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https://doi.org/10.1038/s41562-022-01414-7

nature human behaviour

The effects of cash transfer programmes on HIV-related outcomes in 42 countries from 1996 to 2019

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Many countries have introduced cash transfer programmes as part of their poverty reduction and social protection strategies. These programmes have the potential to overcome drivers of HIV risk behaviours and usage of HIV services, but their overall effects on HIV-related outcomes remain unknown. Here we evaluate the effects of cash transfer programmes covering >5% of the impoverished population on country- and individual-level HIV-related outcomes in 42 countries with generalized epidemics. Cash transfer programmes were associated with a lower probability of sexually transmitted infections among females (odds ratio, 0.67; 95% confidence interval (CI), 0.50–0.91; $P = 0.01$), a higher probability of recent HIV testing among females (odds ratio, 2.61; 95% CI, 1.15–5.88; $P = 0.02$) and among males (odds ratio, 3.19; 95% CI, 2.45–4.15; $P < 0.001$), a reduction in new HIV infections (incidence rate ratio, 0.94; 95% CI, 0.89–0.99; $P = 0.03$) and delayed improvements in antiretroviral coverage (3%; 95% CI, 0.3–5.7 at year 2; $P = 0.03$) and AIDS-related deaths (incidence rate ratio, 0.91; 95% CI, 0.83–0.99 at year 2; $P = 0.03$). Anti-poverty programmes can play a greater role in achieving global targets for HIV prevention and treatment.

HIV continues to be a major global public health threat, causing an estimated 1.7 million new infections and 690,000 AIDS-related deaths in 2019[1]. The Joint United Nations Programme on HIV/AIDS (UNAIDS) Fast Track plan set the goal in 2014 of reducing annual infections to 200,000 and AIDS-related deaths by 90% by 2030[2]. In addition to the rapid scaling-up of clinical services, the Fast Track plan emphasizes the importance of expanding social protection for achieving these objectives[3]. Social protection is thought to be important because of the well-documented relationship between poverty or income shocks and risk factors for HIV transmission (for example, transactional sex among adolescent girls and young women, engagement in sex work by women who experience health shocks in their family, earlier age at sexual debut, lower use of HIV services and worse antiretroviral adherence) and HIV-related morbidity and mortality[4–14].

Over the past two decades, many low- and middle-income countries (LMICs) have introduced cash transfer programmes as central components of their poverty reduction and social protection strategies. These programmes, which range from conditional cash transfer programmes that are common in Latin America to unconditional cash transfer programmes that are common in sub-Saharan Africa, exist in over 100 LMICs, and many countries have expanded or introduced new programmes during the COVID-19 pandemic. A growing evidence base suggests that cash transfer programmes reduce poverty, foster economic autonomy, raise school attendance for children, improve empowerment for women and increase health service use, among other benefits[15]. Conceptually, cash transfer programmes may improve outcomes by increasing income and addressing economic barriers as well as by alleviating the psychological impacts of poverty on mental bandwidth and decision-making[16–21].

Despite the existence of cash transfer programmes in many countries with generalized HIV epidemics and the large number of evaluations of these programmes, relatively few studies have examined their effects on HIV-related outcomes among beneficiaries, and even fewer have studied their effects at the population level. Several studies of predominantly smaller-scale cash transfer interventions have examined the direct effects on beneficiaries and shown mixed but generally favourable changes in HIV-related outcomes. For HIV prevention, a few randomized controlled trials of cash transfers have focused on adolescent girls and young women. In Malawi, unconditional and conditional cash transfer interventions for schooling reduced HIV prevalence among schoolgirls[22]. In South Africa, conditional cash transfers for schooling had no effect on HIV incidence among adolescent girls and young women, although the control group in this study received cash transfers and school attendance was high in both study groups[23]. Non-experimental impact evaluations of the Kenyan government's cash transfer programme for caregivers of orphans and vulnerable children and another of the Malawi government's household cash transfer programme found delays in sexual debut[24,25]. A recent systematic review found that among 27 cash transfer interventions that have been evaluated, there was limited evidence of an effect on HIV outcomes, but unconditional cash transfer programmes implemented by governments showed the most promise[26]. Finally, a much larger literature has examined the effects of financial and non-financial incentives that are tailored to specific HIV-related behaviours, but the incentive amounts are typically much smaller than the size of cash transfers typically administered in LMICs. Studies of incentives have had mixed results, as some have demonstrated improvements in HIV testing uptake[27–30], retention in care[31–33], adherence to antiretroviral therapy[32,34,35] and virologic suppression[33,36], while others have not[31,37–39].

An evaluation of large-scale cash transfer programmes using cross-population-level data from many different countries remains an important gap in the literature. We hypothesized that larger, more generalized cash transfer programmes might improve both population and individual HIV-related outcomes (Fig. 1). While national cash transfer programmes in sub-Saharan Africa are more commonly unconditional and less HIV-specific than those

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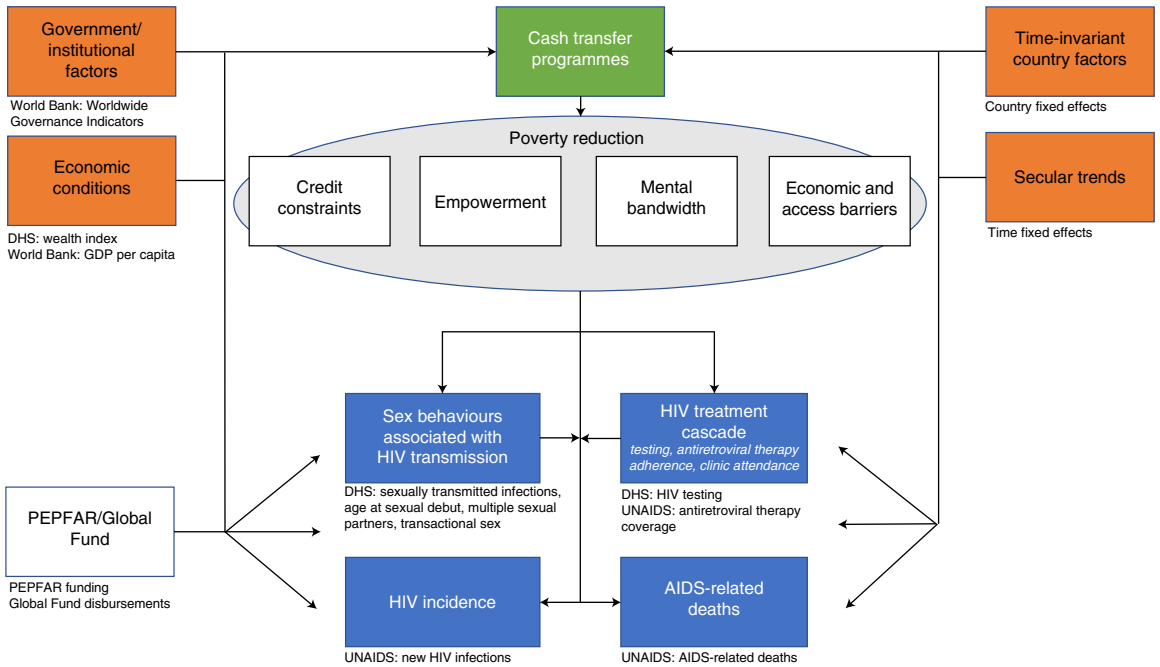

