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Beliefs in Antiretroviral Treatment and Self-Efficacy in HIV Management are Associated with Distinctive HIV Treatment Trajectories

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Abstract An online survey was conducted among people living with HIV (PLHIV) in Australia to discern key factors associated with distinctive ART use patterns. The sample (N = 358), was further divided into three groups: those on ART continuously since initiation (n = 208, 58.1%); those on ART intermittently (n = 117, 32.7%); and those not on ART at the time of survey (n = 33, 9.2%). ART non-users were the most likely to hold serious concerns about ART that outweighed perceived necessities (benefits) from ART (AOR = 0.13; 95% CI 0.06–0.29; p < 0.001). They were also the least self-efficacious in HIV disease management (AOR = 0.29; 95% CI 0.09–0.87; p = 0.028). Intermittent ART users were more likely to receive their HIV diagnosis prior to 2003 (AOR = 0.38; 95% CI 0.28–0.53; p < 0.001) and perceive lower HIV management self-efficacy (AOR = 0.50, 95% CI 0.28–0.87; p = 0.015) than continuous users. ART-related beliefs and perceived self-efficacy in HIV self-management play an important role in achieving universal treatment uptake and sustained high levels of adherence.

Keywords HIV treatment uptake and adherence · Antiretroviral treatment beliefs · Self-efficacy in HIV management · HIV treatment trajectories

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Introduction

Since 2011, the scientific evidence has become much more definitive about both the individual and population health benefits of commencing antiretroviral treatment (ART) immediately after HIV diagnosis [1, 2]. This is accompanied by the worldwide endorsement of clinical guidelines of ART for HIV treatment and swift changes in ART prescribers' practices in promoting universal treatment coverage in countries including Australia [3]. In this context, we set out to examine distinctive ART uptake journeys among people living with HIV (PLHIV) in Australia, where minimal structural barriers exist in terms of ART access [4].

To date, key factors associated with timely ART uptake and sustained high levels of adherence to ART (e.g., [5, 6]) include sociodemographic and cognitive factors (e.g., [7, 8]); clinical factors related to HIV disease progression (e.g., [9]) or ART prescription patterns (e.g., [10]); and interpersonal (e.g., social support) and structural factors such as HIV-related stigma and discrimination (e.g., [11]) or social welfare support (e.g., [12]). One of the most prominent factors identified is a cognitive variable, namely,

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ART necessity and concern beliefs (e.g., [13], which were originally developed by Horne and colleagues based on the Chronic Disease Self-Management model at the very early stage of the HIV epidemic [14–20]. Further, earlier qualitative findings from the same project as this paper shows that some PLHIV in Australia would *intentionally refuse to re-start* ART based on their prior real-life negative experiences either first-hand or vicariously from their peers; and that other PLHIV in Australia would *intentionally refuse to initiate* ART largely due to their perceived good personal health without the need of ART [21, 22]. No study has, however, systematically investigated a range of factors associated with distinctive patterns of ART use following the recommendations of an ecological framework by Mugavero and colleagues [23]. More importantly, the ecological framework emphasises the need to explore interrelated factors at individual, interpersonal/network and broader social structural level that influence ART-related behaviours from initiation to lifelong adherence.

Accordingly, in this paper, particular focus was directed towards assessing differences in ART necessity and concern beliefs and appraisals of self-efficacy in HIV self-management along with other personal, clinical and social factors that distinguish three groups of people in their ART use journeys. These three distinctive groups refer to: those on ART continuously since their HIV diagnosis (continuous ART user group), those currently on ART but having had one or more substantial treatment breaks (self- or prescriber-initiated) in the past (intermittent ART user group), and those not on ART at the time of survey (ART non-user group).

Methods

Sample and Recruitment

An online survey was conducted among people self-reported to be living with HIV (PLHIV) in Australia from October 2014 to August 2015. All study participants were recruited online through email notifications to registered clients or social media advertisements posted by HIV-related community organisations or clinical services as well as through direct recruitment using a study-specific Facebook page.

Participants were self-selected to determine if they met the inclusion criteria shown in the online study advertisement: being at least 18 years old and currently living with HIV in Australia. Survey participation was completely voluntary (with no incentives) and participants took an average of 20 min (25th percentile = 16 min; 75th percentile = 28 min) to complete the anonymous survey with no remuneration. The online survey was approved by UNSW Human Research Ethics Committee.

