

Delay-discounting among homeless, out-of-treatment, substance-dependent men who have sex with men

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Background: Impulsivity is associated with substance use; however, to date, impulsivity has not been characterized among a sample of homeless, non-treatment seeking, substance-dependent men who have sex with men (MSM). **Objectives:** The aim of this study was to utilize the delay-discounting instrument to assess impulsive behaviors among a subsample of homeless, non-treatment seeking, substance-dependent men who have sex with men (S-D MSM) enrolled in a randomized, controlled, contingency management (CM) trial. **Methods:** Twenty S-D MSM participants from the CM parent study were matched on age and ethnicity to 20 non-substance-dependent, non-homeless control participants using propensity scores ($N = 40$) and were administered the delay-discounting procedure. **Results:** Although discounting values decreased rapidly with time in both groups, the S-D MSM participants consistently discounted rewards more steeply than controls ($p = .05$), particularly at all intermediate measured timeframes. The S-D MSM participants also presented greater median discounting rates (k values) compared with the control group ($m_{S-D\text{MSM}} = 2.39$ ($SD = 3.72$) vs. $m_{\text{ctrl}} = 1.27$ ($SD = 3.71$), $p \leq .01$). **Conclusion:** This work extends existing findings of increased delay-discounting among substance-dependent individuals to homeless, substance-dependent, non-treatment seeking MSM. **Scientific Significance:** A better understanding of the prevalence of delay-discounting type behaviors among homeless, substance-dependent MSM can be used to inform the development of tailored substance abuse interventions for this high-risk population.

Keywords: delay-discounting, substance-dependent, MSM

1. BACKGROUND

Impulsivity is a well-characterized multidimensional construct. Among substance-dependent individuals impulsivity is associated with drug use and drug-using behaviors, in part by elevating the value of immediate rewards over the value of larger but delayed rewards (1–3). Among men who have sex with men (MSM; includes gay, bisexual, and heterosexually identified men), impulsivity has been shown to mediate the association between severity of methamphetamine use and sexual risk-taking behavior (4,5).

Substance-dependent individuals are more likely to choose activities that provide immediate gratification over healthier activities that yield delayed rewards (2,3,6). A prototypical example is injection drug users, who share injection equipment with others rather than waiting to disinfect needles or obtain new syringes, despite awareness of potential consequences such as increased vulnerability to HIV and other infectious diseases (7). MSM methamphetamine abusers may engage in unprotected sex during drug intoxication, despite knowledge of its potential risks (4,5,8). Although impulsivity has been found to be associated with methamphetamine use in HIV-seropositive MSM (4), it has not been assessed in homeless, substance-dependent, non-treatment seeking MSM.

Delay-discounting is an index of impulsivity that measures the extent to which an individual devalues larger delayed rewards compared to smaller immediate rewards. Numerous examinations of delay-discounting in substance-dependent individuals have indicated that future rewards decline in value as a hyperbolic function of length of delay from the present (1–3,9). Delay-discounting has been utilized to demonstrate that individuals who abuse substances such as alcohol (3,10), cocaine (11), heroin (12), and methamphetamine (13) make more

impulsive choices than non-substance-abusing participants. Substance-abusing participants in these studies consistently discounted hypothetical monetary values at greater rates than non-substance-using controls. Studies have also demonstrated that offering hypothetical monetary choices yields similar results when actual money or other commodities are used (9,14).

Although there is a substantial body of work linking substance abuse with delay-discounting (2,3), potential associations between homelessness and impulsivity among substance-dependent populations have not been investigated using this procedure. One study observed increased impulsivity among a population of urban African Americans seeking medical care, but the primary target of investigation was psychotic symptoms and homelessness was only a factor in 11% of the observed cases (15).

The purpose of this investigation was to examine whether homeless, substance-dependent, non-treatment seeking MSM (hereafter referred to as S-D MSM) exhibit greater impulsivity, as measured by the delay-discounting procedure, than a matched control group of MSM who are neither homeless nor substance abusers. A better understanding of the role of delay-discounting can be used to inform the development of interventions tailored to this severely impaired population. We hypothesized that S-D MSM would make more impulsive choices compared to matched controls.

2. METHODS

2.1. Participants

Participants were a subset of 20 homeless, S-D MSM enrolled in a NIDA-funded, randomized, controlled trial ($N = 131$) investigating the effects of a contingency management (CM) intervention among individuals participating in a low-intensity HIV health education/risk reduction program (16), and 20 matched volunteer controls. Participants were matched on age and ethnicity using propensity-scoring techniques. Enrollment criteria for the S-D MSM cohort included being an adult male; an active participant in the low-intensity health education/risk reduction program; substance-dependent (SCID-verified); out-of-treatment for substance dependence; reported sex with another male in the previous 12 months; and current homelessness. Exclusion criteria included current psychosis; actively seeking treatment; inability to understand the consent form; or presence of serious psychiatric conditions. Enrollment in the parent study occurred between April 2005 and March 2008. The matched controls were adult MSM with stable housing and no history of psychiatric illness or substance dependence (SCID-verified). Control participants were recruited from newspaper advertisements and word-of-mouth and were enrolled from June to September 2005. The study was approved by the Friends Research Institute's Institutional Review Board.

Individuals with psychiatric disorders featuring impulsivity [lifetime psychotic disorders (schizophrenia, schizophreniform, or schizoaffective); recent history (past

12 months) of bipolar I disorder or obsessive-compulsive disorder; and/or current manic episode] were excluded due to confounding concerns (17,18). The final subsample of S-D MSM participants eligible for matching was 104. Twenty participants from the S-D MSM cohort were matched to 20 controls according to age and ethnicity ($N = 40$).

2.2. Procedures

After providing written informed consent all participants were administered psychosocial assessments to determine eligibility for the parent study before completing the delay-discounting exercise. All potentially eligible participants received a \$50 gift card to one of several local retail stores as compensation for their time during the initial screening process.

Delay-discounting responses were assessed using the hyperbolic model (19):

$$V_d = \frac{V}{1 + kd} \quad (1)$$

where V_d is the present (discounted) value of the delayed reward, V is the objective value of the delayed reward (\$1000), k is an empirically derived constant proportional to the degree of discounting (sometimes referred to as a discounting rate), and d is the time delay corresponding to the delayed reward. Larger values of k in Equation (1) represent greater discounting, indicating more impulsive choices. All procedures and instructions for performing the delay-discounting procedure were adopted from previous work (9).

2.3. Data Analysis

All statistics were generated using SAS statistical software V9.1 (SAS Corporation).

Propensity scores were calculated to match participants in the S-D MSM and control groups based on age and ethnicity; these scores denote the conditional probability of being assigned treatment given the observed covariates (e.g., age and ethnicity). Factors commonly associated with socioeconomic status (SES) such as education level, income, and employment status were initially collected and considered as possible matching factors (20), but these variables had very little overlap between control and experimental groups; therefore, they were not included in the final matching procedure (see Table 1).

Our primary analysis focused on V_d and k . To avoid any reliance on normal theory assumptions, Wilcoxon rank sum tests were used to compare medians between the S-D MSM and the control group. Additionally, a sensitivity analysis was performed to detect any potential hidden bias (from confounders such as the SES factors mentioned above) arising from lack of perfect control on background characteristics (21,22). This analysis allowed us to evaluate the magnitude of hidden bias that would be required to explain the observed differences between the S-D MSM and control groups. The parameter ω measured

TABLE 1. Characteristics of substance-dependent men who have sex with men (S-D MSM) and control participants: matched cohorts by age and ethnicity.

| Variable | S-D MSM cohort | | Matched cohort | |
|------------------------|--------------------|---------------|--------------------|------------------|
| | Full sample | Restricted | S-D MSM | Control |
| | % (N) or mean (SD) | | % (N) or mean (SD) | |
| | N = 131 | N = 104 | N = 20 | N = 20 |
| Race/ethnicity | | | | |
| Caucasian | 53% (70) | 55% (57) | 75% (15) | 55% (11) |
| African American | 23% (30) | 24% (25) | 15% (3) | 30% (6) |
| Hispanic/Latino | 17% (22) | 12% (13) | 5% (1) | 5% (1) |
| Other | 7% (9) | 9% (9) | 5% (1) | 10% (2) |
| Age | | | | |
| Mean (SD) | 36.4 (8.7) | 36.9 (8.8) | 44.6 (8.0) | 44.6 (9.9) |
| Education (years) | | | | |
| Mean (SD) | 12.5 (2.9) | 12.7 (2.7) | 12.1 (2.7)* | 16.1 (3.1)* |
| Employed | | | | |
| Full-time or part-time | 6 (4.6%) | 5 (4.8%) | 1 (5%)* | 10 (50%)* |
| Income | | | | |
| Dollars | 118.9 (447.6) | 127.6 (493.8) | 30.75 (76.2)* | 2827.5 (3027.8)* |

Note: *Statistical differences observed ($p < .05$) between control and S-D MSM cohorts.

the strength of the relationship between these hidden biases and the assignment to treatment or control group. The bounds reflect the range of significance levels that might be obtained by adjusting for the hidden bias, given that the hidden characteristics were not observed in the control group.

3. RESULTS

3.1. Demographics and Substance Use

Table 1 presents demographic characteristics for both the parent study and the matched delay-discounting group. No significant differences were observed in demographic characteristics between the matched subsamples used for the present analyses and either the full parent study sample or the parent study sample after stratifying for age and ethnicity. Differences ($p < .05$) in education between the S-D-MSM and the control group were observed, but these results are not surprising given the differences in selection criteria.

In the matched S-D MSM group, 17 participants (85%) were homeless; the others (15%) were marginally housed. Thirteen (65%) participants in the matched S-D MSM group exhibited current methamphetamine dependence, six (30%) exhibited current alcohol dependence, three (15%) exhibited current cocaine dependence, and one (5%) exhibited current opioid dependence, with some participants having more than one condition. In contrast, in the control group, no participants were homeless or substance-dependent.

3.2. Median k Values

Table 2 contains the derived median k values (in months) for the matched S-D MSM and control groups. The median discounting parameter was significantly different between the S-D MSM and the control group ($p < .01$,

TABLE 2. Median estimated discounting parameter (k) for the substance-dependent men who have sex with men (S-D MSM) and control cohorts.

| Group | Median (SD) ¹ | Interquartile range | R^2 |
|---------|--------------------------|---------------------|-------|
| S-D MSM | 2.39 (3.72) | .28–3.33 | .95 |
| Control | 1.27 (3.71) | .02–.96 | .90 |

Note: Statistically significant differences (median and mean k values) among the S-D MSM and control cohorts were assessed with Wilcoxon rank sum tests.

¹Units in months.

Wilcoxon rank sum test). The median and the interquartile ranges for both the S-D MSM and control groups were as expected; S-D MSM participants exhibited higher variability in the discounting parameter. The discounting model (Equation 1) proved to be a good fit to the data, reflected by median R^2 values of .95 and .90 for the S-D MSM and control groups.

3.3. Indifference Point

Results of the indifference point analysis are shown in Figure 1 and Table 3. Both groups showed decreasing hyperbolic trends over time. The S-D MSM participants exhibited steeper discounting curves than controls, and lower median indifference values at 2, 6, 12, and 60 months ($p < .05$) using both unadjusted and adjusted (Bonferroni) methods.

A sensitivity analysis applied to the Wilcoxon rank sum test demonstrated that the statistical significance of the differences observed between the S-D MSM and control groups could not be accounted for by a modest amount of hidden bias from demographic characteristics (such as income and education) upon which participants are not matched.

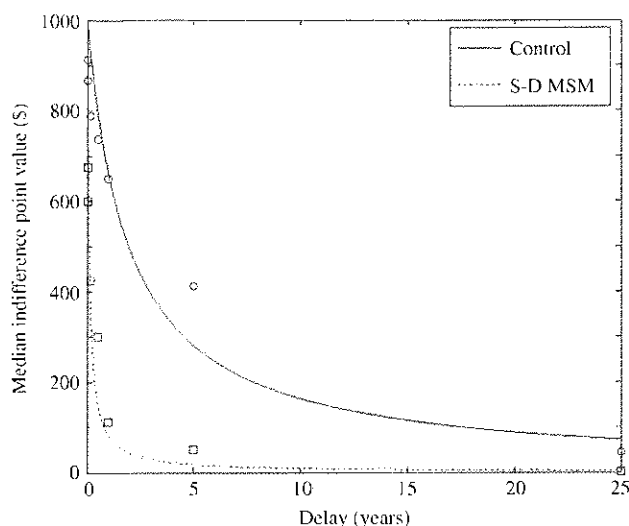


FIGURE 1. Median indifference points for S-D MSM (square) and control (circle) groups as a function of delay (years). Function generated by the Mazer hyperbolic delay model [Equation (1)].

TABLE 3. Sensitivity analysis for hidden bias in observed group differences.

| P value | $\omega = 1$ | $\omega = 2$ | $\omega = 2.5$ | $\omega = 3$ |
|---------|--------------|--------------|--------------------|--------------|
| Minimum | .0089 | .0004 | .0001 ¹ | .0002 |
| Maximum | .0089 | .0485 | .0655 ¹ | .0853 |

Note: A parameter of $\omega = 1$ implies no hidden bias.

¹Study becomes sensitive to hidden bias at $\omega = 2.5$ (*P* values in borderline significant range).

4. CONCLUSIONS

The aim of this study was to examine whether homeless, out-of-treatment, substance-dependent MSM exhibited greater delay-discounting compared to non-substance-using MSM with stable housing. Consistent with our hypothesis, S-D MSM participants displayed increased delay-discounting profiles (signifying more impulsive choices) relative to controls at all but one of the observed time-points. These results are consistent with previous examinations of the delay-discounting procedure among substance-abusing samples (3). For example, delaying \$1000 by 2 weeks reduced its subjective value 40% for the S-D MSM participants, whereas the control participants showed similar decreases after 1 year (35%).

To date, the delay-discounting procedure has primarily been used to assess delay-discounting in individuals dependent on a single substance: cocaine, alcohol, or heroin. Similar efforts with polysubstance-abusing individuals have yielded mixed results (23–25). This work was conducted with a heterogeneous sample of homeless, non-treatment seeking, substance-dependent MSM. Findings are consistent with those from single-substance-dependent samples, indicating that elevated delay-discounting may be associated with the abuse of

all substances (13), and extend the body of work documenting increased delay-discounting among substance-dependent individuals to homeless, substance-dependent, non-treatment seeking MSM.

In Los Angeles County, substance dependence and mental illness are strongly associated with homelessness (26). Associations between substance dependence and delay-discounting are now well established, but the potential role that homelessness may play as a mediator and the direction(s) of causality between delay-discounting, substance dependence, and homelessness have not been investigated. Future work using the delay-discounting procedure might examine associations between homelessness and impulsivity. Such investigations would broaden the utility of this procedure as an independent measure of impulsive behavior across a wider variety of conditions.

Despite the limited sample size, the fact that participants in the control group were neither homeless nor substance-dependent and reported a higher SES than the SD-MSM group, the use of propensity scoring for the matching procedure, and the findings of the sensitivity analysis suggest that these factors likely play no significant role in the outcomes reported here. Although the study would have benefited from a control group of homeless, non-substance-dependent, non-psychiatrically impaired MSM, the sensitivity analysis indicated that the observed treatment effect was not influenced by the lack of such a control (moderate hidden bias). The observed differences in delay-discounting provide an initial characterization of an extremely high-risk and hard-to-reach population and underscore the importance of further work to inform the development of appropriately tailored interventions for this population.

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Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

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