Fig. 1 | Causal framework. Proposed causal framework with a directed acyclic graph outlining potential relationships between large-scale cash transfer programmes and HIV-related outcomes, mediated through an anti-poverty effect. The green box is the exposure of interest (cash transfer programmes). The blue boxes are the HIV-related outcomes of interest, two more proximal (sex behaviours and HIV treatment cascade) and two more distal (HIV incidence and AIDS-related deaths). The orange boxes are ancestors of both the exposure and the outcomes (that is, confounders). Underneath each box are the covariates used to measure the constructs within the boxes. The covariates from the DHS are individual-level, and all other covariates are country-level. DHS, Demographic and Health Survey; GDP, gross domestic product; PEPFAR, The US President's Plan for AIDS Relief; UNAIDS, The Joint United Nations Programme on HIV/AIDS.

considered in the studies described above, benefits may still be seen because of their more expansive reach and spillover effects stemming from reduced HIV transmission. These national cash transfer programmes also tend to persist over time, unlike financial incentive or cash transfer studies in which interventions have tended to be time limited. An advantage of using population-level data when evaluating cash transfer programmes (rather than comparing cash transfer beneficiaries alone with non-beneficiaries) is that it will be possible to detect spillover effects of cash transfers that may occur at the household level and beyond. This is true both because cash transfers are often pooled within households (and among relatives) and because transfers may influence health behaviours that affect the risk of HIV acquisition and transmission[40,41].

However, few studies have evaluated the broader effects of large-scale cash transfer programmes, a policy-relevant topic given the burden of HIV and growing reliance on cash transfer programmes. To address this unanswered question, we conducted a difference-in-differences analysis evaluating the effects of cash transfer programmes on country- and individual-level outcomes in 42 countries with generalized HIV epidemics from 1996 to 2019.

Results

Study sample. Forty-two countries were eligible for inclusion in this study—36 (86%) in Africa, 4 (10%) in Latin America and the Caribbean and 2 (5%) in Asia (Table 1 and Supplementary Figs. 1–3). Among these, 21 countries implemented an eligible cash transfer programme (or combination of cash transfer programmes) at some point during the study period (Fig. 2). In these countries, there were 36 cash transfer programmes—28 were unconditional, and 8 were conditional (Supplementary Table 1). The median total coverage level for cash transfer programmes in the intervention group was 23% of the impoverished population (interquartile range (IQR), 14–63%), and the median HIV prevalence at the beginning of the cash transfer period was 3.7% (IQR, 1.5–10.7%).

At the start of the study period, intervention countries had higher HIV prevalence (median 4.1% versus 1.7%, $P=0.007$) and higher annual HIV incidence rates (median 3.8 versus 2.2 per 1,000 persons, $P=0.01$) relative to comparison countries, but there was no statistically significant difference between them in any of the six World Bank Governance Indicators (Table 1). All countries received some HIV-related Global Fund disbursements during the study period, and 16 (76%) intervention countries and 8 (38%) control countries received President's Emergency Plan for AIDS Relief (PEPFAR) funding at some point during the study period.

We obtained individual survey data from 99 Demographic and Health Surveys (DHS) and 6 AIDS Indicator Surveys (AIS) conducted in the included countries during the study period—24 during intervention years and 82 during comparison years (Fig. 2). There were 1,885,733 survey respondents in total, of whom 1,295,177 (69%) were female and 545,867 (29%) were interviewed during intervention years (Supplementary Tables 4–6).

Primary analyses. In our primary individual-level analyses, among females, cash transfer programmes were associated with a lower probability of having had a sexually transmitted infection within the past 12 months (odds ratio (OR), 0.67; 95% confidence interval (CI), 0.50–0.91; $P=0.01$) and a higher probability of having had an HIV test within the past 12 months (OR, 2.61; 95% CI, 1.15–5.88; $P=0.02$) (Table 2 and Supplementary Tables 7–17). PEPFAR funding per capita (OR, 1.14 per US$5 increase; 95% CI, 1.01–1.30; $P=0.04$) and HIV-related Global Fund disbursements per capita (OR, 1.48 per US$5 increase; 95% CI, 1.18–1.84; $P<0.001$) were also associated with an increased probability of having had an HIV test within 12 months.

Table 1 | Characteristics of included countries that implemented a cash transfer programme (or combination of programmes) with greater than 5% coverage of the impoverished population during the study period (1996–2019) compared with those that did not implement such programmes

	Intervention countries	Comparison countries	Total	*P*
	N = 21	*N* = 21	*N* = 42	
Population (1,000s), 1996, median (IQR)	10,372 (2,786–21,032)	4,349 (1,663–7,251)	11,801 (2,948–25,876)	0.45
Region, *N* (%)				<0.001
Africa	16 (76)	20 (95)	36 (86)	
Latin America / Caribbean	3 (14)	1 (5)	4 (10)	
Asia	2 (10)	0 (0)	2 (5)	
HIV prevalence per 100,000 people, median (IQR)				
1996	4.1 (2.0–12.5)	1.7 (1.4–4)	2.8 (1.6–6.3)	0.007
2005	4.4 (1.7–12.0)	2.2 (1.4–4.0)	2.7 (1.4–6.2)	0.02
2019	3.2 (1.1–12.1)	2.0 (1.3–3.4)	2.4 (1.2–6.1)	0.04
Annual HIV incidence per 100,000 people, median (IQR)				
1996	379 (160–988)	218 (128–377)	246 (145–484)	0.01
2005	237 (77–539)	130 (90–209)	153 (86–350)	0.06
2019	80 (26–273)	59 (40–106)	66 (38–172)	0.32
Annual AIDS-related death rate per 100,000 people, median (IQR)				
1996	137 (69–284)	87 (45–113)	94 (46–193)	0.01
2005	168 (83–546)	125 (73–147)	132 (74–272)	0.02
2019	47 (24–95)	38 (22–79)	47 (22–82)	0.27
Proportion of population receiving antiretroviral therapy, median (IQR)				
2005	4 (3–7)	2 (1–6)	3 (2–7)	0.09
2019	74 (62–82)	57 (43–64)	64 (46–79)	0.01
PEPFAR recipient, *N* (%)	16 (76)	8 (38)	24 (57)	0.03
PEPFAR funding per capita in USD, median (IQR)				
2005	0.0 (0.0–2.8)	0.0 (0.0–0.7)	0.0 (0.0–2.4)	0.57
2019	6.9 (0.3–9.2)	0.0 (0.0–3.2)	1.0 (0.0–8.2)	0.05
HIV Global Fund recipient, *N* (%)	21 (100)	21 (100)	42 (100)	NA
HIV Global Fund disbursements per capita in USD, median (IQR)				
2005	0.7 (0.2–1.6)	0.7 (0.3–1.1)	0.7 (0.2–1.6)	0.4
2019	1.4 (1.1–3.1)	1.4 (0.8–2.0)	1.4 (0.8–2.7)	0.13
World Bank Governance Indicators, 1996				
Corruption, median (IQR)	−0.7 (−1.1 to 0.1)	−0.6 (−0.9 to 0.1)	−0.7 (−1.0 to 0.0)	0.68
Stability and Violence, median (IQR)	−0.4 (−0.9 to 0.1)	−0.3 (−1.2 to 0.3)	−0.4 (−1.1 to 0.1)	0.75
Voice and Accountability, median (IQR)	−0.6 (−0.9 to 0.3)	−0.9 (−1.3 to 0.2)	−0.7 (−1.1 to −0.1)	0.19
Effectiveness, median (IQR)	−0.7 (−1.0 to 0.2)	−0.7 (−1.2 to 0.2)	−0.7 (−1.1 to 0.2)	0.34
Rule of Law, median (IQR)	−0.7 (−1.0 to 0.2)	−0.8 (−1.3 to 0.0)	−0.8 (−1.3 to 0.2)	0.56
Regulatory Quality, median (IQR)	−0.3 (−1.0 to 0.1)	−0.7 (−1.3 to 0.3)	−0.5 (−1.1 to 0.2)	0.21