Questionnaire

Sociodemographic Characteristics

The questionnaire contained conventional variables on participants' age, gender, sexual identity, country of birth, education, sources of income, living arrangements, and relationship status. In addition, it included questions asking about perceived financial difficulties in covering costs of daily living and/or covering any prescribed (HIV and non-HIV-related) medications.

General Health and Wellbeing

Apart from self-rated overall health, questions covered experiences (yes vs. no) of any major life stressors in the previous 12 months, which were derived from a standard question set used by the Australian Bureau of Statistics. Also, PHQ-9 [24], a standard screening tool for major depression was also included. Both mental health measures have been previously applied in PLHIV populations in Australia, with proven sound psychometric qualities [25]. Other questions related to any diagnosis of sexually transmissible infections (STIs) other than HIV in the previous 12 months; a history of hepatitis B and hepatitis C infections; current hepatitis C status; and use of any non-prescribed drugs for recreational purposes (e.g., cannabis/marijuana, amyl/poppers, Viagra) with or without injection in the previous 12 months.

HIV and ART History

The questionnaire contained HIV-related experiences, including year of HIV diagnosis, frequency and latest results of HIV biomarker monitoring (i.e., CD4+ T cell count and viral load levels) and history of any diagnosed HIV-related co-morbidities (e.g., Toxoplasmosis). Also, nine HIV-related statements of symptoms and concerns in the previous 2 weeks, derived from the PROQOL [26], was included.

This was followed by topics specifically related to antiretroviral treatment for HIV. It began with a number of questions on history of ART use (ever and current), years of first and latest ART uptake and total number and length of any ART interruption (i.e., ceasing ART with or without their HIV doctors' instructions).

Service Access (HIV and Non-HIV Related)

In this section, the survey began with a matrix-type scoping question on the extent of service access in the previous 6 months, where a list of nominated organisation-based service providers (e.g., hospital-based outpatient clinics,

sexual health clinics, community-based general practices, pharmacies, community organisation facilitated peer support programs, online self-management programs) was displayed separately for HIV and non-HIV related issues. This was followed by the next three questions which focused on assessing participants' engagement with HIV clinical care. This included whether participants had a primary HIV doctor (i.e., one who has been in charge of treating their HIV infection); what was the exact service provision nature of the primary HIV doctor (e.g., hospital-based specialist with expertise in HIV-related clinical care); and participants' frequency of routine HIV clinical consultation with their primary HIV doctor or other qualified clinicians.

HIV-Related Stigma and Social Support

This section of the survey enquired about participants' experiences of (yes vs. no) stigma and discrimination (e.g., blame, shame, rejection) in relation to a list of situations (e.g., sexual orientation, HIV status, ART use or non-use). To measure the extent of their contact with the HIV epidemic, participants were asked about how many people they knew who were also PLHIV and to their knowledge, how many of these acquaintances with HIV were on ART. Further, perceived social support was assessed from a list of sources including their regular partner, friends (including those online), other PLHIV, staff of HIV-support organisations, HIV doctors or nurse, religious or spiritual advisers, and online forums or support groups. In addition, participants were asked if they had been involved in any HIV-related community organisations, networks, groups, events or activities and in what capacity (e.g., as a staff, volunteer or client).

Beliefs in ART and Self-Efficacy in HIV Self-Management

To measure participants' beliefs in ART benefits/necessities and concerns, as shown in the Appendix, apart from the original 19 statements [16], the questionnaire included 11 additional new items. These new items were developed based on our earlier findings in the same project from in-depth interviews with 27 ART non-users in Australia [21]. For the 19 original and six newly developed ART necessity and concern items, participants were asked to rate each item on a 5-point Likert scale, from 'strongly disagree' [1] to 'strongly agree' [5]. The remaining five newly developed ART belief items, however, used a slightly different 5-point Likert scale, from 'not at all' [1] to 'all of the time' [5], in order to measure the extent of concerns about ART use in everyday life situations.

To measure participants' perceived self-efficacy in HIV self-management, an eight-item Perceived HIV Self-Management Scale (PHIVSMS) was included [27]. Items such as 'It is difficult for me to find effective solutions to problems with managing my HIV infection' and 'I find my efforts to change things I don't like about my HIV infection are ineffective'. Participants were asked to rate these eight statements in a 5-point Likert scale, from 'strongly disagree' [1] to 'strongly agree' [5].

Statistical Analyses

In the descriptive analyses, cross-tabulation with Pearson's Chi square tests were used for categorical variables where proportions or rates were reported; and one-way ANOVA was used for continuous or ordinal variables where means and standard deviations were reported for (approximately) normally distributed variables.

For the ART necessity and concern belief items (19 original and 11 new/proposed ones), principal component analysis with Varimax rotation was performed to determine the reconstructed items, where a minimum Eigen value of 1 (for extracted factors) and a unique rotated factor loading >0.40 (for reserved items) were set as criteria for retention. Cronbach's standard alphas were further calculated for the extracted factors to assess internal consistency. Next, a necessity-concerns differential score was calculated, as suggested by Horne and colleagues [16], where the mean score of all reconstructed necessity items was subtracted by the mean score of all reconstructed concern items. Also, for the PHIVSMS, mean values of corresponding summary scores for each participant was calculated for the eight self-efficacy items.

The sample was further divided into three groups: 33 (9.2%) participants in the ART non-use group including 26 being ART naïve; 208 (57.8%) participants in the continuous ART group; and 117 (32.5%) participants in the intermittent ART group. This was treated as the outcome variable in this analysis.

To further identify key factors that differentiated the three groups on ART use trajectories, a priori purposefully-built model reduction procedure was carried out using multinomial logistic regression, where prevalence ratios (PRs) and their 95% confidence intervals (CIs) were reported. All data analyses were conducted in STATA 14. p value was set at 0.05 throughout.

Results

A total of 437 people initially clicked the survey link and 432 further provided consent online and proceeded to the questionnaire. On the basis of the screening questions, 377 participants were deemed eligible (i.e., excluding 54 participants who did not report as being HIV-positive and

three whose ART status was unable to be determined). After further exclusion of 17 people who had more than 50% missing data, the final sample size was 358. The response rate was estimated to be 81.9%. Further, based on information indicating any involvement with HIV-related community organisations, networks, groups, events or activities, 166 (46.4%) were involved formally (e.g., staff, board members) or informally (e.g., volunteer, client, user); whereas 160 (44.7%) did not have any involvement and a further 32 (8.9%) had missing data.

Of the 124 participants who reported any ART breaks (i.e., 117 intermittent users all had prior breaks and all 7 ART experienced non-users), the top most common reasons for having any ART breaks (not mutually exclusive) were side effects (24.2%), other life priorities (21.0%), doctor's advice (17.7%) and domestic or international travel (17.7%). Of the 117 intermittent ART users, 38 respondents (32.5%) estimated to have an accumulated break for no more than 3 months; 75 respondents (64.1%) had 3 months or longer ART breaks in total; and the remaining (n = 4, 3.4%) had missing data.

Sociodemographic Characteristics

Of the 358 participants with valid responses under analysis, 345 (96.4%) were men with the majority (n = 323) identifying as gay, homosexual or queer. All 13 females identified as straight. Participants were, on average, 46.7 (sd = 10.8; median = 48) years old with close to three-quarters born in Australia (n = 261). Just about half (n = 180) had at least completed a university degree and slightly under half (n = 176) were working in a full time paid job. Participants were recruited from every state/territory with NSW (the most populous state) being the majority (61.7%). Just over half (n = 201) were living in a metropolitan (i.e., capital cities in Australia) area. Over a third (n = 126) were currently living alone. Over a quarter (n = 97) reported social welfare as their main source of income, 15.4% (n = 55) had very much/extreme financial difficulties in meeting daily living costs, and 10% (n = 36) had very much/extreme financial difficulties in paying for any prescribed medications. Of the 153 people (42.7%) with a regular partner at the time of survey, 104 (68.0%) reported having an HIV-negative partner.

As shown in Table 1, the three groups differed in terms of age (the intermittent user group being the oldest), areas of dwelling, dependence on social welfare (continuous user group having the lowest proportion) and perceived financial difficulties in daily living costs, and to a lesser extent, in HIV and non-HIV mediation costs (continuous user group having the lowest proportions on both regards).

General Health and Wellbeing

Close to 70% (n = 249) reported having "very good" or "good" health in general. Based on the PHQ9 screening tool, just over one-quarter (n = 95) reported symptoms consistent with a major depressive disorder in the past 2 weeks. Of the 14 ABS-enlisted major life stressors (standard alpha = 0.55, median = 1, range 0–8), 112 participants (31.3%) reported none and the sample as a whole reported an average of one event in the past 12 months.

For any STIs apart from HIV, 71 (19.8%) reported an STI diagnosis in the past 12 months. While over 65% (n = 234) reported having been vaccinated against hepatitis B, 58 (16.2%) reported past hepatitis B infection. For hepatitis C, 35 (9.8%) reported past hepatitis C infection, and 13 participants were hepatitis C positive due to chronic hepatitis at the time of survey. In terms of recreational drug use, over 35% (n = 135) had used but not injected any drugs and a further 17.0% (n = 61) had injected any drugs in the past 12 months.

As shown in Table 1, the three groups differed in terms of the number of major daily life stressors and having received STI diagnosis (intermittent users having the lowest proportion) in the previous 12 months.

HIV and ART History

About one-third (n = 124) were diagnosed before 1996 (pre-ART); 18.2% (n = 65) were between 1996 and 2003 (pre-highly active ART); 27.7% (n = 99) between 2004 and 2011 (pre-Treatment as Prevention (TasP)) and 18.2% (n = 65) were after 2011 (TasP era). Close to one-third of participants (n = 107) had been diagnosed with AIDS-related conditions. In the past 4 weeks, out of the ten HIV-related symptoms or concerns derived from the PROQOL (standard alpha = 0.86, range 0–30, median = 9), 225 participants (62.8%) endorsed at least one issue which often/always adversely impacted their perceived quality of life.

In terms of routine CD4+ T-count monitoring, 347 (96.9%) reported that they had been tested at least once every 12 months. For the latest CD4+ count, 63.6% (n = 21 out of 33) in the ART non-use group were above 500 cells/mm^3 in comparison to 57.3% (n = 67 out of 117) in the intermittent ART group and 71.2% (n = 148 out of 208) in the continuous ART group (p = 0.038). Similarly, 346 participants (96.7%) reported having viral load monitoring at least once every 12 months. For the latest viral load count, 45.5% (n = 15) in the ART non-use group were ≤50 copies/ml in comparison to 91.5% (n = 107) in the intermittent ART group and 94.7% (n = 197) in the continuous ART group (p < 0.001).

Table 1 Key differences by ART use trajectories: an online sample of PLHIV in Australia

Mean (SD) or % (n)	Currently on ART without any breaks (n = 208)	Currently on ART with prior breaks (n = 117)	Currently not on ART (ART naïve or experienced) (n = 33)	p value
Age (SD)	44.7 (11.3)	50.8 (9.1)	44.4 (10.0)	<0.001
Living in a non-metropolitan (i.e., outside of capital cities) area	79 (38.0%)	58 (49.6%)	20 (60.6%)	0.02
Social welfare as the main source of income	44 (21.2%)	40 (34.2%)	13 (39.4%)	0.01
Perceived somewhat/very much/extreme financial difficulties in meeting				
Daily living costs	58 (27.9%)	53 (45.3%)	13 (39.4%)	0.006
Any prescribed medications (HIV or non-HIV) costs	30 (14.4%)	31 (26.5%)	7 (21.2%)	0.03
More major daily life stressors, previous 12 months (SD)[a]	1.25 (1.42)	1.72 (1.68)	1.50 (1.46)	0.04
Any diagnosed STIs, previous 12 months	51 (24.5%)	12 (10.3%)	8 (24.3%)	0.007
HIV diagnosis after 2003	135 (64.9%)	11 (9.4%)	18 (54.6%)	<0.001
Severer HIV-related symptoms and concerns, previous 2 weeks (SD)[b]	9.21 (6.77)	12.1 (7.97)	12.1 (7.59)	0.001
Routine visit of one's primary HIV doctor at least once every 6 months	179 (86.1%)	100 (85.5%)	21 (63.6%)	0.004
More HIV-related service types accessed, past 6 months (SD)[c]	2.94 (1.77)	3.50 (2.29)	2.41 (2.40)	0.01
Knowing at least ten other PLHIV	88 (42.3%)	74 (63.3%)	13 (39.4%)	0.001
Knowing at least ten other PLHIV on ART	76 (36.5%)	64 (54.7%)	10 (30.3%)	0.002
More perceived HIV-related support source (SD)[d]	5.07 (2.17)	5.50 (2.26)	4.33 (2.07)	0.03
Higher reconstructed necessity-concerns differential mean score (SD)[e]	2.17 (0.93)	2.13 (1.27)	0.10 (1.32)	<0.001
Higher self-efficacy in HIV self-management mean score (SD)[f]	4.11 (0.63)	3.91 (0.72)	3.45 (0.83)	<0.001

Only factors showing significant associations at p < 0.05 are shown

[a] Min = 0, Max = 8; Median = 1

[b] Min = 0, Max = 30; Median = 9

[c] Min = 0, Max = 11; Median = 3

[d] Min = 0, Max = 11; Median = 5

[e] Min = −2.41, Max = 4

[f] Min = 1.5, Max = 5

Of the 305 participants who provided exact years of HIV diagnosis and ART initiation, 111 (36.4%) started their first ART regimen within 1 year of HIV diagnosis; 97 (31.8%) within 1–3 years; 63 (20.7%) within 4–9 years; and 34 (11.2%) started their first ART regimen at least 10 years after HIV diagnosis.

The three groups differed, first and foremost, in the median year of HIV diagnosis: 2006 for ART continuous users (IQR = 14, mean = 2004, max = 2015); 1992 for ART intermittent users (IQR = 11, mean = 1993, max = 2011, i.e., the pre-TasP era); and 2007 for ART non-users (IQR = 17, mean = 2003, max = 2015). It is evident that intermittent users were the least likely to be diagnosed after 2003 (Table 1). Also, as shown in Table 1, the three groups differed in reported severity (number of symptoms and extent of impact) of HIV-related symptoms and concerns in the previous 2 weeks (continuous uses having the lowest severity). More importantly, there were striking differences in latest HIV biomarkers: continuous ART users had the highest proportion reaching >500 cells/mm³ in their latest CD4+ T-count (p = 0.01, no differences between the other two groups); and non-users had the

lowest proportion reaching <50 copies/ml in their latest viral load count (p < 0.001, no differences between the other two groups).

Service Access (HIV and Non-HIV Related)

In the 6 months prior to the survey, 330 participants provided valid responses to a list of 14 service types for HIV (standard alpha = 0.62, range 0–11, median = 3) and non-HIV related conditions (standard alpha = 0.66, range 0–10, median = 2) separately. Of the 330 participants, 48.8% reported two or three sources of service support for HIV-related conditions. Similarly, for non-HIV related health issues, 41.2% accessed two or three different service types. Although 55 participants (16.7%) did not report any service access in the 6-month period, the sample as a whole had accessed an average of five different service types for either HIV or non-HIV-related conditions.

For HIV clinical care more specifically, the majority (n = 317, 96.1%) had a primary HIV doctor: 25.2% (n = 80) had a (public) hospital-based specialist; 24.6% (n = 78) had a (public-funded) sexual health clinic-based physician; and a further 48.6% (n = 154) had a community-based (private) general practitioner qualified to prescribe ART as their primary HIV doctor. More importantly, 91.2% (n = 289) of the 317 participants had routinely visited their primary HIV doctor at least once every 6 months.

As shown in Table 1, the three groups differed in terms of maintaining routine HIV monitoring (at least once every 6 months) with their primary HIV doctor (non-users having the lowest proportion) and the number of different HIV-related service types access in the previous 6 months.

HIV-Related Stigma and Social Support

Of the seven listed HIV-related stigma and discrimination items (standard alpha = 0.49, range 0–5, median = 0), among the 330 participants with valid responses, 147 (44.5%) reported at least one issue in the past 12 months. Further, in terms of contact with other PLHIV: 53.0% (n = 175) knew more than ten other PLHIV; and the majority (n = 311) knew at least one person taking ART. Out of the 13 listed HIV-related social support categories (standard alpha = 0.88, range 0–11, median = 5), the sample as a whole reported an average of five different social support sources.

As shown in Table 1, the three groups differed regarding having close contact with other PLHIV peers with the intermittent users being the most likely to know at least ten other PLHIV and to know at least ten other PLHIV on ART, as this group had been living with HIV the longest.

Further, the three groups differed in the range of perceived different HIV-related support sources.

Beliefs About ART and Self-Efficacy in HIV Self-Management

There were eight reconstructed ART necessity items (as shown in Appendix I): one new/proposed item plus seven of the eight original ones (standard alpha = 0.92, mean 4.20; sd = 0.80; median = 4.38; min = 1.13; max = 5). There were 15 reconstructed ART concern items (as shown in Appendix II): six new/proposed items plus nine of the 11 original ones (standard alpha was 0.90, mean = 2.23; sd = 0.72; median = 2.2; min = 1; max = 4.8). For the necessity-concerns differential score (mean = 1.98; sd = 1.24; median = 2.09; min = −2.41; max = 4), a higher differential score represented stronger ART necessity beliefs that outweighed ART concern beliefs. Similarly, for the eight-item PHIVSMS self-efficacy measure (standardised alpha was 0.88, mean = 3.98; sd = 0.71; median = 4; min = 1.5; max = 5), a higher score represents better self-efficacy in HIV self-management.

As shown in Table 1, the three groups were markedly different in the perceived ART necessity and concerns beliefs (ART non-users having the lowest necessity-concerns differential group mean score, suggesting their concerns substantially outweighed necessities) and perceived HIV management self-efficacy (ART non-users having the lowest group mean score, suggesting they felt least self-efficacious in HIV management).

Multivariable Modelling

In the multinomial logistic regression, the continuous ART users group was treated as the reference category. Sixteen co-variant factors were purposefully selected based on the literature, significant bivariate associations demonstrated by the data (Table 1) and the deliberation to control for multicollinearity. Entered into the model in a hierarchical step-by-step approach, these independent variables included:

- age, living in a non-metropolitan (outside of capital cities) area, social welfare as the main source of income, perceived somewhat/very much/extreme financial difficulties in meeting daily living costs and/or any prescribed medications costs (five sociodemographic factors in Step 1),
- length since HIV diagnosis, a minimum of one visit to one's primary HIV doctor every 6 months, number of different HIV-related service types accessed in the previous 6 months, any STI diagnosis in the past

12 months, number of major life stressors in the previous 12 months (five clinical factors in Step 2);

- knowing at least ten other PLHIV, knowing at least ten PLHIV who were on ART, number of perceived HIV-related social support sources, severity of HIV-related symptoms and concerns in the past 2 weeks (four social factors in Step 3);

- ART beliefs (i.e., the reconstructed necessity-concerns differential mean score) and self-efficacy in HIV self-management (i.e., the PHIVSMS mean score) in the last step.

As show in Table 2, ART non-users had the lowest score in ART beliefs (AOR = 0.13; 95% CI 0.06–0.29; p < 0.001) and the lowest self-efficacy score (AOR = 0.29; 95% CI 0.09–0.87; p = 0.028). Compared with the continuous ART users, despite the fact that ART non-users were unlikely to encounter any financial difficulties in meeting daily living costs (AOR = 0.07, 95% CI 0.01–0.84; p = 0.036), they tended to access a rather limited range of HIV-related services in the 6 months prior to survey (AOR = 0.57, 95% CI 0.34–0.96, p = 0.034). Intermittent ART users, on the other hand, were the ones most likely to receive their HIV diagnosis in much earlier years of the HIV epidemic (AOR = 0.38; 95% CI 0.28–0.53; p < 0.001) and perceive the second lowest HIV management self-efficacy (AOR = 0.50, 95% CI 0.28–0.87, p = 0.015). The full multivariable model (n = 298) explained 37.2% of the overall variance (Table 2).

Further sensitivity analysis was conducted whereby 42 ART intermittent users with accumulated treatment breaks less than 3 months or unknown length of treatment breaks were excluded to reduce sample heterogeneity in the intermittent user group. The multivariate results were essentially the same, apart from having no STI diagnosis in the previous months becoming a second independent factor associated with intermittent ART use replacing lower perceived HIV management self-efficacy (AOR = 0.25, 95% CI 0.07–0.90, p = 0.034; other data not shown).

Conclusions and Discussion

To our knowledge, this is the first study to examine a number of key personal, clinical and social factors associated with distinct ART using journeys among PLHIV. In Australia, with the increasing promotion of ART initiation as soon as possible after an HIV diagnosis and the compelling benefits of long-term ART adherence without interruption, our findings confirm that ART coverage among PLHIV, mainly gay men, is high and reasonably equitable (over 70% of all diagnosed PLHIV and close to 90% of all HIV-positive gay men currently on HIV treatment) [12, 28].

Of the multiple factors examined in this paper, two key socio-cognitive factors—ART beliefs and self-efficacy in HIV self-management—played an important role in differentiating ART non-users from ART users. A major theoretical contribution to Horne's original ART Necessity and Concerns protocol [14] is our set of newly added items (Appendix I and II). Developed from our previous in-depth interviews with ART non-users in Australia, these proposed items along with the traditional items (23 belief items in total), contribute to extend our understanding of the changing knowledge and perceptions in the new era of TasP among PLHIV in Australia and worldwide.

Table 2 Factors independently associated with ART interruption or non-use: an online sample of PLHIV in Australia

Prevalence ratio (PRs) and 95% CI[a]	Currently on ART with prior breaks (n = 117)	p value	Currently not on ART (ART naïve or experienced) (n = 33)	p value
Earlier HIV diagnosis	0.38 (0.28–0.53)	<0.001		
Perceived less financial difficulty in meeting daily living costs			0.07 (0.01–0.84)	0.036
Fewer types of HIV-related services accessed in the past 6 months[b]			0.57 (0.34–0.96)	0.034
Lower reconstructed necessity-concerns differential mean score[c]			0.13 (0.06–0.29)	<0.001
Lower self-efficacy in HIV self-management mean score[d]	0.50 (0.28–0.87)	0.015	0.29 (0.09–0.87)	0.028

R^2 = 37.3%; Model Chi square = 198.4, df = 32, p < 0.001 (full model); Only factors showing significant associations at p < 0.05 were shown

[a] Group 1 on ART continuously as the reference group, N = 298

[b] Min = 0, Max = 11; Median = 3

[c] Min = −2.41, Max = 4

[d] Min = 1.5, Max = 5

Apart from these two key cognitive factors, compared with continuous ART users, those with a history of prior intermittent use were more likely to have been diagnosed with HIV before 2003, a historical period when treatment interruptions (structured or otherwise) due to severe ART side effects were common in Australia and elsewhere [29]. In contrast, ART non-users were most likely to have sub-optimal HIV clinical engagement and limited HIV-related social support, resulting in worse HIV disease outcomes (specifically, poor immunological recovery, persistence of high levels of viral load), as shown in this study. This important finding is consistent with the literature [12, 23].

There are limitations in this study. Despite our efforts to recruit participants from diverse sources online and offline, the sample size remained relatively small (particularly the non-user group in the context of TasP upscaling), limiting the statistical power to detect nuanced differences (e.g., notable heterogeneity in the ART intermittent and non-user groups). However, this cross-sectional sample is similar to other PLHIV community samples in Australia, such as the HIV Futures Study [30]. Data were collected through participants' self-reporting without external validation with clinical records. Although use of recreational drugs (injection or not) in the previous 12 months were reported by more than half of the participants, it did not substantially differentiate between the three ART user groups. However, the extent of problematic substance use (either by standard screening measures or by self-reporting) was not assessed in the questionnaire. Finally, causation could not be established due to lack of longitudinal observation.

To translate our findings into policies and practices, this paper suggests that to enable ART uptake among non-users, an increasingly minority group, their essential concerns about the short- and longer-term adverse impacts of ART need to be addressed thoroughly and consistently by the whole HIV sector, including clinicians, community organisations and peers. Apart from updating all PLHIV about the most recent ART advances and promoting the norm of universal ART coverage, cognitive reconstruction aimed at changing individual conceptions holds some promise. For example, through motivational interviewing, a person's focus on the immediate 'losses' associated with ART use could be turned into more future-oriented 'gains'; or a person's excess optimism about relying on one's natural immunological responses to control HIV replication could be turned into a more realistic appreciation of effective ART assistance [31]. Another viable and equally important approach is to enhance self-efficacy in HIV self-management through empowering individuals to adopt effective chronic disease self-management strategies and expand appropriate support networks through both online and offline platforms/channels, such as mobile phone messaging [32].

Compliance with Ethical Standards

Conflict of interest All authors declare that he/she has no conflict of interest.

Ethical Approval The online survey was approved by UNSW Human Research Ethics Committee (# HC14183); ACON Research Ethics Review Committee (#RERC2014/18) and Victorian AIDS Council Research Committee (#VAC/RE&P 14/008). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committees (as declared above) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained (online) from all individual participants included in the study.

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