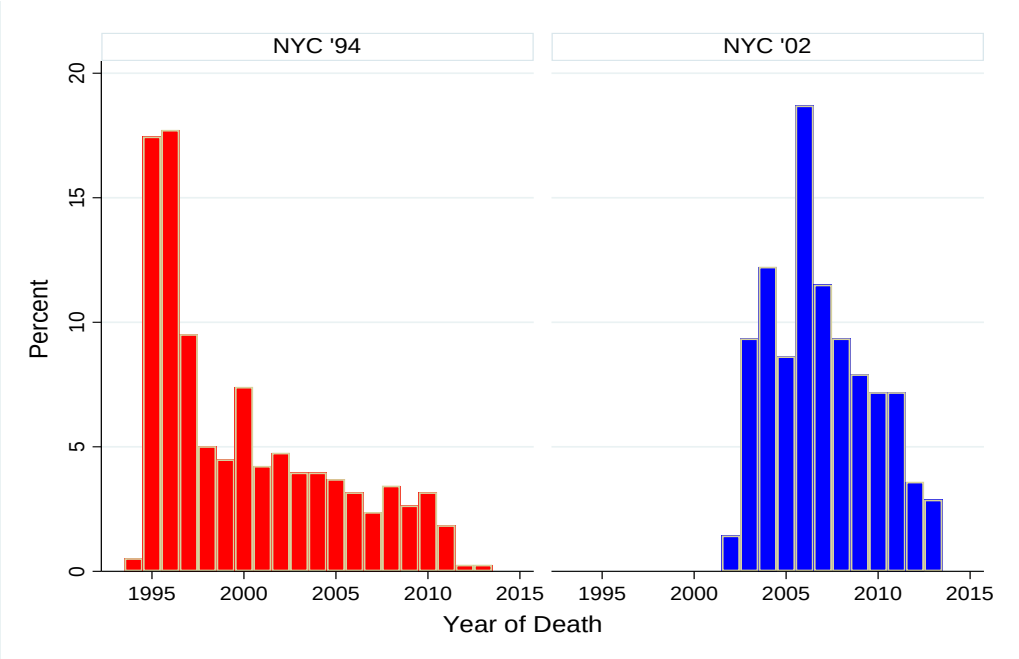
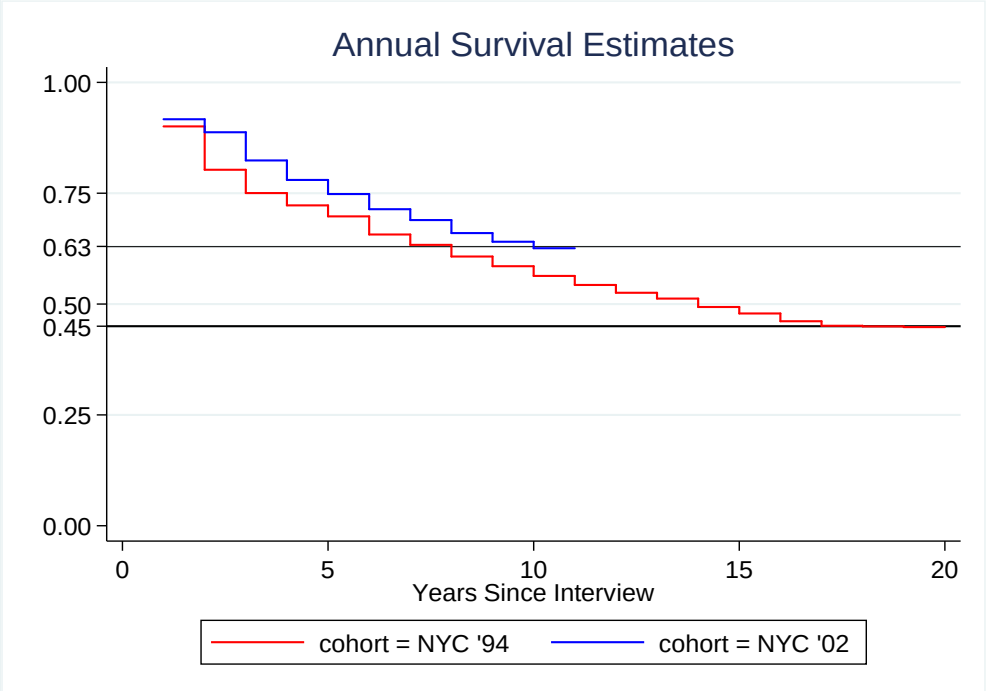


Figure 2: Cohort Specific Survival Curves



Sample Characteristics

Table 1 displays sample characteristics for the study cohorts. Members of the two cohorts were similar with respect to their sociodemographic profiles. The two study cohorts roughly spanned the same birth years. The median birth year for the two cohorts was only a year apart--1956 for the 1994 cohort and 1957 for the 2002 cohort. The similarity in birth years meant that the 2002 cohort was on average 6.6-year older than the 1994 cohort at time of baseline interview. Both cohorts were predominantly male and over 80 percent of participants were from minority ethnic or racial groups. Roughly, half of the men reported same-sex sexual behavior.[6]

Educational attainment and employment were limited. One in four 1994 cohort members and less than one in five 2002 cohort members had continued their education beyond high school. Although large majorities of both cohorts had worked at some point in their lives, less than 20 percent of study participants were working at time of baseline interviews, mostly in part-time jobs.