Comparisons of proportional variables were made using Pearson's chi-square test, and comparisons of continuous variables were made using Student's *t*-test. All comparisons were two-sided, and no adjustments were made for multiple testing. NA, not applicable.

Among males, cash transfer programmes were significantly associated with an increased probability of having had an HIV test within the past 12 months (OR, 3.19; 95% CI, 2.45–4.15; $P < 0.001$) (Table 2 and Supplementary Tables 7–17). PEPFAR funding per capita (OR, 1.22 per US$5 increase; 95% CI, 1.12–1.32; $P < 0.001$) and HIV-related Global Fund disbursements per capita (OR, 1.22 per US$5 increase; 95% CI, 1.09–1.36; $P < 0.001$) were also associated with an increased probability of having had an HIV test within the past 12 months.

In our primary country-level analyses, cash transfer programmes were associated with a reduction in new HIV infections (incidence rate ratio (IRR), 0.94; 95% CI, 0.89–0.99; $P = 0.03$), but not with the proportion of people with HIV receiving antiretroviral therapy (5.0%; 95% CI, −0.2%–10.1%; $P = 0.06$) or AIDS-related deaths (IRR,

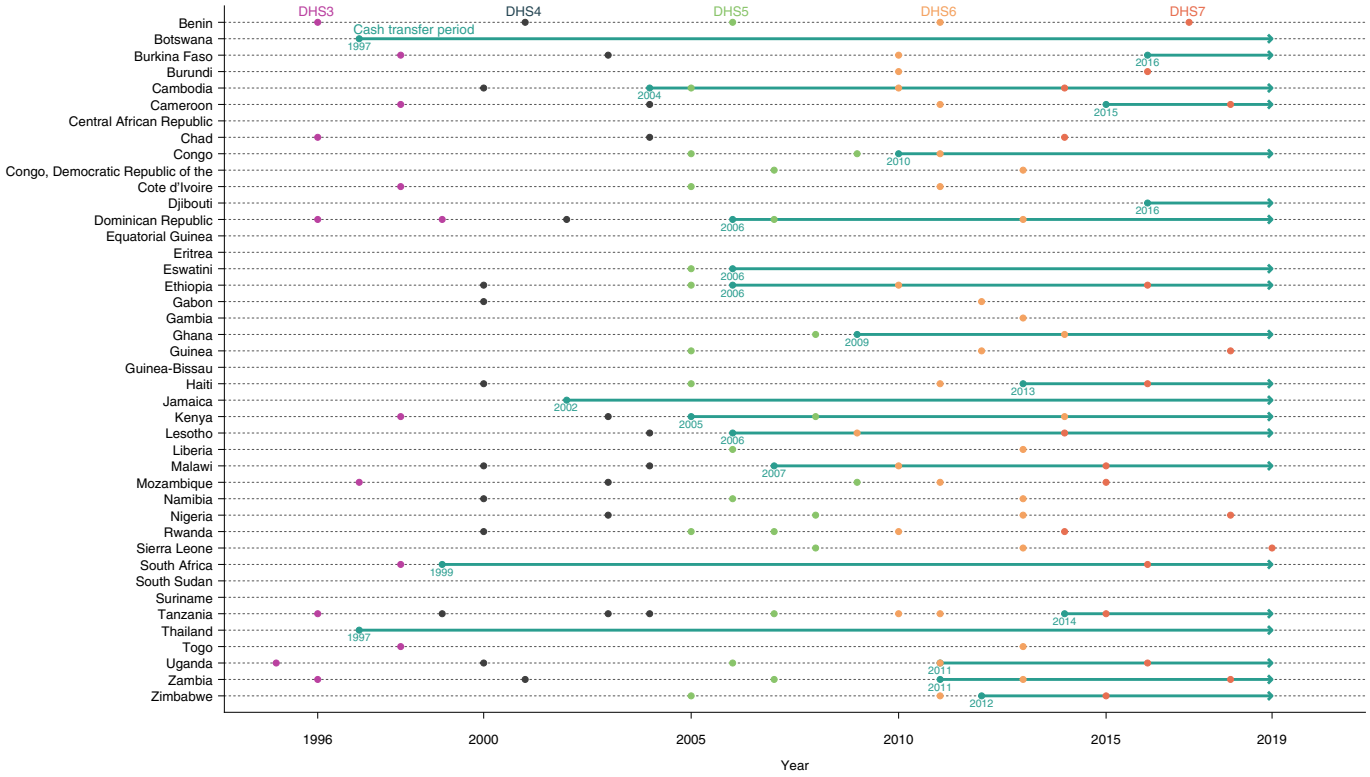

Fig. 2 | Timeline. Timeline of the included countries. The green lines indicate the cash transfer periods, and the coloured dots indicate years during which a DHS was conducted.

0.99; 95% CI, 0.95–1.03; $P=0.53$). In the same models, PEPFAR funding per capita was associated with a reduction in AIDS-related deaths (IRR, 0.98 per US$5 increase; 95% CI, 0.97–0.99; $P=0.004$) and an increase in the proportion of people with HIV receiving antiretroviral therapy (2.6% per US$5 increase; 95% CI, 1.7–3.5; $P<0.001$), results that are consistent with an earlier analysis of the relationship between PEPFAR and HIV outcomes[42]. PEPFAR funding per capita was not significantly associated with new HIV infections (IRR, 1.00 per US$5 increase; 95% CI, 0.99–1.01; $P=0.63$). In addition, HIV-related Global Fund disbursements per capita were associated with an increase in the proportion of people with HIV receiving antiretroviral therapy (3.3% per US$5 increase; 95% CI, 0.4–6.2; $P=0.03$), but not with new HIV infections (IRR, 0.99 per US$5 increase; 95% CI, 0.98–1.00; $P=0.19$) or AIDS-related deaths (IRR, 0.99 per US$5 increase; 95% CI, 0.98–1.01; $P=0.33$).

