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finding

Combining a lottery incentive with protection against losing the lottery improves exercise adherence

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abstract

Two common incentives for participating in exercise programs are cash rewards for meeting goals and the loss of deposited money when goals are missed. Direct cash rewards lead to higher enrollment, but the risk of losing money is a stronger motivator for sticking with a program. We conducted an experiment using loss protection to leverage the power of both approaches. Participants were offered two exercise classes a week for 12 weeks. Anyone who attended the first weekly class received a chance to play a lottery that was very likely to pay a cash reward, but they also faced a low risk of not winning any money. Participants in the loss-protection group could insure against the loss by also attending the second class of the week. Participants in the control group could earn the equivalent money by likewise attending the second class, but the incentive was a straight reward for class participation (a flat payment), not as loss protection. For any weekly pattern of attendance, expected earnings were the same in both groups. We randomly assigned 153 participants to either the loss-protection or the control group. The loss-protection framing resulted in greater exercise class attendance, suggesting that the approach could enhance the outcomes of reward-based programs without increasing program costs.

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Core Findings

What is the issue?
Motivating individuals to participate in exercise and diet programs should take into account that people are more driven to avoid a loss than to achieve a gain of the same amount. Loss avoidance interventions, however, are a challenge for low-income groups. Instead, leveraging both cash rewards for meeting goals and the anticipated loss of deposited money when goals are missed—that is, *loss protection*—offers the best of both worlds.

How can you act?
Selected recommendations include:
1) Offering incentive structures with features of both reward and deposit contract programs
2) Incorporating a repeated and public lottery to make losses more salient to individuals

Who should take the lead?
Researchers and decision-makers in health care, insurance, and labor policy

Regular exercise offers well-known benefits, including reduced risk for heart attacks, high blood pressure, type 2 diabetes, and colon cancer.[1–4] Yet sticking to an exercise plan is often challenging.

Various kinds of financial incentives meant to encourage a healthy lifestyle have been tested, with mixed results.[5–8] These include paying people cash for meeting particular goals or having them sign "deposit contracts," which obligate them to forfeit money if they do not meet the agreed-on goals.

Once signed, deposit contracts are much more motivating,[9,10] probably because they leverage aversion to loss: people are more driven to avoid a loss than to achieve a gain of the same amount. In one early study of aerobic exercise, participants in a deposit contract condition ran more than twice as far overall than participants who earned lottery tickets through their efforts.[11]

Deposit contracts help only those who agree to them, however. Many individuals refuse to lay out money that they may lose. People may be as much as six times less likely to enroll in a deposit contract than in a straight reward program.[12] Participation is particularly low, in the range of 11%–14%, when the required deposits are large.[12,13] The reluctance can be mitigated by requiring only extremely small deposits (from $0.01 to $3.00), offering matching (or doubled) sums, allowing early withdrawal from programs, or permitting daily deposits to be slowed or stopped during the contract; such features result in participation rates between 29% and 96%.[10,14–16] This increase in participation comes at the cost of reducing the strength of the motivation that results from the prospect of larger losses, however. Moreover, people who lack financial resources may be unable to afford deposits of any amount.

We wondered whether an incentive structure that was based on rewards but that also included the powerful forfeiture feature of a deposit contract could enhance the rewards' ability to motivate people to exercise. In the study presented here, we tested an intervention in which the reward for doing a certain amount of exercise was a ticket to a lottery that was highly likely but not guaranteed to pay off. People could protect against the risk of loss by doing still more exercise. We call this incentive structure *loss protection* because exercising to prevent a loss is analogous to purchasing an extended warranty to avoid having to pay for repairs on a consumer product.

