Prevalence and factors associated with fertility desire among people living with HIV: A systematic review and meta-analysis

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Abstract

Background

The fertility desire of people living with HIV (PLHIV) has been rising in the past decade. However, there are many studies among which the association remains controversial between the fertility desire of HIV-infected persons and antiretroviral therapy (ART), sex, marital status, and educational level.

Methods

We performed a literature search of these meta-analyses in PubMed, the Cochrane Library, Web of Science and ScienceDirect in November 2019. We also reviewed references of eligible studies to complement the search. We used pooled odds ratios (ORs) and 95% confidence intervals (CIs) with a random-effects model and a fixed-effects model to estimate the association between fertility desire among PLHIV and ART, sex, marital status, educational level, and number of children. Subgroups with I² square values (I²) and sensitivity analyses were performed to assess the heterogeneity and the stability of the overall ORs, respectively. We evaluated publication bias using Egger’s test and a visual inspection of the symmetry in funnel plots.

Results

In these meta-analyses 50 articles were included with 22,367 subjects. The pooled prevalence of fertility desire among PLHIV was estimated to be 42.04%. The pooled analyses showed that the fertility desire of PLHIV is associated with ART (OR = 1.11, 95% CI:1.00–1.23, P = 0.043), sex (OR = 1.51, 95% CI:1.10–2.09), age (OR = 2.65, 95% CI:2.24–3.14), marital status (OR = 1.34, 95% CI:1.08–1.66), educational level (OR = 0.85, 95% CI:0.73–1.00, P = 0.047) and the number of children (OR = 3.99, 95% CI:3.06–5.20). PLHIV who are on ART, are male, are younger than 30, are married/cohabiting, have received a secondary education or above, and are childless have a higher prevalence of fertility desire. The two factors of age and the number of children, in particular demonstrated a strong significant
association with fertility desire. We found moderate heterogeneity in the meta-analyses of age and educational level and high heterogeneity in the meta-analyses of sex, marital status and number of children. Publication bias was detected in the meta-analyses of the association of fertility with sex and educational level.

Conclusion

This study demonstrates that the prevalence of fertility desire among HIV-infected people is 42.04%, and the fertility desire among PLHIV is associated with ART experience, sex, age, marital status, the number of children, and educational level. Since a majority of PLHIV are of reproductive age, it is necessary to support PLHIV in terms of their needs regarding reproductive decision-making. Through counseling and reproductive health care, further measures to prevent the horizontal and vertical transmission of HIV should be taken.

Introduction

According to the 2019 reports of Joint United Nations Programme on HIV/AIDS (UNAIDS), there were approximately 37.9 million people living with HIV (PLHIV) across the world, among whom 1.47 million were of reproductive age [1]. It is common for them to want to get married and start a family. However, the prevalence of fertility desire/intention among PLHIV has been low for the past two decades due to poor health status, fear of infecting one’s spouse or fetus, and discouraging policies in many countries [2]. In 2000, a study conducted in Europe showed that the pregnancy rate trended to decrease in women after receiving a diagnosis of HIV while the rate of abortion had increased [3]. Lewis et al showed that HIV-infected women in Sub-Saharan Africa have a lower fertility rate than their non-infected counterparts [4].

With more access to highly active antiretroviral therapy (HAART), nevertheless, the quality of life for PLHIV has significantly improved, and their life span is expected to be longer [5, 6]. As a result, their fertility desire or intention has risen [7, 8]. A study from Ethiopia indicated that the prevalence of fertility desire among HIV-positive individuals increased from 20.0% in 2010 to 42.1% in 2013 [9, 10]. A similar growing tendency toward the desire to reproduce has been found in other regions as well [11]. A number of studies have pointed to many factors that could influence the fertility desire of PLHIV. For example, HIV-positive individuals who are young tend to have a higher prevalence of fertility desire [12, 13]. Decreased fertility desire is related to divorce or separation compared to being married, and to having at least one child in contrast to having no children [12–14]. Several studies have revealed that educational status is a predictor of fertility desire [15]. In addition, HIV disclosure to sexual partners could affect the fertility desire of HIV-infected people [14, 16].