Temporal analyses. We next evaluated associations between cash transfer programmes and country-level outcomes over time (Fig. 3). In fully adjusted models, we found that new HIV infections were significantly lower in the first year of the cash transfer programme (IRR, 0.94; 95% CI, 0.89–0.99; $P=0.03$). The effects on new infections became larger in subsequent years after the introduction of cash transfer programmes, but they were less precisely estimated over time as a result of declining numbers of observations and were no longer significant after the second year of the cash transfer programme. There were no significant changes in AIDS-related deaths during the first year of the cash transfer programme (IRR, 0.99; 95% CI, 0.95–1.03; $P=0.56$), consistent with our primary analysis. However, we found significant reductions in AIDS-related deaths by the second year of the cash transfer programme (IRR, 0.91; 95% CI, 0.83–0.99; $P=0.03$), with larger reductions over time that peaked in the ninth year of the cash transfer programme (IRR, 0.75; 95% CI, 0.57–0.99; $P=0.04$). Similarly, there was no significant change in the proportion of people with HIV receiving antiretroviral therapy in the first year of the cash transfer programme (0.8%; 95% CI, −1.0%–2.5%; $P=0.4$), but we found a significant increase by the second year (3.0%; 95% CI, 0.3%–5.7%; $P=0.03$), with larger increases over time.

Interaction analyses. In the interaction analyses, the effects of cash transfer programmes were greater in higher-prevalence countries for the outcomes of an HIV test in the past 12 months among females (high-prevalence OR, 3.91; 95% CI, 2.29–6.67; $P=0.0002$; low-prevalence OR, 1.27; 95% CI, 0.7–2.28; $P=0.1$; P for interaction, <0.001) and among males (high-prevalence OR, 3.80; 95% CI, 2.99–4.85; $P<0.001$; low-prevalence OR, 2.38; 95% CI, 1.76–3.21; $P<0.001$; P for interaction, <0.001), and in lower-prevalence countries for new HIV infections (high-prevalence IRR, 1.00; 95% CI, 0.97–1.04; $P=0.91$; low-prevalence IRR, 0.88; 95% CI, 0.80–0.96; $P=0.005$; P for interaction, 0.007) (Fig. 4 and Supplementary Table 21). The effects of cash transfer programmes were greater with higher-coverage cash transfer programmes for the outcomes of sexually transmitted infection in the past 12 months among females (high-coverage OR, 0.23; 95% CI, 0.13–0.43; $P<0.001$; low-coverage OR, 0.83; 95% CI, 0.68–1.00; $P=0.05$; P for interaction, <0.001), having had an HIV test in the past 12 months among males (high-coverage OR, 5.08; 95% CI, 3.7–6.54; $P<0.001$; low-coverage OR, 2.72; 95% CI, 2.03–3.64; $P<0.001$; P for interaction, <0.001) and AIDS-related deaths (high-coverage IRR, 0.94; 95% CI, 0.89–1.00; $P=0.04$; low-coverage IRR, 1.04; 95% CI, 0.99–1.09; $P=0.14$; P for interaction, 0.01).

Other secondary and sensitivity analyses. When we stratified individual-level outcomes by wealth quintile, there were some modest trends suggesting larger effects in poorer segments of the population, though these were inconsistent and not definitively identified (Supplementary Fig. 4). We confirmed that there was no significant association between the presence of cash transfer programmes and

Table 2 | The relationship between cash transfer programmes and individual- and country-level HIV-related outcomes

Outcomes	Cash transfer programme		PEPFAR funding per capita (per US$5 increase)		HIV-related Global Fund disbursements per capita (per US$5 increase)	
	Effect measure	95% CI	Effect measure	95% CI	Effect measure	95% CI
Individual-level, females						
Age at sexual debut among youths, coefficient[1]	0.00	−0.09–0.10	0.03	−0.01–0.07	0.01	−0.09–0.12
Sexually transmitted infection within 12 months, OR[1]	0.67	0.50–0.91	0.98	0.80–1.19	0.90	0.74–1.09
More than one sexual partner within 12 months, OR[1]	1.04	0.75–1.46	1.17	0.89–1.54	0.88	0.67–1.15
HIV test within 12 months, OR[1]	2.61	1.15–5.88	1.14	1.01–1.30	1.48	1.18–1.84
Condom use at last sex, OR[1]	0.94	0.77–1.14	1.01	0.91–1.09	1.16	0.99–1.37
Individual-level, males						
Age at sexual debut among youths, coefficient[1]	−0.14	−0.28–0.01	0.04	−0.04–0.11	−0.023	−0.16–0.12
Sexually transmitted infection within 12 months, OR[1]	1.10	0.85–1.43	1.01	0.90–1.13	1.02	0.80–1.31
More than one sexual partner within 12 months, OR[1]	1.12	0.99–1.28	1.02	0.91–1.13	1.00	0.91–1.09
HIV test within 12 months, OR[1]	3.19	2.45–4.15	1.22	1.12–1.32	1.22	1.09–1.36
Condom use at last sex, OR[1]	0.88	0.75–1.04	1.02	0.96–1.07	1.00	0.89–1.14
Transactional sex within 12 months, OR[1]	0.99	0.85–1.15	0.93	0.80–1.09	1.07	0.88–1.31
Country-level						
New HIV infections, IRR[2]	0.94	0.89–0.99	1.00	0.99–1.01	0.99	0.98–1.00
AIDS-related deaths, IRR[2]	0.99	0.95–1.03	0.98	0.97–0.99	0.99	0.98–1.01
Proportion of people with HIV receiving antiretroviral therapy, coefficient[2]	5.0	−0.2–10.1	2.6	1.7–3.5	3.3	0.4–6.2

[1]Multivariable models include cash transfer programme, age, single marital status, education, wealth quintile, rural household setting and the country-level covariates GDP per capita, PEPFAR funding per capita, HIV-related Global Fund disbursements per capita and three World Bank Governance Indicators: Corruption, Stability and Violence, and Voice and Accountability. [2]Multivariable models include the country-level covariates GDP per capita, PEPFAR funding per capita, HIV-related Global Fund disbursements per capita and three World Bank Governance Indicators: Corruption, Stability and Violence, and Voice and Accountability.

either PEPFAR funding per capita or HIV-related Global Fund disbursements when these were included in our primary model as outcomes (Supplementary Tables 22 and 23). The exclusion of individual countries did not reveal possible outlier countries for any outcome except for HIV testing in females, for which Guinea and Zambia were potentially outliers whose exclusion substantially changed the estimated effect of cash transfers (Supplementary Tables 24–27). Stratification by region and World Bank income group did not substantially change the estimated effect of cash transfers on new HIV infections (Supplementary Table 28).

Our fully adjusted models to test whether intervention and comparison countries had similar trends in outcomes before the introduction of cash transfers in a given country showed no differences between countries for the individual-level outcome of having had a sexually transmitted infection in the past 12 months for females (OR, 0.98; 95% CI, 0.92–1.04; $P=0.47$) or males (OR, 0.99; 95% CI, 0.95–1.02; $P=0.49$), or for the country-level outcome of new HIV infections (IRR, 0.99; 95% CI, 0.96–1.02; $P=0.55$) (Supplementary Tables 29–31). There were small, significant differences of opposite magnitude in trends in outcomes before the introduction of cash transfers for the individual-level outcome of having had an HIV test within the prior 12 months for females (OR, 0.81; 95% CI, 0.81–0.82; $P<0.001$) and males (OR, 1.27; 95% CI, 1.01–1.12; $P<0.001$) (Supplementary Tables 32 and 33). There were no visually discernible differences in outcomes between intervention and control countries in the 4 years prior to the cash transfer period in our temporal analysis of country-level (Fig. 3) or individual-level outcomes (Supplementary Figs. 5 and 6) except for the HIV testing outcome among males, where there was some visual evidence of differential pre-trends in cash transfer countries. Additional analyses suggested that the effect of cash transfers was heterogeneous over time but that any resultant bias was probably small (Supplementary Information, Supplementary Figs. 7 and 8 and Supplementary Tables 34 and 35).