Despite the similarity in the age at initial diagnosis, HIV disease had progressed further at time of baseline interviews in the 1994 cohort than in the 2002 cohort. Thus, a larger percentage of the 1994 than the 2002 cohort, 44 percent, compared to 26 percent, self-reported a CD4 count below 200 at the time of baseline interview.

Notwithstanding the large cohort difference in HIV-related health, general physical wellbeing was similar for the two cohorts. Table 1 shows that at baseline interviews the means for the Physical Summary Component (PSC) scale were about eight points or almost a standard deviation below the mean U.S. population value of 50 on the SF-36 instrument; whereas, the means for self-rated vitality were close to the U.S. general population mean of 50. About a

[6] By comparison, 87 percent of men reported having sex with a person of the opposite sex.

quarter of both cohorts reported a diagnosis of wasting syndrome at some point in their lives; further evidence that HIV infection had exacted a similar toll on the physical health of both cohorts.

Table 1: Study Sample Characteristics

		Range	1994 Cohort n=685	2002 Cohort n=409
			% (n)	*% (n)*
Long-Term Survival	Yes		45 (307)	63 (256)
(Still living as of Dec. 31, 2013)	No		55 (378)	37 (153)
Demographic Characteristics				
Age	*Mean (SD)*	20 to 75	38.9 (8.1)	45.5 (7.9)
Sex	Men		63 (433)	60 (247)
	Women		37 (252)	40 (162)
Same-Sex Sexual Behavior:				
Men (MSM)[a]	Yes		53 (228)	43 (107)
	No		47 (205)	57 (140)
Women (WSW)[b]	Yes		25 (64)	25 (40)
	No		75 (188)	75 (122)
Race/Ethnicity	White		18 (118)	12 (46)
	Black		50 (345)	52 (213)
	Latino		32 (215)	36 (146)
Socioeconomic Status				
Educational Attainment	Less than High School		33 (226)	38 (154)
	High School		43 (293)	44 (181)
	More than High School		24 (166)	18 (73)
Employed for a year or more	Yes		82 (561)	83 (340)
	No		37 (253)	19 (69)
Currently Employed[c]	Yes		19 (132)	17 (69)
	No		81 (553)	83 (340)
HIV Clinical Characteristics				
CD4 Count	<200	<=100 to	44 (274)	26 (105)
	>=200	>500	56 (351)	74 (298)
Age at diagnosis	*Mean (SD)*	8 to 65	35.0 (8.5)	32.8 (8.2)
Physical Wasting	Yes		23 (155)	26 (107)
	No		77 (530)	74 (302)
Physical Wellbeing				
Physical Component Summary Scale (PCS)	*Mean (SD)*	9 to 70	42.3 (11.1)	41.5 (11.3)
Vitality	*Mean (SD)*	0 to 100	50.0 (23.4)	52.0 (22.3)

		Range	1994 Cohort n=685	2002 Cohort n=409
			% *(n)*	*%* *(n)*
Psychological Wellbeing				
Mental Component Summary Scale (MCS)	*Mean (SD)*	9 to 69	41.0 (11.4)	43.1 (12.1)
Health Locus of Control	*Mean (SD)*	33 to 100	66.6 (13.4)	72.0 (16.1)
Self-Efficacy	*Mean (SD)*	9 to 24	17.3 (2.6)	17.5 (2.5)
Cognition	*Mean (SD)*	2 to 10	5.1 (1.5)	5.6 (1.7)
		0 to 3		
Highly Religious or Spiritual	Yes		35 (241)	31 (128)
	No		65 (444)	69 (281)
Social Wellbeing				
Social Network	*Median (Inter-quartile range)*	0 to 154	8 (31)	7 (10)
Disclosure Network	*Median (Inter-quartile range)*	0 to 100	8 (12)	9 (13)
Housing Status	Stable		64 (435)	73 (300)
	Unstable		15 (105)	8 (34)
	Homeless		21 (145)	18 (21)
Health Care				
Provider-Patient Encounter Scale	*Mean (SD)*	0 to 5	3.2 (1.6)	3.7 (1.45)
Perceived Importance of Substance Use Treatment[d]	Slightly to Extremely		66 (296)	68 (186)
	Not at All		34 (150)	32 (86)
Substance Use Treatment (recent)[d]	Yes		49 (264)	33 (105)
	No		51 (270)	67 (218)
Health-Related Behavior-Substance Use Involvement				
Substance Use History	Never		22 (150)	21 (86)
	Past		34 (232)	45 (185)
	Current		44 (303)	34 (138)
Lifetime Injection Drug Use	Yes		43 (292)	45 (185)
	No		57 (393)	55 (224)
Cigarette Use	Never		17 (117)	18 (73)
	Past		19 (130)	20 (80)
	Current		64 (436)	63 (256)

[a] The base population is males.

[b] The base population is females.

[c] Includes a small number of 2002 cohort currently reporting unpaid work (n=14).

[d] The base population for these percentages is past and current substance users.

