Original Article

Anti-retroviral therapy adherence in India (2012-18): A systematic review and meta-analysis

Saurav Basu, Yamini Marimuthu[1], Suneela Garg, Velusamy Saravanakumar[2], Balasubramanian Ganesh[2]

Department of Community Medicine, Maulana Azad Medical College, New Delhi, [1]Department of Community and Family Medicine, AIIMS, Mangalagiri, Andhra Pradesh, [2]ICMR-National Institute of Epidemiology, Chennai, Tamil Nadu, India

Address for correspondence:
Dr. Yamini Marimuthu, Department of Community and Family Medicine, AIIMS, Mangalagiri - 522 503, Andhra Pradesh, India.
E-mail: yaminivaishnavidevi@gmail.com

Abstract

Background: India has 2.1 million people living with HIV/AIDS (PLHIV). The objective of this study was to ascertain the extent of anti-retroviral therapy (ART) adherence and reasons for nonadherence among PLHIV in India. **Methods:** We conducted a systematic review and meta-analysis using the following criteria: (1) Observational or experimental studies conducted in India and (2) English language studies. Published during January 2012–June 2018 with data collection during the same period (3). 95% ART adherence rate (primary outcome). We reviewed bibliographic databases (PubMed, Scopus) and extracted relevant data. The forest plot was used to display the meta-analysis results. Analyses were performed in Stata 14 using the "Metaprop_one" function. **Results:** A total of 511 records were identified after removing duplicates, 59 full-texts were screened of which 15 studies were included in the meta-analysis. Only one study was conducted in rural India, with <95% adherence reported by all its participants. The PLHIV reported several reasons for their ART nonadherence including forgetfulness (8/15), running out of pills (3/15), distance from the health center and associated travel (2/15), alcohol abuse (3/15), concealment of HIV status from family (2/15, felt stigma (2/15), depressive symptoms (2/15), and fear of side-effects (2/15). The overall pooled estimate of ART adherence was 54.1% (95% confidence interval [CI] 27%–81%), while among facility-based studies, the ≥95% adherence rate was significant higher. 62% (95% CI 46%–0.78%). **Conclusions:** Despite the universal provision of free of cost ART to all PLHIV in government health facilities in India, suboptimal adherence to treatment persists in nearly half of these patients.

Key words: Adherence, anti-retroviral therapy, India

Introduction

India has an HIV infection prevalence of 0.22% in the adult population, with an estimated 2.1 million people living with HIV (PLHIV).[1] The control and treatment of HIV represent a major public health challenge. The National Aids Control Program (NACP) is committed to the goal of ending the AIDS epidemic as a public health threat by 2030' in India. The national response driven by the NACP for over the three decades has resulted in a 54% reduction in AIDS-related deaths since 2007, which has been rendered possible by the accelerated availability and provision of free of cost anti-retroviral therapy (ART) through the government-funded program. India has now adopted the "test and treat" policy that extends ART to all PLHIV irrespective of their CD4 count. Furthermore, the National Strategic Plan for HIV-AIDS has set targets for significantly scaling up ART for achieving viral load suppression in 95% of the PLHIV on treatment.[2]

It is well-established that a high rate of adherence (95%–100%) to ART is required to achieve and maintain viral suppression in the PLHIV.[3,4] Failure to maintain adherence to ART is causally associated with the progression of HIV to AIDS, increased risk of opportunistic infections, and mortality with lowering of quality of life.[5,6] Moreover, nonadherence substantially increases the risk of resistance to second-line ART that requires switching to third-line ART associated with increased toxicity and healthcare costs.[7]

The World Health Organization considers the improvement in medication adherence as a critical driver for achieving

How to cite this article: Basu S, Marimuthu Y, Garg S, Saravanakumar V, Ganesh B. Anti-retroviral therapy adherence in India (2012-18): A systematic review and meta-analysis. Indian J Sex Transm Dis 2024;45:2-7.

effective health change in chronic diseases.[8] Compared to other chronic conditions, adherence requirements in the PLHIV are substantially stringent as it requires them to omit no more than a single dose of anti-retroviral (ARV) medication in a month, and this needs to be continued throughout the patient lifespan.[9] Furthermore, adherence to ART is a complex phenomenon guided by the patient sociodemographic factors, the social environment, stage of the illness, and health-care system characteristics.[10,11] Barriers and challenges in maintaining ART adherence among the socioeconomically vulnerable groups and in those experiencing stigma and discrimination are well-established.[12] In India, ART nonadherence is a major health concern due to the problems of both unintentional nonadherence signifying lack of drug accessibility and affordability, along with intentional nonadherence due to behavioral factors.