Discussion

In this study of 42 countries with generalized HIV epidemics of varying magnitude across three continents from 1996 to 2019, we found that sizeable cash transfer programmes were associated with important improvements in HIV-related outcomes at both the population and individual levels. These included an immediate reduction in new HIV infections and delayed improvements in both AIDS-related deaths and the proportion of people with HIV receiving antiretroviral therapy, with benefits that grew larger over time. Among individuals, we found that cash transfer programmes were associated with a reduction in sexually transmitted infections (a key proxy measure for risk of HIV transmission) among females, as well as large increases in recent HIV testing among males and females, though there were small differential pre-trends for the HIV testing outcome, so this finding should be interpreted with some caution. Our interaction analyses showed that cash transfer programmes with greater numbers of beneficiaries had the largest effects on HIV-related outcomes, suggesting an element of dose–response at the population level. We also found that the relationship between cash transfer programmes and HIV testing was the strongest in countries with higher baseline HIV prevalence, indicating the importance of the specific context of a given country's HIV epidemic.

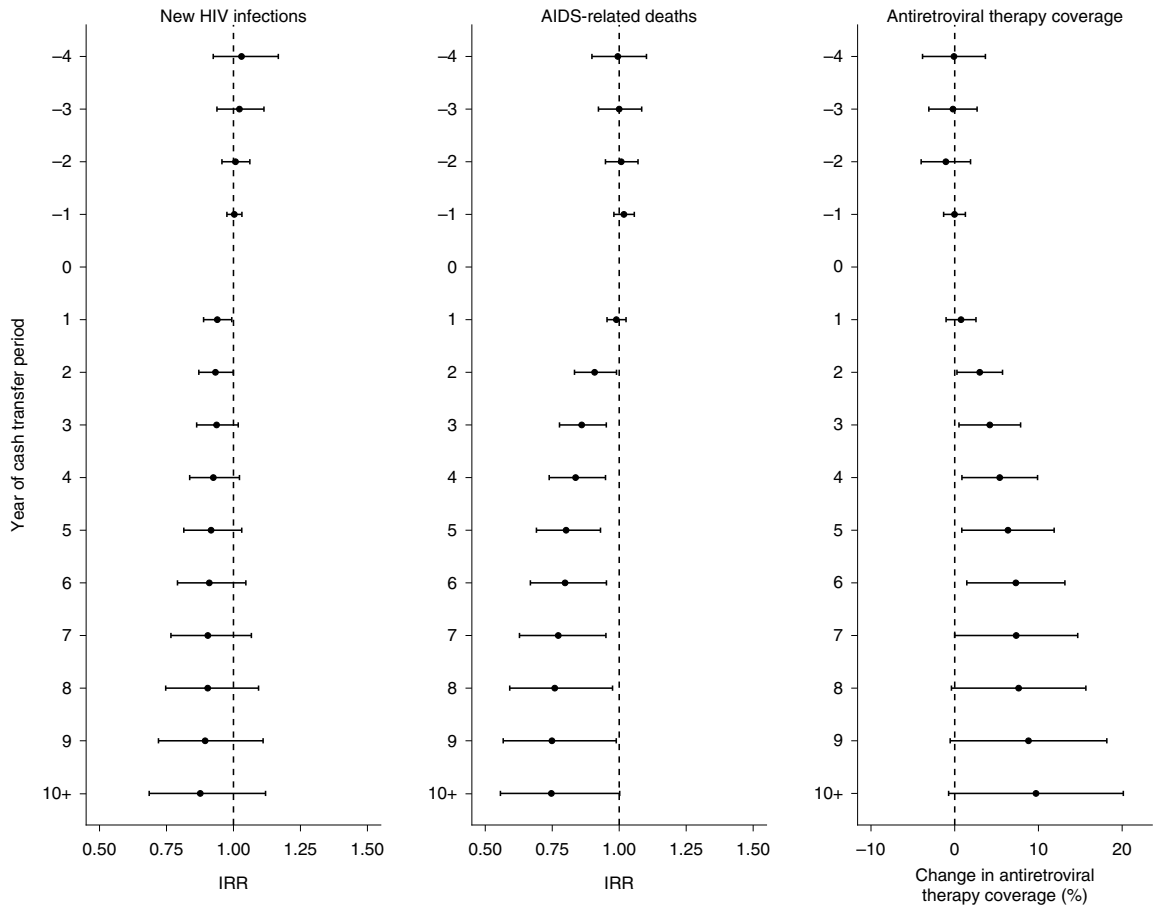

Fig. 3 | Temporal trends in country-level outcomes. Adjusted IRRs of new HIV infections and AIDS-related deaths ($N = 976$ country-years), and adjusted change in the proportion of people with HIV receiving antiretroviral therapy ($N = 796$ country-years), as a function of year of the cash transfer period. The data are presented as IRRs with 95% CIs.

While our findings are consistent with prior evidence from randomized controlled trials of cash transfer interventions that support the use of cash transfers for the prevention of HIV[22,43–45] and along the HIV care continuum[27–36], there are several notable distinctions to consider when interpreting our findings. First, the cash transfer programmes considered in this study were generally of larger scale and less HIV-specific than those studied in the randomized trials. Second, almost all of the cash transfer interventions studied in randomized trials were conditional on intermediary outcomes such as school attendance, negative testing for sexually transmitted infections, HIV testing or clinical follow-up, whereas nearly 80% of the programmes considered in our analysis were unconditional. Our study thus provides evidence, across many countries with generalized HIV epidemics, of the effects of primarily government-led cash transfer programmes. Third, by evaluating outcomes for entire populations (that is, by including individuals and households that did not receive transfers), our findings also capture the indirect or spillover effects of these interventions. While many of the programmes included in this study targeted specific populations (for example, older adults or families with young children), resources are likely to have been pooled within households and among relatives to meet basic needs, and thus it is plausible that, for example, transfers to older members of a household may impact HIV risk behaviours of younger household members[40,41]. These spillover effects are also likely to be important in the context of an infectious disease with transmission dynamics and clinical outcomes that are heavily influenced by structural factors such as poverty and food insecurity.