Similar to their physical health, the study cohorts' psychological wellbeing, as measured by the Mental Summary Component (MSC) scale, was seven to nine points below the U.S.

mean. The distribution of other mental health measures, including HLOC, self-efficacy, and cognition (higher values indicated fewer reasoning and memory problems), were also similar for both cohorts. Rounding out their psychological profile, about a third of members of each cohort said they were highly religious or spiritual.

Study participants' social networks showed similar variation in size for both cohorts. The 1994 cohort reported a median social network of eight individuals and the 2002 cohort reported a median social network of seven individuals. A quarter of the 1994 cohort's social networks numbered 15 or more members, and a quarter of the 2002 cohort's social networks numbered 13 or more individuals. At the other extreme, a quarter of each cohort reported social networks of four or fewer individuals. The number of individuals to whom cohort members disclosed their HIV positive status also varied greatly. The 1994 cohort disclosed their HIV status to a median of eight individuals and the 2002 cohort to nine individuals. A quarter of each cohort disclosed to 15 or more individuals, and a quarter disclosed to four or fewer individuals.

Large minorities of both cohorts reported precarious housing conditions. Over one-third of the 1994 cohort and a quarter of the 2002 cohort were either unstably housed at the time of interviews or had experienced a recent spell of homelessness.

A history of substance use was the norm for both cohorts. Approximately 80 percent of both cohorts reported substance use at some point in their lives, although substance use within six months of baseline interviews was much lower. Recent substance use was higher for the 1994 cohort (44 percent) than for the 2002 cohort (34 percent). In both cohorts, about 66 percent of lifetime substance users acknowledged the importance of substance use treatment, and 50 percent of the 1994 lifetime substance users and 33 percent of the 2002 lifetime substance users were in treatment at the time of the interviews. High rates of lifetime smoking for both cohorts,

over 80 percent, were matched by high rates of current smoking of over 60 percent at time of baseline interviews.

Baseline predictors of long-term survival

Tables 2 summarizes cohort-specific bivariate association between each predictor and LTS, adjusted for age at time of interview. Table 3 presents results of the separate multiple regression analyses for the 1994 and 2002 cohorts. Tables 4a and 4b present results of the multiple regression analysis that pooled data across cohorts. Taken together, the results of the multiple regression models presented in Tables 3, 4a and 4b indicate that LTS predictors encompassed at least one variable from each of the conceptual domains, except for social wellbeing, that independently predicted LTS (at $p<.05$ significance level).

CD4 count, physical health functioning and same-sex sexual behavior among men (MSM) were the most robust predictors of LTS. Table 2 shows that 57 percent of individuals with CD4 counts greater than 200 at time of interview for the 1994 cohort and 72 percent of those for the 2002 cohort were still alive through the end of 2013. This compares to much lower LTS rates of 26 percent and 53 percent, for the respective cohorts, among individuals with CD4 counts below 200. A substantial difference in LTS for both cohorts was also evident when we compared individuals with physical health functioning scores above and below the median. Among individuals with physical health functioning scores above the sample median, 54 percent of the 1994 cohort and 73 percent of the 2002 cohort were long-term survivors. This compares to statistically significant lower LTS rates of 36 percent and 59 percent for members of the respective cohorts whose physical health scores fell below the sample median. Among men, there was an 11 percent difference in LTS for the 1994 cohort and a 24 percent difference in LTS for the 2002 cohort between those who did and did not engage in same-sex sexual behavior.

Table 2: Long-Term Survival for Various CHAIN Cohort Subgroups Adjusted for Age

	1994 Cohort			2002 Cohort		
	%	95% CI		%	95% CI	
Over Entire Study Sample	44.8%	41.1%	48.5%	62.6%	57.9%	67.3%
Demographics						
Gender						
Men	44.0%	39.2%	48.7%	59.6%	53.4%	65.8%
Women	45.3%	39.0%	51.6%	67.8%	60.5%	75.1%
Sexual Behavior						
NonMSM Men	38.1%*	31.1%	45.0%	48.8%***	40.3%	57.3%
MSM	49.0%	42.2%	55.7%	72.8%	64.3%	81.2%
NonWSW Women	46.0%	38.8%	53.2%	66.8%	58.2%	75.4%
WSW	46.0%	33.7%	58.2%	70.2%	55.8%	84.6%
Race/Ethnicity						
White	43.8%	34.7%	53.0%	72.5%	59.6%	85.4%
Black	44.5%	38.1%	50.9%	59.1%	50.0%	68.2%
Latino	45.1%	36.4%	53.7%	55.4%	43.4%	67.4%
Socioeconomic Status						
Education						
Did not Graduate HS	39.4%+	32.0%	46.8%	51.1%*	40.7%	61.4%
HS Graduate	39.2%	32.8%	45.6%	59.2%	50.0%	68.4%
Post HS Education	51.1%	43.3%	58.8%	71.8%	61.4%	82.1%
Employment History						
Ever Employed	45.6%	41.4%	49.8%	71.5%	60.8%	82.2%
Never Employed	39.4%	30.6%	48.2%	61.1%	55.8%	66.3%
Employed at Time of Interview	63.8%***	55.4%	72.2%	71.5%	60.8%	82.2%
Not Currently Employed	39.8%	35.7%	44.0%	61.1%	55.8%	66.3%
HIV Clinical Characteristics						
CD4 Count						
CD4 Count <=200	26.1%***	20.9%	31.4%	53.0%**	43.1%	62.9%
CD4 Count >200	56.8%	51.9%	61.7%	71.5%	65.8%	77.3%
Age at HIV Diagnosis						
< 34	40.5%	30.8%	50.3%	64.4%	58.0%	70.7%
34 or older	48.0%	39.2%	56.7%	74.8%	62.7%	87.0%
Experienced Wasting Syndrome						
No	48.1%**	43.8%	52.5%	70.4%**	64.7%	76.1%
Yes	32.5%	25.0%	40.0%	54.9%	44.9%	64.9%
Physical Wellbeing						
Low PCS	35.6%***	30.8%	40.4%	58.9%***	52.0%	65.9%
High PCS	53.5%	48.4%	58.5%	73.4%	67.5%	79.2%
Low Vitality	41.3%+	36.2%	46.4%	63.0%	55.8%	70.1%
High Vitality	47.0%	42.3%	51.8%	68.8%	62.9%	74.7%

