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# Using Incentives and Nudging to Improve Non-Targeted HIV Testing in Ecuador: A Randomized Trial

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## Abstract

Under-detection of HIV/AIDS still burdens many low- and middle-income countries (LMICs). Our randomized trial investigated the effects of financial incentives and a behavioral nudge to induce HIV testing and learning HIV status in Ecuador. In the control group, 12.2% of participants agreed to testing, and 5.3% learned results. A financial incentive paid at testing increased the fraction of participants tested by 50.1 percentage points (95% CI 38.8 to 61.4) and the fraction who learned their status by 8.9 percentage points (95% CI 5.3 to 12.5); the nudge had no effect. The HIV-positive rate was 1.2% in the control group, and incentives prompted a 4.7 percentage point (95% CI 0.5 to 8.9) higher proportion of HIV-positive detection. Incentives also induced earlier testing, suggesting reduced procrastination. This suggests that information with appropriately timed small financial incentives can improve HIV testing and detection of new cases in the general population in LMIC settings.

**Keywords** HIV · Testing · Incentives · Behavioral nudges · Cost analysis · Ethnic minority · Ecuador

## Introduction

Many health agencies recommend routine HIV testing for everyone—regardless of risk status—to increase detection. Yet the under-detection of HIV/AIDS remains a severe public health issue in low- and middle-income countries (LMICs). For example, the Ecuadorian Ministry of Health reports that 39% of people living with HIV are not receiving treatment, in part because only 64% know their status, less than the Latin American average of 73% [1–3]. Economic and psychological barriers, social stigma, and unawareness are possible reasons why people avoid testing. When individuals don't know the importance of testing, various authorities might encourage testing either by providing information about it or by increasing the salience of its benefits for oneself and one's sexual partner. Financial incentives may induce testing by overcoming the economic costs due to the loss of wages or travel time to a testing facility. Behavioral nudges, defined as changes in the "choice architecture" that alter people's behavior without reducing their

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choices or changing incentives, may overcome inattention or procrastination [4].

In this study, we conduct a randomized controlled trial that assessed the effects of information, financial incentives, and one nudging strategy to improve HIV testing among the general population of a large city in Ecuador that is located in a province with one of the highest burdens of HIV/AIDS in that country. Scholars have studied the effect of financial incentives on several HIV-related behaviors including testing, male circumcision, antenatal check-ups by HIV-positive women, sexual behavior, and adherence to ART [5–15]. A majority of these studies considered specific high-risk populations. Our study complements this growing literature by testing the effect of incentives offered to the general public, which are paid either at the time of testing ("immediate" incentive) or upon collecting the test results ("delayed" incentive). We also test the effect of a behavioral nudge, namely the opportunity for participants to express a non-binding intention ("soft commitment") to be tested by a certain date. In this respect, our study complements the research on other types of nudges such as changes in default choice options and choice framing [7, 8]. In addition to the studies mentioned, planning prompts and soft-commitment mechanisms have also been tested in other contexts to address self-control problems [6, 16, 17].

Whereas most studies have typically examined interventions one at a time, we compare the relative effectiveness of different interventions in the same setting. Moreover, given the clinical importance of early detection, we investigate if our interventions may accelerate the decision to act. We hypothesize that if individuals display hyperbolic discounting (i.e., if they discount benefits in the future over benefits in the present), they may delay their decision to be tested, a sub-optimal public health outcome. In principle, both a soft-commitment opportunity and incentives might counteract the procrastination induced by present-biased preferences [18, 19]. Finally, we perform cost calculations to compare our strategies against each other. This is useful because the cost effectiveness of non-targeted (general population) HIV testing—compared to testing targeted high-risk groups—is unclear [20]. Our study can thus inform large-scale programs that target the general population in an LMIC context.