We had a few reasons for thinking that the loss-protection approach would result in more physical activity than a straight payment for extra exercise would. For one, people entered in a low-risk lottery are likely to think of the projected lottery winnings (the reward) as money that already belongs to them. They would then view the possibility of losing the lottery as a forfeiture similar to losing a deposit and would thus be motivated to avoid the loss if possible.[17] (Botond Kőszegi and Matthew Rabin have termed the desire to avoid forfeiting anticipated income *expectation-based loss aversion*.)[17] We suspected that people would also want to avoid feeling regret over not taking action to assure a lottery win.[18,19]

Methods

Overview

In earlier work, we showed that loss protection was a powerful incentive for attending a scheduled health screening.[20] We extended this concept in our study to evaluate the effectiveness of loss protection as an incentive for exercising. The trial lasted 12 weeks. Participants were offered two exercise classes each week. For attending the first session of the week, all participants earned a ticket for a lottery drawing held the following week; the drawing offered each player a 90% chance of a $20 payout and a 10% chance of no payout. In other words, participants would expect to win 90% of the time and lose 10% of the time, which comes to average winnings of $18 a week (0.90 × $20).

Half the participants were randomly assigned to the loss-protection arm. These participants

could insure against a loss by attending a second session in the same week (guaranteeing themselves a payout of $20, for a gain of $2 over the expected winnings of $18). The remaining participants were assigned to the control arm. These individuals were not offered the insurance option; if they attended the second session as well as the first, they received a fixed sum of money—$2—in addition to the chance to play the lottery.

From a funder's perspective, this $2 payment for attending a second class is equivalent to the average payout it would take to indemnify the lottery under loss protection. The study design thus ensured that, on average, participants in both arms who participated in the same combination of classes each week would expect to receive the same amount of incentive money. Any difference in exercise patterns between these groups would therefore not be explained by the incentive's cash value and would have to stem from differences in the motivational effects of the incentive designs.

Setting

The study took place at QueensCare Family Clinics, which serves more than 30,000 patients in locations around central and eastern Los Angeles. QueensCare Family Clinics is a federally qualified health center that cares for financially disadvantaged and medically underserved individuals. The organization provides a variety of disease-management services to its clients. Primary care providers refer their patients to disease-management programs, such as clinician-taught classes about lifestyle, diet, exercise, and medication regimens. Case managers improve patients' adherence to care plans by helping them with educational, language, and logistical barriers. The clinics also offer free one-hour exercise classes in an on-site facility.

Participant Recruitment & Eligibility

Adult patients (18 years of age or older) who were referred to the exercise program by their primary care provider were invited to participate in the study if they were referred because they had a chronic disorder, such as diabetes, or because they were overweight or obese, with a weight-to-height ratio, or body mass index (BMI), of 25–40 kg/m^2. All patients meeting referral criteria, including physician clearance for exercise, were eligible. A bilingual enrollment coordinator recruited participants either by phone or in person from March 2012 to May 2014. Interested patients provided verbal consent. The coordinator scheduled the classes.

> "Deposit contracts help only those who agree to them"

At the first class of the program (Week 1, Class 1), participants received a one-time $10 payment and training on how the incentives would be issued. Training was based on study-arm assignment, as described below. After training, participants were asked a set of questions to ensure that they understood how the incentives would be administered; when needed, we provided additional training and retesting until comprehension was confirmed. (Find the questionnaires in Tables S1 and S2 of the Supplemental Material.)

Experimental Design

When participants enrolled in the study, we randomly assigned them to one of nine classrooms. Participants in five of the classrooms were in the loss-protection arm of the study, and participants in the other four classrooms were in the control arm.[21] The study was partially masked: Exercise instructors and statistical analysts were unaware of the incentive conditions. We had adequate statistical power to determine whether being in the loss-protection condition affected the outcome, as is described in the Supplemental Material, which also presents more details about the screening, enrollment, and randomization for this study (see Figure S1 in the Supplemental Material).

Exercise Program & Lottery

The exercise program offered 24 one-hour sessions—two per week across all 12 weeks. Each session included aerobic and nonaerobic exercise, and participants had to attend

the sessions in the classroom to which they were assigned at the start. All classes in a given room were taught by the same instructor and occurred either on Monday and Wednesday or on Tuesday and Thursday.

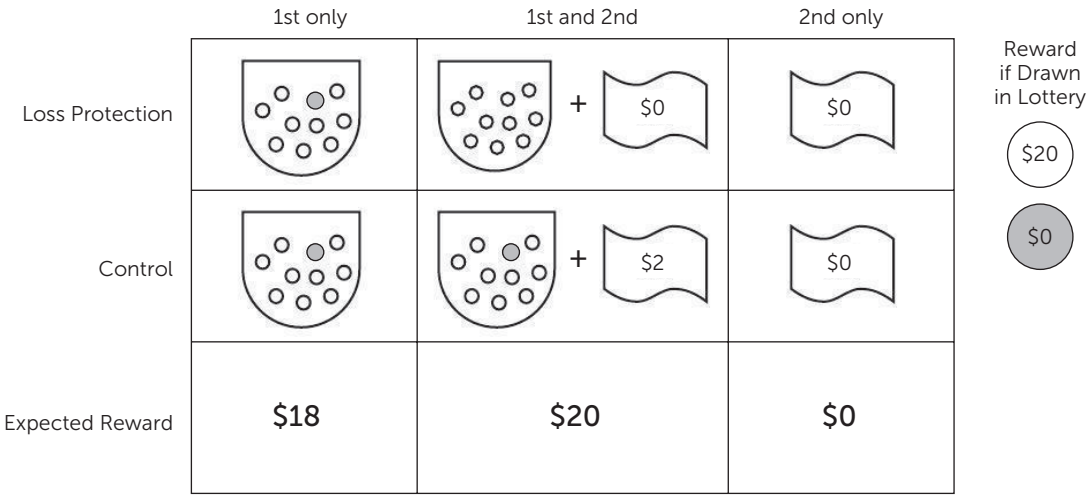
As noted in the Overview section, participants in each condition were given a ticket enabling them to participate in a lottery drawing as an incentive for completing the first session of the week. The lottery was held at the start of the first session the following week. It was carried out using a masked raffle drum containing nine green balls and one red ball. The drum was turned several revolutions before each participant reached in to grab a ball; participants could not see the color of the ball before they pulled it out of the drum. If a green ball was selected, the participant received $20 in cash. If the red ball cropped up, the participant received no payment.

Also as noted earlier, this arrangement yielded an average weekly anticipated payout of $18 (0.90 × $20 = $18) to each participant who attended only the first class of the week. We gave participants a lot of leeway for playing the lottery: they were not required to attend the exercise session at which they played the lottery, they could exchange an unused ticket for the chance to play any future lottery during the 12-week period, and they could play two or more unused tickets in a week. This way, the payouts relating to one week's participation were not affected by how the participant acted in the other weeks.

Loss-Protection Incentive & Control Condition

Figure 1 depicts the experimental and control conditions. In the loss-protection arm, participants who earned a lottery ticket by participating in the first exercise class session of a week could protect against the potential loss of the $20 lottery payout by also participating in the second session that week. This action would ensure a 100% chance of receiving payment, even if the person picked a red ball. Essentially, for them, all lottery balls were green. For someone in the loss-protection arm who attended all proffered classes, this insurance yielded an expected gain in reward of $2 per week (0.10 × $20 = $2) over

Figure 1. Comparison of incentives offered each week in the loss-protection & control groups, depending on which classes were attended



Note. Participants in both groups were offered two classes a week. Attending the first weekly class earned a ticket for a lottery to be played at the start of the first class held the following week. During the lottery, each participant drew one of 10 balls from a masked drum. Nine (depicted by the open circles in the figure) were worth $20; one (depicted by the solid circles in the figure) was worth nothing. Hence, each player had a 90% chance of winning $20, for an average expected take-home payment of $18 for attending the first class of the week. For the loss-protection group, also attending the second class of the week insured that all the balls drawn would be $20 winners (an expected gain of $2). For people in the control group, attending the second class of the week earned a flat cash payment of $2. Any pattern of attendance during the week yielded an equivalent expected reward for both groups.

what would likely be earned if the person had no insurance. Put another way, over 12 weeks, a person in either arm who attended only the first class each week would be expected to win 90% of the time, a yield of $216. Over 12 weeks, a person in the loss-protection arm who attended both sessions each week would win 100% of the time, a yield of $240. This difference amounts to $24 dollars, or an average of $2 per week—the amount of added earnings given to those who insured the lottery outcome with a second day of exercise.