A systematic review of nine Indian studies conducted from 2006 to 2009 reported the pooled prevalence of ART adherence to be 70%, with the cost of medication and difficulty in drug access found as the principal barriers encountered by patients.[13] A large scale prospective observation study (*n* = 3285) by Joshi *et al.* (2014) conducted during 2009–2010 reported suboptimal ART adherence in 24.5% of PLHIV, with illiteracy, male gender, nondisclosure of HIV status to the family, frequent change of residence, and travel expenses significantly associated with nonadherence.[14]

The NACP launched phase IV of the program (NACP IV) in 2012 inclusive of a dedicated component toward expansion of care, support and treatment services for promotion of greater adherence and compliance, especially in at-risk groups like women and children.[15] The impact of the NACP IV on overall ART treatment adherence among PLHIV in India warrants further evaluation. We, therefore, conducted this study to ascertain the extent of ART adherence and reasons for nonadherence among PLHIV in India from 2012 to 2018.

Methods

Search strategy and selection criteria

This systematic review was registered in PROSPERO (Reg. No. CRD).[16] We searched PubMed and Scopus for articles conducted in India between January 2012 and June 2018 and published in the English language. We excluded retrospective studies with the entire data collected before 2012, the cutoff indicating the initiation of the NACP-Phase 4 in 2012-2013.

A combination of the following text keywords and MeSH terms: "Medication Adherence," "Patient Compliance," "anti-retroviral therapy," "Antiretroviral Therapy, Highly Active," "HIV," "AIDS" and "India" was applied. Back referencing of included studies was also done to identify additional studies that fit the inclusion criteria.

Review approach

A total of 427 PubMed/Medline records and 231 Scopus records were identified, which were imported into Mendeley reference management software, following which the duplicate records were removed. All the titles were then subject to abstract screening. Our inclusion criterion was studies reporting medication adherence and treatment adherence to ART regimens in the PLHIV living in India. Studies were included if their abstracts reported methods or results relating to adherence to ART in Indian PLHIV and their predictors [Figure 1]. We included observational

studies, interventional trials, and qualitative studies with sample size ≥25, with no restrictions by age, gender, and sexual identity of the participants. Using a predesigned data extraction form, two reviewers extracted data from the selected articles independently. Any disagreements at any stage were resolved by consensus.

Data extraction

Information on the sociodemographic population characteristics: Age-group, gender, sexual identity, socioeconomic status; the name of the first author, year of publication, study design, study period, study location, type of health facility, sample size, the definition of medication adherence, method of assessment of medication adherence, 95% ART adherence rate, recall period and factors influencing ART adherence. Reasons for ART nonadherence were retained if reported to be significant on regression analysis or reported by at least 10% of the nonadherent participants.

The primary outcome measure was the rate of medication (ART) adherence in the PLHIV/PHWA. The secondary outcomes were a 95% adherence rate with the respective confidence interval (CI) for all the studies.

Risk of bias (quality) assessment: The risk of bias was assessed using a modified Joanna Briggs Institute appraisal checklist for studies reporting the prevalence data.[17]

Statistical analysis

The extracted data were single entered in EpiData software version 3.1 (EpiData Association Odense, Denmark) and data analysis was done using Stata statistical software version 14 (StataCorp LP. College Station, TX, USA). Meta-analysis was conducted using the "Metaprop_one" function in STATA. The Chi square test for heterogeneity was done and the $P < 0.001$ with an I^2 statistic of 99%. Since there was significant heterogeneity between the studies, random effects model was used to calculate the pooled estimates for measuring adherence to ART. The pooled estimate was expressed as proportions with 95% CIs.

Results

Identification of studies

A total of 511 records were initially identified, meeting the inclusion criteria on title cum abstract screening. A total of 59 articles were full-text reviewed, of which 19 were excluded as they were reviews, utilizing a duplicate dataset or did not contain original India country-specific data. Furthermore, a total of 25 studies were conducted pre-2011 and were therefore excluded. Finally, 15 studies were selected for the systematic review [Figure 1].