	1994 Cohort			2002 Cohort		
	%	95% CI		%	95% CI	
Psychological Wellbeing						
Low MCS	46.5%	41.6%	51.4%	64.5%	57.9%	71.1%
High MCS	42.4%	37.4%	47.4%	68.5%	62.1%	74.9%
Low Health Locus of Control	38.4%**	33.1%	43.6%	56.9%**	48.3%	65.5%
High Health Locus of Control	48.3%	43.8%	52.0%	71.5%	66.0%	77.0%
Low Self-Efficacy	42.3%	37.0%	47.6%	62.0%*	54.2%	69.7%
High Self-Efficacy	45.8%	41.4%	50.3%	70.6%	64.7%	76.4%
Poor Cognition	44.2%	39.4%	49.0%	65.3%	58.1%	72.4%
Good Cognition	44.7%	39.8%	49.6%	69.2%	63.0%	75.4%
Not Highly Religious or Spiritual	43.6%	38.9%	48.4%	64.9%	58.8%	70.9%
Highly Religious or Spiritual	46.0%	39.6%	52.5%	70.3%	62.0%	78.7%
Social Wellbeing						
Small Social Network	42.1%	37.2%	47.0%	63.6%+	57.3%	69.8%
Large Social Network	46.6%	41.9%	51.4%	70.2%	63.9%	76.5%
Small Disclosure Network	45.3%	40.5%	50.0%	62.5%*	55.9%	69.1%
Large Disclosure Network	43.6%	38.8%	48.5%	69.9%	64.1%	75.7%
Stable Housing	44.4%	39.6%	49.2%	70.0%*	64.0%	75.9%
Unstable Housing	42.4%	32.5%	52.2%	50.7%	33.5%	67.9%
Homeless	46.1%	37.7%	54.5%	53.6%	42.0%	65.1%
Health Care						
Poor Provider-Patient Encounter	47.9%+	42.3%	53.5%	62.8%	53.6%	72.0%
Good Provider-Patient Encounter	42.3%	37.7%	46.8%	67.7%	62.0%	73.4%
Substance Use Rx Not Important	46.5%	41.0%	52.0%	70.2%+	63.2%	77.2%
Substance Use Rx Important	42.4%	37.0%	47.8%	61.5%	54.4%	68.6%
Substance Use Treatment (No)	45.5%	40.6%	50.4%	66.6%	60.7%	72.5%
Substance Use Treatment(Yes)	43.0%	36.9%	49.0%	66.1%	56.9%	75.2%
Health-Related Behaviors						
No History of Substance Use	51.0%	42.7%	59.3%	78.2%**	69.2%	87.2%
Past Substance Use	40.7%	38.4%	47.0%	62.5%	55.5%	69.6%
Current Substance Use	44.3%	38.65	50.0%	54.0%	45.6%	62.3%
Lifetime Injection Drug Use (No)	46.4%	40.7%	52.1%	73.0%***	66.9%	79.1%
Lifetime Injection Drug Use (Yes)	41.5%	35.7%	47.4%	53.7%	45.2%	62.2%

	1994 Cohort			2002 Cohort		
	%	95% CI		%	95% CI	
Never Smoked	44.9%	40.3%	49.4%	67.9%***	62.4%	73.4%
Former Smoker	42.1%	31.5%	52.8%	57.8%	43.0%	72.9%
Current Smoker	41.4%	36.2%	46.7%	54.3%	47.1%	61.5%

Statistical significance of subgroup differences +p<.1. *p<.05, **p<.01. *** p<0.001
Percentage LTS are estimated at the mean age of each cohort.
MCS: Mental Component Summary Scale
PCS: Physical Component Summary Scale
Continuous variables are divided at their medians.

Table 3 presents further confirmation that CD4 count, physical health functioning and male same-sex sexual behavior were the most robust predictors of LTS. It shows that higher CD4 count and better physical health functioning were the only predictors of LTS that achieved conventional levels of statistical significance (p<.05) in both the 1994 and 2002 cohort-specific regression models. The strength of association was only slightly weaker for MSM, which was marginally significant for the 1994 cohort model (p<.1) and statistically significant at p<.05 for the 2002 cohort model.