Since the fertility desires of PLHIV is tied to sexual practices and pregnancy, it is crucial to prevent horizontal transmission between partners and mother-to-child transmission (MTCT). Previous studies indicate that the viral load of PLHIV on ART could be suppressed; therefore, the risk of transmitting HIV to sexual partners could decrease or even be eliminated [17]. Many measures for sero-discordant couples, such as artificial insemination, timed unprotected intercourse, assisted reproductive techniques, sperm washing and pre-exposure prophylaxis, could be used to reduce HIV horizontal transmission [18–20]. There are also many means of preventing the mother-to-child transmission of HIV (PMTCT), including HIV testing and counseling, the use of ARV drugs, safe delivery, and safe breastfeeding. As a consequence, fertility desire among PLHIV not only has significant implications for such individuals, their
partners, and fetuses, but also plays a critical role in preventing HIV transmission and providing reproductive health care.

Studies have shown that the fertility desire of PLHIV is associated with many sociodemographic factors, while there are many inconsistent conclusions regarding whether being on ART is related to higher fertility desire [21–23]. A previous meta-analysis conducted in 2013 explored the associations of fertility with some variables including ART experience, sex, age, the number of children, and educational level [24]. In that study, however, the results showed no significant association of fertility desire with ART experience and sex and hence might not estimate the true effect size; it should be noted that the association between fertility desire and the factors stated above remains inconsistent. Since this study involves more literature on research performed from 2013 to 2019, the objective is to offer a broad description of fertility desire among PLHIV, and was to underscore the strength of the association between these factors and fertility desire.

**Methods**

We reported this meta-analysis with reference to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines [25] (S1 Table).

**Search strategy**

The literature searching was conducted in PubMed, Cochrane Library, Web of Science and ScienceDirect by following the search strategy and completed before November 24, 2019 (S2 Table): (Fertility desire OR Fertility intention OR desire to have children OR Reproductive intention OR Reproductive decision making OR Desire for child OR Childbearing desire OR Childbearing intention OR parenthood OR fatherhood OR motherhood OR maternity OR paternity) AND (HIV OR people living with HIV OR HIV-positive OR HIV-infected). We extracted all relevant studies by reading theirs titles, abstracts, keywords and full texts. The references of the included studies and any relevant meta-analyses were also reviewed.

**Inclusion and exclusion criteria**

The inclusion criteria were: 1) the outcome of interest was fertility desire or intention in the future; 2) the female subjects in the study were all of childbearing age and able to achieve pregnancy; 3) the studies reported the prevalence of fertility desire among PLHIV or least one of the selected associated factors (sex, age, marital status, educational level, number of children, and ART experience); 4) the details of the sample/subsample could be extracted; 5) observational studies published from 2000 to November 2019; and 6) quantitative studies. Studies were excluded if 1) the study was a review, a qualitative study or only an abstract; 2) the study’s objective was irrelevant; 3) the study’s subjects were ineligible. and 4) data were not available or adequate.

**Data extraction**

The following data from the eligible studies were collected: the first author’s name, publication year, the country/location where the study was conducted, the study design, the sample size, the number of men and women, the prevalence of fertility desire among PLHIV, and the study’s quality assessment score. If the adjusted odds ratio (OR) values and their 95% confidence intervals (CIs) were unavailable, we directly extracted or calculated the ORs with corresponding 95% CIs using the raw data. Variables of age, marital status, the number of children and educational level were respectively dichotomized as aged below 30 years vs aged 30 years and above, currently married/cohabiting vs not currently married (single, widowed, separated or divorced), having children vs having one or more children, and up to primary education vs
secondary education or above. In this review, two investigators (XY and JD) screened all studies carefully to ensure that they met the inclusion criteria. Inconsistencies were resolved by the chief investigator GPJ if they existed.

**Quality assessment**

The quality of the included studies was assessed by using an 11-item checklist for cross-sectional study quality, as recommended by the Agency for Healthcare Research and Quality (AHRQ) [26]. For the 11-item checklist, an item would be scored '0' if an answer of “NO” or “UNCLEAR” was given; if an answer of “YES” was given, then the item scored ‘1’. The definition of article quality was as follows: low quality = 0–3; moderate quality = 4–7; and high quality = 8–11 (S3 and S4 Tables).