Characteristics of included studies

The average sample size of the studies was 262.73 (142.71). The mean (standard deviation [SD]) effective sample size of the studies was 215 (160). The mean (SD) age of the participants in the included studies was 34.4 (10.1). Only one study was rural community based,[25] and the other studies were urban facility based. With regard to geographical location, two studies were conducted in Northern India, one from Western India, one from Eastern India, and the remaining were from Southern India [Table 1].

Anti-retroviral therapy adherence

ART adherence was assessed with a single method in 11 studies (3 pill count, 2 VAS, and 6 self-report), and a combination of methods in four studies. The period of

Table 1: Characteristics of the included studies (2012-2018)

Author	Year of publication	Effective sample size	Location	Study design	Study population	Mean (SD) age	Men/women
Achappa *et al.*[18]	2013	116	Karnataka	Cross sectional	Adults	-	80/36
Basti *et al.*[19]	2017	242	Karnataka	Prospective	Adults	35 (7.8)	109/133
Dworkin *et al.*[20]	2016	211	Hyderabad	Cross sectional	Adults with FSW	-	114/97
Hasabi *et al.*[21]	2016	200	Karnataka	Cross sectional	Adults	40 (9.9)	100/100
Jones *et al.*[22]	2013	45	Chandigarh	Intervention	Adults	38.1 (8.6)	21/24
Meena *et al.*[23]	2014	79	Varanasi	Prospective	Adults	-	42/37
Mehta *et al.*[24]	2016	164	South India	Cross sectional	Pediatric	10.2 (3.6)	95/69
Nyamathi *et al.*[25]	2018	400	Andhra Pradesh	Cross sectional	Women	33.8 (6.6)	400
Panigrahi *et al.*[26]	2015	78	Orissa	Cross sectional	Adults	-	-
Piña *et al.*[27]	2018	65	Mumbai	Cross sectional	MSM	38.4 (8.6)	0
Rajesh *et al.*[28]	2013	240	South India	Intervention	Adults	-	188/52
Schensul *et al.*[29]	2017	55	Mumbai	Qualitative	Adult men	41.5	-
Shet *et al.*[30]	2016	599	South India	Prospective	Adults	-	-
Shukla *et al.*[31]	2016	322	North India	Cross sectional	Adults	-	201/121
Banagi *et al.*[32]	2016	409	Karnataka	Cross sectional	Adults	38.3 (9)	256/153

FSW: Female sex workers, MSM: Men sex workers, SD: Standard deviation
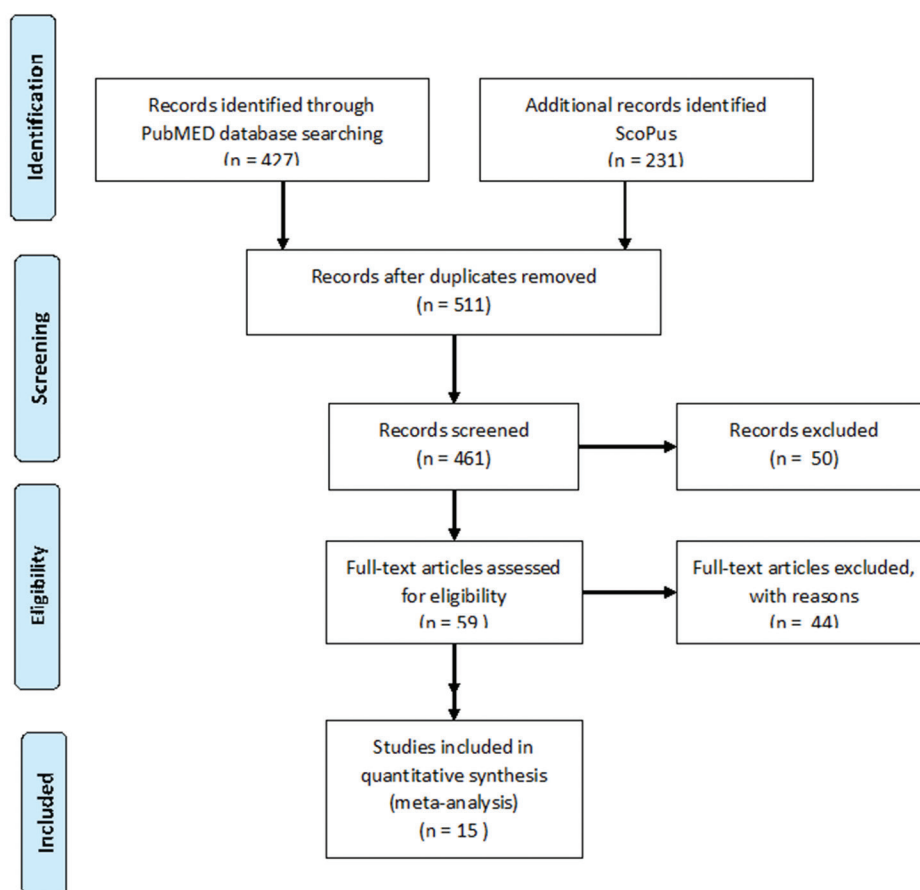
Figure 1: PRISMA flow diagram of the systematic review and meta-analysis