With less certainty, we might add to the list of LTS predictors common to both cohorts—gender (female), employment at time of interview, and stronger internal health locus of control. These three variables were statistically significant in the pooled cohort models (see Tables 4a and 4b). Furthermore, the regression coefficients for each of these variables in the cohort-specific models (Table 3) were of similar size, although they were at best marginally significant predictors in the cohort-specific models.

Consistent with the results of the regression models, the descriptive data in Table 2 show that gender differences in LTS obscured a much larger disparity among males who did and did not report same-sex sexual behavior. Specifically for the 1994 cohort, after adjusting for age, 49 percent of MSM and 45 percent of women were long-term survivors compared to 38 percent of non-MSM males. The joint contribution of gender and sexual behavior to variation in LTS was

Table 3: Adjusted Odds Ratios and 95% Confidence Intervals for Cohort-Specific Models of LTS

	1994 Cohort N=525			2002 Cohort N=350		
	AOR	95% CI		AOR	95% CI	
Demographics						
Age	0.99	0.92	1.07	0.90*	0.83	0.98
Gender(Male)	0.64+	0.38	1.08	0.55+	0.28	1.09
Sexual Behavior(MSM)	1.80+	0.99	3.27	2.28*	1.05	4.95
Ethnicity: Black	1.25	0.68	2.28	0.67	0.27	1.70
Latino	2.03*	1.06	3.90	0.91	0.35	2.39
Socioeconomic Status						
Education: less than HS	1.09	0.60	1.99	0.54	0.24	1.24
HS Education	0.68	0.40	1.14	0.74	0.34	1.62
Currently Employed	1.73+	0.97	3.08	1.73	0.80	3.74
HIV Clinical Characteristics						
CD4 Count [a]	1.57***	1.36	1.81	1.57***	1.25	1.97
Age at HIV Diagnosis	0.97	0.90	1.04	1.07+	0.99	1.15
Physical Wellbeing						
PCS	1.03**	1.01	1.06	1.04*	1.00	1.07
Vitality	1.00	0.98	1.01	0.99	0.97	1.01
Wasting Syndrome	0.80	0.47	1.35	0.65	0.36	1.18
Psychological Wellbeing						
MCS	0.99	0.96	1.02	1.01	0.97	1.04
Health Locus of Control	1.01	1.00	1.03	1.01	0.99	1.03
Self-Efficacy	1.00	0.91	1.10	1.02	0.90	1.17
Cognition	0.91	0.79	1.06	1.04	0.87	1.24
Religious or Spiritual	1.00	0.84	1.19	1.03	0.81	1.29
Social Wellbeing						
Social Network	1.01+	1.00	1.03	0.99	0.97	1.01
Disclosure Network	1.00	0.99	1.01	1.01	0.99	1.02
Housing Status: Homeless	1.49	0.87	2.54	1.11	0.54	2.29
Unstable Housing	1.13	0.64	2.00	0.60	0.25	1.46
Health Care						
Provider-Patient Encounter	0.92	0.81	1.06	1.00	0.83	1.21
Importance of Substance Use Treatment	0.78	0.46	1.32	0.73	0.39	1.37
Substance Use Treatment	1.09	0.64	1.86	2.09*	1.09	3.40
Health-Related Behaviors						
Past Substance Use	0.64	0.32	1.26	1.19	0.48	2.96
Current Substance Use	0.69	0.35	1.39	0.78	0.30	2.05
Lifetime injection Drug Use	0.84	0.50	1.42	0.73	0.39	1.37
Past Smoking	0.99	0.48	2.01	0.64	0.24	1.68
Current Smoking	0.74	0.40	1.37	0.37*	0.15	0.88

+p<0.1,*p<0.05,**p<0.01,*** p<0.001

[a] CD4 Count is coded as a five category ordinal variable: 1=0-100 /2=101-200/3=201-300/4=301-500/5>500.

Table 4a: Adjusted Odds Ratios and 95% Confidence Intervals for Predictors of LTS for Pooled Cohort Sample

	Model A (N=897)	
	AOR	95% CI
Demographics		
Age	0.96	0.91 1.01
Gender(Male)	0.60*	0.40 0.90
Sexual Behavior (MSM)	1.90**	1.20 2.99
Ethnicity: Black	1.06	0.65 1.72
Latino	1.58+	0.95 2.62
Socioeconomic Status		
Education: Less than HS	0.89	0.56 1.41
HS Graduate	0.77	0.51 1.18
Employed at time of interview	1.66*	1.07 2.57
HIV Clinical Characteristics		
CD4 Count [a]	1.58***	1.40 1.77
HIV Diagnosis Age	1.00	0.95 1.05
Ever Diagnosed Wasting Syndrome	0.73	0.50 1.07
Physical Wellbeing		
PCS	1.03**	1.01 1.05
Vitality	1.00	0.99 1.01
Psychological Wellbeing		
MCS	1.00	0.98 1.01
Health Locus of Control	1.01*	1.00 1.03
Self-Efficacy	1.00	0.93 1.08
Cognitive Functioning	0.97	0.87 1.08
Religious or Spiritual	0.99	0.87 1.13
Social Wellbeing		
Social Network	1.01	0.99 1.02
Disclosure Network	1.00	0.99 1.01
Housing Status: Homeless	1.33	0.88 2.00
Unstable Housing	0.90	0.56 1.44
Health Care		
Provider-Patient Encounter	0.94	0.85 1.05
Importance of Substance Use Treatment	0.76	0.52 1.11
Substance Use Treatment	1.37	0.92 2.01
Health-Related Behaviors		
Substance Use: Past	0.79	0.47 1.32
Current	0.78	0.45 1.34
Lifetime Injection Drug Use	0.82	0.55 1.21
Smoking: Past	0.88	0.51 1.51
Current	0.58*	0.36 0.94

