A Case-Controlled Study of Successful Aging in Older HIV-Infected Adults

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ABSTRACT

Objective: There is a growing public health interest in the aging human immunodeficiency virus (HIV)–infected (HIV+) population, although there is a dearth of research on successful aging with HIV. This study aimed to understand the risk and protective factors associated with self-rated successful aging (SRSA) with HIV.

Design: Cross-sectional, case-controlled.

Setting: HIV Neurobehavioral Research Program and the Stein Institute for Research on Aging at University of California, San Diego.

Participants: Eighty-three community-dwelling HIV+ and 83 demographically matched HIV-uninfected (HIV–) individuals, enrolled between December 1, 2011, and May 10, 2012, mean age of 59 years, primarily white men, 69% with acquired immune deficiency syndrome (AIDS), who had been living with an HIV diagnosis for 16 years. Diagnostic criteria for HIV/AIDS were obtained through a blood analysis.

Measurements: Participants provided ratings of SRSA, the primary outcome measure, as part of a comprehensive survey that included measures of physical and emotional functioning and positive psychological traits. Relationships between how the different variables related to SRSA were explored.

Results: While SRSA was lower in the HIV+ individuals than their HIV– counterparts, 66% of adults with HIV reported scores of 5 or higher on a 10-point scale of SRSA. Despite worse physical and mental functioning and greater psychosocial stress among the HIV+ participants, the 2 groups had comparable levels of optimism, personal mastery, and social support. Higher SRSA in HIV+ individuals was associated with better physical and emotional functioning and positive psychological factors, but not HIV disease status or negative life events.

Conclusions: Successful psychosocial aging is possible in older HIV+ individuals. Positive psychological traits such as resilience, optimism, and sense of personal mastery have stronger relationship with SRSA than duration or severity of HIV disease. Research on interventions to enhance these positive traits in HIV+ adults is warranted.

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The number of people aged 50 years and over[1] who are HIV-infected (HIV+) is growing because of the success of antiretroviral therapy and consequent decreased mortality as well as an increase in incident HIV infection among older adults.[2] It is estimated that by 2015 half of the HIV+ individuals in the United States will be > 50 years old.[1] From a public health perspective, the United States and the rest of the world are not well prepared to manage and treat a rapidly aging population with HIV.[3] Health care professionals are still learning to optimize antiretroviral therapy treatment as well as determining how to best address the increased medical comorbidities[4] that occur among older HIV+ persons.

Old age is associated with a complexity of physical, emotional, and societal changes and adaptations.[5] Individuals living with HIV are at a high risk at a younger age for medical comorbidities typically associated with old age, including cancer,[6] cardiovascular[7] and liver diseases,[8] and osteoporosis.[9] These medical illnesses are believed to be related to persistent inflammation and, possibly, side effects of antiretroviral therapy,[10] and it is these medical illnesses and not the HIV disease per se that are increasingly responsible for mortality in older HIV+ adults.[11] Additionally, quality of life among individuals aging with HIV is impacted by stigma and discrimination, and these factors in turn have been associated with limited familial and social support, social isolation leading to increased depression, suicidal ideation, and additional mental health problems (eg, anxiety, loneliness).[12] Nonetheless, there is a growing body of literature that suggests the possibility of successful aging in individuals with HIV,[13–15] and understanding HIV in the context of successful aging may help identify individual factors related to better well-being.

A growing amount of objective evidence exists in the form of biological, genetic, and neurologic data for the validity of subjective measures of well-being.[16–19] Self-rated successful aging (SRSA) has been defined as a holistic, multidimensional assessment of one's overall physical and mental health and is a separate construct from the absence of disease, freedom from disability, independent living, positive psychological factors, and psychosocial functioning.[20,21] Indeed, psychosocial factors were emphasized more strongly than physical factors (including absence of disease and disability, longevity, genetics, and independent living) in qualitative studies on older adults' perceptions of successful aging.[22,23] The measure of SRSA used in this study is based on participants' subjective definition of successful aging, and the rationale for this decision has been previously described in detail.[20,21,24] In HIV-uninfected (HIV–) older adults, Vahia and colleagues[25] developed an empirically based, multidimensional model of successful aging in which physical functioning and positive psychological factors appeared to have a direct effect on SRSA. In a sample of 1,006 community-dwelling HIV– adults aged 50–99 years, a multivariate model of SRSA included greater resilience, lower levels of depression, better physical health, and older age (in that order), and the associations with SRSA and resilience and

Clinical Points

- Human immunodeficiency virus (HIV) infected (HIV+) adults give high ratings of successful aging, although their ratings are somewhat lower than HIV uninfected adults.
- Self-rated successful aging in HIV+ adults is related to better physical and mental health functioning; increased happiness; greater resilience, optimism, and personal mastery; better attitudes toward aging; fewer depressive symptoms; and less perceived stress.
- Clinicians can potentially help improve well-being in HIV+ adults by focusing on interventions to enhance positive psychological traits.

depression were comparable to the effect size between SRSA and physical health.[20] On the basis of these findings, it can be inferred that resilience and depression play as significant a role on SRSA as physical health, highlighting an important role for psychiatry and aging.

In HIV+ individuals, 2 models of successful aging have been proposed.[26,27] Kahana and Kahana's model[26] is based on factors related to quality of life, including affective states and maintenance of valued activities and relationships. The second model, proposed by Vance and colleagues,[27] includes interactions between 8 components of successful aging: length of life, biological and mental health, cognitive efficiency, social competence, productivity, personal control, and life satisfaction. However, to date neither model has been empirically validated, nor is it clear how these models relate to models of successful aging we have previously used. Furthermore, SRSA has not yet been compared between HIV+ and HIV− individuals.

There is a pressing need to understand the risk and protective factors associated with aging with HIV. The National Institutes of Health (NIH) Office of AIDS Research (OAR) HIV and Aging Working Group has identified a priority research area to study the mechanisms of successful aging in older HIV+ adults.[28] Per the OAR Working Group, one of the important challenges to identifying unique characteristics and biomarkers related to individuals with HIV relates to difficulties in identifying appropriate well-matched comparison groups. The specific mechanism of successful aging the present study chose to explore is the relationships between domains previously identified as being predictive of SRSA among HIV− persons and compare differences in these domains between demographically matched HIV+ and HIV− older adults. We proposed 2 hypotheses: (1) HIV+ participants would report worse SRSA, physical functioning, emotional functioning, and positive psychosocial factors than the HIV− group and (2) in both groups, physical and emotional functioning, as well as positive psychological factors, would be associated with SRSA.

METHOD

Sample

This study was approved by the University of California, San Diego (UCSD) Institutional Review Board, and all the participants signed a written informed consent. Participants included 83 HIV+ and 83 demographically matched HIV− individuals. The present study represented a joint effort involving the HIV Neurobehavioral Research Program and the Stein Institute for Research on Aging (Stein Institute) at UCSD.

Participants who were HIV+ were recruited from ongoing studies at the HIV Neurobehavioral Research Program. An HIV diagnosis was obtained from a positive HIV test, and an acquired immune deficiency syndrome (AIDS) diagnosis was based on 1993 Center for Disease Control classification.[1] One hundred fifty questionnaire packets were mailed to current participants in 1 or more studies at the HIV Neurobehavioral Research Program between December 1, 2011, and May 10, 2012, and we obtained a response rate of 58%. Accordingly, the specific inclusion criteria were fluency in English, active status at the HIV Neurobehavioral Research Program, and completion of blood analysis with certain blood-based biomarker data (including cluster of differentiation 4 [CD4] counts and plasma viral load) available within the past 2 years. An emphasis was placed on including participants who were older (eg, over 50 years of age) in order to try and have a comparable sample to the Stein Institute's existing data. Exclusion criteria were a diagnosis of serious mental illness (eg, schizophrenia), major neuromedical comorbidities (eg, seizure disorders, brain trauma with loss of consciousness for > 30 minutes), or any other cognitive impairment that could be definitively attributed to factors other than HIV illness.

Once the HIV+ sample was identified, an HIV− comparison group was selected from the ongoing Successful Aging Evaluation (SAGE) Study at the Stein Institute. The SAGE Study used a multicohort longitudinal design to randomly select 1,300 community-dwelling adults of San Diego County, aged > 50 years. Participants were included in the SAGE study if they had a telephone in the home, were physically and mentally able to participate in both a phone interview and paper-and-pencil mail survey, and were fluent in English. Exclusion criteria included subjects who were residing in a nursing home or skilled nursing facility and those who had an existing diagnosis of dementia or a terminal illness. Participants from SAGE were matched, one-to-one, with the HIV+ subjects on the following variables (in order of importance): age, gender, education, and race/ethnicity. All of the HIV+ participants were mailed a self-report survey of successful aging largely similar to the one we had used in our prior studies of an HIV− population.[29–31] The survey contained 2 copies of a consent form to participate in the study, a demographics worksheet, 15 scales, and a preaddressed and stamped return envelope.

Measures

The survey questionnaire included the following measures:

Self-rated successful aging. Self-rated successful aging was the primary outcome measure of this study. The participants were asked to rate themselves in terms of "successful aging" on a single-item, 10-point scale, with 1 being the least

successful and 10 being the most successful.[21] It was left to the individual participant to define successful aging for himself or herself.

Physical functioning. Physical functioning was measured with the physical component score on the Medical Outcome Study 36-Item Short-Form, version 1.0 (SF-36).[32] The physical component is composed of the following subscales: physical functioning, role-physical, bodily pain, and general health.

Emotional functioning. General emotional well-being was assessed with the mental health component score from the SF-36,[32] which is composed of vitality, social functioning, role-emotional, and mental health subscales. Happiness was measured with the Center for Epidemiologic Studies Depression Scale-happiness (CES-D-H).[33] The CES-D-H consists of 4 items from the original CES-D asking participants to describe how they experienced their feelings over the previous week (eg, "I enjoyed life"). Scores on this scale range from 1 (rarely or none of the time) to 4 (most or all of the time), with high scores indicating greater happiness.

Different depression inventories were administered to the HIV+ and HIV− groups because of variations in the surveys administered to the 2 samples. For the HIV+ group, the Beck Depression Inventory-II (BDI-II)[34] was administered. The BDI-II contains 21 questions asking participants about multiple depressive symptoms (eg, sadness, guilt, increases and decreases in sleep) answered on a scale from 0 to 3, with higher scores indicating greater depressive symptoms. The HIV− group completed the Patient Health Questionairre-9 (PHQ-9).[35] The 10-items of the PHQ-9 overlap considerably with the BDI-II and include items such as, "little interest in doing things" and "trouble concentrating." Items are rated on a scale from 0 (not difficult at all) to 3 (extremely difficult). Anxiety was measured with the Brief Symptom Inventory-anxiety subscale.[36] The 6 questions on this scale ask participants to indicate how anxious they have felt during the past week on items such as "nervousness" and "panic," from not at all (1) to extremely (5), with higher scores indicating greater symptoms of anxiety. Stressful life events (eg, deaths, divorce, move) in past year were measured with the Life Event Scale.[37] Participants are asked to report whether a stressful life event occurred (2–4 = yes or 1 = no), and if yes, how much it upset them, from not too much (2) to very much (4).

Positive psychosocial factors. Measures of resilience, optimism, perceived stress, spirituality, social support, personal mastery, and attitudes toward own aging were included to assess positive psychosocial factors. Resilience was measured with the 10-item Connor-Davidson Resilience Scale.[38] Items include statements such as, "I can do just about anything I really set my mind to do," and are recorded on a Likert-type scale from 1 (not true at all) to 5 (true nearly all the time). Optimism was measured with the Life Orientation Test-Revised (LOT-R).[39] The LOT-R consists of 6 items (eg, "Overall, I expect more good things to happen to me than bad") that are recoded from 1 to 5 in which 1 = strongly disagree and 5 = strongly agree. Amount of perceived stress was measured with the 10-item Perceived Stress Scale.[40] The PSS has participants respond to a 5-point scale ranging from 1 (never) to 5 (often), with items such as, "How often, in the past month, have you felt nervous or 'stressed'?" Social interactions were measured with the Duke Social Support Index social interaction subscale.[41] This 4-time questionnaire aims to quantify how often (within the past week) the participant spent time visiting or talking with people or groups (eg, "How often did you go to meetings or clubs, religious meetings, or other groups that you belong to in the past week?"). Responses range from 1 (none) to 8 (7 or more times). Personal mastery was measured with the 7-item Personal Mastery Scale.[42] Participants respond on a continuum ranging from 1 to 4, with 1 (agree) or 4 (disagree) to statements such as, "I can do just about anything I really set my mind to do." Lastly, information on participants' feelings toward their own aging was measured by using the 5-item Philadelphia Geriatric Center (PGC) Morale Scale, attitudes subtest.[43] The PGC Morale Scale asks participants whether they agree or disagree to statements such as, "Things keep getting worse as I get older."