There are a number of hypothesized mechanisms by which cash transfer interventions could improve HIV-related outcomes. By increasing economic well-being, empowerment among women and educational attainment, cash transfers may lead to lower-risk sexual behaviours (as evidenced in our analysis by a reduction in sexually transmitted infections), thus lowering the probability of acquiring or transmitting HIV[15]. This plausibly includes a reduction in transactional sex among women[46], an important driver of HIV risk among adolescent girls and young women in particular, for which data were unavailable to consider in our analysis[5]. Cash transfer programmes may also lead to improvements along the HIV care continuum (that is, HIV testing, clinic attendance and antiretroviral adherence) through a direct economic mechanism that reduces barriers to care and a psychological mechanism that promotes health-seeking behaviours through improvements in mental bandwidth[16]. As a result, cash transfers may lead to increases in HIV diagnoses (as evidenced in our analysis by increased HIV testing), engagement in clinical care by people with HIV and higher probabilities of receiving and adhering to antiretroviral therapy with subsequent virologic suppression (as evidenced in our analysis by a delayed increase in the proportion of people with HIV receiving antiretroviral therapy). This would both directly improve clinical outcomes for people with HIV and reduce rates of transmission because of the highly effective strategy of using HIV treatment as prevention, commonly referred to as "Undetectable = Untransmittable" or "U = U". By supporting preventive health behaviours, anti-poverty interventions such as cash transfers can thus play an important role in improving individual HIV outcomes and preventing HIV transmission by intervening

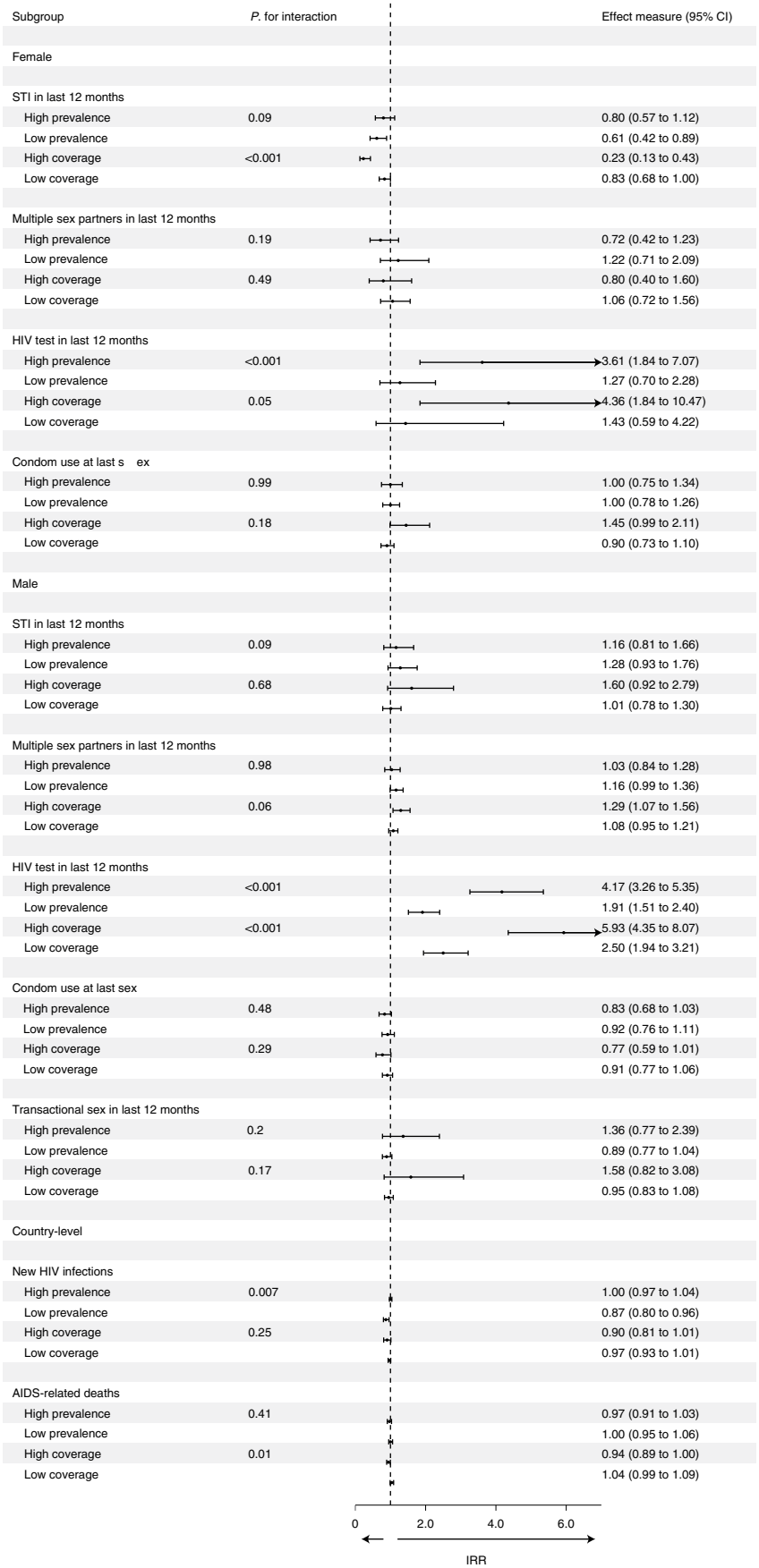
Subgroup
P. for interaction
Effect measure (95% CI)
Female
STI in last 12 months
High prevalence 0.09 0.80 (0.57 to 1.12)
Low prevalence 0.61 (0.42 to 0.89)
High coverage <0.001 0.23 (0.13 to 0.43)
Low coverage 0.83 (0.68 to 1.00)
Multiple sex partners in last 12 months
High prevalence 0.19 0.72 (0.42 to 1.23)
Low prevalence 1.22 (0.71 to 2.09)
High coverage 0.49 0.80 (0.40 to 1.60)
Low coverage 1.06 (0.72 to 1.56)
HIV test in last 12 months
High prevalence <0.001 3.61 (1.84 to 7.07)
Low prevalence 1.27 (0.70 to 2.28)
High coverage 0.05 4.36 (1.84 to 10.47)
Low coverage 1.43 (0.59 to 4.22)
Condom use at last s ex
High prevalence 0.99 1.00 (0.75 to 1.34)
Low prevalence 1.00 (0.78 to 1.26)
High coverage 0.18 1.45 (0.99 to 2.11)
Low coverage 0.90 (0.73 to 1.10)
Male
STI in last 12 months
High prevalence 0.09 1.16 (0.81 to 1.66)
Low prevalence 1.28 (0.93 to 1.76)
High coverage 0.68 1.60 (0.92 to 2.79)
Low coverage 1.01 (0.78 to 1.30)
Multiple sex partners in last 12 months
High prevalence 0.98 1.03 (0.84 to 1.28)
Low prevalence 1.16 (0.99 to 1.36)
High coverage 0.06 1.29 (1.07 to 1.56)
Low coverage 1.08 (0.95 to 1.21)
HIV test in last 12 months
High prevalence <0.001 4.17 (3.26 to 5.35)
Low prevalence 1.91 (1.51 to 2.40)
High coverage <0.001 5.93 (4.35 to 8.07)
Low coverage 2.50 (1.94 to 3.21)
Condom use at last sex
High prevalence 0.48 0.83 (0.68 to 1.03)
Low prevalence 0.92 (0.76 to 1.11)
High coverage 0.29 0.77 (0.59 to 1.01)
Low coverage 0.91 (0.77 to 1.06)
Transactional sex in last 12 months
High prevalence 0.2 1.36 (0.77 to 2.39)
Low prevalence 0.89 (0.77 to 1.04)
High coverage 0.17 1.58 (0.82 to 3.08)
Low coverage 0.95 (0.83 to 1.08)
Country-level
New HIV infections
High prevalence 0.007 1.00 (0.97 to 1.04)
Low prevalence 0.87 (0.80 to 0.96)
High coverage 0.25 0.90 (0.81 to 1.01)
Low coverage 0.97 (0.93 to 1.01)
AIDS-related deaths
High prevalence 0.41 0.97 (0.91 to 1.03)
Low prevalence 1.00 (0.95 to 1.06)
High coverage 0.01 0.94 (0.89 to 1.00)
Low coverage 1.04 (0.99 to 1.09)
0
2.0
4.0
6.0
IRR