**Statistical analysis**

First, pooled ORs with 95% CIs were calculated by using the extracted raw data, crude or adjusted ORs with 95% CIs that evaluate the strength of the association between fertility desire/intention among PLHIV and the factors of interest (sex, age, marriage status, educational level, number of children and ART experience). Then six meta-analyses were performed. To assess the robustness of the outcomes, we conducted subgroup analysis in terms of publication year, region, and quality assessment score. Heterogeneity between the studies was assessed by using the Cochran’s Q Chi-square test and I² analysis (I² values of 50% and 75% were considered moderate and high heterogeneity respectively). When I² ≥ 50%, we selected a random-effects model for heterogeneity analyses, and an otherwise fixed-effects model. Sensitivity analysis was performed to explore the impact of individual studies on the results. We evaluated publication bias through visual inspection of asymmetry in funnel plots or with the P value of Egger’s test. We carried out all analyses were done with Stata (Version12.0).

**Results**

**Study selection**

According to the search strategy we retrieved 5,314 articles, of which 1,795 were duplicates. Finally, 50 articles were assessed for eligibility in these meta-analyses after full-text screening [10, 14, 27–74]. A flowchart of the literature search was presented in Fig 1.

**Description of the studies**

In these meta-analyses, we included a total of 50 articles with 22,367 participants. All included studies were cross-sectional and published between 2000 and -2019, and scored no less than 6 points on the basis of quality assessment. According to the income group defined by the World Bank for 2017, the study countries were categorized as low income, lower middle income, upper middle income, and high income [75]. Among these studies, 20 were conducted in low-income countries (LICs), 12 in lower middle-income countries (LMICs), 11 in upper middle-income countries (UMICs) and 7 in high-income countries (HICs). The general information is shown in Table 1.

**Meta-analysis of fertility desire**

The prevalence of fertility desire among PLHIV was 13.57% to 80.00% in the fifty included studies (Table 1). The meta-analysis revealed that the prevalence of fertility desire was 42.04% (95% CI: 37.80, 46.28%), with high heterogeneity (I² = 97.9%, P < 0.001) using the random-effects model (Fig 2).
We have reported the meta-analyses of the associated factors. As portrayed in Fig 3, in this meta-analysis, we have included 26 studies, five of which showed a statistically significant association between ART and fertility desire/intention. As a result, the pooled OR indicated that the fertility desire of PLHIV is statistically and significantly associated with ART (OR = 1.11; 95% CI:1.00–1.23; \( P = 0.043 \)). The testing for heterogeneity did not reveal variability among the included studies (\( I^2 = 44.1\%, \ P = 0.009 \)).

As presented in Fig 4, twenty-five studies were included in this meta-analysis. Thirteen studies showed statistically significant association between sex and fertility desire/intention. Eleven suggested that men have more fertility desire than women while the other two implied the opposite. In terms of sex, the overall OR indicated that men have higher fertility desire than women (OR = 1.51; 95% CI:1.10–2.09). It should be noted that heterogeneity among the included studies was high (\( I^2 = 90.7\%, \ P <0.001 \)).

As seen in Fig 5, we included fourteen studies in the meta-analysis of the association between fertility desire and age. It is evident that being younger than 30 is a strong predictor of fertility desire among PLHIV, as almost all ORs with 95% CIs of the included studies fell on
Table 1. The main features of the studies included in the meta-analysis.