recall ranged from 4 to 90 days. Most frequently applied recall period was 30 days in eight studies, 4 days in two studies, 90 days in two studies, 14 days in one study, and not reported in two studies. A total of 10 studies reported ≥95% adherence rates, while three studies reported 100% adherence rates.

Among facility-based studies (*n* = 14) conducted in any part of India from 2012 to 2018, ≥95% adherence rate was reported in 1448 out of 2381 PLHIV. Only one study was community-based cross-sectional conducted in a rural area in Southern India by Nyamathi *et al.* (2018).[25] In this study, adherence was assessed among a sample of previously identified women living with HIV, using a previously validated VAS scale, which detected none of the participants with ≥95% ART adherence in a 30-day recall period, while 4 out of 400 reported a ≥90% adherence rate [Table 2].

Table 2: Anti-retroviral therapy adherence in the included studies on anti-retroviral therapy adherence in India (2012-2018)

Author	Assessment method(s)	Recall (days)	≥95% adherent	100% adherent	Reasons for nonadherence
Achappa *et al.*[18]	Self-report	4	74	-	Forget, financial reasons
Basti *et al.*[19]	Self-report, pill count	30	120	76	Forget, stigma, depression
Dworkin *et al.*[20]	Self-report (scale)	14	-	-	Forget, run out, travel, depression
Hasabi *et al.*[21]	Pill count	90	162	124	Forget, travel, increasing age
Jones *et al.*[22]	Self-report, pill count	30	-	-	Poor patient provider communication
Meena *et al.*[23]	Self-report, pill, VAS	30	28	-	Family problems
Mehta *et al.*[24]	VAS	30	149	-	Run out, stigma, adverse effects
Nyamathi *et al.*[25]	VAS	30	4**	-	Opportunistic infections
Panigrahi *et al.*[26]	Pill count	-	-	-	Forget, financial reasons
Piña *et al.*[27]	Self-report	30	-	44	Forget, run out, alcohol abuse, carelessness
Rajesh *et al.*[28]	Self-report	30	139	-	Lack of family support
Schensul *et al.*[29]	Self-report	4	-	-	Lack of social support, alcohol abuse
Shet *et al.*[30]	Self-report, pill count	90	453	-	Younger age (<40 years)
Shukla *et al.*[31]	Pill count	-	35	-	Forget, busy, felt sick
Banagi *et al.*[32]	Self-report	30	288	-	Forget, alcohol abuse

**4 participants had 90% adherence rate, extrapolated to 95% adherence rate for estimation of pooled prevalence. VAS: Visual Analog Scale

The pooled proportion of ART adherence as per ≥95% adherence criterion was 0.54 (95% CI: 0.27–0.81) [Figure 2], and on combining the Piña *et al.* study[27] that only reported 100% adherence, the adherence rate estimated was 0.55 (95% CI: 0.29-0.81) [Figure 3]. However, among facility-based studies, the ≥95% adherence rate was higher 0.62 (95% CI 0.46–0.78).