+p<.1 *p<.05 **p<.01 ***p<.001

[a] CD4 Count is coded as a five category ordinal variable: 1=0-100 /2=101-200/3=201-300/4=301-500/5>500.

Reference categories: Gender: Female: MSM: non-MSM men and all women; Ethnicity/race: White; Education: Beyond H.S.; Housing: Stable housing; Substance Use: Never used; Smoking: Never smoked

Table 4b Adjusted Odds Ratios and 95% Confidence Intervals for Predictors of LTS Pooled Cohort Sample with Selected Cohort Specific Estimates

	Model B (N=935)	
	AOR	95% CI
Demographics		
Age 1994 cohort	0.99	0.92 1.06
Age 2002 cohort	0.90**	0.83 0.97
Male	0.62*	0.42 0.92
MSM	1.88**	1.20 2.93
Black 1994 cohort	1.30	0.73 2.30
Black 2002 cohort	0.62	0.26 1.49
Latino 1994 cohort	2.02*	1.11 3.66
Latino 2002 cohort	0.80	0.32 2.00
Socioeconomic Status		
Education less than HS	0.86	0.55 1.36
Graduated H.S.	0.74	0.49 1.12
Currently employed	1.87**	1.22 2.88
HIV Clinical Characteristics		
CD4 Count [a]	1.56***	1.39 1.75
HIV Diagnosis Age 1994 cohort	0.97	0.91 1.04
HIV Diagnosis Age 2002 cohort	1.07+	1.00 1.15
Physical Health		
PCS	1.03**	1.01 1.05
Vitality	1.00	0.98 1.01
Wasting Syndrome	0.73	0.51 1.07
Mental Health		
MCS	0.99	0.98 1.01
Cognition 1994 cohort	0.94	0.82 1.08
Cognition 2002 cohort	1.06	0.90 1.24
Self efficacy	1.00	0.93 1.08
Health Locus of Control	1.01*	1.00 1.03
Religious or Spiritual	1.03	0.90 1.17
Social Wellbeing		
Social Network	1.01	1.00 1.02
Disclosure Network	1.00	0.99 1.01
Homeless 1994 cohort	1.60+	0.96 2.65
Homeless 2002 cohort	1.01	0.52 1.97
Unstable Housing 1994 cohort	1.17	0.68 2.02
Unstable Housing 2002 cohort	0.51	0.22 1.21
Health Care		
Provider-Patient Encounter	0.95	0.86 1.05
Substance Use Treatment Important	0.82	0.45 0.98
Substance Use Treatment 1994 cohort	1.13	0.70 1.83
Substance Use Treatment 2002 cohort	1.82*	1.00 3.30
Health-Related Behaviors		
Past Substance	0.77	0.47 1.26
Current Substance	0.69	0.41 1.15
Lifetime Injection Drug Use	0.79	0.53 1.16
Past Cigarette Use 1994 cohort	1.02	0.54 1.96
Past Cigarette Use 2002 cohort	0.69	0.28 1.70
Current Cigarette Use 1994 cohort	0.76	0.44 1.32
Current Cigarette Use 2002 cohort	0.36*	0.17 0.78

See Table 3a for reference categories and significance levels

even stronger for the 2002 cohort: 73 percent of MSM and 68 percent of women were long-term survivors compared to 49% of non-MSM men.

Four variables were statistically significant predictors in one but not both cohorts. Being Latino (vs being white) predicted LTS in 1994 but not in 2002.Younger age at interview, substance abuse treatment and current smoking were statistically significant LTS predictors in 2002 but not in 1994. Potential predictors with significant bivariate associations with LTS (Table 2) that lost statistical significance in the regression models (Tables 3, 4a and 4b) were education (in 2002), wasting syndrome (in both cohorts), self-efficacy (in 2002), number of people to whom one disclosed HIV status (in 2002), housing stability (in 2002), history of substance use (in 2002) and lifetime injection drug use (in 2002).

Variables not associated with LTS for the separate or pooled cohort models were being black (versus white), vitality, age at HIV diagnosis, mental health functioning, religiosity/ spirituality, the perceived importance of substance use treatment, and the quality of medical provider encounters.

Supplemental Analysis of Sexual Identity and Behavior. Thus far, we have limited our assessment of sexuality to male same-sex behavior. However, the CHAIN interview permits further exploration of sexual identity: individuals were asked whether they self-identified as heterosexual or a sexual minority—gay, lesbian, homosexual, bisexual or other. Table 5 presents in more detail how sexual behavior (same sex behavior) and sexual identity (self-identify as either heterosexual or a sexual minority) were interrelated with LTS.