| First author | Publication year | Location   | Country’s income level | Study design      | Sample size | Number of men/women | Fertility desire (%) | Study quality score |
|--------------|------------------|------------|------------------------|-------------------|-------------|---------------------|----------------------|---------------------|
| Abbawa, F.   | 2015             | Ethiopia   | Low                    | Cross-sectional   | 422         | 217/205             | 141(33.41%)          | 7                   |
| Adilo, T. M. | 2017             | Ethiopia   | Low                    | Cross-sectional   | 416         | 124/292             | 227(54.57%)          | 7                   |
| Adler, D. H. | 2017             | South Africa | Upper middle          | Cross-sectional   | 50          | 0/50                | 40(80.00%)           | 7                   |
| Alemayehu B  | 2012             | Ethiopia   | Low                    | Cross-sectional   | 307         | 185/122             | 203(66.12%)          | 7                   |
| Asfaw, H. M. | 2014             | Ethiopia   | Low                    | Cross-sectional   | 1855        | 0/1855              | 815(43.94%)          | 6                   |
| Cohn, S. E.  | 2018             | USA        | High                   | Cross-sectional   | 1425        | 1181/244            | 580(40.70%)          | 8                   |
| Cooper, D.   | 2009             | South Africa | Upper middle          | Cross-sectional   | 459         | 174/285             | 148(32.24%)          | 9                   |
| de Souza, M. R. | 2017        | Brazil     | Upper middle          | Cross-sectional   | 274         | 0/274               | 71(25.91%)           | 7                   |
| Demissie, D. B. | 2014         | Ethiopia   | Low                    | Cross-sectional   | 340         | 126/214             | 133(39.12%)          | 7                   |
| Finocchario Kessler, S.1 | 2010 | USA        | High                   | Cross-sectional   | 181         | 0/181               | 107(59.12%)          | 8                   |
| Finocchario Kessler, S.2 | 2014 | Brazil    | Upper middle          | Cross-sectional   | 295         | 295/0               | 115(38.98%)          | 8                   |
| Erhabor, O.  | 2012             | Nigeria    | Lower middle          | Cross-sectional   | 195         | 88/107              | 111(56.92%)          | 6                   |
| Gyimah, A. A. | 2015           | Ghana      | Lower middle          | Cross-sectional   | 295         | 0/295               | 172(58.31%)          | 8                   |
| Haddad, L. B. | 2016           | USA        | High                   | Cross-sectional   | 181         | 0/181               | 62(34.25%)           | 7                   |
| Heard, I.    | 2007             | France     | High                   | Cross-sectional   | 1254        | 699/555             | 322(25.68%)          | 9                   |
| Hernando, V. | 2014            | Spain      | High                   | Cross-sectional   | 134         | 0/134               | 66(49.25%)           | 9                   |
| Iliyasu, Z.  | 2009             | Nigeria    | Lower middle          | Cross-sectional   | 340         | 85/255              | 219(64.41%)          | 8                   |
| Jose, H.     | 2016             | India      | Lower middle          | Cross-sectional   | 230         | 132/98              | 77(33.48%)           | 8                   |
| Kaida, A.    | 2011             | South Africa | Upper middle          | Cross-sectional   | 432         | 0/432               | 130(30.09%)          | 9                   |
| Kawale, P.   | 2014             | Malawi     | Low                    | Cross-sectional   | 202         | 75/127              | 103(50.99%)          | 9                   |
| Kipp, W.     | 2011             | Uganda     | Low                    | Cross-sectional   | 199         | 77/122              | 27(13.57%)           | 9                   |
| Krashin, J. W. | 2018          | Malawi     | Low                    | Cross-sectional   | 558         | 250/308             | 175(31.36%)          | 8                   |
| Laar, A. K.  | 2015             | Ghana      | Lower middle          | Cross-sectional   | 318         | 0/318               | 135(42.45%)          | 7                   |
| Laryea, D. O. | 2014           | Ghana      | Lower middle          | Cross-sectional   | 230         | 0/230               | 123(53.48%)          | 7                   |
| Litwin, L. E. | 2015           | Uganda     | Low                    | Cross-sectional   | 436         | 0/436               | 162(37.16%)          | 9                   |
| Maier, M.    | 2009             | Uganda     | Low                    | Cross-sectional   | 501         | 0/501               | 73(14.57%)           | 9                   |

(Continued)
the side of increased fertility desire. Similarly, the pooled OR with moderate heterogeneity ($I^2 = 51.0\%, P = 0.014$), showed that PLHIV younger than 30 years have a 2.6-fold increase in fertility desire compared to their older counterparts (OR = 2.65; 95% CI:2.24–3.14)
As outlined in Fig 6, a meta-analysis including 24 studies was performed to assess association between marriage status and fertility desire. Among the 11 studies that revealed a significant association, only one indicated that PLHIV who are married/cohabiting have less fertility desire than PLHIV who are not married (single, widowed, divorced, or separated). The overall OR demonstrated a positive association of fertility desire with being married/cohabiting (OR = 1.34; 95% CI:1.08–1.65). However, we noted the high heterogeneity ($I^2 = 83.8\%$, $P < 0.001$).

