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# Relationship between weight status and delay discounting in a sample of adolescent cigarette smokers

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## Abstract

Obesity and cigarette smoking are often cited separately as the top two preventable causes of death in the US; however, little research has explored factors associated with being both obese and a smoker. Delay discounting is a behavioral characteristic that may underlie both of these conditions/behaviors. Delay discounting describes the extent to which an individual discounts the value of an outcome because of a delay to its occurrence. Higher rates of discounting are often considered an index of impulsivity and have been linked with obesity and cigarette smoking. No research to date has explored delay discounting in a sample obese smokers. For the current study, adolescent smokers classified as obese (BMI greater than 95$^{th}$ percentile) or healthy-weight (BMI between the 5$^{th}$ and 85$^{th}$ percentiles) were compared on a laboratory assessment of delay discounting. Obese smokers discounted significantly more by delay than healthy-weight smokers. This difference remained statistically significant even after controlling for demographic variables that differed across groups. These findings suggest that the relationships between delay discounting and obesity and cigarette smoking may be additive, such that extreme discounting might proportionally increase risk of becoming an obese smoker. However, future prospective work is needed to fully determine the veracity of this hypothesis.

### Keywords

Obesity; cigarette smoking; delay discounting; human

## INTRODUCTION

Obesity and cigarette smoking are often cited as the top two preventable causes of death in the United States (US); and combined, these conditions/behaviors account for over one third of all deaths in the US each year (Mokdad et al., 2004). It has been suggested that approximately 20% of obese adolescents also smoke (Wee et al., 2001), which accounts for approximately 5% of the population. Independently, both obesity and cigarette smoking are serious health risks; however, the combination of being both obese and a smoker may cumulatively put individuals at even greater risk of disease or early death.

One behavioral phenomenon that is likely relevant to both obesity and cigarette smoking is delay discounting. Delay discounting describes the extent to which an individual discounts the value of an outcome because of a delay to its occurrence (Reynolds, 2006). However, there have been only a small number of discounting studies related to obesity. In one study,

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women who were obese discounted more by delay than healthy-weight control participants, though this effect was not reported for obese men (Weller at al., 2008). A more recent study showed that high rates of delay discounting were associated with higher body fat percentages in both women and men when the discounting measure involved making choices for either delayed or immediate food items (Rasmussen et al., 2010). On the other hand, across studies, smokers discount more by delay than nonsmokers (e.g., Bickel et al., 1999), thus reflecting a robust effect for smoking status and delay discounting.

To date, no research has examined the relationship between delay discounting and being both obese and a smoker. Identifying the behavioral characteristics that increase risk of becoming an obese smoker is important to better inform prevention and treatment approaches for this population. The current cross-sectional study compared delay discounting in an adolescent sample of obese and healthy-weight smokers.

## METHODS

### Participants

The current data are from adolescent smokers participating in a larger study involving predictors of treatment response for smoking. However, none of the data reported here have been previously published.

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Participants were classified as obese (body mass index (BMI) greater than the 95$^{th}$ percentile) or healthy-weight (BMI between the 5$^{th}$ and 85$^{th}$ percentile for age and sex). Data from one underweight individual (BMI below the 5$^{th}$ percentile) were eliminated from the analysis. Participants also were required to be between 13 and 19 years of age and to self-report smoking four or more cigarettes per day for at least three months prior to participation. To verify smoking status participants were required to have urinary cotinine levels of ≥ 200 ng/ml. Participants also self-reported their height and weight, which were used to calculate BMI. All participants were recruited from an adolescent quit-smoking program offered at Nationwide Children's Hospital.

### Procedure

All data collection took place in a human-behavior laboratory at the Research Institute at Nationwide Children's Hospital, Department of Pediatrics, The Ohio State University. Participants were scheduled for their research appointments before they began the quit-smoking program from which they were recruited. An Institutional Review Board approved consent and assent forms were reviewed and signed by all participants. Following consent/assent, participants completed a brief demographic questionnaire and other self-report measures. Participants also completed several laboratory behavioral tasks (i.e., stop paradigm, sustained attention, delay discounting), with task order counterbalanced across participants to reduce possible task-order effects. Only results from the measure of delay discounting are reported here. Participants provided a urine sample that was later assayed for cotinine content. Participants were then debriefed and paid for their participation, which was partially calculated based on behavioral-task performance. All laboratory sessions were scheduled between 12:00 and 19:00 h and lasted approximately 2.5 h.

### Question Based Delay Discounting Measure (DDQ; Richards et al., 1999)

For the DDQ, participants were presented with choices between $10 available after a specified delay (i.e., 1, 2, 30, 180, or 365 days) and a smaller amount available immediately (e.g., 'would you rather have $10 in 30 days or $2 now?'). This computerized task used an

adjusting amount procedure (adjusting the immediate amount in increments of ± $0.50) to derive indifference points between the delayed standard and immediate adjusting options for each of the five delays assessed. An indifference point reflected the smallest amount of money an individual chose to receive immediately instead of the delayed standard amount ($10) at the specific delay. Participants were told that their answers to the questions were important because at the end of the session one question would be selected at random and honored—resulting in either immediate or delayed money.

### Statistical Analyses

An area-under-the-curve (AUC) method, as specified by Myerson et al. (2001), was used to characterize data from the DDQ. From the AUC method, smaller AUC values reflect greater discounting and impulsivity. The AUC data were inspected for normality using Shapiro-Wilk tests, and they were transformed using a log-10 function to improve normality.

All statistical analyses were performed using SPSS 17.0. Demographic characteristics were compared using one-way ANOVAs for continuous variables and Chi-square for categorical variables. Outcomes from the DDQ were compared using a one way ANOVA with weight status as the grouping variable.

## RESULTS

### Participants

Participant demographic data are presented in Table 1. No significant differences were found between obese and healthy-weight participants for age, ethnicity, annual household income or IQ. There was a gender difference between the two groups [$\chi^2 = 8.69$, $p < .05$], with the obese group having significantly fewer males, and the healthy-weight group having significantly fewer females. There also was a significant difference for cotinine levels [$F$ (1, 34) = 5.52, $p < .05$], with the obese group having lower levels of cotinine. Lastly, there was a significant difference for alcohol use, which was higher in the healthy-weight group [$F$ (1, 35) = 4.54, $p < .05$].

### Delay Discounting

Weight-status effects were found for the DDQ [$F$ (1, 34) = 7.36, $p < .01$]. Specifically, obese smokers discounted significantly more than healthy-weight smokers (see Figure 1). All findings for the DDQ remained statistically significant after controlling for group differences in gender, cotinine level, and alcohol use as statistical covariates [$F$ (4, 32) = 3.85, $p < .05$].

## DISCUSSION

Obese smokers discounted more by delay than healthy-weight smokers, indicating that being both obese and a smoker is associated with more extreme discounting than smoking alone. This finding is consistent with obesity and cigarette smoking having an additive association with delay discounting. That is, more extreme discounting may proportionally increase risk of becoming an obese smoker. However, future prospective work is needed to more fully test this hypothesis.

This study had limitations that should be considered in interpreting the current findings and addressed in future research. First, the participants self-reported height and weight. While we expect these self-reports to be reasonably accurate, more objective measurements would improve confidence in the BMI values. Additionally, the participants in this study were treatment-seeking cigarette smokers. These findings may not generalize to other cigarette

smokers not seeking treatment. Also, there was a lack of control over medical status; therefore, there may have been individuals classified as obese who had a medical condition that contributed to this status. Finally, future research might also include a group of obese nonsmokers to determine if these nonsmokers discount less by delay than obese smokers, similarly to healthy-weight smokers. Such a finding would more definitively demonstrate additive associations between obesity and cigarette smoking and delay discounting.

An interesting observation from Figure 1 is that the shapes of the discounting curves across the obese and healthy-weight groupings are similar. This similarity in pattern may reflect group differences in the reinforcing effects of money more so than delay discounting, in that there does not appear to be a difference in the steepness of the discounting curves. Alternatively, the observed group difference might reflect a difference in delay discounting; however, this difference would be consistent across the delays (i.e., 1, 2, 30, 180, and 365 days) for both groups. For future research, including an indifference point involving no delay (i.e., both options are received immediately) would help distinguish money reinforcing effects from effects based on discounting by delay.

Even with these limitations, the current study provides an initial evaluation of delay discounting in obese smokers. From this study, obese smokers may represent a distinct at-risk group when compared to smokers, and possibly obese nonsmokers. Developing a better understanding of the uniqueness of this group may have implications for prevention and treatment strategies specifically oriented to obese smokers.

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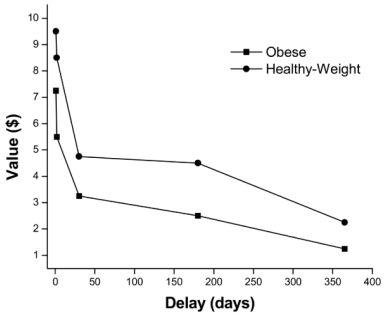


**Figure 1.**
Delay discounting gradients for obese and healthy-weight participants for five different delays to the $10 standard. Symbols represent sample median indifference values for the standard as a function of the delay.

## Table 1

Participant Demographics and Drug-Use Summaries

| | Obese | Healthy-Weight |
|---|---|---|
| Demographics | | |
| Age [years; *M* (*SD, range*)] | 17.19 (1.42, 14–19) | 17.35 (1.46, 14–19) |
| Gender (n; male:female) | 5:11 | 16:4* |
| Ethnicity (n; white:black:other) | 11:5:1 | 15:4:1 |
| Median Annual Household Income [*M* (*SD: range*)][a] | $40,452 (11,514: 29,155-74,143) | $47,373 (23,282: 24,778-127,493) |
| KBIT [IQ; *M* (*SD, range*)] | 89.13 (7.06, 66–118) | 88.42 (14.61, 54–113) |
| Body Mass Index [BMI; *M* (*SD, range*)] | 35.37 (6.42, 24.9–53) | 21.28 (2.54, 17.8–25.5)* |
| Cotinine [ng/ml; *M* (*SD, range*)] | 850.25 (494.11, 208–2154) | 1271.70 (564.69, 343–2520)* |
| Drug Use[b] | | |
| Cigarettes [number per day, *M* (*SD, range*)] | 3.17 (2.10, 0.14–6.43) | 2.78 (2.65, 0.27–10) |
| Alcohol [*M* (*SD, range*)] | 1.71(1.05, 0–4) | 2.55 (1.32, 0–5)* |
| Marijuana [*M* (*SD, range*)] | 1.82 (1.88, 0–5) | 2.65 (1.95, 0–5) |

*Note*. KBIT = Kaufman Brief Intelligence Test – II

[a]The median annual household income was calculated based on average income for census track of the participant's residence.

[b]Except where otherwise specified, drug use was assessed with the following question: "Thinking about the past six months, how often have you used the following substances?": 0 = *never tried*, 1 = *tried*, 2 = *use 1–2 times per month*, 3 = *use once a week*, 4 = *use 2–4 times per week*, 5 = *use 5 or more times per week*.

[c]Cigarettes per day were calculated using a timeline follow back procedure to determine cigarettes smoked each day during the past 30 days.

*Significantly different from obese ($p < .05$).