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ORIGINAL PAPER

Psychosocial Mechanisms of Self-rated Successful Aging with HIV: A Structural Equation Model

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Abstract

This study tested a conceptual psychosocial model of self-rated successful aging (SRSA) with HIV. Our sample ($n=356$) included older women living with HIV (OWLH): average age 56.5 years, 73% Black. SRSA was assessed using a research-based 10-point scale (higher scores = better outcomes). We conducted adjusted structural equation modeling. The global model included two latent variables—protective attributes (composite of positive psychosocial factors: resilience, personal mastery, optimism, spirituality) and psychological distress (composite of negative psychosocial factors: anxiety, depression, loneliness, internalized HIV-related stigma). The model showed good fit ($\chi^2(58)=76$, $p=0.06$; $RMSEA=0.03$; $CFI=0.99$). Increased protective attributes were associated with improved SRSA both directly and mediated by improved coping with stress. While psychological distress did not have a direct effect on SRSA, it was indirectly associated with worsened SRSA via diminished protective attributes and via decreased coping with stress. Findings suggest the need for interventions enhancing positive and mitigating negative psychosocial factors in OWLH.

Keywords Aging well · Healthy aging · Older adults · Positive psychosocial factors · HIV/AIDS · Structural equation modeling

Introduction

The population of people living with HIV (PLWH) is aging. The number of diagnosed PLWH aged 50 and older has doubled in the decade since 2008 and reached over half a million or about 51% of all PLWH in the USA at year-end 2018 [1, 2]. Older women living with HIV (OWLH) represent a distinctive yet understudied sociodemographic group within older PLWH [3, 4]. Compared to older men living with HIV (OMLH) who are 43% white and 33% African American, only 18% of OWLH are white and 58% are African American [5]. Whereas 64% of OMLH acquired HIV through male-to-male contact, 70% of OWLH belong to a heterosexual HIV transmission

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category [5]. OWLH also suffer from gender-specific vulnerabilities, such as gender-related stigma and discrimination, gender-based violence, reduced access to healthcare, and increased likelihood of poverty [6, 7]. In fact, 60% of OWLH were estimated to live at or below the household poverty line [3]. The poverty and social disadvantage, together with biomedical factors related to HIV infection and toxicity of antiretroviral therapy (ART), have been further linked to the increased likelihood of aging-related comorbidities [8]. Thus, OWLH suffer from greater comorbidity burden as well as higher prevalence of psychiatric illness, dyslipidemia, non-AIDS cancers, kidney, liver, and bone disease than otherwise comparable HIV-uninfected women [9]. As compared to OMLH, OWLH may experience higher likelihood of such aging-related comorbidities as osteoporosis, frailty, falls, and neurocognitive impairment [10–13]. In sum, due to the improvements in ART, OWLH live longer [14] but their aging is associated with significant psychosocial and health challenges. Therefore, it is important to understand whether and how OWLH may experience successful aging. Our previously published study suggests that successful aging is possible for OWLH [4]; it is a goal of our present research to examine the mechanisms of successful aging among OWLH.

Within the context of HIV disease, successful aging can be best understood as the process of psychological and behavioral adaptations to age-related losses and disabilities [15–17]. Although successful aging is sometimes defined from the perspective of investigators as the absence of disease and disability [18], qualitative research shows that older individuals themselves take a more holistic approach and view successful aging as psychological adaptation and subjective well-being [15, 19–21]. Respectively, we defined successful aging from the perspective of older individuals and assessed a construct of self-rated successful aging (SRSA) understood as individuals' own holistic appraisals of how well they are aging [4, 22]. SRSA is usually measured by asking the respondents how successfully they have aged on a single-item ten-point scale, ranging from 1 (least successful) to 10 (most successful) [22–24]. Research among older community-dwelling U.S. adults tends to find high prevalence of SRSA—approximately 90% of respondents rate themselves 7 or higher on the SRSA scale [23, 25]. Our earlier study was the first to assess SRSA prevalence specifically among OWLH [4]. We found 83.7% SRSA prevalence, which suggests that successful aging is achievable for OWLH. However, our findings also suggest that close to 20% of OWLH may not be able to adapt to their aging-related limitations and achieve psychological well-being. This is significant since current research links better self-rated outcomes, such as well-being, to improved coping with disease and longevity [26]. Therefore, we need to better understand SRSA mechanisms among OWLH.