Fig. 4 | Interaction analyses. Interaction analyses of baseline HIV prevalence at the start of the cash transfer period (above or below the median, 3.7%) and impoverished population coverage of the cash transfer programme(s) (above or below the median, 23%) for individual-level (stratified by sex) and country-level outcomes, with adjusted ORs for the individual-level outcomes and adjusted IRRs for the country-level outcomes, and *P* values for the interactions (*F* statistic, two-sided comparisons, no adjustment for multiple comparisons). The data are presented as IRRs with 95% CIs, with sample sizes as follows: country-level $N = 976$ country-years; individual-level female $N = 1{,}295{,}177$; individual-level male $N = 590{,}556$. STI, sexually transmitted infection.

proximally to current efforts for HIV control, which are focused primarily at the health-system level.

Our findings showing a differential individual-level impact of cash transfers by sex—with effects being larger for females than for males—is notable for two reasons. First, most cash transfer programmes we identified are targeted either directly to women or in ways that favour women. Second, there is evidence that cash transfers may have specific benefits for women, including increasing empowerment, which may reduce reliance on economically dependent sexual relationships[15,47,48].

While previous analyses have used a similar design to study effects of programmes such as PEPFAR, this study does so for a common anti-poverty programme that a growing number of LMICs are introducing as a central feature of their poverty reduction and social protection strategies[42]. While not the primary objective of this study, our findings also suggest improvements in HIV testing, population antiretroviral coverage and AIDS-related deaths related to PEPFAR and the Global Fund.

This study has several limitations. The cash transfer programmes we considered were heterogeneous in terms of target population, size of transfer, conditionality and coverage. Due to sample size limitations, we cannot precisely determine the relative importance of these other features of cash transfer programmes, although in our interaction analyses we do establish that programmes that covered more individuals tended to have larger effects. In particular, the relative amount of the transfer is likely to influence any effect it has on health outcomes, but because of variability of transfer size within many of the programmes and inconsistent reporting, we were unable to meaningfully consider this in our analysis. While the DHS and AIS do not uniformly indicate whether participants received cash transfers, and thus we cannot separately determine cash transfer programme effects on beneficiaries and non-beneficiaries, our objective was to evaluate the overall population-level effects of these programmes, and it is plausible that the effects are larger on beneficiaries than on non-beneficiaries. We included country and year fixed effects and used a difference-in-differences design, but the possibility of residual confounding related to unmeasured time-varying variables remains, though the robustness of our results after controlling for the available time-varying country-specific variables suggests that this bias, if present, is minor. Specifically, there are country-specific policies that influence cash transfer programme coverage and uptake (for example, outreach, enrolment procedures and ease of benefit receipt). Importantly, though, we were attempting to examine the effects of cash transfer programmes as they are delivered in the real world, and we emphasize that implementation failures would most likely bias our results towards the null. Country-specific factors such as infrastructure and resources to expand HIV services may also be associated with both the capacity to implement cash transfer programmes and HIV-related outcomes. We attempted to control for these differences by including country fixed effects and the World Bank Governance Indicators in our regression models, but if these policies differed between countries over time and were also associated with changes in HIV-related outcomes, this may influence our findings. The study period we considered was one of generally substantial expansion of HIV control programmes, and the relationship between cash transfer programmes and HIV-related outcomes may differ in settings with already established HIV care systems.

In this difference-in-differences study of 42 countries with generalized HIV epidemics from 1996 to 2019, we found that cash transfer programmes were associated with an immediate reduction in new HIV infections, delayed improvements in AIDS-related deaths and the proportion of people with HIV receiving antiretroviral therapy, a reduction in sexually transmitted infections in the past 12 months among females and an increase in recent HIV testing among males and females. On the basis of our results, experimental studies that further investigate the effects of unconditional cash transfers on HIV incidence and other HIV prevention behaviours should be a priority for future research. Specific cash transfer features (for example, the amount of transfer) should similarly be evaluated. This study also contributes to our understanding of the social determinants of health and suggests that HIV-related benefits should be included in cost–benefit analyses of cash transfer programmes in addition to other social protection policies. As countries expand cash transfer programmes, particularly in the context of the COVID-19 pandemic, these findings suggest that anti-poverty interventions such as cash transfers should receive greater attention as part of HIV control efforts, alongside the already existing focus on expanding biomedical services.

Methods

We included all countries with HIV incidence greater than 1 per 1,000 persons in 1996 and HIV prevalence greater than 1% in at least 1 year between 1996 and 2019[1], a period when many countries introduced cash transfer programmes.

Data. We identified all major cash transfer programmes within the included countries. We manually searched a variety of sources, detailed in the Supplementary Information, to identify the programmes and determine the year in which they were introduced, their target population, whether they were conditional or unconditional, the amount of transfer and the most recently available number of beneficiaries. For each cash transfer programme, we estimated the most recent impoverished population coverage by dividing the total number of beneficiaries by the number of people living below the international poverty line (Supplementary Information).

For individual-level data on HIV outcomes, we used the DHS, which are nationally representative cross-sectional household surveys conducted every 5 years in many LMICs (Supplementary Information). Information was obtained for household and individual characteristics for all female household members of reproductive age (15–49 years) and a subset of males of reproductive age (typically 15–49, 54 or 59 years). We also used AIS, which are similar household surveys focused on HIV knowledge, attitudes, behaviour and prevalence. We used DHS or AIS data from any country that met the eligibility criteria and any year between 1996 and 2019. The procedures and questionnaires for the DHS have been reviewed and approved by the Independent Consulting Firm Institutional Review Board, all survey respondents provided informed consent and all analysed data were anonymized.

For country-level HIV statistics, we relied on UNAIDS annual estimates that are generated with modelling techniques on the basis of representative population-based surveys and surveillance studies[1,49]. We obtained country and year UNAIDS estimates for the number of new HIV infections, the number of AIDS-related deaths and the proportion of people with HIV receiving antiretroviral therapy.

We obtained additional time-varying covariates for each country and year that were likely to be associated with changes in cash transfer programmes and HIV outcomes: GDP per capita[50]; PEPFAR funding budgeted per capita[51]; the Global Fund to Fight AIDS, Tuberculosis and Malaria disbursements for HIV-related programmes per capita[52]; and six Worldwide Governance Indicators from the World Bank that are composite indicators based on 30 data sources: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption[50].

Statistical analysis. Characteristics of intervention and comparison countries were compared. Comparisons of proportional variables were made using Pearson's

chi-square test, and comparisons of continuous variables were made using Student's *t*-test. Normality and equal variances were not formally tested.