### Predictors of anti-retroviral therapy nonadherence

The PLHIV reported several reasons for their ART nonadherence including forgetfulness (8/15), running out of pills (3/15), distance from the health center and associated travel (2/15), alcohol abuse (3/15), concealment of HIV status from family (2/15, felt stigma (2/15), depressive symptoms (2/15), and fear of side-effects (2/15). Lack of satisfaction with the healthcare facility due to the perceived need for frequent follow-up to replenish ART drug refills was explicitly attributed as a cause of ART nonadherence in the study by Shukla *et al.*[31]

Only one study was conducted among sexual minorities, in men having sex with men by Piña *et al.* in the city of Mumbai. The PLHIV attributed skipping doses resulting in nonadherence due to their desire not to mix the medicine with alcohol intake, forgetfulness, running out of drug stocks with an inability to replenish them in a timely manner.[27]

Educational interventions to improve adherence to ART among the PLHIV reported positive outcomes.[22,28]

Methodological quality

The quality of the studies was appropriate except in dealing with confounding factors (60%) [Figure 4]. For instance, most studies did not assess for the social desirability bias (SDB), which is a type of response bias, in which the survey respondents tend to answer questions in a manner that will be viewed favorably by others.[33] There is a consensus among researchers that SDB is likely to overestimate medication adherence rates based on patient self-report. However, only the study by Jones *et al.* suspected the presence of SDB in the adherence-related responses provided by the participants.[22] Eggers test was used to assess publication bias which showed that there were significant small study effects (*P* = 0.004). The funnel plot also depicted asymmetry which indicates the probable presence of publication bias [Figure 5].
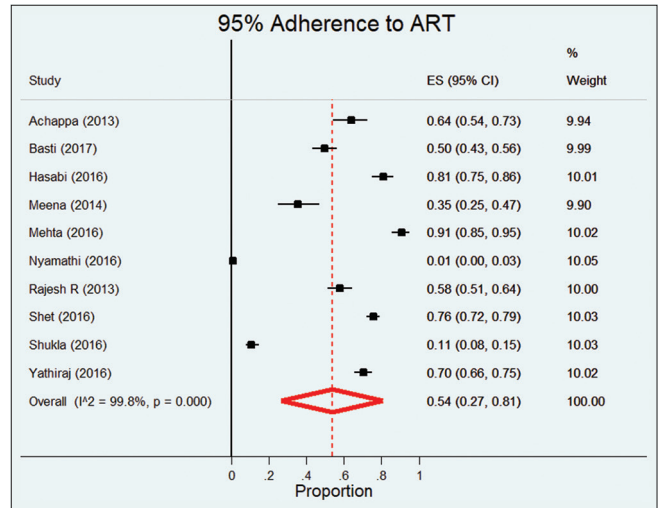
Figure 2: Forest Plot (10 studies)

Discussion

The results of this systematic review and meta-analysis show that overall adherence to ART in India is 54%–55%, much lower than the 70% reported in another meta-analysis by Mhaskar *et al.* which included studies conducted till 2009.[13] Adherence rate in the facility-based studies was significantly higher (62%), compared to the only available community-based study in rural India among PLHIV women that found nonadherence in all the participants.[25]

The reasons for nonadherence were mostly behavioral and rarely due to adverse effects. Forgetfulness was the most common reason for nonadherence reported across studies. It is well-established that provision of free of cost ART medication improves adherence.[10] Previously, qualitative research by Joglekar *et al.* identified financial barriers to ART adherence where the contributing factors were unemployment, economic dependency, and debt.[34] However, in the present review, ART nonadherence due to running out of drug stocks and travel-related costs were reported in only three studies, indicating improved dispensing of ART to the PLHIV via the NACP. However, there was only one study from rural India that observed nonadherence in all the PLHIV participants that were
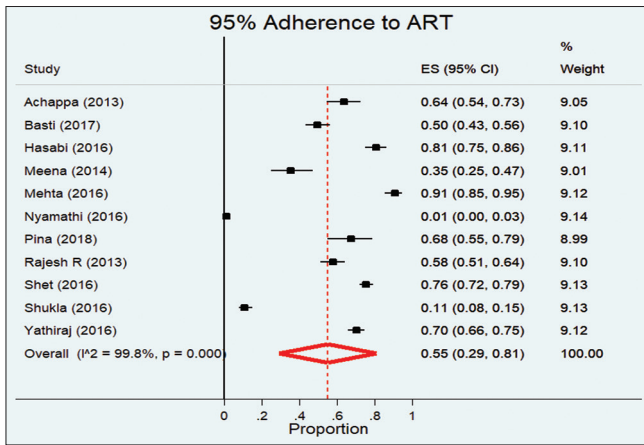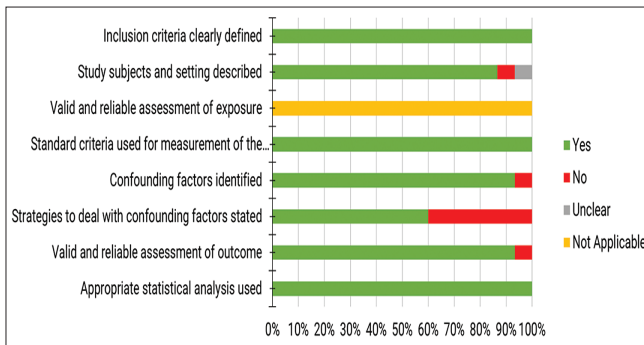
Figure 3: Forest Plot (11 studies)

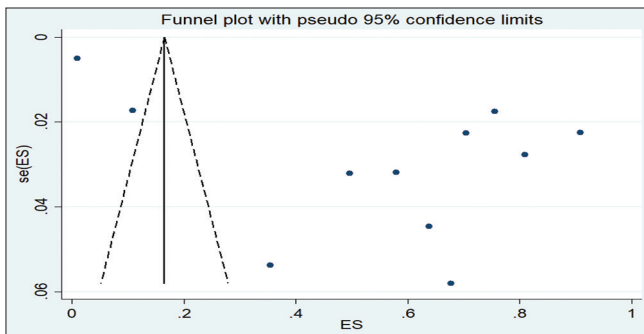**Figure 4:** Methodological quality of the included studies

Figure 5: Funnel plot

women, indicating that lack of accessibility of government ART centers continues to be a significant barrier in attaining optimal ART adherence apart from threats of internalized stigma resulting in concealment of HIV status from their families.[35]

Limitations of existing studies: Most of the studies were conducted in Southern India. Studies were lacking from the North-Eastern part of India that has a high HIV burden, and also the less prominent cities. Groups likely to be nonadherent due to issues of stigmatization and ART accessibility like FSWs and MSM were individually evaluated only in two studies. Most studies applied either a 95% or a 100% adherence rate but not both and omitted reported the actual adherence estimate as a continuous outcome. The assessment of medication adherence through self-report should also be assessed

with validated questionnaires and inventories consisting of multiple items to increase the sensitivity for detection of medication nonadherence.[33]

The lack of in-depth interviews and qualitative perspectives were observed in nearly all the included studies, which precluded ascertaining the determinants of ART non adherence from a health systems point of view such as the distance and costs incurred in accessing ART, frequency, and quality of counseling received at the ART center, knowledge of optimal ART requirements, expectations from the health care facility and staff, and self-management of adverse effects.

Implications for future research

Studies evaluating ART adherence in India should achieve geographic penetration across India. Considering all PLHIV in India are eligible to receive ART irrespective of CD-4 since 2017, ensuring the adequacy of ART drug stocks and its accessibility remains a priority area for government health settings. The assessment of adherence from a retrospective clinic or hospital audit data by calculating the proportion of days covered and the medication possession ratio in the PLHIV can bridge the evidence gap by generating evidence in a short time across India.[33] Furthermore, prospective studies need to capture the dynamic phenomenon of ART adherence. Considering the NACP targets expansion of ART coverage to 90-90-90 levels by 2020, the feasibility of multi-month ART drug dispensing, mooted in the NSP, needs prioritized assessment in Indian health settings.[2] More adherence research also requires to be directed among the disadvantaged and vulnerable PLHIV among groups such as female sex workers, men having sex with men, and rural women.

Limitations of the systematic review and meta-analysis

There are certain limitations to this review. Due to limited searches conducted only in standardized databases, research published in gray literature could have been omitted. Most studies did not report the attainment of virological suppression as an objective parameter that could correlate with actual ART adherence levels. Since the studies were conducted mostly in the clinic facilities of South Indian states, the results should not be generalized across India due to the significant diversity in the quality of services and care. Finally, we could not assess the maintenance of ART adherence in the PLHIV over a long-term period due to the lack of either prospective data collection or secondary pharmacy database analysis among the included studies.

Conclusions

Despite the universal provision of free of cost ART to all PLHIV in government health facilities in India, suboptimal adherence to treatment persists in nearly half of these patients. Running out of pills among the PLHIV remains a concern for the NACP, suggesting the need for multi-month dispensation of drugs in public health facilities.

Conflicts of interest
There are no conflicts of interest.

References

1. National AIDS Control Organization & ICMR-National Institute of Medical Statistics. HIV Estimations 2017: Technical Report. New Delhi: NACO, Ministry of Health and Family Welfare, Government of India; 2018.

2. National Strategic Plan for HIV/AIDS and STI 2017-2024. "Paving Way for an AIDS Free India". New Delhi: Ministry of Health and Family Welfare, Government of India; 2017.

3. Viswanathan S, Detels R, Mehta SH, Macatangay BJ, Kirk GD, Jacobson LP. Level of adherence and HIV RNA suppression in the current era of highly active antiretroviral therapy (HAART). AIDS Behav 2015;19:601-11.

4. Nelson M, Girard PM, Demasi R, Chen L, Smets E, Sekar V, *et al.* Suboptimal adherence to darunavir/ritonavir has minimal effect on efficacy compared with lopinavir/ritonavir in treatment-naive, HIV-infected patients: 96 week ARTEMIS data. J Antimicrob Chemother 2010;65:1505-9.

5. Golin CE, Liu H, Hays RD, Miller LG, Beck CK, Ickovics J, *et al.* A prospective study of predictors of adherence to combination anti-retroviral medication. J Gen Intern Med 2002;17:756-65.

6. E Silva AC, Reis RK, Nogueira JA, Gir E. Quality of life, clinical characteristics and treatment adherence of people living with HIV/AIDS. Rev Lat Am Enfermagem 2014;22:994-1000.

7. Nachega JB, Marconi VC, van Zyl GU, Gardner EM, Preiser W, Hong SY, *et al.* HIV treatment adherence, drug resistance, Virologic failure: Evolving concepts. Infect Disord Drug Targets 2011;11:167-74.

8. Sabatâe E. Adherence to Long-Term Therapies: Evidence for Action. 1st ed. Geneva: World Health Organization; 2003.

9. Paterson DL, Swindells S, Mohr J, Brester M, Vergis EN, Squier C, *et al.* Adherence to protease inhibitor therapy and outcomes in patients with HIV infection. Ann Intern Med 2000;133:21-30.

10. Hardon A, Davey S, Gerritt T, Hodgkin C, Irunde H, Kgatlwane J, *et al.* From access to Adherence: The Challenges of Anti-Retroviral Treatment: Studies from Botswana, Tanzania and Uganda. Geneva:World Health Organization; 2006.

11. Kumarasamy N, Safren SA, Raminani SR, Pickard R, James R, Krishnan AK, *et al.* Barriers and facilitators to anti-retroviral medication adherence among patients with HIV in Chennai, India: A qualitative study. AIDS Patient Care STDS 2005;19:526-37.

12. Paramesha AE, Chacko LK. Predictors of adherence to anti-retroviral therapy among PLHIV. Indian J Public Health 2019;63:367-76.

13. Mhaskar R, Alandikar V, Emmanuel P, Djulbegovic B, Patel S, Patel A, *et al.* Adherence to antiretroviral therapy in India: A systematic review and meta-analysis. Indian J Community Med 2013;38:74-82.

14. Joshi B, Chauhan S, Pasi A, Kulkarni R, Sunil N, Bachani D, *et al.* Level of suboptimal adherence to first line antiretroviral treatment & its determinants among HIV positive people in India. Indian J Med Res 2014;140:84-95.

15. National Aids Control Organization. Care and Support Centres; 2018. Available from: http://naco.gov.in/care-and-support-centres-0. [Last accessed on 2020 Mar 21].

16. Basu S, Garg S, Yamini M, Subramanian B. Adherence to Anti-Retroviral Therapy in India: A Systematic Review. PROSPERO 2018 CRD42018104450. Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42018104450. [Last accessed on 2020 Mar 21].

17. Checklist for Prevalence Studies. The Joanna Briggs Institute Critical Appraisal Tools for Use in JBI Systematic Reviews. Available from: https://joannabriggs.org/sites/default/files/2019-05/JBI_Critical_Appraisal-Checklist_for_Prevalence_Studies2017_0.pdf. [Last accessed on 2020 Mar 21].

18. Achappa B, Madi D, Bhaskaran U, Ramapuram JT, Rao S, Mahalingam S. Adherence to antiretroviral therapy among people living with HIV. N Am J Med Sci 2013;5:220-3.

19. Basti B, Mahesh V, Bant D, Bathija G. Factors affecting anti-retroviral treatment adherence among people living with human immunodeficiency virus/acquired immunodeficiency syndrome: A prospective study. J Fam Med Prim Care 2017;6:482.

20. Dworkin MS, Douglas GW, Rani GP, Chakraborty A. Adherence to highly active anti-retroviral therapy in Hyderabad, India: Barriers, facilitators and identification of target groups. Int J STD AIDS 2016;27:186-95.

21. Hasabi IS, Shivashankarappa AB, Kachapur C, Kaulgud RS. A study of compliance to anti-retroviral therapy among HIV infected patients at a tertiary care hospital in North Karnataka. J Clin Diagn Res 2016;10:OC27-31.

22. Jones D, Sharma A, Kumar M, Waldrop-Valverde D, Nehra R, Vamos S, *et al.* Enhancing HIV medication adherence in India. J Int Assoc Provid AIDS Care 2013;12:343-8.

23. Meena LP, Pandey SK, Rai M, Bharti A, Chakravarty J, Sundar S. Study the drug adherence and possible factor influencing drug adherence in HIV/AIDS patients in north eastern part of India. J Educ Health Promot 2014;3:31.

24. Mehta K, Ekstrand ML, Heylen E, Sanjeeva GN, Shet A. Adherence to antiretroviral therapy among children living with HIV in South India. AIDS Behav 2016;20:1076-83.

25. Nyamathi A, Ekstrand M, Heylen E, Ramakrishna P, Yadav K, Sinha S, *et al.* Relationships among adherence and physical and mental health among women living with HIV in rural India. AIDS Behav 2018;22:867-76.

26. Panigrahi M, Swain TR, Mohanty S. Nonadherence to anti-HIV medication is associated with higher level of anxiety: Experience from a tertiary care hospital of Odisha. Indian J Pharmacol 2015;47:672-5.

27. Piña C, Dange A, Rawat S, Jadhav U, Arnsten JH, Chhabra R, *et al.* Antiretroviral treatment uptake and adherence among men who have sex with men and transgender women with HIV in Mumbai, India: A cross-sectional study. J Assoc Nurses AIDS Care 2018;29:310-6.

28. Rajesh R, Vidyasagar S, Muralidhar Varma D, Guddattu V, Hameed A. Evaluating the impact of educational interventions on use of highly active anti-retroviral therapy and adherence behavior in Indian human immunodeficiency virus positive patients: Prospective randomized controlled study. J AIDS Clin Res 2013;4:4(8):1-9.

29. Schensul SL, Ha T, Schensul JJ, Vaz M, Singh R, Burleson JA, *et al.* The role of alcohol on antiretroviral therapy adherence among persons living with HIV in Urban India. J Stud Alcohol Drugs 2017;78:716-24.

30. Shet A, Kumarasamy N, Poongulali S, Shastri S, Kumar DS, Rewari BB, *et al.* Longitudinal analysis of adherence to first-line antiretroviral therapy: Evidence of treatment sustainability from an Indian HIV cohort. Curr HIV Res 2016;14:71-9.

31. Shukla M, Agarwal M, Singh JV, Tripathi AK, Srivastava AK, Singh VK. Nonadherence to anti-retroviral therapy among people living with HIV/AIDS attending two tertiary care hospitals in district of northern India. Indian J Community Med 2016;41:55-61.

32. Banagi Yathiraj A, Unnikrishnan B, Ramapuram JT, Kumar N, Mithra P, Kulkarni V, *et al.* Factors influencing adherence to antiretroviral therapy among people living with HIV in coastal South India. J Int Assoc Provid AIDS Care 2016;15:529-33.

33. Basu S, Garg S, Sharma N, Singh MM. Improving the assessment of medication adherence: Challenges and considerations with a focus on low-resource settings. Ci Ji Yi Xue Za Zhi 2019;31:73-80.

34. Joglekar N, Paranjape R, Jain R, Rahane G, Potdar R, Reddy KS, *et al.* Barriers to ART adherence & follow ups among patients attending ART centres in Maharashtra, India. Indian J Med Res 2011;134:954-9.

35. Ekstrand ML, Heylen E, Mazur A, Steward WT, Carpenter C, Yadav K, *et al.* The role of HIV stigma in ART adherence and quality of life among rural women living with HIV in India. AIDS Behav 2018;22:3859-68.