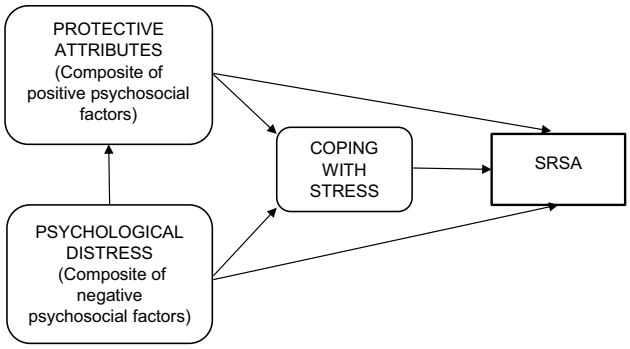

Fig. 1 Conceptual Psychosocial Model of SRSA with HIV. *SRSA* self-rated successful aging

Research has identified several SRSA correlates. In one study specifically among OWLH, better SRSA was associated with higher levels of positive psychosocial factors (e.g., optimism, resilience, personal mastery, spirituality, social support) and lower levels of negative psychosocial factors (e.g., depression, anxiety, loneliness, lifetime discrimination) [4]. Similar results were obtained in a study by Moore et al. [22] based on a sample of PLWH. Importantly, in both studies SRSA was not associated with either age or HIV disease characteristics and was weakly associated with only some sociodemographic characteristics, such as education level [4, 22]. SRSA research among older adults in the general population has similarly found strong associations with psychosocial factors [25]. Yet, few SRSA studies have examined constellations of psychosocial factors in the same model [27, 28] and little is known about psychosocial mechanisms of SRSA among either OWLH or PLWH.

Therefore, the main objective of the present study is to test a psychosocial model of SRSA in OWLH (Fig. 1). Our model builds upon the empirical studies described above and a theoretical model of successful aging by Kahana and Kahana [17], which is anchored in the stress paradigm and has life stressors, coping behaviors, and psychological dispositions as important elements. Thus, guided by Kahana and Kahana [17] and building on our previous research that found high correlations among positive psychosocial correlates of SRSA [4], such as optimism, resilience, and personal mastery, we hypothesize that these variables reflect a latent construct indicative of protective personal attributes or dispositions. In the same vein, we hypothesize that negative psychosocial correlates of SRSA reflect a latent construct indicative of life stressors and related psychological distress [17] and can be reduced to a composite score. Psychological distress is defined as a state of emotional suffering associated with stressors of daily life and often characterized by symptoms of depression and anxiety [29]. Based on findings

described above, we further hypothesize that a higher composite score of positive psychosocial factors will be associated with better SRSA, whereas the higher composite score of negative psychosocial factors will be associated with worse SRSA.

The next set of our hypotheses concerns mediating relationships. Thus, the negative effects of stress and psychological distress on health and well-being may be reduced by such protective dispositions as optimism, resilience, and spirituality [30–32]. Another important mechanism may be represented by coping [17, 30] defined as thoughts and behaviors used to deal with stressful situations [33]. In general, coping may be one of the key mechanisms by which life stress influences health and well-being [34, 35]. However, coping may also mediate the effects on SRSA of protective dispositions so that, for example, individuals with higher levels of optimism and resilience may be more likely to engage in positive coping focused on problem-solving [30]. We thus expect that: (1) protective attributes will mediate the effects of psychological distress; (2) coping will be directly positively associated with SRSA and will also mediate the effects on SRSA of both protective attributes and psychological distress. We will test our model in a sample of OWLH and using the longitudinal data from the Women's Interagency HIV Study (WIHS) [36–38] and the linked data from the From Surviving to Thriving (FROST) substudy [4].