We performed difference-in-differences analyses using multivariable regression models to compare trends in HIV-related outcomes in countries with cash transfer programmes with those in the same countries prior to cash transfer programme introduction and those in comparison countries without cash transfer programmes. Our analysis was developed on the basis of a proposed causal framework linking cash transfer programmes to HIV-related outcomes, mediated through an effect on poverty (Fig. 1). Our primary explanatory variable of interest was a binary variable indicating the presence in a given year of a cash transfer programme (or a combination of programmes) for which the number of beneficiaries exceeded 5% of the population living below the poverty line (Supplementary Information)[50]. Our choice of 5% impoverished population coverage as the threshold for our intervention group was subjective but chosen empirically as the smallest likely coverage with which we might expect to see population effects.

We examined the association between cash transfer programmes and both individual- and country-level outcomes. For individual-level outcomes, the unit of observation was a surveyed person in a given country during a given year, and we stratified individual-level outcomes by sex. Individual-level outcomes included the continuous variable age at sexual debut among youths and the binary variables sexually transmitted infection within the prior 12 months, more than one sexual partner within the prior 12 months, HIV test within the prior 12 months, transactional sex within the prior 12 months and condom use during the last sexual encounter. The transactional sex outcome was analysed only for males because this question was only recently added to the female questionnaire in the DHS and there were not enough observations for meaningful comparisons.

For country-level outcomes, the unit of observation was the country-year. Country-level outcomes included the number of new HIV infections, the number of AIDS-related deaths and the proportion of people with HIV receiving antiretroviral therapy.

We estimated linear regression models for continuous outcomes, logistic regression models for binary outcomes and negative binomial regression models for outcomes aggregated as counts. We included fixed effects for each country, which adjusted for measured and unmeasured time-invariant differences between countries, and for each year, which controlled for secular trends in the outcomes across all countries. We used robust standard errors clustered at the country level. For all outcomes, we included additional time-varying, country-level covariates of GDP per capita, PEPFAR funding per capita, HIV-related disbursements by the Global Fund per capita and three World Bank Worldwide Governance Indicators (Control of Corruption, Political Stability and Absence of Violence, and Voice and Accountability). The other three World Bank Worldwide Governance Indicators (Government Effectiveness, Regulatory Quality and Rule of Law) were not included because of collinearity (Supplementary Information). For individual-level outcomes, we included additional covariates—age, single marital status, education, wealth quintile and rural/urban household setting—and used survey commands to apply sampling probability weights.

We performed several secondary and sensitivity analyses to better characterize the association between cash transfer programmes and HIV-related outcomes. First, because country-level outcomes were available annually, we evaluated the temporal relationship between cash transfer programmes and country-level outcomes by creating a series of binary indicators for each year after the cash transfer period began. Second, we explored whether there were interactions between cash transfer programmes and having above-median HIV prevalence (>3.7%) at the start of the cash transfer programme. Third, we did a similar interaction analysis based on whether a country's cash transfer programme had above-median coverage (>23% of the population living below the poverty line). Fourth, we stratified models for individual-level outcomes by wealth quintile. Fifth, while our models controlled for PEPFAR and Global Fund spending, to further ensure there was no major collinearity contributing to our findings, we used PEPFAR funding per capita and HIV-related Global Fund disbursements per capita as outcomes in our primary models to assess for correlation with cash transfer programmes. Sixth, we assessed whether individual countries might be outliers for key outcomes by assessing whether estimates changed substantially after excluding each country individually. Seventh, we repeated our primary analysis for new HIV infections after stratifying by region (sub-Saharan Africa versus Asia / Latin America / Caribbean) and by World Bank income group.

The difference-in-differences design is quasi-experimental and relies on the parallel trends assumption, which is that in the absence of the implementation of cash transfer programmes, trends in outcomes would be similar in the intervention and comparison countries. We tested whether the intervention and comparison countries had similar trends in the pre-cash-transfer period by estimating regression models using only data prior to the cash transfer period in each country and including an interaction term between an indicator of whether the country was in the intervention group and a linear time trend. We tested the parallel trends assumption for outcomes with significant findings in our primary analysis. We further evaluated pre-trends in the country-level outcomes by including binary indicators for the four years prior to the cash transfer period in the previously mentioned temporal analysis. Using a temporal analysis to visualize pre-trends for the individual-level outcomes (which were measured in surveys) is more difficult because annual survey data were not available for countries. As a result, the sample sizes vary greatly by year. We attempted to mitigate this issue somewhat by categorizing multiple years together to allow for greater interpretability, but temporal trends for the individual-level outcomes should be interpreted with caution.

Recent advances in difference-in-differences analyses with variation in intervention timing have shown that estimates may be biased particularly if there is heterogeneity in intervention effect over time[53,54]. We conducted a series of additional analyses to assess for the presence and magnitude of this potential bias[55], detailed in the Supplementary Information.

All significance testing was two-tailed, with no adjustments for multiple comparisons. Because this analysis uses existing data and we included all countries meeting our inclusion criteria, no statistical methods were used to determine sample sizes[56]. Additional details on the regression models are available in the Supplementary Information. We performed the statistical analysis using SAS v.9.4 (ref. [57]) and R v.3.5.2 (ref. [58]) using the ggplot2 (ref. [59]) package.

Reporting summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

The analysed data can be requested from the DHS programme website (individual, men's and household recodes from the included countries are at https://www.dhsprogram.com/Data/) or are publicly available from UNAIDS (data sheets for HIV prevalence, new HIV infections, AIDS-related deaths and people living with HIV receiving antiretroviral therapy (%) from http://aidsinfo.unaids.org/), the World Bank (population, GDP per capita and Worldwide Governance Indicator datasets from https://data.worldbank.org/data-catalog/), PEPFAR (PEPFAR Operating Unit Budgets by Financial Classifications FY04–FY20 dataset from https://data.pepfar.gov/financial) and the Global Fund (Grant Agreement Disbursements dataset from https://data-service.theglobalfund.org/downloads).

Code availability

The analysis code is available upon request from the corresponding author.

Received: 16 May 2021; Accepted: 15 June 2022;
Published online: 18 July 2022

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Acknowledgements

The authors received no specific funding for this work. We acknowledge the work of the numerous individuals who collected and prepared the publicly available data used in this study.

Author contributions

A.R. and H.T. conceptualized and designed the study. A.R. conducted the primary analysis and wrote the first draft of the manuscript, both with critical feedback from H.T.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s41562-022-01414-7.

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Peer review information *Nature Human Behaviour* thanks Jeremy Barofsky, Eran Bendavid, Jacob Bor, Erin Torkelson and the other, anonymous, reviewer(s) for their contribution to the peer review of this work.

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Software and code

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Data collection	No software was used to collect the data.
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☐ Life sciences ☒ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Quantitative difference-in-differences study
Research sample	(1) Countries with generalized HIV epidemics (country-level outcomes) (2) Individuals living in countries with generalized HIV epidemics who completed a DHS or AIS questionnaire
Sampling strategy	The DHS/AIS are nationally representative cross-sectional household surveys conducted every 5 years in many low and middle income countries, typically using a two-stage cluster sampling design.
Data collection	Data collection was conducted by requesting and downloading DHS/AIS datasets from the relevant years, and by downloading other publicly available data from UNAIDS, The World Bank, PEPFAR, and The Global Fund.
Timing	Data collection for the manuscript was from September 2020 through February 2021.
Data exclusions	No data were excluded.
Non-participation	Not applicable.
Randomization	There was no randomization. To control for confounding we used a difference-in-differences design with country and year fixed effects and other relevant time-varying covariates.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging