Economic Preferences and Obesity among a Low-Income African American Community

1. Introduction

The prevalence of obesity has reached epidemic proportions in the US.¹ Data from the National Health and Nutrition Examination Survey (NHANES) indicate that approximately one-third (32.2% of men and 35.5% of women) of US adults are considered obese, with a Body Mass Index (BMI), $BMI \geq 30$ (Flegal *et al.*, 2010). Developing a full understanding of the factors leading to obesity is particularly important since obesity increases the risk of numerous chronic diseases (e.g., coronary heart disease, type 2 diabetes, hypertension), leads to higher medical care costs (Finkelstein *et al.*, 2008), and even premature death.² Risk factors for obesity are numerous, including insufficient physical activity and an unhealthful diet, genes, economic and health conditions, and smoking among others (Anderson *et al.*, 2009). We contribute to the discussion by investigating the possible role of one set of factors, individual risk and time preferences, on the tendency to be obese among a population of low-income African Americans in the United States.

Previous research has found that lifestyle interventions can result in weight loss and decreased risk for morbidity (Diabetes Prevention Program Research Group, 2002). However, an individual's willingness to undertake and maintain the necessary lifestyle changes is impacted by numerous factors at both the individual (e.g., self-efficacy) and socio-environmental (e.g., unsafe neighborhoods) levels (Sallis *et al.*, 2006). Further, some individuals may be more responsive to changes in incentives than others (e.g., Courtemanche, Heutel and McAlvanah 2014).

¹ Differences in prevalence of obesity among black, white, and Hispanic adults—United States, 2006—2008, in MMWR2009, Centers for Disease Control and Prevention. p. 740-744.

² 2008 Physical activity guidelines for Americans. U.S. Department of Health and Human Services, cited August 2 2009. Available from: <http://www.health.gov/paguidelines/default.aspx>.

Ethnic minority populations, such as African Americans, are more likely to be physically inactive and experience higher levels of obesity and other chronic conditions than their ethnic majority counterparts (Barnes 2007; Flegal *et al.*, 2010; Shuval *et al.*, 2011). This disparity may be attributed in part to socio-economic status, lack of access to healthful foods and exercise facilities, and differential access to and utilization of healthcare services (Faridi *et al.*, 2010; Joynt, Orav and Jha 2011; Orsi, Margellos-Anast and Whitman 2010).

However, little is understood about why some individuals in such settings become obese and others do not. In addition to these broader factors, understanding individual characteristics, such as how individuals evaluate risk and make inter-temporal tradeoffs is important for understanding health decisions. We extend the literature by eliciting economic preferences using high-stakes incentivized activities (for many of the subjects in our sample, the experimental stakes represent 0.5-1% of their annual income), where participants face choices that have salient financial consequences, and relate these preferences to objectively-measured BMI. We focus on a low-income, predominantly African American community.

Consider, for clarity, the decision to become more physically active, which is a health-related activity. Engaging in physical activity is costly in the present (assuming the immediate energy expenditure outweighs any immediate pleasure from physical activity), but has a possible future gain in terms of decreased obesity and health risks for various chronic diseases. If the decision of whether to become physically active is made in isolation, then a simple hypothesis would be that individuals who are more risk tolerant would be less likely to engage in physical activity, choosing instead to bear any risks associated with a sedentary lifestyle. For very low-income residents of a high-crime neighborhood such as ours, there may be immediate risks connected with physical activity, such as the lack of safety while outdoors, or the potential for

physical injury in the absence of health insurance. These immediate risks may then lead to the hypothesis that individuals who are more risk tolerant are more likely to engage in physical activity, and so less likely to be obese. Thus, for our population of interest, the overall relationship between risk preferences and obesity is an open empirical question.

Considering time preferences, one would propose that individuals who are more patient are more likely to increase physical activity and consume a healthful diet (both leading to reduced obesity risk) because they would be more willing to sacrifice immediate pleasures for future rewards. We investigate these hypotheses by examining the relationship of incentivized measures of risk tolerance and patience with obesity.

Other studies have investigated the relationship between health and such preferences using hypothetical decisions, where time or risk preferences are revealed based on how subjects say they would behave in a hypothetical situation (e.g., Barsky *et al.*, 1997; Borghans and Golsteyn 2006; Dohmen *et al.*, 2011 among others). Hypothetical risk tolerance is positively associated with smoking (Barsky *et al.*, 1997; Dohmen *et al.*, 2011), chronic diseases (Guiso and Paiella 2004), drinking, a lack of insurance (Barsky *et al.*, 1997) and poor health (self-reported, e.g., van der Pol 2011). However, conflicting results have been reported. For example, hypothetical risk tolerance has also been found to be positively associated with the likelihood and quantity of purchased life, health, and casualty insurances (Guiso and Paiella 2004).

A number of studies have examined how individuals discount health outcomes by having individuals make a series of hypothetical decisions regarding life expectancy or health quality (e.g., see Chapman 2003 and the papers discussed within). These studies indicate that inter-temporal health decisions are sensitive to context and subject to biases found in the study of

monetary time preferences.³ Further, individuals tend to be more impatient, or to discount the future more heavily, when making health decisions.

However, the evidence relating patience to health behaviors is mixed. Hypothetical measures of patience do not correlate strongly with preventive health choices (e.g., Chapman and Coups 1999; Fuchs 1982), though they do correlate with self-reported health status (e.g., van der Pol 2011). Empirical evidence suggests that patience may be negatively related to BMI (e.g., Borghans and Golsteyn 2006; Courtemanche, Heutel and McAlvanah 2014; Ikeda, Kang and Ohtake 2010). Often these estimates use proxies for patience, such as self-reported evaluations of how well a person manages their finances (Borghans and Golsteyn 2006), debt (Ikeda, Kang and Ohtake 2010) or willpower (Zhang and Rashad 2008) rather than by using direct measures of patience. The strength of the relationship observed in the data is sensitive to the choice of proxy.

Only a few papers use incentivized measures to examine the impact of economic preferences on health outcomes (particularly obesity).⁴ Most of the current studies consider either risk tolerance or patience in isolation. For example, an incentivized measure of patience at age four predicts obesity later in life (Seeyave *et al.*, 2009). For a sample of high-income, well-educated adults and students in Williamsburg, Virginia, individuals who are more risk tolerant are more likely to engage in smoking and heavy drinking and are more likely to be obese (Anderson and Mellor 2008), but patience is not considered. In a sample of Boston, Massachusetts adults, patience is negatively associated with BMI and smoking, while positively correlated with physical activity and diet (Chabris *et al.*, 2008), but risk preferences are not considered. For the same community considered here, Leonard *et al.* (2013) relate risk and time

³ Regularities include the high magnitude and variability of discount rates, higher estimated discount rates for short timespans, and lower discount rates for losses among others.

⁴ Using a different approach, several studies have used behavioral insights to either propose or design health-related interventions (e.g., Charness and Gneezy 2009; Epstein *et al.*, 1990; Schnier *et al.*, 2013) or to examine the importance of incentives for healthcare providers (Hennig-Schmidt, Selten and Wiesen 2011).

preferences with self-reported physical activity ‘stages of change.’ We find that individuals who are more risk tolerant and patient are more likely to be in an advanced physical activity stage.

The closest study to ours is Sutter *et al.* (2013) who use a sample of Austrian children and adolescents. They find support for a weak, positive relationship between impatience and BMI, and a strong, positive relationship between risk tolerance and BMI.

We consider both risk and time *via* incentivized tasks for a different sample: low-income African Americans. Further, as in Sutter *et al.* (2013), we note that it is particularly important to simultaneously control for both time and risk preferences because the health-related decisions of interest involve both dimensions.

Thus, the evidence is building that risk tolerance and impatience are positively related to obesity. However, the robustness of these effects across populations, empirical specifications, and preference measures remains an open empirical question, to which we contribute.

We conduct a lab-in-field experiment where we implement incentivized measures of risk tolerance and patience. Additionally, we objectively collect height and weight information in order to compute BMI. We find that risk tolerance is positively related with increased obesity risk. The positive relationship is driven by the most risk tolerant individuals. We do not find an independent relationship between experimentally-elicited patience and obesity in this sample. However, there is a significant interaction effect between risk aversion and patience that indicates that more patient people have a stronger relationship between risk aversion and obesity.

We will now turn to a discussion of the methods used in this study in Section 2. Section 3 discusses the results and Section 4 concludes.

2. Methods

2.1 Selection and Description of Participants

This study utilizes data collected as part of a large cross-sectional, longitudinal research project. The overall purpose of that project is to study the effects of publicly driven investment in a low-income (median=\$19,939), minority (70% African American and 26% Hispanic) neighborhood (US Census, 2005-2009 American Community Survey 5 Year Estimates). The neighborhood, located less than two miles southeast of downtown Dallas, Texas, has approximately 20,000 residents. We analyze cross-sectional data from the second phase of the study which includes information from both the economics experiments and objectively measured BMI. Leonard *et al.* (2011) provides a complete project description, including the sampling strategy. The overall sample is a geographically-weighted random sample of households in the neighborhood.

The subsample used in this study consists of 496 participants who completed a detailed survey including socio-economic data, lifestyle behaviors and anthropometric measures; and 198 of these 496 participants were randomly selected to participate in economic experiments, including the preference-elicitation tasks.

T-tests were conducted to compare the mean characteristics of the sample that participated in the economic experiments and the sample that completed only the survey and obesity measures. The two samples were not statistically different with respect to gender ($t=-0.37$), age ($t=1.19$), marital status ($t=-0.53$), income ($t=0.15$) or BMI ($t=0.17$). In two cases, participants in the economic experiments had missing data, leaving 196 complete observations for time and risk preferences. After accounting for missing data in the dependent variable (2 observations) and independent variables (40 observations), 154 participants were found to have

fully completed both lifestyle behavior measurements, anthropometric measures, and the incentivized preference elicitations.

Data were collected during October 2009 through February 2010 in a research field station in the neighborhood. The research in the community began in 2006 and the field station was a rented storefront in a central location. The study was community based and community members who were trusted by the community were an integral part of the research team. This enhanced enrollment and created a sense of trust among the both the community at large and the study participants. All participants were compensated for their time. Subjects received \$30 for the completing the survey. They received an additional \$20 show-up fee for economic experiments. Additionally, the incentivized preference elicitations described below provided the opportunity for participants to earn additional compensation (mean=\$50.42, SD=\$21.52).

2.2 Collection of BMI

Participants' weight and height were measured by trained personnel using a calibrated digital scale and stadiometer respectively. BMI was calculated using the standard formula: kg/meters^2 . Participants were categorized into five groups: Not overweight or obese—which includes both underweight and normal weight categories (<24.9); Overweight (25-29.9); Obesity I (30.0-34.9); Obesity II (35.0-39.9); Obesity III (≥ 40), based on National Institute for Health guidelines.⁵ The underweight and normal weight categories were combined because there were only 5 participants (3.25% of the sample) falling into the underweight category.

2.2 Collection of Incentivized Measures of Economic Preferences

Participants randomly selected to participate in the experimental portion of the study arrive at the study location, receive an identification number, and complete the written informed

⁵ Classification of overweight and obesity by BMI, waist circumference and associated disease risks. US Department of Health and Human Services, National Institute of Health. Obesity education initiative. http://www.nhlbi.nih.gov/health/public/heart/obesity/lose_wt/bmi_dis.htm. Accessed August 1, 2014.

consent. The experimental sessions consist of a series of nine activities, all of which are context-free and involve choices over real money outcomes. Decisions always proceed in the same order, with no feedback between decisions.⁶ The risk and time preference decisions are the focus of this paper. One of the activities is randomly chosen for payment in cash at the end of the session. All experimental materials are available upon request.

Risk Tolerance: Risk preferences can be measured using a variety of methodologies (see e.g., Charness, Gneezy and Imas 2013). The method used in this study has its origins in Binswanger (1980) and Eckel and Grossman (2008). This method presents a pictorial representation of the financial gambles, which was developed for use in low-literacy populations (Eckel *et al.*, 2012).

Several elicitation methods have been proposed in the literature, there is little agreement as to the preferred elicitation method. Since our population of interest tends to have low levels of education, we have chosen to implement a visual elicitation method, shown to have less noise than a multiple-price list format for low-math literacy populations (Dave *et al.*, 2010). The decision form for this task is shown in Figure 1, below.

[Figure 1]

Specifically, the risk preference elicitation presents the participant with six possible fifty-fifty gambles which are increasing in both expected value and variance (risk), with the final choice (6) involving only an increase in variance. The low and high payoffs for these gambles are: (1) \$40/\$40 – a sure thing, (2) \$30/\$60, (3) \$20/\$80, (4) \$10/\$100, (5) \$0/\$120 and

⁶ In order, the tasks are: risk preferences, correlated risk within a group, preferences over positively skewed risky alternatives, time preferences, two comparative dictator decisions (dictator games with four different targets), a trust game, and two versions of the solidarity game. These measures are included in the study to examine other aspects of the community and are not relevant for the current analysis. None of these measures are statistically significant in or alter the robustness of the following analysis. Solidarity results are available in de Oliveira, Eckel and Croson (2014). Other studies have examined the impact of peer effects and social network on obesity (e.g. Christakis and Fowler 2007).

(6) -\$10/\$130. Each participant chooses the one gamble they most prefer, indicating their willingness to trade off between a higher reward (the potential for earning more money) and a higher risk (from the higher variance). Only those with extremely low risk tolerance will choose gamble 1, and only risk-seeking individuals should choose gamble 6, which constitutes only an increase in variance compared with gamble 5. The choice of the gamble allows us to infer a level of risk tolerance (for details see Binswanger 1980, Eckel and Grossman 2008). The risk preference data are thus coded one through six, corresponding to the gamble choice. Higher numbers therefore indicate increasing risk tolerance.

Patience: Time preference elicitations can be traced to survey work in Thaler (1981). Modern protocols originate with Coller and Williams (1999), which we present in a simple pictorial form (Eckel *et al.*, 2011; Eckel, Johnson, and Montmarquette 2005).

In the time preference elicitation, we use participants' choices between sooner and later amounts as a measure of their willingness to wait for delayed rewards. Participants make six separate choices between receiving \$50 tomorrow or a larger sum of money (\$51, \$55, \$60, \$70, \$100 or \$150, respectively) six months from tomorrow. The decision form is shown in Figure 2.

[Figure 2]

Both the sooner and the later payment dates are in the future to minimize confounding effects of trust in the experimenter, and to avoid the problem of impulsiveness (there is no 'now' option). Choosing the later payment indicates a "patient choice" and the subsequent analysis will examine the number of patient choices individuals were willing to make as a measure of their patience.⁷ The more patient choices a participant makes, the less he discounts the future. For example, if a participant chose to wait only once – for the largest future amount – then he would

⁷ We are, unfortunately, not able to empirically estimate discount factors for this population due to the high number of participants who are never willing to make a patient choice. However, the number of patient choices provides a consistent ranking: individuals who make more 'patient choices' have larger discount factors (are more patient).

be very impatient and would discount the future a great deal. If he made six patient choices, even for the smallest future amount, then he would be very patient.

Time preference data are coded by the total number of patient choices. With additional assumptions concerning individual preferences, it is possible to calculate the discount factor for individuals and the CRRA for risk. We have chosen to make the minimal assumptions possible rather than imposing additional structure which may not be appropriate. Specifically, we assume that the individuals choice is revealed preferred to the other options.

3. Results

3.1 Descriptive Results

While obesity is known to be a public health concern in low-income, minority communities, little empirical evidence exists regarding the economic risk and time preferences in these communities, or their relationship to obesity. Table 1 provides a description of the sample and all variables used for this analysis. Figure 3 shows the distribution of weight status categories in this sample (Panel A) as well as the distribution of risk tolerance (Panel B) and patience (Panel C).

[Table 1 & Figure 3]

For the dependent variable, BMI, we see that the average BMI is 31.8, which is indicative of obesity. Over two-thirds of our sample is categorized as either overweight or obese, with approximately 15% of the sample classified as ‘Obese III,’ the most severe weight status classification.

The participants in this study exhibit high levels of risk aversion, with 64.28% of the sample willing to take on little or no risk (choosing Gambles 1 or 2). Risk-neutral behavior is

exhibited by only 6.49% of the sample and 3.25% reveal a preference for risk-seeking behavior in this decision environment.

The results of the time preference elicitation indicate high levels of impatience in the sample, with over 40% of the sample never willing to wait for the larger and later payoff. Eleven percent are only willing to wait for the larger and later payoff when their investment will triple in six months. Another 21.4% of the sample require that their investment double before they were willing to make the patient choice.

In terms of demographics, our sample is predominantly African American, with only 5% Hispanic. Forty-one percent of the subjects are male, and the average age is 42 years. Only 23% of the sample are currently married and over half have children under the age of eighteen living at home. This is a low-income population, with almost half of the subjects earning under \$10,000 a year (annual household income) and 64% reporting that they have been unemployed within the past 12 months.

In addition to our independently-confirmed BMI, we also have self-reported health measures which could impact BMI. Almost 40% of our sample rates their health as either excellent or very good, and only 2% of the sample reports that they are in poor health, none of which are in the Obese III category.

High levels of impatience, like those observed in our sample, are thought to be consistent with high levels of obesity: the costs of prevention are in the present and any associated risks are in the future. We will now turn to an individual-level analysis to examine the possible relationship between risk tolerance, patience and obesity.

3.2 Correlates of Obesity

Following the public health literature, we use weight status category as the dependent variable.⁸ We estimate an ordered logistic regression model using STATA 13 (STATA, College Station, Texas). The coefficients are reported in Table 2. For ease of interpretation, the marginal effects for the relationship between the incentivized preference measures and BMI are reported in Table 3. The marginal effects give the percentage point change in the likelihood of an individual with average characteristics being classified in a particular BMI category for a 1 unit change in the explanatory variable (i.e., risk tolerance or patience). We include controls for demographics and health status.

[Tables 2 & 3]

Confirming the results of Anderson and Mellor (2008), we see that increased risk tolerance is associated with a higher BMI (controlling for covariates).⁹ The marginal effects in Table 3 indicate that each step-level increase in risk tolerance is associated with a 5.8% decrease in the likelihood of being under/normal weight and a 3.8% increase in the likelihood of being classified as Obese III.

In comparison to Sutter *et al.* (2013), patience does not show a statistically significant association with BMI in our sample. It may be that the elicited time preferences are not related to obesity in this sample or it may be a consequence of the limited variation in the data due to the substantial number of subjects who are never willing to wait for the larger and later payoff. To confirm that the non-significant time preference result is not due to multicollinearity, we check

⁸ www.nhlbi.nih.gov/health/public/heart/obesity/lose_wt/bmi_dis.htm

⁹ The qualitative results are robust to excluding all of the covariates except ‘male.’ For a logit model with only risk tolerance, patience, and male as explanatory variables the coefficients (standard error) are 0.25 (0.11) for risk tolerance, 0.10 (0.09) for patience and -1.05 (0.31) for male. Further excluding male reduces the significance on risk tolerance to the 10% level.

the correlation between the elicited risk and time preferences measures, which is not significant in this sample (corr=0.0313, p=0.8946; Pearson $\chi^2=25.6397$, Pr=0.693).

Socio-demographic characteristics show little association with the obesity measures, but this is likely due to the homogeneity of the sample. For example, 95% of the sample is African American, 77% are not married, and 48% have incomes less than \$10,000 a year (see Table 1). Alternate income specifications are similarly not significantly related to obesity.¹⁰ We see that men are less likely to be obese, which is consistent with the literature (Ogden *et al.*, 2014). Turning to the self-reported health status controls, we find that individuals with health insurance or poorer health status are more likely to be obese.

To more fully examine the relationship between risk tolerance, patience and obesity, we re-estimate the model in Table 2, allowing for a non-linear impact of risk tolerance. Results are shown in Table 4, with the accompanying marginal effects shown in Appendix Table 1.

[Table 4]

Examining Table 4, we see that the positive relationship between risk tolerance and obesity is driven by the most risk-tolerant individuals, particularly the risk-neutral, expected-value maximizing individuals who selected Gamble 5. However, likelihood-ratio tests do not indicate an increase in the explanatory power of the model, suggesting that the linear model remains a reasonable approximation of the relationship.¹¹ Risk neutrality in the risk experiment is associated with a 14.5% increase in the likelihood of being classified as Obese II and a 26.7% increase in the likelihood of being classified as Obese III.

One source of individual heterogeneity in patience could be different reactions to an uncertain future. It is therefore important to consider a possible interaction effect between risk

¹⁰ Alternate specifications include: a dummy variable for low-income (\$10K or \$20K threshold), dummy variables for each income category, or Income^2 .

¹¹ $\chi^2(4) = 4.88$, $\text{Prob} > \chi^2 = 0.2993$.

tolerance and patience. For this analysis, we need to make several changes to the model specification. First, since risk tolerance is likely positively related to obesity and patience is expected to be negatively related with obesity, the expected direction and interpretation of an interaction between the two is unclear. We therefore reverse code risk tolerance into risk aversion by subtracting the chosen gamble from 7. Thus, if the subject chooses the no-risk option they are coded as 6, and the risk seeking choice is coded as 1.

Second, the correlation between Patient and the interaction term is too strong to include both variables without causing multicollinearity issues ($\text{corr}=0.9227$, $p=0.00$). To address this specification issue, we standardize both risk aversion and patience by subtracting their respective means. Thus positive (negative) numbers indicate the degree to which an individual's risk aversion or patience is above (below) the mean in the sample. We then interact these standardized variables.

[Table 5]

The first column includes the standardized risk aversion and standardized patience variables while the second additionally includes the interaction between the two. The remaining columns show the average marginal effects for each of the five BMI categories. Since deviations from the mean are sample-specific, we focus on the sign and significance of the variables as opposed to the magnitude.

Examining the first column, we see that risk aversion (tolerance) is negatively (positively) correlated with obesity, as before, and that there is no statistically significant relationship between the patience measure and obesity. Including the interaction term strengthens the relationship between risk aversion and obesity, with those who are both more patient and more risk averse being more likely to have a lower BMI. The negative sign on the interaction

term can be interpreted as an indication that more patient people have a stronger relationship between risk aversion and obesity.

4. Closing Discussion

Consistent with previous work (Anderson and Mellor 2008; Sutter *et al.*, 2013), we find that a higher tolerance for risk is associated with a higher BMI. This result is consistent with more risk-tolerant individuals in the elicitation activity being more accepting of the risks that come from the future health consequences of obesity. We extend their work to a new policy-relevant sample. We further show that, for this sample of participants, the relationship between risk and BMI is driven by the most risk-tolerant individuals, particularly the expected-value maximizing subjects in the sample.

Our work does differ from theirs in a few key respects. First, we use a different risk preference elicitation than either of the choice list formats used in Anderson and Mellor (2008) or Sutter *et al.* (2013). Dave *et al.* (2010) finds that there is more noise in the Holt-Laury style choice list than in the Eckel-Grossman gamble choice for those with low math literacy. We therefore chose the single-decision measure because of the low literacy rate and low math skills in our population. While stable risk preferences would indicate that results should be comparable across elicitations, if the procedure impacts the elicited risk preference then our results may not be comparable to theirs. Understanding the robustness of the relationship between risk preferences and field behavior to the preference elicitation mechanism is an important question for future work. We also use higher stakes than the previous studies.

Next, both Anderson and Mellor (2008) and Sutter *et al.* (2013) calculate BMI with self-reported height and weight.¹² In contrast, we measure the height and weight of each participant, avoiding the potential problems with self-reported data and providing a clean measure of BMI. Self-reported height and weight can misrepresent BMI since weight is frequently under-reported and height over-reported, especially among unemployed women (e.g., Nawaz *et al.*, 2001). We also differ in the specification of the dependent variable. We examine the weight classifications used by public health researchers. Sutter *et al.* (2013) use normalized BMI as a continuous dependent variable, which ignores the non-linear relationship between BMI and health status. Anderson and Mellor (2008) predict the probability of being overweight or obese ($BMI \geq 25$): 46.8% of their sample fits this description. In our sample, almost 70% of the sample is either overweight or obese.

We find no statistically significant independent relationship between the elicited time preferences and obesity, suggesting caution in the interpretation of previous studies. However, we do find that time preferences impact the extent to which risk preferences were related to obesity: more patient individuals who were also risk averse, were less likely to be obese. Thus caution is warranted in assessing the external validity of previous results in low-income ethnic minority communities. Examining impulsivity in addition to impatience and their interaction with risk preferences may be a fruitful next step for research with this population.

Our results also suggest that examining the portfolio risks, both those with immediate consequences and those occurring in the future, as well as risk perceptions, would provide an interesting and potentially important avenue for future research. Using the tools of experimental economics to better understand the interaction between these preferences could provide a more

¹² Sutter *et al.* (2013) does compare the self-reported measure to one obtained from medical reports for a subsample (87/661) of their data. They find a strong correlation between self-reported data and verified data ($\text{corr}=0.92$, $p < 0.001$), lending support to their analysis of self-reported data.

rigorous framework for further study of individual health decisions. Insights could further inform and target interventions. For example, the walking school bus program in low-income communities has been shown to promote physical activity by lowering the risk associated with walking in low-income neighborhoods (Kong *et al.*, 2009).

Additionally, the results may be viewed in light of the recent policy moves on the part of insurance companies to provide premium rebates for positive health behaviors or outcomes. On one hand, financial incentives for gym use (which move more of the rewards into the present) have been shown to increase gym use among those who were not previously regular gym-goers and to improve several health indicators (e.g., obesity, heart rate) (Charness and Gneezy 2009). However, if the incentives are not timely (i.e., a delayed reward), they might be ineffective in changing health behaviors (Volpp *et al.*, 2011).

In our sample, patience is not independently related to obesity. Our results suggest that the rebates may be effective if they help modify the perceived risks associated with obesity. Insurance companies may be able to signal the severity of the risk by offering a reward for behaviors promoting a healthy lifestyle. Further studies might investigate the effect of insurance rebates on modifying risk perceptions associated with the health behaviors or outcomes that are being targeted.

There are some key limitations to our study and as such it should be viewed as only a preliminary investigation into the behavioral economic determinants of obesity and their link with incentivized measures of preferences. The study design is cross-sectional which prevents analysis of temporal relationships between economic preferences and obesity. Additionally, the sample is relatively homogenous from one geographic location, which impacts the generalizability of the findings (i.e., external validity). However, the low-income, minority

sample is of high interest both because of the group's increased morbidity and mortality risk and because of the degree to which low-income individuals have access to and utilize health services.

Despite these limitations, the results of our study suggest that relationship between time and risk preferences clearly warrants further examination. Future work should continue to investigate the role economic preferences play in impacting obesity in larger more representative samples while using prospective designs to determine a causal relationship. Additional studies using validated methods of economic experiments to measure preferences and relate these preferences to health behaviors will build a body of evidence through which we can more precisely apply behavioral economic theory to make health policy recommendations.

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Tables

Table 1. Characteristics of 154 Fair Park residents

Variable	Mean	Std. Dev.	Description
BMI	31.68	11.30	Measured BMI, kg/meters ²
Risk Tolerance	2.31	1.38	Gamble choice, 1-6
Patience	1.55	1.68	Number of patient choices, 0-6
Hispanic	0.05	0.21	DV=1 if Hispanic, 0 otherwise
Male	0.41	0.49	DV=1 if Male, 0 otherwise
Age	42.29	12.00	Age in years, 18-77 years
Married	0.23	0.42	DV=1 if currently married, 0 otherwise
Kids	0.56	0.50	DV=1 if children <18 years living at home, 0 otherwise
No Insurance	0.34	0.47	DV=1 if no current health insurance, 0 otherwise
Income	0.23	1.69	Categorical income variable, 1-8
1 Less than \$10,000			48.05%
2 \$10,000 to less than \$20,000			23.38%
3 \$20,000 to less than \$30,000			10.39%
4 \$30,000 to less than \$40,000			7.14%
5 \$40,000 to less than \$50,000			2.60%
6 \$50,000 to less than \$60,000			5.19%
7 \$60,000 to less than \$70,000			1.95%
8 \$70,000 to less than \$80,000			1.30%
Unemployed	0.64	0.48	DV=1 if unemployed in the last year, 0 otherwise
Health Status ^a	2.77	0.99	Self-reported health status, 1-5
1 Excellent			11.04%
2 Very Good			27.27%
3 Good			37.01%
4 Fair			22.73%
5 Poor			1.95%
Health Limits Activity ^b	2.21	4.05	Number of days of where poor health prevents activity, 0-30
ER Trips ^c	1.36	1.77	Number of ER trips in the past year due to illness, 0-12

^a “In general, your health is: Excellent, Very good, Good, Fair, Poor.”

^b “During the past month, how many days did poor mental or physical health keep you from doing your usual activities (for example, you were too sick to go to work or complete household chores)? ____Times”

^c “How many times in the past year has a member of your household had to visit the emergency room for an illness (such as fever, infection, virus, etc.)? ____Times”

Table 2. Impact of Risk Tolerance and Patience on BMI

Variable	5 Category ^a
Risk Tolerance	0.339** (0.113)
Patience	0.100 (0.096)
Hispanic	0.816 (0.743)
Male	-0.925** (0.352)
Age	0.012 (0.015)
Married	0.105 (0.380)
Kids	0.248 (0.335)
No Insurance	-1.311*** (0.352)
Income	0.040 (0.098)
Unemployed	-0.218 (0.354)
Health Status	0.461** (0.174)
Health Limits Activity	-0.052 (0.038)
ER Trips	0.027 (0.095)
LnL	-218.01
LR χ^2 (prob > χ^2)	45.35 (0.00)
Pseudo R ²	0.0942

⁺ p ≤ 0.10, * p ≤ 0.05, ** p ≤ 0.01, *** p ≤ 0.001

Notes: N=154.

^a The 5 category regression is modeled as an Ordered Logit. Coefficients are shown, with standard errors in parentheses. Marginal effects for risk tolerance and patience are shown in Table 3. The five BMI categories are: Not overweight or obese (<24.9); Overweight (25-29.9); Obesity I (30.0-34.9); Obesity II (35.0-39.9); Obesity III (≥ 40).

Table 3. Marginal effects of risk tolerance and patience on BMI

BMI Category	Risk Tolerance	Patience
Not overweight or obese	-0.058*** (0.019)	-0.017 (0.016)
Overweight	-0.009* (0.004)	0.003 (0.003)
Obese I	0.010* (0.005)	0.003 (0.003)
Obese II	0.020** (0.007)	0.006 (0.006)
Obese III	0.038** (0.013)	0.011 (0.011)

⁺ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

Notes: N=154.

Marginal effects to accompany Table 2. Standard errors are in parentheses. The five BMI categories are: Not overweight or obese (<24.9); Overweight (25-29.9); Obesity I (30.0-34.9); Obesity II (35.0-39.9); Obesity III (≥ 40).

Table 4. Correlates of BMI
Ordered Logit regression, standard errors in parenthesis

Variable	5 Category BMI
Risk Tolerance	
\$30/\$60	0.469 (0.391)
\$20/\$80	0.365 (0.456)
\$10/\$100	0.618 (0.551)
\$0/\$120	2.464*** (0.717)
-\$10/\$130	1.303 (0.901)
Patience	0.099 (0.097)
LnL	-215.57
LR χ^2 (prob > χ^2)	50.23 (0.00)
Pseudo R ²	0.1044

⁺ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

Notes: N=154.

Controlling for all variables in Table 2. Coefficients are shown, with standard errors in parentheses. Marginal effects for risk tolerance and patience are shown in Appendix Table 1.

Table 5. Interacting risk and patience

	Coef.	Coef.	Not Overweight Or Obese	Overweight	Obesity I	Obesity II	Obesity III
S.Risk Averse	-0.339** (0.113)	-0.392*** (0.118)	0.067*** (0.020)	0.009* (0.004)	-0.012* (0.005)	-0.023** (0.008)	-0.041*** (0.012)
S.Patience	0.100 (0.096)	0.071 (0.098)	-0.012 (0.017)	-0.002 (0.002)	0.002 (0.003)	0.004 (0.006)	0.007 (0.010)
S.Risk Averse*S.Patience	...	-0.204** (0.075)	0.035** (0.013)	0.005+ (0.003)	-0.006* (0.003)	-0.012* (0.005)	-0.021*** (0.008)
LnL	-218.01	-213.88					
Pseudo R ²	0.0942	0.1114					

⁺ p ≤ 0.10, * p ≤ 0.05, ** p ≤ 0.01, *** p ≤ 0.001

Notes: N=154.

Ordered Logit, Standard errors in parentheses. Controlling for all variables from Table 2. The 5 category regression is modeled as an Ordered Logit. The five BMI categories are: Not overweight or obese (<24.9); Overweight (25-29.9); Obesity I (30.0-34.9); Obesity II (35.0-39.9); Obesity III (≥ 40).

Figures

Figure 1. Risk Tolerance Elicitation

ACTIVITY 4 EXAMPLE

Your Choice

	Receive Money Tomorrow	Receive Money 6 Months from Tomorrow
1	\$50 ☐	☐ \$51
2	\$50 ☐	☐ \$55
3	\$50 ☐	☐ \$60
4	\$50 ☐	☐ \$70
5	\$50 ☐	☐ \$100
6	\$50 ☐	☐ \$150

Do not turn
the page until
 instructed.

Figure 2. Patience Elicitation

Panel A

Panel B

Panel C

Figure 3. Distribution of Obesity and Economic Preferences in Sample

Appendix
Appendix Table 1. Marginal effects to accompany Table 4
Ordered Logit regression, standard errors in parenthesis

Variable	\$30/\$60	\$20/\$80	\$10/\$100	\$0/\$120	-\$10/\$130	Patience
Not overweight	-0.080	-0.062	-0.105	-0.420***	-0.222	-0.017
or obese	(0.066)	(0.078)	(0.094)	(0.120)	(0.151)	(0.016)
Overweight	-0.012	-0.010	-0.016	-0.064*	-0.034	-0.003
	(0.010)	(0.012)	(0.015)	(0.028)	(0.027)	(0.003)
Obese I	0.014	0.011	0.018	0.073*	0.039	0.003
	(0.012)	(0.014)	(0.017)	(0.033)	(0.029)	(0.003)
Obese II	0.028	0.021	0.036	0.145**	0.077	0.006
	(0.023)	(0.027)	(0.033)	(0.050)	(0.054)	(0.006)
Obese III	0.051	0.039	0.067	0.267***	0.141	0.011
	(0.042)	(0.049)	(0.059)	(0.076)	(0.098)	(0.011)

⁺ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$