As portrayed in Fig 7, we included twenty-two studies in the meta-analysis. Five studies consistently found that educational level is associated with fertility desire among PLHIV. The pooled OR implied that, with moderate heterogeneity among the included studies ($I^2 = 69.8\%$, $P < 0.001$), PLHIV with a level of up to primary education have less fertility desire than PLHIV whose educational level is secondary or above (OR = 0.85; 95% CI: 0.73–1.00).

As displayed in Fig 8, there were 26 included studies, of which only four showed no significant association between the number of children and fertility desire in the meta-analysis. As a result, having no children is another strong predictor of fertility desire among PLHIV. The pooled OR indicated that PLHIV who are childless have a nearly 4-fold increase in fertility desire compared to PLHIV who have one or more children (OR = 3.99; 95% CI: 3.06–5.20). There was high heterogeneity among the included studies ($I^2 = 84.9\%$, $P < 0.001$).

Subgroup analysis

Next, we performed subgroup analysis on the basis of publication year, the region where the study was done, and the quality assessment score of the studies. We found associations of
fertility desire with age and with the number of children in all subgroups that people living with HIV who were younger than 30 and had no children experienced greater fertility desire. There were relationships between sex and fertility desire shown in studies from Africa.

Fig 3. Forest plot of pooled OR for fertility desire in PLHIV (ART experienced vs ART naive).
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Fig 4. Forest plot of pooled OR for fertility desire in PLHIV (men vs women).
https://doi.org/10.1371/journal.pone.0248872.g004
In the subgroup of marriage status, studies published after 2014 (OR = 1.75; 95% CI: 1.44–2.12; $I^2 = 63.6$), those conducted in Africa (OR = 1.42; 95% CI: 1.13–1.77; $I^2 = 83.9$) and those that scored higher than 7 on the quality assessment (OR = 1.44; 95% CI: 1.02–2.03; $I^2 = 87.8$) were statistically significant. In light of educational level, we observed an association with fertility desire in studies from Africa as well.

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**Fig 5.** Forest plot of pooled OR for fertility desire in PLHIV (aged below 30 years vs aged 30 and above).

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**(OR = 1.54; 95% CI: 1.04–2.30; $I^2 = 90.3$%).** In the subgroup of marriage status, studies published after 2014 (OR = 1.75; 95% CI: 1.44–2.12; $I^2 = 63.6$), those conducted in Africa (OR = 1.42; 95% CI: 1.13–1.77; $I^2 = 83.9$) and those that scored higher than 7 on the quality assessment (OR = 1.44; 95% CI: 1.02–2.03; $I^2 = 87.8$) were statistically significant. In light of educational level, we observed an association with fertility desire in studies from Africa as well.

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**Fig 6.** Forest plot of pooled OR for fertility desire in PLHIV (currently married vs unmarried).

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as in which the studies of which quality assessment score was higher than 7, and the pooled ORs were 0.84 (95% CI: 0.72–0.99, \(I^2 = 72.2\%\)) and 0.78 (95% CI: 0.64–0.95, \(I^2 = 68.3\%\)) respectively. The details of the subgroup analysis were summarized in Table 2.

![Fig 7. Forest plot of pooled OR for fertility desire in PLHIV (up to primary vs secondary or above).](https://doi.org/10.1371/journal.pone.0248872.g007)