## Methods

### Participants and Setting

The target population consisted of adults in a city (population ~ 200,000) in the province of Esmeraldas, Ecuador. We chose this region for empirical and practical reasons. In Ecuador, there are 19.02 people living with HIV (PLHIV) per 10,000 population. With 29.60 PLHIV per 10,000 population, the province of Esmeraldas has the third-highest HIV prevalence rate in the country. Further, Esmeraldas has the second-highest HIV incidence rate, at 4.75 per 10,000 inhabitants against 2.94 nationally [21]. The province also has one of the highest poverty rates (78% against 60% nationally) and is home to 70% of the country's Afro-Ecuadorian population, who suffer from poor socio-economic conditions such as low education achievement and high unemployment [22]. Recruitment stands were set up at four public places: the esplanade on the city's waterfront, a large shopping mall, the municipal market, and the public park in the city center. These locations are popular gathering places that attract a broad socio-economic spectrum, ensuring that we could recruit a roughly representative population of the region. The stand featured a sign displaying the words, "Your health is important: be informed!" in Spanish. Free refreshments (juice and water) were provided to anyone who visited the booth. Potential participants were approached by trained, non-clinical enumerators who asked for their willingness and consent to participate in a health initiative by the Fundacion Raices (a well-known, local non-governmental organization or NGO). If the answer was "yes," the enumerator read aloud from a script that corresponded to one of the treatment arms and the participant was offered a free anonymous HIV test. Exclusions included those under 18 years old, anyone who appeared unable to understand or consent, and anyone who appeared to be under the influence of alcohol or drugs.

In designing this study, we were acutely aware of the trade-offs that came with assured anonymity. On the one hand, participant anonymity mitigated the problem of biased selection since those who self-identify as high risk may be less inclined to participate due to stigma. On the other hand, anonymity prevented the research team from following up with seropositive participants who did not pick up their test results [23, 24]. Our research design respected individual autonomy as it gave participants the option of being tested and learning their status. Those who tested positive received detailed advice regarding the national program available for HIV-positive people that provides free-of-charge counseling, treatment, and follow-up. The study was approved by the Johns Hopkins Homewood Institutional Review Board and by the Institutional Review Board of the Universidad San Francisco de Quito in Ecuador, which increased our confidence in our decision.

### Interventions

The four experimental arms or conditions are as follows.

#### Arm 1 (Control): Information Alone

Participants were read a script that informed them of the benefits and importance of HIV/AIDS testing for themselves, partners, loved ones, and the community. They received a flyer with the same information (see Supporting Information or "SI") and were encouraged to get tested at a nearby testing facility within two weeks.

#### Arm 2: Soft-Commitment

Participants received the same information as in Arm 1. They were then given the opportunity to privately express their intention to get tested (a form of "soft" or non-binding commitment [16, 17]) by ticking one of two statements on a sheet of paper, initialing, and keeping it. The first statement said, "I intend to get tested for HIV within the next two weeks," and the second, "I will consider getting tested within the next two weeks, but I am not ready to commit at this time" (see SI).

#### Arm 3.1: Immediate-Incentive

Participants received the same information as in Arm 1. They were then told that if they got tested for HIV/AIDS within two weeks, they would receive US$10 at the time of testing. US$10 was about 53% of the daily minimum wage at the time of the study. (The US dollar is the official currency in Ecuador).

#### Arm 3.2: Delayed-Incentive

Participants received the same information as in Arm 1. They were then told that if they got tested for HIV/AIDS within two weeks, they would receive US$10 upon collecting their test results, which were available three weeks after the blood draw.

To avoid cross-contamination of the two incentive arms, the study was conducted in two waves. Participants were randomly assigned to Arms 1, 2, or 3.1 in the first wave (June–August 2017) and to Arms 1, 2, or 3.2 in the second (September–December 2017).

### Outcomes

Three *primary outcomes* of interest were (1) the decision to get tested for HIV, (2) the decision to collect the results (know HIV status), and (3) the detection of new HIV-positive cases. We also considered (4) the time interval between the behavioral intervention and testing, and (5) the time interval between testing and the collection of results. Finally, we calculated (6) the per-case cost of detection in each treatment arm.

### Randomization

To minimize cross-communication amongst participants and to simplify recruitment, we adopted a randomized cohort design. In this design, we divided the study period into 48 blocks of two or three days (e.g., Monday–Tuesday and Wednesday–Friday) with each block randomly assigned to a site-treatment condition using a random number generator in Microsoft Excel. Thus, on any given day, participants would be recruited in a specific location and would all be assigned to the same experimental condition. This design ensured that each experimental condition would be allocated twice to each of the four study locations.

### Implementation Details

Each participant received a card consisting of three detachable parts (SI). Each part had a matching numerical ID. Part 1 stayed with the researchers, Part 2 was kept by the testing facility, and participants used Part 3 to claim their results. This procedure and the numerical identifier preserved participant anonymity while enabling the researchers (a) to associate participants with treatment condition, place of recruitment, and staff who recruited them; and (b) to determine the outcomes (whether tested and the test result). Participants were asked to complete an anonymous survey to capture demographic, socio-economic, and prior HIV testing information. No incentive was offered to complete the questionnaire. The testing facility was located in the city center near a large public hospital. Blood samples were tested with the Elecsys HIV combi PT (Roche Diagnostics; Indianapolis, USA) for the diagnosis of HIV-1 and/or HIV-2, including acute or primary HIV-1 infection. Testing was performed in the laboratories of the Universidad San Francisco de Quito. Following official Ministry of Health guidelines, seropositive individuals who learned their status were advised to enroll in the free national HIV/AIDS treatment program at the local health district office.

### Statistical Methods

We estimated multivariate regressions including controls for enrollment conditions and participants' socio-demographic characteristics. Specifically, control variables include location fixed effects, wave indicators, day-of-the-week indicators, and enumerator identifiers, as well as socio-demographic characteristics (see Table 1). To probe the robustness of our results to modeling choice, we estimated both multivariate Logit regressions and Ordinary Least Squares (OLS) regressions, obtaining very similar results [25]. Because the proportion of participants who adopt a given behavior is the metric of interest, we did not compute odds ratios. Regressions were performed with *Stata 15* [26]. The standard errors

**Table 1** Participants' characteristics

| | % (n) Total N = 7720 |
|---|---|
| Female | 58.7 (4533) |
| Age 18–22 | 27.0 (2085) |
| Age 23–32 | 36.0 (2776) |
| Age 33–47 | 25.8 (1988) |
| Age 48+ | 11.3 (871) |
| Afro-Ecuadorian | 43.1 (3326) |
| Mixed race | 51.9 (4007) |
| Secondary education | 50.7 (3915) |
| Tertiary/university education | 32.9 (2543) |
| Currently working | 36.9 (2848) |
| Currently unemployed | 19.2 (1481) |
| Homemaker | 20.1 (1550) |
| Currently enrolled in school/university | 21.5 (1662) |
| Other occupation | 0.23 (179) |
| Walk-in | 96.0 (7411) |
| Previously tested for HIV | 55.6 (4284) |

were adjusted to account for intra-cluster correlation using the *cluster* option in *Stata 15* [27, 28].

## Results

### Recruitment

A total of 7720 adults participated, comprising 4276 in wave 1 and 3444 in wave 2 (see trial profile and flow in Fig. 1). Actual implementation of the protocol largely followed the planned design (see Fig. 1 and SI).

### Baseline Data

As shown in Table 1, nearly 60% of recruited participants were women, 43% were Afro-Ecuadorian, and 52% were mixed race. Twenty-seven percent were 18–22, 62% were 23–47, and 11% were over 48 years old. About 50% had secondary school, while 33% had tertiary education. Forty-four percent had never been tested for HIV. For comparison, official statistics indicate that 51% of residents in the province are female, 55% are Afro-Ecuadorian, and 37% are mixed race; the average resident is 27 years old and has 10.1 years of schooling. Only 4% said they had heard of the initiative from someone. We performed balance tests comparing participants' characteristics by experimental condition. Although a few differences were statistically significant at conventional levels, in most cases the differences were smaller than five percentage points, and in many cases smaller than two percentage points. Nonetheless, we opted for a conservative approach and we included participants' characteristics as covariates in our statistical analyses. (Results from uncontrolled regressions are very similar).

### Numbers Analyzed

Of the 7720 enrolled participants, 1304 (16.9%) across the two waves presented for testing. Of the 1304 tested, 451 (34.6%) collected their results. Nineteen new HIV-positive cases were detected, or 1.46% of the tested. Analysis of primary outcome (1) was performed on all 7720 participants. Analysis of primary outcomes (2) and (3) was performed on all 7720 enrolled (intent-to-treat) *and* on the 1304 individuals tested. Analysis of secondary outcomes was performed on the 1304 individuals tested (outcome 4) and on the 451 who collected their results (outcome 5). Although the analyses that were limited to participants who were tested do not have a causal interpretation (because testing was not exogenously assigned), it is nonetheless informative to study whether individuals in the different groups behaved differently.

### Outcomes and Estimation

Tables 2 and 3 report analyses of pooled data from the two waves (separate analyses by wave are reported in the SI). Table 2 reports the raw data (i.e., the proportions of participants who agreed to be tested (outcome 1), who learned their results (outcome 2), and who tested positive for HIV (outcome 3)). Table 3 reports coefficients estimated with multivariate Ordinary Least Squares (OLS) and marginal effects from multivariate Logit regressions. Because the two sets of estimates are very similar (demonstrating that the results are robust to modeling choice), below we describe the OLS results. Reported confidence intervals refer to differences between treatments and control (information alone).

#### Testing for HIV

In Table 2, Column (1) shows that the proportion of participants who agreed to be tested was 12.2% in the control, 11% in the soft-commitment group, 66.3% in the immediate-incentive group, and 8.7% in the delayed-incentive group. The multivariate regression estimates reported in Table 3, Column (1) indicate that immediate incentives increased the proportion that agreed to be tested by 50.1 percentage points (95% CI 38.8 to 61.4). Delayed incentives and soft commitment, instead, had small and statistically insignificant effects.

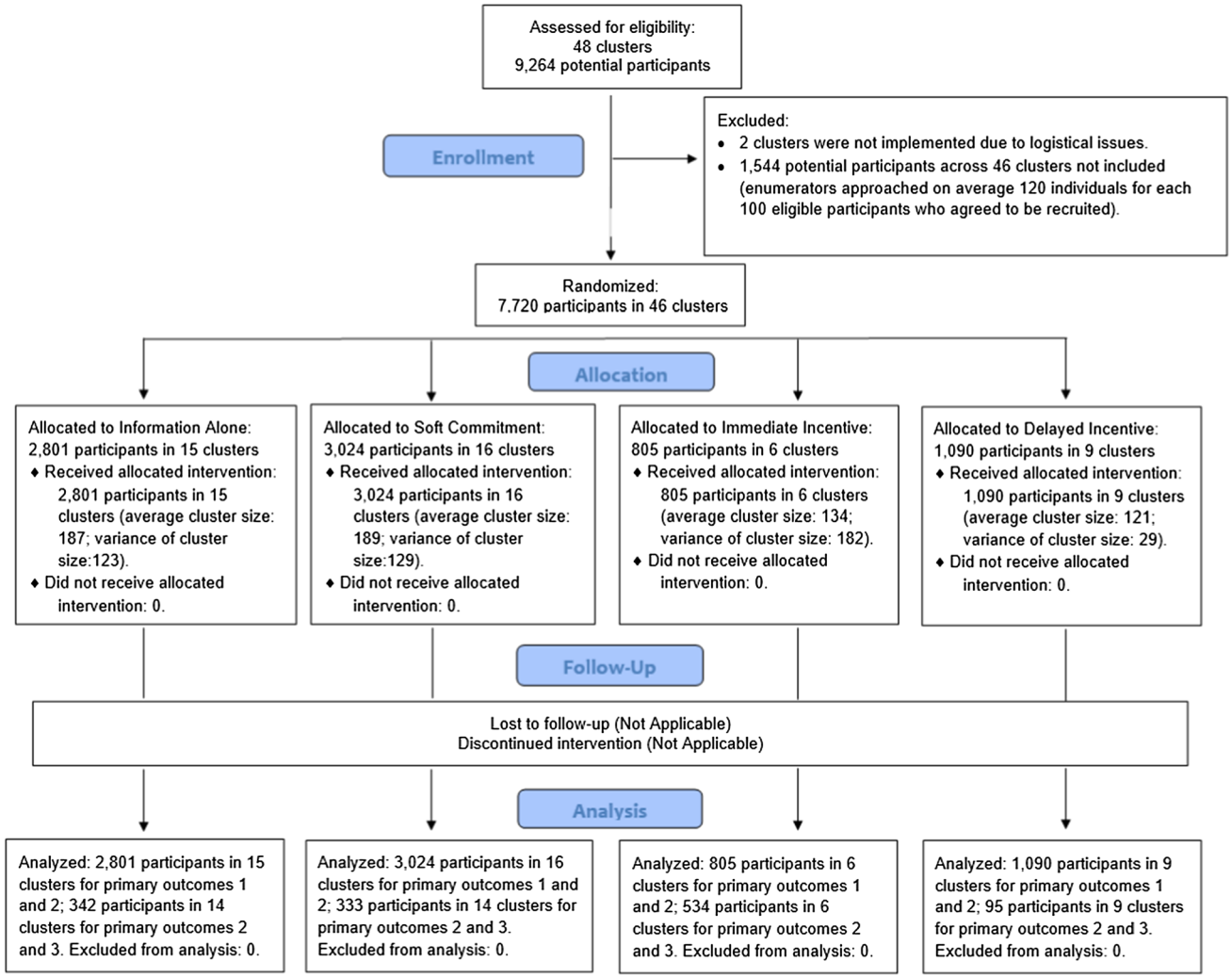


**Fig. 1** Trial flow diagram

**Table 2** Primary analysis results: Raw data

| Outcome variable | Outcome 1 % of participants who were tested | Outcome 2 % of participants who learned their HIV status | | Outcome 3 % of participants who tested positive for HIV | |
|---|---|---|---|---|---|
| Sample | Full sample | Full sample | Tested | Full Sample | Tested |
| | (1) | (2) | (3) | (4) | (5) |
| Information alone (control group) | 12.21% | 5.32% | 43.57% | 0.14% | 1.17% |
| Soft commitment | 11.01% | 4.43% | 40.24% | 0.13% | 1.20% |
| Immediate incentive | 66.34% | 14.78% | 22.28% | 0.75% | 1.20% |
| Delayed incentive | 8.72% | 4.50% | 51.58% | 0.46% | 5.26% |
| N. of clusters | 46 | 46 | 46 | 46 | 46 |
| N. of individuals | 7720 | 7720 | 1304 | 7720 | 1304 |

The table reports primary outcomes (raw data) separately for the control group (Information alone) and the three treatment groups (Information + soft commitment, Information + immediate incentive, Information + delayed incentive)

**Table 3** Primary analysis results: Estimated coefficients from OLS and Logit regressions (percentage-point differences relative to the control group)

| Outcome variable: | | Outcome 1<br>% of participants who were tested | Outcome 2<br>% of participants who learned their HIV status | | Outcome 3<br>% of participants who tested positive for HIV | |
|---|---|---|---|---|---|---|
| Sample | | Full sample | Full sample | Tested | Full sample | Tested |
| | | (1) | (2) | (3) | (4) | (5) |
| Soft commitment | OLS | −1.52<br>[−3.83,0.80] | −1.07<br>[−2.43,0.30] | 0.31<br>[−8.95,9.58] | −0.02<br>[−0.20,0.20] | 0.10<br>[−1.80,1.99] |
| | Logit | −1.88<br>[−3.86,1.09] | −1.07<br>[−2.37,0.24] | 0.59<br>[−8.26,9.44] | −0.00<br>[−0.21,0.19] | 0.62<br>[−0.89,2.13] |
| Immediate incentive | OLS | 50.09<br>[38.82,61.38] | 8.89<br>[5.27,12.50] | −13.43<br>[−24.22,−2.64] | 0.45<br>[0.04,0.87] | −0.22<br>[−1.67,1.24] |
| | Logit | 43.63<br>[33.27,54.00] | 8.04<br>[4.74,11.34] | −14.05<br>[−24.18,−3.93] | 0.39<br>[−0.06,0.84] | 0.29<br>[−1.28, 1.87] |
| Delayed incentive | OLS | 1.06<br>[−2.24,4.45] | 0.20<br>[−2.11,2.50] | −2.84<br>[−16.99,11.32] | 0.39<br>[−0.02,0.81] | 4.69<br>[0.49,8.89] |
| | Logit | 1.88<br>[−2.41,6.16] | 0.34<br>[−2.35,3.04] | −2.47<br>[−15.58,10.64] | 1.06<br>[−0.94, 3.07] | 9.75<br>[−1.23,20.73] |
| N. of individuals | | 7720 | 7720 | 1304 | 7720 | 1304 |
| N. of clusters | | 46 | 46 | 46 | 46 | 46 |

The table reports estimates from Ordinary Least Squares (OLS) and Logit regressions. The reported coefficients are expressed as percentage-point differences relative to the control group. 95% Confidence Intervals (CI) are reported below the point estimates. Control variables include indicators for phase, study location, enumerator, and day of the week, as well as controls for participant sex, age, race, education, employment, and whether previously tested for HIV. Moreover, we adjusted the standard errors to account for possible intra-cluster correlation

### Learning HIV Status

Table 2, Column (2) reports the full sample (intent-to-treat), while Column (3) restricts the sample to those who were tested. The proportion of participants who were tested *and* learned their results was 5.32% for the control, 4.43% for soft-commitment, 14.8% for immediate-incentive, and 4.50% for delayed-incentive conditions. The corresponding results in Table 3, Column (2) show that immediate incentives raised the proportion who learned their status by 8.89 percentage points (95% CI 5.27 to 12.50) compared to the control, whereas soft commitment and delayed incentives had small and insignificant effects. The intent-to-treat analysis thus indicates that immediate incentives were the most effective intervention overall to induce testing and learning HIV status. We now turn to analyzing the sub-sample of individuals who were tested (Table 2, Column 3). For tested individuals, 43.6% chose to learn their results in the control, against 40.2% for soft-commitment, 22.3% for immediate-incentive, and 51.6% for delayed-incentive conditions. The results in Table 3, Column (3) show that tested participants who were in the immediate-incentive group were 13.43 percentage points (95% CI −24.22 to −2.64) less likely to learn their results compared to tested participants in the control group. Thus, the positive effect of immediate incentives from the intent-to-treat analysis were obtained in spite of the fact that, conditional on being tested, incentivized individuals were proportionally less likely to collect their test results than non-incentivized participants. This suggests that immediate incentives induced testing among individuals who were less interested in learning their HIV status, on average, than those in the control condition.

### Detecting HIV-Positive Cases

Table 2, Column (4) reports the full sample (intent-to-treat), while Column (5) restricts the sample to those who were tested. Due to the small number of HIV-positive cases, these results should be regarded as preliminary. Overall, the proportion of study participants who were identified as testing positive for HIV was 0.14% in the control group, 0.13% in soft-commitment, 0.75% in immediate-incentive, and 0.46% in delayed-incentive groups. Table 3, Column (4) shows an estimated positive effect of the immediate incentive of 0.45 percentage points (95% CI 0.04 to 0.87). We next turn to the sub-group of participants who got tested. Among tested individuals, the HIV-positive rate was 1.17% in the control group. Tested individuals in the delayed-incentive group yielded a much higher HIV-positive rate: 5.26%. The multivariate regression results from Table 3 confirm that those who got tested under the delayed-incentive condition were 4.69 percentage points (95% CI 0.49 to 8.89) more likely to be HIV positive than those in the control group. This suggest that individuals who were induced to be tested by the

delayed incentive were more likely to be interested in learning their HIV status than those in the control group.

### Secondary Outcomes

We considered the time interval between the intervention and getting tested (time-to-test), and the interval between getting tested and collecting the results (time-to-pickup) (full results are available in the SI). Conditional on getting tested, time-to-test for the control group was 2.2 days. The immediate incentive shortened this by 1.12 days (95% CI −1.98 to −0.25), and the delayed incentive by 1.5 days (95% CI −2.92 to −0.08). The soft commitment increased time-to-test by 1.15 days (95% CI −0.01 to 2.31). For time-to-pickup, the estimated coefficients were all statistically insignificant.

### Auxiliary Analyses

We investigated whether the treatments differentially affected participants' choices depending on their sex, race, education level, age, and whether they were previously tested for HIV. To do this, we estimated versions of our statistical models with interaction terms of the treatment arm indicators with participant characteristics (full results in the SI). There were no notable differences in the responses to the interventions by sex and race. Participants with only primary education were 15.4 percentage points more likely to be tested in response to the immediate incentive than those with more education (95% CI 9.56 to 21.25). Participants who had never been tested for HIV (self-reported) were 12.9 percentage points more likely to respond to the immediate incentive (95% CI 6.08 to 19.67). Next, we tested for heterogeneity across arms for learning one's HIV status, conditional on being tested. We find no statistically significant differences by sex, race, age, or education. Those who had never been tested before were 14.2 percentage points less likely to collect their results in the immediate-incentive group (95% CI −31.43 to 2.95), and 21.5 percentage points less likely in the delayed-incentive group (95% CI −43.63 to 0.67). Both these results are only marginally statistically significant.

### Cost Analyses

We computed the cost of inducing individuals to get tested, learning their test results, and identifying HIV-positive cases (Table 4). We calculated average costs including incentive payments (where applicable), printing of materials, the cost of testing, and the time cost of recruiting participants (details in SI). It was less expensive to induce an individual to get tested using an immediate incentive (US$28) than with information alone (US$55), a soft commitment (US$63), or a delayed incentive (US$78). The cost per person learning their HIV status was lowest and similar in the control (US$127) and immediate-incentive (US$128) conditions. The detection of a new HIV-positive case cost US$1487 in the delayed-incentive, US$2536 in the immediate-incentive, US$4741 in the information-alone, and US$5217 in the soft-commitment conditions.

## Discussion

A small financial incentive paid at the time of testing increased the propensity of members of the general population to get tested for HIV. This effect was stronger for those with lower education levels and who had never been tested before. However, individuals who were tested under this condition were less likely to collect their results, suggesting that incentives emphasizing test taking attracted individuals who might be more financially motivated than interested in their health status. In contrast, while delayed incentives did not increase the participants' propensity to be tested, they appeared to motivate those with a prior belief that they were at higher risk of being HIV positive. Moreover, both immediate and delayed incentives shortened time-to-test, suggesting that financial

**Table 4** Cost of testing, learning HIV status, and detecting HIV-positive cases

| | Information alone (control group) | Soft commitment | Immediate incentive | Delayed incentive |
|---|---|---|---|---|
| Incentive payments | NA | NA | $5350 | $490 |
| Printing of materials | $1541 | $2419 | $448 | $594 |
| Sample collection and testing | $3420 | $3330 | $5340 | $950 |
| Payments to recruiters | $14,005 | $15,120 | $4075 | $5400 |
| Total | $18,966 | $20,869 | $15,213 | $7434 |
| Cost per individual tested | $55 | $63 | $28 | $78 |
| Cost per individual who learned HIV status | $127 | $156 | $128 | $152 |
| Cost per HIV-positive case detected | $4741 | $5217 | $2536 | $1487 |

All costs are in US dollars (official currency in Ecuador). See SI for details

incentives can attenuate procrastination [18]. The opportunity to express a soft commitment to be tested did not have meaningful effects. This contrasts with existing studies in other contexts. For example, the opportunity to express a non-binding intention to donate umbilical cord blood increased actual donations in Italy [29]. One reason for this difference may be that cord blood donation is seen as a social good, whereas HIV is socially stigmatized. Moreover, in the cord blood study, the commitment was communicated to a nurse, whereas the decision to be tested was kept private (not communicated) by participants in our study. Our findings suggest that, to be effective, behavioral nudge mechanisms need to be contextually tuned to the target.

Our cost analyses indicate that detection of new HIV cases through immediate and—especially— delayed incentives was less costly (US$1487–$2536) than without incentives (US$4741–$5217). These costs are lower than those of existing strategies. A recent systematic review reported costs per new case of HIV identified in the United States to be between US$2000–US$30,500 for routine testing in healthcare settings, and between US$3000–US$31,300 for targeted testing in non-healthcare settings [30]. The costs per individual who learned their HIV status, an important policy outcome regardless of whether an individual tests positive or negative, were also low (between US$127 and US$152).

As discussed in the methods section, we adopted an anonymous respondent design because of the strong social stigma associated with HIV/AIDS in Ecuador. Although our incentive conditions increased the number of individuals tested and the number of individuals who learned their HIV status, the anonymous design prevented us from directly contacting those seropositive individuals who did not pick up their results. The adoption of rapid tests might overcome this limitation. We also suggest that future research could employ a non-anonymous design, especially if a larger general population were targeted. This would allow follow-up interventions such as text reminders to ensure prompt treatment and adherence. In the context of Ecuador, such interventions would need to be implemented in partnership with local health authorities while ensuring the patients' privacy and data confidentiality.

Another limitation of the study is that we did not consider interactions between the various interventions. For instance, financial incentives to get tested *and* to collect the results might have been disproportionately effective. One could imagine that the combined effect of two or more interventions could disproportionately boost response rates.

## Conclusions

Routine HIV testing for members of the general population can play an important role to ensure that individuals learn their HIV status, thus contributing to achieving the "90–90–90" 2020 UNAIDS targets [31]. Yet, implementation and take-up remain a challenge, especially in LMICs. In this study, we identified interventions that can improve the situation. Specifically, we found that financial incentives can cost-effectively motivate general-population HIV testing in an LMIC context. Although our interventions should not replace existing strategies, our findings suggest that they might be useful to complement or support outreach programs aimed at inducing members of the general population to be tested and learn their status. Critically, our results suggest that incentives have the potential to improve HIV detection at lower costs than existing strategies. Our results are in line with evidence from other contexts suggesting that anonymous HIV testing can contribute to improving HIV detection [32]. However, additional work is needed to establish the applicability of incentive strategies for general-population testing in public health outreach programs in which it may be undesirable to guarantee individuals their anonymity.

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s10461-021-03215-x.

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**Author Contributions** MM, MG, RI, MRO, PP, and ET conceived and designed the study. CR and EG conducted the fieldwork and collected the data. ET and MM supervised the study. ET was responsible for the lab analysis. MM performed the statistical analysis. MM and PP and wrote the first draft. All authors contributed to the interpretation of the results, revised the manuscript for important intellectual content, and approved the final version.

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**Data Availability** Data for replication purposes is available from the corresponding author upon reasonable request.

**Code Availability** The code used to produce the analyses is available from the corresponding author upon reasonable request.

## Compliance with Ethical Standards

**Conflict of interest** The authors have no relevant financial or non-financial interests to disclose.

**Ethical Approval** The study was approved by the Johns Hopkins Homewood Institutional Review Board and by the Institutional Review Board of the Universidad San Francisco de Quito in Ecuador.

**Consent to Participate** Verbal informed consent was obtained prior to the interview and intervention.

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