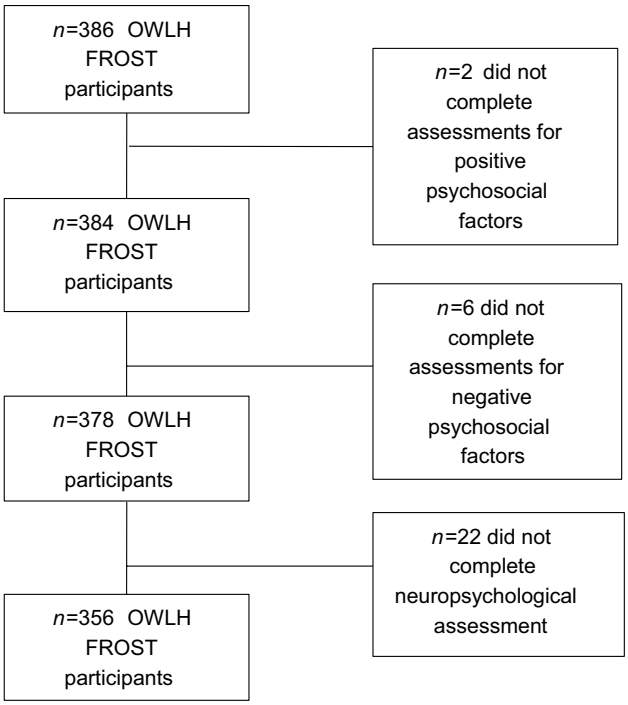

Fig. 2 Flow diagram for eligibility: older women living with HIV (OWLH) who participated in the FROST substudy and completed assessments for positive and negative psychosocial factors, and neuropsychological assessment

Methods

Study Sample

Our study sample is comprised of OWLH (age ≥ 50 years) who were enrolled in WIHS and completed the FROST substudy, which was administered between October, 2017 and March, 2018 at four WIHS sites: Atlanta, Chapel Hill, Brooklyn, and Bronx. WIHS is an observational multi-site cohort of women living with or at risk of HIV. WIHS was established in 1994, and in 2019 it was combined with the Multicenter AIDS Cohort Study (MACS) to become the MACS/WIHS Combined Cohort Study. Within its timeframe, WIHS comprised 50 consecutively numbered study visits (visit 1 through visit 50). WIHS study visits occurred every 6 months and usually included a centrally scripted interview, clinical examination, laboratory testing, and various substudy modules [37]. FROST was a substudy specifically designed to examine successful aging and consisted of an interviewer-administered survey. The details of both the WIHS study design and the FROST substudy have been previously published [4, 36–38]. WIHS research protocols were approved by Institutional Review Boards at each study site; participants provided informed consent and were compensated for each study visit.

Thus, for each participant in our sample, we used both FROST survey and other relevant WIHS data. The cross-sectional FROST survey was administered during the WIHS visit 47 and included SRSA assessments and validated scales assessing positive psychosocial factors. The remaining information was obtained from WIHS visit 47 (e.g., sociodemographic characteristics) and earlier WIHS visits (e.g., negative psychosocial factors). In particular, in order to be able to assess the effects of psychological distress on positive attributes (and not vice versa), all negative psychosocial factors were lagged and come from the latest available visit preceding visit 47. Most negative psychosocial factors of interest (i.e., anxiety, loneliness) were assessed in WIHS at even visits (e.g., 44 or 46), whereas HIV-related stigma was assessed only at visits 42 and 43. The inclusion criteria for this analysis were: (1) OWLH who fully completed FROST assessments (i.e., completed assessments for SRSA and all positive psychosocial factors), (2) completed assessments for negative psychosocial factors at the latest available visit (visits 42–43 for stigma, and visits 44–46 for the rest of factors), and (3) have completed a neuropsychological assessment (see Fig. 2). The resulting analytic sample comprises 356 OWLH.

Measures

SRSA

SRSA was assessed by the following question: "Using your own definition, where would you rate yourself in terms of "successful aging," from "1" (least successful) to "10" (most successful)?" This is a valid and reliable measure of successful aging [39] that has been widely used in published research among adults in the general population and PLWH [4, 22–24]. Similar to these studies, we use a continuous SRSA outcome for our analyses.

Coping with Stress and Positive Psychosocial Factors

The following measures of positive psychosocial factors were available—*resilience* was assessed by a 10-item ($\alpha = 0.90$) Connor Davidson Resilience Scale (CD-RISC-10) [40]; *personal mastery* was measured by a 7-item ($\alpha = 0.80$) Pearlin-Schooler Personal Mastery Scale (PMS) [41]; optimism was measured by a 6-item ($\alpha = 0.60$) Life Orientation Test-Revised (LOT-R) (42). To assess *spirituality* we used the following question from the Brief Multidimensional Measure of Religiousness/Spirituality [42]—"To what extent do you consider yourself a spiritual person?" Lastly, *coping with stress* was assessed by the question: "In the past 30 days, how effectively have you been able to cope with stress in your life? Please rate your ability to cope with stress from "0" (feel unable to cope) to "100" (I have coped extremely well)."

Negative Psychosocial Factors

Depression and *anxiety* were measured, respectively, by the widely used and validated 20-item ($\alpha = 0.93$) Center for Epidemiologic Studies Depression Scale (CES-D) [43] and a 7-item ($\alpha = 0.93$) General Anxiety Disorder Scale (GAD-7) [44]. Additionally, *loneliness* was assessed by a 3-item ($\alpha = 0.84$) shortened version of the Revised UCLA Loneliness Scale (R-UCLA) [45]; lifetime experience of *discrimination* – by the 6 items ($\alpha = 0.60$) abbreviated version of Major Experiences of Discrimination Scale [46, 47]; and *internalized HIV-related stigma* – by negative self-image 7-item ($\alpha = 0.90$) subscale of the revised HIV stigma scale adapted from Berger et al. [48] and previously used by published research based on WIHS data [49].

Covariates and Confounders

As potential confounders, we have considered the following variables available in the core WIHS data. Several aging-related *comorbidities* were routinely assessed at each WIHS visit based on self-reports and, in case of selected comorbidities (e.g., diabetes), lab work and medical records abstraction. Obesity was classified as body mass index (BMI) ≥ 30 [50], where BMI was calculated as body weight in kilograms divided by body height in meters squared (kg/m^2). History of bone disease was assessed based on participants' self-reports of any of the following: low bone density, osteopenia, osteoporosis, fracture, or receipt of osteoporosis medication. History of renal disease was measured as having two consecutive visits with estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73 m^2 at any time in WIHS [51]. History of stroke and cardiovascular disease (CVD) was assessed based on self-reports and, where available, medical records abstraction, with CVD defined as any of the following conditions: myocardial infarction, hospitalization for congestive heart failure, hospitalization for angina, transient ischemic attack, or surgery on heart vessels. History of hypertension was defined as systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or as self-reported hypertension diagnosis with anti-hypertensive medication use [52]. Diabetes was defined as fasting blood glucose > 126 mg/dL, hemoglobin A1c $> 6.5\%$, or self-reported anti-diabetic medication use combined with self-reported diabetes diagnosis [53]. History of cancer was measured as any cancer confirmed by medical records abstraction. History of lung disease was assessed as self-reports and, when available, medical records abstraction of any of the following: asthma, chronic obstructive pulmonary disease, chronic bronchitis, or hospitalization for a lung problem other than pneumonia. Lastly, we measured history of neuropsychological impairment (NPI) by global neuropsychological performance scores ≥ 5 at any time during WIHS enrollment (with scores ranging from 1 "above average performance" to 9 "severe impairment"). The information on WIHS neuropsychological assessment and computation of the global neuropsychological performance scores is available in earlier publications [54–56]. As additional potential confounders, we included *HIV disease characteristics* (e.g., HIV RNA viral load, current CD4 cell count, nadir CD4 cell count, and the self-reported ART use), *sociodemographic characteristics* (e.g., participants' age, education, annual income), and *research study site* (Atlanta, Chapel Hill, Brooklyn, and Bronx).

Statistical Analysis

All analyses were performed using STATA 15 statistical software. We began our analyses by computing descriptive statistics to examine sample distributions for our variables of interest. To identify covariates for our models, we used a theory-driven data-informed approach [57]. We fitted univariable linear regression models on continuous SRSA outcome. Those sociodemographic characteristics, HIV disease characteristics, and comorbidities that were

theoretically important and/or associated with SRSA at $p \leq 0.1$ level were subsequently included in the structural equation modeling (SEM). As the last step, we conducted SEM with standardized estimates using maximum likelihood estimation to test our theoretical model presented in Fig. 1. SEM was chosen as a method that allows both observed and latent variables and estimates both direct effects and mediation [58]. To account for missing values in confounders, we also conducted SEM with maximum likelihood missing values (MLMV) option as an alternative. All SEM models were adjusted for covariates; the significance level was set at $p < 0.05$.

The SEM was conducted in several stages. First, we fitted a model that, in the measurement part, contained all available observed indicators of protective attributes (i.e., optimism, resilience, personal mastery, and spirituality) and all available observed indicators of psychological distress (i.e., depression, anxiety, loneliness, internalized HIV-related stigma, and perceived lifetime discrimination). We then removed the indicator variables with factor loading < 0.3 from the model. We used the same theory-driven data-informed approach to retain covariates in the subsequent models—only those covariates were kept that were either theoretically important or associated with SRSA at $p \leq 0.1$ level. Further modifications of the resulting model were done based on postestimation results, including modification indices and goodness of fit indices, such as the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). Based on these results, we continued modifications (e.g. including covariance of error terms for selected variables) until reasonable modifications were made and/or a good model fit was achieved ($CFI \geq 0.95$, $RMSEA \leq 0.05$) [58]. For each predictor in our final model, we have estimated direct, indirect, and total effects.

Results

Participants

The sociodemographic and clinical characteristics of study participants are presented in Table 1. OWLH were, on average, 57 years old, predominantly non-Hispanic Black and not married or partnered, with the majority having an annual income of $12,000 or less, and only about a third being currently employed. Most of our participants had health insurance, were on ART, and had well-controlled HIV, with 74% of them having an undetectable viral load (< 20 copies/ml) and median current CD4 cell count of 673 [$Q1 = 486$, $Q3 = 880$]. However, participants also presented with an average of 3.6 comorbid diseases out of 10 examined, and history of NPI, hypertension, current obesity, and lung disease were the most prevalent in our sample. Nevertheless,

Table 1 Sociodemographic and clinical characteristics of study participants ($n = 356$)

Characteristic	Number	Percentage
Sociodemographic		
Age		
Years, mean (*SD*)	56.5 (5.2)	–
50–59	268	75%
60–64	60	17%
≥ 65	28	8%
Race		
Black, non-Hispanic	261	73.3%
White, non-Hispanic	22	6.2%
Hispanic	62	17.4%
Other	11	3.1%
Education		
Grade 11 or less	132	37.1%
Completed high school	111	31.2%
Some college or more	113	31.7%
Married or partnered	76	21.4%
Employed	109	30.6%
Annual income ≤ $12,000[a]	194	54.8%
Health insurance	352	98.9%
HIV disease characteristics		
On ART	334	93.8%
ART adherence ≥ 95%[b]	285	85.3%
Undetectable viral load (< 20 cp/ml)[a]	259	74.0%
Current CD4 cell count ≤ 200 cells/mm^3[a]	19	5.4%
Nadir CD4 cell count ≤ 200 cells/mm^3[a]	136	40.0%
Comorbidities		
Any history of cancer	27	7.6%
Diabetes	103	28.9%
History of hypertension	312	87.6%
History of neuropsychological impairment	171	48.0%
Current obesity (BMI ≥ 30)	181	50.8%
Renal disease	71	19.9%
History of cardio-vascular disease	56	15.7%
Stroke	19	5.3%
Lung disease	177	49.7%
Bone disease	153	43.0%
Number of comorbidities, mean (*SD*)[c]	3.6 (1.7)	–
Successful aging		
SRSA, mean (*SD*)	8.1 (1.7)	–
SRSA ≥ 7	296	83.2%

SD standard deviation, *ART* antiretroviral therapy, *BMI* body mass index, *SRSA* self-rated successful aging

[a]The following variables had different denominators due to missing values: annual income ≤ $12,000 $n = 354$, undetectable viral load $n = 350$, current CD4 cell count $n = 355$, nadir CD4 cell count $n = 340$

[b]The percentage of ART adherence ≥ 95% was calculated among those on ART

[c]The number of comorbidities was calculated based on the presence of the 10 comorbidities listed in this table

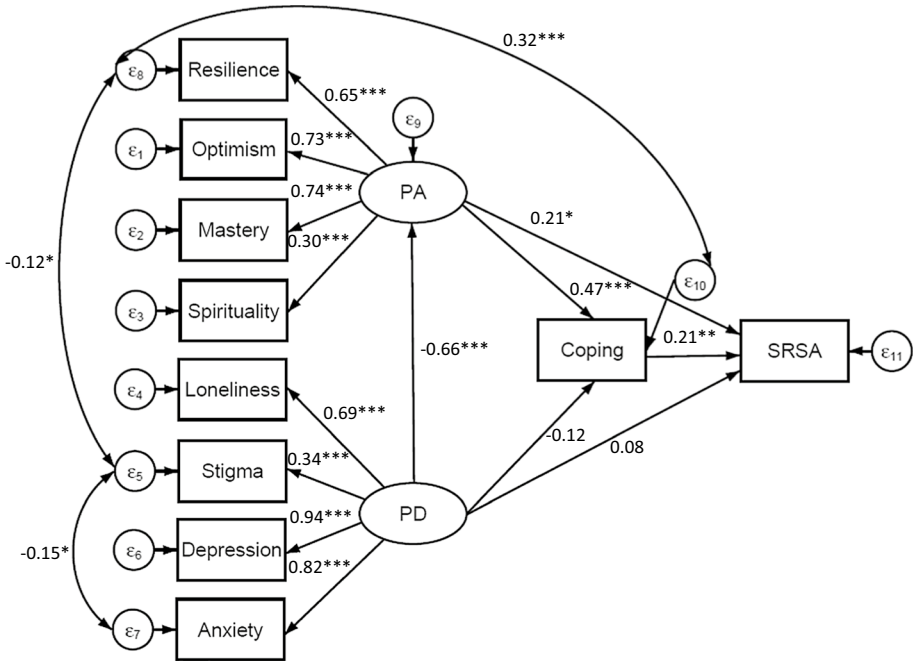

Fig. 3 Psychosocial mechanisms of SRSA with HIV: Structural equation model with standardized estimates, adjusted for important covariates—age ≥ 60 years old, current CD4 ≤ 200 cells/mm^3, non-Hispanic Black, hypertension, and neuropsychological impairment ($n = 355$; *p < 0.05, **p < 0.01, ***p < 0.001). Model fit: $\chi^2(58) = 76$, $p = 0.06$; *RMSEA* = 0.03; *CFI* = 0.99. *Mastery* personal mastery, *Stigma* internalized HIV-related stigma, *PA* protective attributes, *PD* psychological distress, *SRSA* self-rated successful aging

83.2% of OWLH rated their SRSA ≥ 7, with the mean SRSA in our sample being 8.1 (1.7).

Structural Equation Modeling

Our final SEM is shown in Fig. 3. The initial set of covariates was identified through univariable linear regression analyses (see Supplemental Table S1). Our final SEM was adjusted for those covariates that were either theoretically important (e.g., age) or maintained their significance in SEM at $p \leq 0.1$ level: age ≥ 60 years old, current CD4 ≤ 200 cells/mm^3, non-Hispanic Black race, hypertension, and NPI. The final SEM is based on 355 observations due to one missing value on current CD4 cell count.[1] The lifetime experience of discrimination was excluded from this model as an indicator variable for psychological distress with factor loading < 0.3. Based on postestimation diagnostics, the final model includes theoretically sound covariance of error terms for coping and resilience, anxiety and HIV-related stigma, as well as HIV-related stigma and resilience. The final model explains 16% of variance in SRSA and has a good fit: $\chi^2(58) = 76$, $p = 0.25$; *RMSEA* = 0.03; *CFI* = 0.99. The final model was an improvement in terms of goodness-of-fit indices over an initial model, where $\chi^2(96) = 168.9$, $p < 0.001$; *RMSEA* = 0.05; *CFI* = 0.94.

The measurement model part of our final SEM consists of two latent variables along with eight observed indicator variables: protective attributes (composite of optimism, resilience, personal mastery, and spirituality) and psychological distress (composite of depression, stress, loneliness, and internalized HIV-related stigma). All indicator variables had significant factor loadings on respective latent variables—psychological distress or protective attributes. The standardized factor loadings are displayed in Fig. 3.

The structural part of our final SEM includes structural paths between latent variables, coping, and SRSA. The standardized estimates for direct effects are displayed in Fig. 3. As predicted, better coping was statistically significantly associated with higher SRSA scores (standardized estimate = 0.21, $p < 0.01$). Also as expected, better protective attributes were associated with better coping (standardized estimate = 0.47, $p < 0.001$) and higher SRSA scores (standardized estimate = 0.21, $p < 0.05$). However, our hypotheses regarding psychological distress were only partially supported: higher scores on psychological distress were associated with decreased protective attributes (standardized estimate = − 0.66, $p < 0.001$) but had no direct effects on either coping or SRSA.

A fuller and a more interesting picture is provided by indirect and total effects presented in Table 2. As predicted, protective attributes had indirect effects on SRSA (standardized estimate = 0.10, $p < 0.01$), mediated by coping; and psychological distress had indirect effect on SRSA (standardized estimate = − 0.23, $p < 0.01$), via both protective attributes (PD → PA → SRSA path on Fig. 3) and coping (PD → PA → Coping → SRSA path on Fig. 3). As an illustration of indirect effects, we also provide an example of manual calculations, although we used STATA software

[1] As an alternative, we also ran SEM with MLMV option, which accounts for missing data, and received similar results.

Table 2 Psychosocial mechanisms of SRSA with HIV: structural equation model with standardized estimates

Outcome	Direct	Indirect	Total
Protective attributes			
Psychological distress → Protective attributes	− 0.66***		− 0.66***
Coping			
Protective attributes → Coping	0.47***		0.47***
Psychological distress → Coping	− 0.12	− 0.31***	− 0.43***
SRSA			
Psychological distress → SRSA	0.08	− 0.23**	− 0.15**
Protective attributes → SRSA[a]	0.21*	0.10**	0.30**
Coping → SRSA	0.21**		0.21**

Model adjusted for important covariates—age ≥ 60 years old, current CD4 ≤ 200 cells/mm^3, non-Hispanic Black, hypertension, and neuropsychological impairment. The significance levels shown are for the unstandardized solution: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

SRSA self-rated successful aging

[a]The Total effect of Protective attributes on SRSA does not represent an exact sum of Direct and Indirect effects due to rounding error

to arrive at similar results. Thus, the indirect effects of protective attributes on SRSA can be calculated by multiplying standardized coefficients along the following path on Fig. 3: PA → Coping → SRSA ($0.47 \times 0.21 = 0.10$). The total effects of protective attributes on SRSA are a sum of indirect effects via coping and direct effects (standardized estimate = 0.30, $p < 0.01$). Similarly, psychological distress had statistically significant total effect on SRSA (standardized estimate = − 0.15, $p < 0.01$).

Discussion

This is among the first studies to examine psychosocial mechanisms of SRSA with HIV. Our findings, based on a sample of OWLH enrolled in WIHS, supported several of our hypotheses. Thus, our observed psychosocial indicators significantly loaded on two latent constructs—protective attributes (composite of positive psychosocial factors: resilience, personal mastery, optimism, spirituality) and psychological distress (composite of negative psychosocial factors: anxiety, depression, loneliness, and internalized HIV-related stigma). As predicted, higher scores on protective attributes were significantly associated with higher SRSA scores both directly and indirectly, via improved coping with stress. Whereas psychological distress did not have direct effects on SRSA, it was indirectly significantly associated with decreased SRSA via decreased protective attributes as well as via worsened coping with stress. Below, each of these findings is discussed in detail.

Our results support a theoretical proposition by Kahana and Kahana [17] that individuals may have internal psychological resources (i.e., protective attributes), which predispose them to successful aging. Such individual characteristics as optimism, resilience, or personal mastery, may tend to co-occur and, when present at higher levels, offer buffering or protective effects against stressful life events [17], thus increasing the likelihood of SRSA. Although, this is the first study examining the latent construct of protective attributes in relation to SRSA with HIV, our findings are consistent with previous research showing strong associations between positive psychosocial factors and SRSA among older adults in the general population as well as PLWH [4, 22–24, 27].

Importantly, ours is also among the first studies investigating the mediating role of coping in SRSA with HIV; our findings suggest that the higher degree of protective attributes is linked to better coping with stress, and better coping is linked to higher SRSA. Coping is a significant construct in our psychosocial model due to its situational character. Whereas protective attributes, such as optimism, are relatively stable personality traits [59], coping represents cognitive and behavioral responses that people use to manage situations that are appraised as stressful [33]. Studies suggest that coping may serve as a mediator between personality and mental health outcomes [60]. Although coping strategies are linked to the personality traits, coping is a complex process that is also reflective of environment with its resources and demands [33, 61]. Individual coping may change depending on the type of stressful situation, the availability of social support, or other resources. Most significantly, coping skills can be improved via cognitive-behavioral therapy [33]. Given our findings that better coping is linked with higher SRSA, improving coping skills among OWLH may be an important target of future public health interventions.

Perhaps, some of the most important findings of this study concern the latent construct of psychological distress. Building upon Kahana and Kahana [17] we assumed that PLWH are confronted with a multitude of stressors or negative life events connected to aging with HIV and comorbidities. Additionally guided by empirical research that found no or weak associations between negative life events and SRSA [4, 22], we also assumed that what matters for SRSA is not the negative events per se but the resulting psychological distress as expressed by depressive symptomatology, anxiety, and emotional suffering connected to such stressors as loneliness and HIV-related stigma [29]. Our findings were supportive of the latent construct of psychological distress and provided interesting insights as to its effects on SRSA.

We found that the latent construct of psychological distress had significant loadings by depression, anxiety, internalized HIV-related stigma, and loneliness but not by perceived lifetime discrimination. This may be due to the fact that lifetime experiences of discrimination involve past

events that are no longer associated with acute emotional suffering, although further research is needed. To date, a study by Emlet et al. [62] similarly suggests that lifetime experiences of discrimination may be distinct from other contributors to psychological distress—they found that while depression and past victimization were respectively associated with reduced resilience and mastery, lifetime experiences of discrimination were not.

All indicators of psychological distress in our study were measured at time periods preceding those of protective attributes so that we could examine temporal ordering of factors. As such, we have conceptual and empirical clarity in our model that psychological distress has effects on protective attributes, and not vice versa. Our results thus support the hypothesis that protective attributes mediate (buffer) the effects of psychological distress on SRSA. The temporal ordering also helps explain the lack of direct effects of psychological distress on either coping or SRSA. Perhaps, past emotional suffering may not directly dampen current psychological wellbeing inherent in SRSA. Its effects appear to be more subtle. Our results suggest that past psychological distress may have lasting negative effects on protective attributes, for example, reducing optimism; in turn, the reduced protective attributes are associated with worse coping and decreased SRSA.

Our findings have important clinical and public health implications. As the status of HIV has changed from a fatal disease to a chronic condition, individual well-being, health-related quality of life, and successful aging become important outcomes of HIV care [63, 64]. However, about 20–40% of PLWH may fare poorly in terms of SRSA [4, 22]. This study points to the importance of assessing and mitigating individual psychological distress. Even past distress may have lasting negative consequences. Comprehensive geriatric evaluation of all OWLH aged 50 and older may be one of the key clinical tools available to promote SRSA since it includes affective assessment as its integral part [65]. This underscores the need for geriatric consultation as part of routine HIV care, given that few HIV clinics provide this service in the US [66].

Our results also suggest the need for public health interventions promoting protective attributes and coping with stress as means to enhance SRSA. Even though dispositional optimism, resilience, and personal mastery can be considered personality traits, they are also teachable skills [67] and interventions need to be designed to promote these skills among OWLH. There is still a paucity of behavioral and mental health interventions designed specifically for OWLH or older PLWH [68]. A resilience building intervention has been recently developed for older PLWH [69]. Effective interventions training optimism have been designed for other populations, such as patients with heart disease, and can be potentially adopted for use in OWLH [70]. Coping skills represent another important target that can be effectively addressed not only by individual cognitive-behavioral therapy [33] but also by a telephone-delivered coping improvement group intervention, which was designed specifically for older adults with HIV [71]. Lastly, stress management training as well as mindfulness-based interventions appear to be promising tools for stress reduction and improvement of mental health among women living with HIV [72, 73]. It is also worth noting that poverty represents one of the key stressors among OWLH and providing referrals for supplemental food, income, and housing may be one of the most effective means available to social workers and healthcare providers to promote successful aging with HIV [74].

To conclude, this study provides the first glimpse into psychosocial mechanisms of SRSA with HIV, drawing on high-quality, longitudinal, multi-site data collected by WIHS. Similar to the larger population of OWLH in the US, participants in our study were predominantly non-Hispanic Black women and a high proportion of them struggled with poverty and suffered from aging-related comorbidities, such as hypertension, diabetes, and bone and lung disease. Yet, this study had several limitations. First, our findings cannot be generalized to other racial/ethnic groups or to men living with HIV. Our psychosocial model was developed based on the theoretical assumptions by Kahana and Kahana [17] as well as the empirical research on SRSA that was not exclusive to OWLH. Therefore, we think that similar psychosocial mechanisms will exist among other subgroups of PLWH, although they may have different observed indicators of protective attributes and psychological distress. Future research will be needed to test this hypothesis. Second, we acknowledge that this is an early attempt to examine psychosocial mechanisms of SRSA with HIV. As such, the model does not include several important factors (e.g., social support or neighborhood effects) that need to be examined in the future. Lastly, only one measure of coping was available to us and it will be important for subsequent studies to include other and more detailed assessments, such as the Brief COPE Inventory [75].

Conclusions

Successful aging is one of the important indicators of HIV care. SRSA is achievable even in the presence of HIV and comorbidities but research shows that a considerable proportion of PLWH do not experience SRSA. Our study provides important insights into psychosocial mechanisms of SRSA with HIV. These findings suggest that even past emotional suffering related to stressors of aging with HIV, such as loneliness and HIV-related stigma, may dampen SRSA. In contrast, better coping with stress and protective personal attributes, such as optimism and resilience, can

enhance SRSA both directly and by buffering the negative effects of psychological distress. Public health interventions as well as geriatric consultation as an integral part of HIV care may be needed to mitigate the negative effects of psychological distress and promote coping skills and protective attributes.

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Data Availability Access to individual-level data from the MACS/WIHS Combined Cohort Study Data (MWCCS) may be obtained upon review and approval of a MWCCS concept sheet. Links and instructions for online concept sheet submission are on the study website.

Code Availability Code is available upon request.

Declarations

Conflict of interest Authors report no conflict of interest.

Ethical Approval Data in this manuscript were collected by the Women's Interagency HIV Study (WIHS). WIHS research protocols were approved by Institutional Review Boards at each study site.

Consent to Participate Informed consent was obtained from all individual participants included in the study.

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