![Fig 8. Forest plot of pooled OR for fertility desire in PLHIV (having no children vs having one or more children).](https://doi.org/10.1371/journal.pone.0248872.g008)
| Subgroup * | Number of studies | OR (95% CI) | I square (%) | P      | P for Egger's test |
|------------|-------------------|------------|--------------|--------|-------------------|
| **ART**    |                   |            |              |        |                   |
| Overall    | 26                | 1.11(1.00–1.23) \(^b\) | 44.1         | 0.009  | 0.109             |
| **Publication year** |                  |            |              |        |                   |
| Pre 2014   | 13                | 1.17(0.93–1.48) | 57.0         | 0.006  | 0.187             |
| Post 2014  | 13                | 1.05(0.91–1.22) | 23.8         | 0.203  | 0.469             |
| **Region** |                   |            |              |        |                   |
| Africa     | 18                | 1.14(0.95–1.37) | 50.1         | 0.008  | 0.457             |
| Other      | 8                 | 0.95(0.77–1.17) | 10.3         | 0.350  | 0.089             |
| **Quality assessment score** |                 |            |              |        |                   |
| ≤7         | 8                 | 1.22(1.04–1.44) | 0.0          | 0.717  | 0.014             |
| >7         | 18                | 1.01(0.81–1.25) | 55.2         | 0.003  | 0.964             |
| **Sex**    |                   |            |              |        |                   |
| Overall    | 25                | 1.51(1.10–2.09) | 90.7         | <0.001 | 0.038             |
| **Publication year** |             |            |              |        |                   |
| Pre 2014   | 15                | 1.58(0.96–2.62) | 92.9         | <0.001 | 0.183             |
| Post 2014  | 10                | 1.40(0.96–2.05) | 84.8         | <0.001 | 0.096             |
| **Region** |                   |            |              |        |                   |
| Africa     | 19                | 1.54(1.04–2.30) | 90.3         | <0.001 | 0.696             |
| Other      | 6                 | 1.41(0.82–2.42) | 90.7         | <0.001 | 0.008             |
| **Quality assessment score** |             |            |              |        |                   |
| ≤7         | 10                | 1.37(0.93–2.02) | 82.5         | <0.001 | 0.187             |
| >7         | 15                | 1.61(1.00–2.59) | 93.2         | <0.001 | 0.108             |
| **Age**    |                   |            |              |        |                   |
| Overall    | 14                | 2.65(2.24–3.14) | 51.0         | 0.014  | 0.082             |
| **Publication year** |             |            |              |        |                   |
| Pre 2014   | 5                 | 2.76(2.30–3.32) | 0.0          | 0.967  | 0.38              |
| Post 2014  | 9                 | 2.64(2.02–3.47) | 67.2         | 0.002  | 1.37              |
| **Region** |                   |            |              |        |                   |
| Africa     | 10                | 2.41(2.14–2.71) | 44.7         | 0.061  | 0.527             |
| Other      | 4                 | 3.47(2.28–5.26) | 58.8         | 0.063  | 0.054             |
| **Quality assessment score** |             |            |              |        |                   |
| ≤7         | 7                 | 2.34(2.04–2.68) | 47.0         | 0.079  | 0.329             |
| >7         | 7                 | 2.87(2.21–3.73) | 52.3         | 0.049  | 0.343             |
| **Marital status** |             |            |              |        |                   |
| Overall    | 24                | 1.34(1.08–1.65) | 83.8         | <0.001 | 0.115             |
| **Publication year** |             |            |              |        |                   |
| Pre 2014   | 11                | 0.99(0.69–1.42) | 86.8         | <0.001 | 0.161             |
| Post 2014  | 13                | 1.75(1.44–2.12) | 63.6         | 0.001  | 0.653             |
| **Region** |                   |            |              |        |                   |
| Africa     | 21                | 1.42(1.13–1.77) | 83.9         | <0.001 | 0.198             |
| Other      | 3                 | 0.91(0.60–1.39) | 56.2         | 0.102  | 0.878             |
| **Quality assessment score** |             |            |              |        |                   |
| ≤7         | 10                | 1.23(0.97–1.57) | 73.7         | <0.001 | 0.02              |
| >7         | 14                | 1.44(1.02–2.03) | 87.8         | <0.001 | 0.483             |
| **Educational level** |             |            |              |        |                   |
| Overall    | 22                | 0.85(0.73–1.00) \(^d\) | 69.8         | <0.001 | 0.003             |
| **Publication year** |             |            |              |        |                   |

(Continued)
Heterogeneity analysis and publication bias

The results of the heterogeneity test and Egger’s test were outlined in Table 2. We performed the random-effects model to do meta-analyses for studies with heterogeneity ($I^2 \geq 50\%$), and analyzed the rest using a fixed-effects model. According to Egger’s test and the funnel plot, there was evidence of publication bias in many studies included in the meta-analyses of the association of fertility desire with sex and educational level. (Table 2, S1–S6 Figs)

Discussion

In our study, the prevalence of fertility desire among HIV-infected people was 42.04%, which indicated that their desire to have children cannot be ignored. These meta-analyses demonstrate that for PLHIV, ART use, sex, age, marital status, number of children, and education level are all associated with fertility desire. However, many studies, including a meta-analysis, showed that ART use has no association with fertility desire among PLHIV [9, 24, 76, 77]. In effect, as the most efficient treatment for HIV-infected people, ART could improve their overall well-being, suppress the viral load to a great extent, and help them remain optimistic about fertility [42]. Therefore, it is reasonable for PLHIV on ART to have a higher prevalence of the desire for reproduction than their ART-naive counterparts. In contrast to the previous meta-analysis, this study found that HIV-infected men trend to have more fertility desire than HIV-infected women. Although men and women are both required in the reproductive process, women often suffer the most during pregnancy, which might make them more cautious about fertility [27]. In many patrilineal societies such as in South Africa, HIV-infected men’s greater

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Table 2. (Continued)

| Subgroup * | Number of studies | OR (95% CI) | I square (%) | P    | P for Egger’s test |
|------------|-------------------|-------------|-------------|------|-------------------|
| Pre 2014   | 12                | 0.84 (0.67–1.06) | 73.3 | <0.001 | 0.003             |
| Post 2014  | 10                | 0.87 (0.70–1.09) | 64.3 | 0.003 | 0.288             |
| Region     |                   |             |             |      |                   |
| Africa     | 19                | 0.84 (0.72–0.99) | 72.2 | <0.001 | 0.01              |
| Other      | 3                 | 0.87 (0.68–1.14) | 48.5 | 0.143 | 0.146             |
| Quality assessment score | | | | | |
| ≤7         | 8                 | 0.99 (0.78–1.29) | 68.2 | 0.003 | 0.019             |
| >7         | 14                | 0.78 (0.64–0.95) | 68.3 | <0.001 | 0.027             |
| Number of child | | | | | |
| Overall    | 26                | 3.99 (3.06–5.20) | 84.9 | <0.001 | 0.272             |
| Publication year | | | | | |
| Pre 2014   | 9                 | 2.77 (1.60–4.81) | 92.4 | <0.001 | 0.53              |
| Post 2014  | 17                | 4.64 (4.09–5.27) | 37.4 | 0.061 | 0.299             |
| Region     |                   |             |             |      |                   |
| Africa     | 17                | 4.54 (3.53–5.84) | 73.0 | <0.001 | 0.878             |
| Other      | 9                 | 3.11 (1.87–5.19) | 87.6 | <0.001 | 0.135             |
| Quality assessment score | | | | | |
| ≤7         | 13                | 3.72 (2.66–5.19) | 83.3 | <0.001 | 0.753             |
| >7         | 13                | 4.33 (2.76–6.80) | 86.7 | <0.001 | 0.034             |

* The variables in the subgroup analyses were ART (experienced vs naive), sex (men vs women), age (below 30 vs 30 and above), marital status (married/cohabiting vs not married), educational level (up to primary vs secondary or above), and number of children (none vs one child or more).

b, d: 1 is not included in confidence intervals when the digits after decimal are kept three.

c: 2014 is the median.

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desire to have children than women might result from the inclination to leave something behind, such as lineage, after they pass away [78–80]. Younger PLHIV, as this study showed, have stronger fertility desire than their older counterparts. For one thing, the desire for children is usually strong in young people of reproductive age, irrespective of HIV infection status. For another, older HIV-infected persons might have already achieved their ideal family sizes and thus would not like to bear other children [14, 52]. Likewise, a majority of studies demonstrated that PLHIV with none or fewer children have a higher prevalence of fertility desire [11, 52, 61]. In some countries, such as Ethiopia, it is believed that family life will not be happy and fulfilled without a child [81]. Additionally, the desire to have biological children and a family of a certain size, as is case in many African nations, are significant reasons for fertility intention among HIV-infected women [82]. As this study indicated, PLHIV who are married or cohabiting have more fertility desire than HIV-infected people who are single, widowed, divorced or separated. Married HIV-infected individuals often have stable relationships or regular sexual partners, and thus might have more reliable support for raising children compared to PLHIV who are not married [50]. Within Ugandan society and in many cultures of Sub-Saharan Africa, childbearing plays a critical role in marriages and families, which may explain the greater fertility desire among PLHIV who are married than among those who are not [66]. Normally, better educated people are expected to have increasingly greater access to information, particularly, AIDS prevention knowledge such as the MTCT of HIV. In addition, well-educated people tend to have better jobs and relatively higher incomes which could make them have better access to medical services [83]. In terms of issues of reproduction, women with higher educational levels tend to make independent decisions, which may be related to higher fertility desire [15]. The meta-analysis likewise showed that HIV-infected people with higher educational levels have more fertility desire than their less educated peers.

Since the advent of ART, it has been possible for PLHIV to give birth to healthy children, due to an enhanced quality of life, longer lifespans and reduced MTCT [76]. However, as a predictor of reproductive practices, fertility desire, if increased, would prompt HIV-infected people to have unprotected intercourse, to give birth and to breastfeed their children, which might heighten the risk of infecting their partners, spouses or children with HIV [8, 84–86]. Many studies have revealed that in Africa horizontal and vertical transmission remain the primary forms of HIV infection, with transmission rates ranging from 20%-25% by HIV-positive people to their HIV-negative partners [87, 88]. Despite being aware of HIV transmission, many HIV-infected individuals, strong fertility desire could pose barriers to contraception use and thus they would be at risk of unprotected sex [89]. Meanwhile, they would face a complex decision about whether to fulfill their desire to have children.

Consequently, it is important for local health care providers to develop appropriate reproductive health service policies and interventions for men and women living with HIV. For instance, HIV-infected individuals should be provided with counseling and related tests of HIV, such as tests of HIV viral load and CD4 count, and with advice on safe conception. Eligible HIV-infected individuals should initiate ART as soon as possible, and the use of assisted reproductive technology should be recommended for sero-discordant couples. On the whole, fully understanding the fertility desire of PLHIV is essential to providing targeted sexual and reproductive health services.

This study has many limitations. First, there were only six variables included. Previous studies have shown that the following factors are also related to fertility desire among PLHIV: health status, the duration of ART, the influence of partners or spouses, ethnicity, income, culture, stigma, and attitudes of local health care providers; we were unable to extracted these factors either due to a lack of or the unfitness of data for the meta-analyses [18]. As a consequence, it was not easy to draw conclusion on fertility desire by taking six limited
variables as determinants. Further, it was found that the duration of ART has potential influence on fertility desire [33]. Therefore it seems more reasonable to consider duration of ART as a factor rather than ART use. Second, there might be a difference in the definition of educational status in various countries; as a result, the pooled effect size of the association between fertility desire and educational level might not be accurate. Moreover, both the lower limit (1.003) of CI in the analysis of ART and the upper limit (0.998) of CI in the analysis of educational level were close to 1, which suggests the need for deeper investigation. Third, the fertility practices of PLHIV are affected by many social factors, such as discrimination; therefore studies on fertility desire might not reflect their genuine intentions. Fourth, the included studies in these meta-analyses were mainly from Sub-Saharan Africa and few were from high-income countries. Hence, positive association of fertility desire with the factors considered in this study is less likely to represent the countries in all of the included studies.

**Conclusion**

In summary, the results of this study demonstrate that fertility desire among PLHIV is associated with ART experience, sex, age, marital status, the number of children, and educational level. HIV-infected individuals who are on ART, are male, are younger than 30, are married/cohabiting, are childless and have a secondary education or above have a higher prevalence of fertility desire. Through reproductive health counseling and care, further measures to prevent the horizontal and vertical transmission of HIV should be taken. In addition, their reproductive needs should be met, particularly targeted PLHIV.

**Supporting information**

S1 Table. PRISMA 2009 checklist.
(DOC)

S2 Table. Search for PubMed, Cochrane Library, Web of Science and ScienceDirect.
(DOCX)

S3 Table. Scoring criteria for the quality of studies.
(XLSX)

S4 Table. Quality assessment of the included studies.
(XLSX)

S1 Fig. Funnel plot of publication bias of the studies included in the analysis of the association of fertility desire with ART.
(PNG)

S2 Fig. Funnel plot of publication bias of the studies included in the analysis of the association of fertility desire with sex.
(PNG)

S3 Fig. Funnel plot of publication bias of the studies included in the analysis of the association of fertility desire with age.
(PNG)

S4 Fig. Funnel plot of publication bias of the studies included in the analysis of the association of fertility desire with marital status.
(PNG)
S5 Fig. Funnel plot of publication bias of the studies included in the analysis of the association of fertility desire with educational level.
(PNG)

S6 Fig. Funnel plot of publication bias of the studies included in the analysis of the association of fertility desire with the number of children.
(PNG)

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