Table 5: Age Adjusted LTS Broken Down by Cohort, Gender, Sexual Identity and Sexual Behavior (Cell N's are in parentheses)

		Men		Women	
		Sexual Identity			
		Heterosexual	Sexual Minority	Heterosexual	Sexual Minority
		1994 Cohort			
Same Sex	Yes	42% (26)	50% (203)	59% (25)	38% (39)
	No	38% (201)	N<5	46% (179)	N<5
Sexual		2002 Cohort			
Behavior	Yes	73% (13)	74% (89)	71% (24)	73% (15)
	No	49% (134)	50% (6)	71% (107)	N<5

Cell sizes in parentheses.

In brief, Table 5 replicates the previously reported finding that male same-sex sexual behavior was associated with increased LTS for the 2002 but not the 1994 cohort (compare percentages across rows). By contrast, male sexual minority identity had, at best, a modest association with LTS in 1994 and none in 2002 (compare percentages across columns). For women participating in the 1994 cohort but not for those in the 2002 cohort, heterosexual compared to sexual minority identity was marginally associated with LTS. Same-sex sexual behavior had no effect on women's LTS for either cohort.

Discussion

Study findings are generally consistent with the existing research literature; a broad range of biopsychosocial variables are associated with LTS for NYC residents living with HIV followed between thirteen to twenty-two years after baseline interviews. The CHAIN sample closely matched the demographic distribution of the HIV population receiving NYC Ryan White CARE Act funded services, and most were young or middle-aged adults at the time of baseline interviews. This study is unusual if not unique in that it compares long-term survival for two cohorts of HIV-positive individuals sampled from similar birth cohorts and infected prior to the

introduction of HAART--one cohort was recruited prior to widespread introduction of HAART and the second well into the era of HAART. Therefore, the long-term survivors in the 1994 cohort had survived a period of high mortality *after* completing their baseline interview; whereas, the 2002 cohort was recruited at a time when they had already survived several years after the widespread introduction of HAART had substantially reduced HIV mortality.

Table 6 presents a simplified classification of LTS predictors. Higher CD4 counts and better physical health functioning were statistically significant for both cohorts and probably tapped into the enduring effects of physical health status at time of baseline interviews. The independent direct effects of these two measures suggest that the effect of physical health on LTS operates independently through two general causal pathways; one linked to HIV disease progression and the other linked to non-HIV determinants of physical health. The incidence of opportunistic infections was not tested in this study, but it suggests a further specification of the pathways through which HIV disease progression operates to shorten survival.

Another potential mechanism linking physical health to LTS, wasting, had a statistically significant bivariate association ($p<.01$, see Table 2) in both cohorts, but unexpectedly did not exert a statistically significant effect in the multiple regression models. More detailed regression analysis suggests that wasting operated indirectly on LTS through its negative association with three other LTS predictors, physical health functioning, CD4 count and internal health locus of control. When the two cohorts are pooled, the odds ratio of wasting on LTS, controlling for age and cohort, is 0.52 ($p<0.001$) (indicating a strong inverse association with survival). After controlling for differences in physical health functioning, CD4 count, and health locus of control,

TABLE 6: Summary of Regression Model Predictors of LTS

1a. Statistically significant predictors in pooled and in both cohort-specific models

-CD4 count
-Physical health functioning
-MSM is marginally significant (p<.1) in 1994 cohort specific model but significant in 2002 cohort model

1b. Statistically significant (p<.05) predictors in pooled but not cohort-specific models

-Sex (Female) (in pooled models with and without cohort interactions (Models A and B))
-Health locus of control
- Currently employed

2. Statistically significant predictors in 1994 cohort but not 2002 cohort

-Latino

3. Statistically significant predictors in 2002 and not 1994

-Younger biological age (statistically significant in pooled cohort models with interaction term, Model B)
-Older age at time of HIV diagnosis (pooled model with cohort interaction terms Model B)
-Substance use treatment
-Not smoking at time of interview

4. Variables that did not independently predict LTS

-Black (vs White)
-Education
-Ever employed
-Vitality
-Wasting*
-Older age at time of HIV diagnosis
-Self-efficacy*
-Mental health functioning
-Cognition
-Religiosity
-Size of social network*
-Number of people disclosed HIV status*
-Housing status*
-Satisfaction with medical provider encounters
-Perceived substance use treatment as important
-Lifetime drug use*
-Lifetime injection drug use*

*****Significant bivariate association with LTS

the adjusted odds ratio of wasting was reduced to 0.71 ($p<0.045$),[7] or a 37 percent [(0.71-0.52)/0.52] reduction in the size of its direct effect on LTS.

This study also presented data on the complex relationship between gender, sexual behavior and identity. Although women had higher LTS than men, in general, the gender difference was smaller than the effect of sexual behavior among men. Thus, MSM sexual behavior had a robust association with LTS in both cohorts, and MSM had higher LTS than women. It is not immediately evident why men's sexual behavior rather than their sexual identity should have exhibited such a robust association with LTS. The strong direct effect of MSM might be attributed to its association with more fundamental social determinants of health. However, inclusion of several socioeconomic variables in the regression models--education, employment, ethnicity, and social networks--would seem to have controlled for the survival benefits that MSM gained from their advantaged social and economic position. By contrast, neither sexual behavior nor identity were associated with LTS for women.

This study provides mixed support for previous research findings that a more "positive" emotional disposition and better mental health predict LTS. We found that stronger internal health locus of control, but not general mental health functioning, was among the more robust predictors of LTS. These results point specifically to the possible LTS benefits of believing that one is responsible for and has control over maintaining good health.

A history of substance use and of injection drug use, in particular, had age adjusted bivariate associations with lower rates of LTS for the 2002 but not the 1994 cohort. Examination of the joint effect of these two variables suggests that injection drug use was the dominant factor behind the detrimental effect of drug use on LTS particularly among the 2002 cohort. Thus for

[7] When interpreting the size of effects of odds ratio between zero and one, values closer to one represent weaker effects.

the 1994 cohort, LTS is similar for lifetime drug use, whether or not it includes injection ($p>.1$): 41 percent of individuals reporting injection drug use at some point in their lives survived to 2013, compared to 44 percent of lifetime substance users who had never injected. LTS for individuals with no history of substance use was higher, 51 percent. A larger substance-use related difference in LTS is present for the 2002 cohort ($p<.001$): 52 percent of lifetime injection drug users survived to 2013 compared to 68 percent of lifetime substance users who did not inject and 79 percent of individuals who reported no history of substance use.

Study findings give some support to the possibility that substance use treatment conferred survival benefit, at least for the 2002 cohort, pointing to the possible benefit of simultaneous management of medical and behavioral medicine problems.

Employment at time of interview, but not lifetime employment, improved chances of LTS. We should note that the model included measures that controlled for physical health at time of interview, so current employment may capture unmeasured additional beneficial health effects that accrue to individuals, who occupy more advantageous positions in society's socioeconomic hierarchy (Link and Phelan, 1995).

Previous research that has linked social support with survival finds at best weak support based on the measures used in this study. Modest bivariate associations for the 2002 cohort between LTS and social network size and number of people to whom cohort members disclosed HIV infection lost statistical significance in the LTS in the regression models.

Data confirmed prior findings of the detrimental effect of smoking on LTS. That former smokers had a higher rate of LTS than current smokers suggests that smoking cessation interventions may be an effective means to lengthen life among HIV-infected individuals (Vardi and Messeri, 2013).

In addition, we did not replicate evidence from previous studies that a good relationship with medical providers mattered for the CHAIN cohort. Religiosity as measured in this study was also not a factor in long-term survival. Given the generally adverse effects of housing instability and injection drug use on health, we were surprised that the observed associations of housing status and injection drug use history on LTS failed to be sustained as direct effects in the multiple regression analysis.

Limitations

Although CHAIN's research design is a cohort study involving repeated interviews, we only used baseline measures as predictors of LTS, which meant that we did not attempt to model the more proximal effects of the time-varying variables included in this study. It is worth noting that despite the fact that many variables in this study could vary over time, we still found a large number of baseline correlations.

Conclusion

Multiple facets of health and wellbeing were associated with long-term survival for the NYC CHAIN cohort monitored up to 19 years after baseline data collection. Although the findings do not fit a simple explanatory narrative, they do point out that social determinants of health appear to have mattered for CHAIN cohorts both during times when effective treatment was absent and when it was widely available. An important lesson learned from the CHAIN cohorts is that persons living with HIV, and most likely other chronic conditions, have some control over duration of survival. There appear to be survival benefits for interventions that support efforts to maintain good physical health and find positive reasons for living when confronted with life's adversities.

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Appendix

Scale Items and reliability coefficients

Unless otherwise note response categories are strongly disagree/disagree/agree/strongly agree

Health locus of control (.257)

I can maintain my health through good health behavior.

Monitoring my health is primary my doctor's responsibility. (response categories are reverse coded)

Individuals should follow good health practices even if it means giving up some things they like to do.

If a person doesn't have good health, he or she doesn't have anything.

Personal Efficacy (.665)

Every time I try to get ahead, something or someone stops me. (reverse coded)

There is not much chance that people will really do anything to make this a better world. (reverse code)

Persons like me don't have a very good chance to be successful in life. (reverse coded)

For success, good luck is more important than hard work. (reverse coded)

Most of the time I am in firm control of my feelings and behaviors.

I can handle most things that happen in my life.

Vitality (.82) *coded all of the time/much of the time/A good bit of the time/some of the time/a little of the time/none of the time*

During the past month, how much of the time

Did you have a lot of energy? (reverse coded)

Did you feel full of pep? (reverse coded)

Did you feel worn out?

Did you feel tired?

Cognition (scale reliability=.65)

Did you have difficulty reasoning or solving problems for example, making plans, making decisions, learning new things? (reverse coded)

In the past month how would you describe your memory on the whole as compared to the best it has ever been (much worse/somewhat worse/about the same/somewhat better/much better)

In the past month, compare to the best your memory has been, how would you describe the speed with which you now remember things (much slower/somewhat slower/about the same/somewhat quicker/much quicker)