Data Analysis

Data were examined for normality, and 2 sets of analyses were conducted. First, because of heterogeneity of variance on many of the measures, Man-Whitney *U* tests were employed to determine group differences on all variables. Next, Spearman correlations were computed to explore the relationship of SRSA with variables in the following domains: (1) physical, (2) emotional, and (3) positive psychosocial factors. To control for familywise type I error, we used an adjusted α of $P < .01$ for group comparisons and Bonferroni-adjusted α of .003 (.05/17 total comparisons) for correlational analyses.

RESULTS

Sample Characteristics of HIV+ and HIV− Groups

Demographic and clinical characteristics for both the HIV+ and HIV− groups are presented in Table 1. Mean age of the HIV+ participants was 59 years (range, 48–84) and, for the HIV− participants, 60 years (range, 51–83). The proportion of subjects currently married or living in a marriage-like relationship was much lower (29.8%) among HIV+ than in HIV− (69.9%) individuals. Approximately two-thirds of the HIV+ participants had a diagnosis of AIDS, as based on 1993 Centers for Disease Control classification.[1] As a group, the HIV+ participants were stable on antiviral treatment (participants on antiretroviral therapy = 86.7%), had well-controlled HIV disease (median CD4 count = 558.0 [interquartile range, 357–796.5] cells/mL; median log plasma = 1.7 [interquartile range, 1.6–1.7]), and had a mean HIV infection duration from date of positive HIV test of 15.2 years. Seventy percent of the HIV+ participants identified their primary risk factor for contraction of HIV as homosexual contact. Other stated primary risk factors were heterosexual contact (19%), intravenous drug use (6%), and other or unknown manners of contraction (5%). Forty-nine percent met criteria for a lifetime substance abuse or dependence diagnosis. Employment data were available on 74

Table 1. Comparison of HIV+ and HIV– Groups

Variable	Range	HIV– (n = 83) Mean (SD)[a]	HIV– (n = 83) Median	HIV+ (n = 83) Mean (SD)[a]	HIV+ (n = 83) Median	Group Differences, z or χ^{2b}	P Value
Demographic							
Age, n (%), y		60.4 (6.3)	60.2	59.3 (6.7)	58.7	NA	NA
Men, n (%)		71 (85.5)		71 (85.5)		NA	NA
White, n (%)		74 (89.2)		66 (79.5)		2.24	.14
Marital status (currently married or living in a marriage-like relationship), n (%)		58 (69.9)		22 (29.8)		23.65	< .001*
Education, n (%)							
1–12 y, high school diploma, or GED		8 (9.6)		20 (24.1)		5.20	.02*
13–15 y		39 (47)		28 (33.7)		2.50	.11
Bachelor's degree or above		36 (43.4)		35 (42.1)		0.00	1.00
HIV disease status							
Duration of HIV disease, y	0–31	NA		15.2 (7.6)	15.9 (10.2–15.9)[c]	NA	NA
Current CD4 count, cells/mL	26–1,428	NA		600.1 (294.1)	558.0 (357–796.5)[c]	NA	NA
Nadir CD4 count, cells/mL	1–720	NA		167.4 (158.0)	150.0 (40–250)[c]	NA	NA
Plasma HIV RNA (log_{10}) (n [proportion undetectable])	1.6–4.9	NA		71 (81.7)		NA	NA
AIDS, n (%)		NA		57 (68.7)		NA	NA
Antiretroviral therapy, n (%)		NA		72 (86.7)		NA	NA
Successful aging[d]							
SRSA	1–10	7.5 (1.9)	8.0	6.7 (2.0)	7.0	−2.84	.005*
Physical							
SF-36, physical component score	0–100	47.1 (10.8)	50.7	42.1 (11.3)	43.5	−2.99	.003*
Emotional							
CES-D-H score (happiness)	0–12	10.2 (2.9)	12.0	8.7 (2.9)	8.0	−3.30	.001*
SF-36 mental component score	0–100	52.9 (9.5)	55.6	45.5 (11.4)	45.8	−4.52	< .001*
BDI-II score	0–46	NA		11.3 (10.6)	9.0	NA	NA
PHQ-9 score	0–25	3.29 (4.4)	2.0	NA		NA	NA
LES score (life events)	0–33	3.8 (3.3)	3.0	5.6 (4.5)	5.0	−2.71	.007*
BSI-A score (anxiety)	0–24	1.9 (3.6)	1.0	4.1 (4.3)	2.0	−4.20	.001*
Positive psychosocial							
CD-RISC-10 score (resiliency)	0–40	31.0 (6.5)	31.0	27.9 (7.5)	28.0	−2.72	.007*
LOT-R score (optimism)	1–30	22.4 (4.3)	22.0	21.6 (4.0)	22.0	−0.88	.38
PSS score (perceived stress)	0–40	12.0 (5.6)	11.0	14.6 (7.4)	14.0	−2.73	.006*
DSSI-social interactions score	4–12	8.3 (3.3)	9.0	8.2 (1.8)	8.0	−0.66	.51
PMS score (personal mastery)	1–28	13.3 (3.7)	14.0	14.4 (4.1)	14.5	−1.88	.06
PGC Morale Scale score (attitudes toward aging)	0–5	3.6 (1.5)	4.0	2.9 (1.8)	3.0	−2.60	.009*

[a]Values shown are mean (SD) except where indicated otherwise.
[b]Mann-Whitney U test for continuous variables; χ^2 test for categorical variables.
[c]Values in parentheses indicate interquartile range.
[d]For all measures, higher scores indicate higher functioning except the PMS, in which lower scores indicate higher mastery.
*$P < .01$ (adjusted α value for significance).
Abbreviations: AIDS = acquired immune deficiency syndrome, BDI-II = Beck Depression Inventory-II, BSI-A = Brief Symptom Inventory-anxiety, CD-RISC-10 = 10-item Connor-Davidson Resilience Scale, CD4 = cluster of differentiation 4 , CES-D-H = Center for Epidemiologic Studies Depression Scale-happiness, DSSI = Duke Social Support Index, GED = General Education Development, HIV– = human immunodeficiency virus uninfected, HIV+ = human immunodeficiency virus infected, LES = Life Events Scale, LOT-R = Lifetime Orientation Test-Revised, NA = not applicable, PGC = Philadelphia Geriatric Center, PHQ-9 = Patient Health Questionnaire, PMS = Personal Mastery Scale, PSS = Perceived Stress Scale, RNA = ribonucleic acid, SF-36 = 36-item Short Form, SRSA = self-rated successful aging.

HIV+ participants, of which 20% were employed full time and 15% were employed part time.

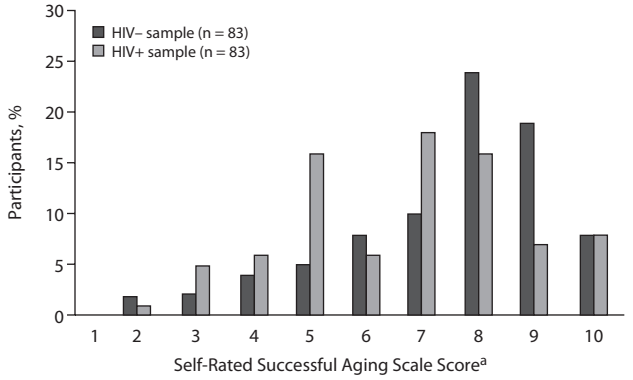
Sixty-six percent of the HIV+ participants reported SRSA scores of > 5 (mean = 6.7, SD = 2.0, median = 7.0) on a scale from 1 (least successful) to 10 (most successful). A greater proportion (84%) of the HIV– group reported SRSA scores of > 5 (mean = 7.5, SD = 1.9, median = 8.0; Figure 1), and mean SRSA scores significantly differed between the 2 groups (Table 1). A cutoff of > 5 was chosen to compare the groups on this measure, as SRSA was designed with vague anchors and without cutoff values.[21] Scores on SF-36 physical and mental health components, as well as measures of happiness, resilience, and attitudes toward own aging, were significantly lower among HIV+ than HIV– participants, whereas negative life events, anxiety, and perceived stress were significantly higher among HIV+ participants (Table 1). The 2 groups were similar on levels of optimism, social support, and personal mastery.

Spearman correlations between SRSA and other relevant variables indicated that neither age nor HIV disease status was associated with SRSA (Table 2). In both groups, higher SRSA was significantly associated with better physical and mental functioning (on the SF-36), as well as fewer depressive symptoms; greater happiness, resilience, optimism, and personal mastery; better attitudes toward own aging; and lower perceived stress. Social support was related to SRSA only in the HIV– group.

DISCUSSION

In our sample of HIV+ community-dwelling adults who had been living with HIV for 16 years and two-thirds of whom had AIDS, 66% of the participants rated themselves

Figure 1. Comparison of HIV+ and HIV– Participants' SRSA Scores



[a]Range, 1 (lowest) to 10 (highest).
Abbreviations: HIV– = human immunodeficiency virus uninfected, HIV+ = human immunodeficiency virus infected, SRSA = self-rated successful aging.

Table 2. Spearman's Correlations With SRSA

Variable	SRSA[a] HIV– (n = 83)	SRSA[a] HIV+ (n = 83)
Age, y	0.24	0.20
HIV disease status		
Duration of HIV disease, y	NA	–0.05
Current CD4 count, cells/mL	NA	0.08
Nadir CD4 count, cells/mL	NA	0.04
Plasma HIV RNA (log_{10})	NA	–0.09
AIDS	NA	0.06
Physical		
SF-36 physical component	0.50*	0.46*
Psychosocial		
CES-D-H (happiness)	0.47*	0.67*
SF-36 mental component	0.27	0.52*
BDI-II (depression)	NA	–0.42*
PHQ-9 (depression)	–0.44*	NA
LES (life events)	–0.09	–0.20
BSI-A (anxiety)	–0.12	–0.27
Protective psychosocial		
CD-RISC-10 (resilience)	0.50*	0.51*
LOT-R (optimism)	0.50*	0.50*
PSS (perceived stress)	–0.37*	–0.49*
DSSI-social interactions	0.37*	0.22
PMS (personal mastery)	–0.38*	–0.55*
PGC Morale scale (attitudes toward aging)	0.59*	0.72*

[a]For all measures, higher scores indicate higher functioning except the PMS, in which lower scores indicate higher mastery.
*$P < .003$ (Bonferroni-adjusted α value for significance).
Abbreviations: AIDS = acquired immune deficiency syndrome, BDI-II = Beck Depression Inventory-II, BSI-A = Brief Symptom Inventory-anxiety, CD-RISC-10 = 10-item Connor-Davidson Resilience Scale, CD4 = cluster of differentiation 4, CES-D-H = Center for Epidemiologic Studies Depression Scale-happiness, DSSI = Duke Social Support Index, GED = General Education Development, HIV– = human immunodeficiency virus uninfected, HIV+ = human immunodeficiency virus infected, LES = Life Events Scale, LOT-R = Lifetime Orientation Test-Revised, NA = not applicable, PGC = Philadelphia Geriatric Center, PHQ-9 = Patient Health Questionnaire, PMS = Personal Mastery Scale, PSS = Perceived Stress Scale, RNA = ribonucleic acid, SF-36 = 36-item Short Form, SRSA = self-rated successful aging.

in the upper half (6 to 10) on a 10-point scale of SRSA, despite being an older sample and having a chronic medical condition. As expected, the HIV+ subjects had worse SRSA as well as physical and mental health along with greater perceived stress, number of negative life events, and lower happiness than demographically matched HIV– participants. Remarkably, however, the 2 groups did not differ on levels of optimism, personal mastery, and social support. There is a possibility that the high levels of social support in the HIV+ group are related to the cohesive San Diego gay community, although this possibility is merely speculation at this time. Furthermore, similar moderate-to-strong associations between SRSA and physical, emotional, and positive psychological factors were found in both groups. Strikingly, SRSA in HIV+ subjects was not related to HIV disease status (duration or severity, as measured by CD4 count) or negative life events.

Depp and Jeste[44] conducted a review of the aging literature and found 90% of quantitative studies to define successful aging as an absence of medical illness and disability. Our study provides evidence for a definition of successful aging that is broader than one based on absence of disease. Indeed, in the past few years several clinical researchers have adopted a multidimensional model of successful aging that incorporates factors such as self-rated physical and mental health, social engagement, resilience, optimism, and satisfaction with life.[25,45,46] While the literature on successful aging in the context of HIV is limited, Vance and colleagues[14,15,47] have advocated for a multiple-factor model that demonstrates adults with HIV can still age well despite physical, social, and economic losses. The results of this study support the multidimensional model of successful aging theory, which emphasizes an integration of positive attitudes toward self and aging and attainment and maintenance of life goals and social interconnectedness.[24]

Differences have been found in regard to disability status, social networks, symptoms of anxiety and depression, and attitudes toward aging in that those recently diagnosed appear to be coping more successfully with the diagnosis than those who have aged with HIV.[14,48] However, we did not find an association between SRSA and duration or severity of HIV infection. Perhaps a survivorship effect occurred among our cohort of older HIV+ individuals in that they saw themselves as more resilient because they had been living with HIV for some time and have most likely survived beyond their expectations. There could also be a mediation effect of age, with older people being more prone to accept chronic illness as part of the aging process.[49] Our results might have differed if our sample had been younger or had consisted of older adults infected with HIV later in life.

This study has several limitations. Our participants were relatively well-educated and primarily white men who were mostly middle-aged and older, and, therefore, these results may not generalize to younger, less-educated groups, women, and ethnic minorities. Additionally, there may have been a sampling bias toward successful aging HIV+ adults given that active status in the HIV Neurobehavioral Research Program was part of the inclusion criteria for this study. It should be noted, however, that the HIV Neurobehavioral Research Program is part of a community-based outpatient clinic, so participants in this study most likely reflect a broad range

of HIV+ adults. Another limitation is that the data were cross-sectional, and inferences of causality cannot be made. Our measures were all self-report in nature, and we did not receive any collateral reports from caregivers or others. It may be argued that self-reports are biased by a tendency to give socially desirable responses. However, in an earlier study[50] of 1,860 community-dwelling older women (probably most were HIV−), no evidence for a social desirability effect, as measured by the Marlowe-Crowne Social Desirability Scale, was shown on most of the self-report measures of successful aging, including SRSA and physical function. Nonetheless, longitudinal studies are needed with larger sample sizes, different age groups, and greater sample diversity (including more ethnic/racial minorities, women, broader range of education) to obtain information regarding change in these factors over time. The interrelationships among different components of successful aging are most likely just as important as the individual factors, and multivariate analyses with larger sample sizes are needed to better characterize a model of successful aging with HIV infection. Furthermore, these studies would benefit from the inclusion of clinically relevant biomarkers, as well as assessments of sleep, fatigue, and pain, all of which might influence functioning, which in turn impacts SRSA. Other limitations to this study include different depression measures across groups, so group differences in depressive symptoms could not be explored, and limitations to the Holmes-Rahe Life Event Scale, which assigns an absolute number of points to life stressors without allowing for individual variation. Lastly, we did not include a neuropsychological test battery to evaluate neurocognitive functioning in order to examine a possible link between cognition and SRSA. Neurocognitive impairment has been found to be more common in older HIV+ adults than older HIV− adults,[51] so the influence of neurocognitive functioning in a multidimensional model of SRSA in HIV+ adults may be different than its influence in HIV− samples.[25]

Notwithstanding its limitations, our work demonstrates the potential for successful aging in HIV+ individuals. It also shows that HIV infection does not appear to impact the relationship between positive psychological factors and SRSA. What is even more encouraging is that factors outside of a person's control, including negative life events and HIV disease severity, were not related to successful aging. Depression and other mental health issues continue to remain a significant problem in people living with HIV,[27] and there is an urgent need for identifying factors that could help protect against the multiple comorbidities and complexities associated with aging and HIV infection. A number of studies have demonstrated a link between positive psychological traits and improved mental and physical health and decreased mortality. For example, resilience and optimism have been found to be potentially amenable to intervention, as resilience training was effective in breast cancer survivors[52] and optimism was malleable to intervention in HIV+ women.[53] Social engagement has been found to have a protective buffering effect against both mental health and physical health problems, including depressive symptoms, cardiovascular health, cancer recovery, and dementia.[54–56] Our findings that HIV+ adults had comparable levels of social engagement and positive psychological traits indicate that interventions designed to improve these factors in HIV− adults may be relevant to HIV+ adults as well. This study is a first step in developing an empirical understanding of the factors involved in successful aging with HIV. Overall, the potential public health significance of improving functional outcomes and quality of life in older HIV+ individuals has been highlighted by the NIH.[28] Facilitating the development of effective interventions aimed at promoting well-being and optimizing clinical outcomes (eg, treat depression, increase social engagement, lower levels of perceived stress) in the rapidly growing population of aging HIV+ adults will be productive areas for future research.

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