In the control arm, participants who added the second class in a week to the first received a voucher for $2, an amount equal to the expected gain in reward received by the loss-protection group, for participating in that second class. People in this arm were not offered the ability to protect against loss and guarantee a lottery win. The control group received payment at the same time as the lottery group did. Thus, the financial rewards expected by people in the loss-protection and control groups were identical.

Primary & Secondary Outcomes Defined

Our primary outcome was the difference in the overall rate of exercise class attendance between the loss-protection group and the control group. We also examined secondary outcomes relating to patterns of attendance, including changes in rates of attendance by study week and by day of the week.

Statistical Analysis Methods

The attendance rate was calculated as the number of classes attended relative to the number offered. We analyzed the rate in multiple ways to ensure that the results were robust and not sensitive to any particular analytic approach. The details of these analyses are described in the Supplemental Material.

By randomly assigning participants to each condition, we equalized the probable influence on outcomes of such factors as how much participants liked gambling or exercise. Given that participants in the two conditions expected to gain the same amount of money for attending both exercise classes in a week, we hypothesized that if money alone motivated attendance, participants in the loss-protection condition and participants in the control condition would attend classes at equal rates (this was the null hypothesis). If, however, the opportunity to "purchase" loss protection with extra exercise added to the motivation provided by the cash, participants in the loss-protection condition would attend significantly more exercise classes than would people in the control condition. We assessed the differences between the two study conditions using logistic regression, which measured the probability of class attendance on any given day. The regression controlled for such potential confounds as different effects of the classrooms people were assigned to, the days of the week when classes were held, and which week was examined.

Results

Participant Characteristics & Attendance Patterns

Research coordinators contacted 488 eligible patients who were referred to an exercise class by clinic physicians: 153 (31%) enrolled. Of those, 79 were randomly assigned to the loss-protection group and 74 were assigned to the control group. Demographic characteristics and lottery outcomes by study arm are displayed in Table 1. The groups did not differ significantly in demographic characteristics or lottery outcomes. The average participant was 50 years old, obese (with an average BMI of 31.4 kg/m^2, which exceeds the standard 30 kg/m^2 obesity threshold), female, and Latino. Participants in both groups won the lottery at empirical

Table 1. Participant characteristics & lottery outcomes

Demographic characteristic	Loss protection (n = 79)	Control (n = 74)
Mean age in years (*SD*)	50.0 (10.3)	50.2 (9.3)
Mean BMI (*SD*)	31.8 (4.9)	31.0 (3.9)
Female	84.8%	83.8%
Latino/Hispanic	94.9%	87.8%
Lottery outcomes[a]	91.9%	91.0%

Note. BMI = initial body mass index; *SD* = standard deviation. For nonscientists: Subtracting the standard deviation from and adding it to the mean yields the range for 68% of the sample.
[a]The odds of winning a lottery were 90%.

"offering loss protection is more effective than offering a straight cash reward for added exercise"

frequencies very close to the expected 90% frequency (91.0% for the loss-protection group and 91.9% for the control group).

Effects of Loss Protection

Our data support the hypothesis that offering loss protection is more effective than offering a straight cash reward for added exercise.

Overall, for the 12-week study period, participants in the loss-protection group attended 64.8% of classes offered (95% CI [62.6%, 67.0%]), and participants in the control group attended 55.5% (95% CI [53.2%, 57.8%]). The 10% difference was significant (p = .01). (For information on the statistical notations used in this article, see note A.) We saw much the same pattern when we adjusted the data to statistically correct for baseline differences in exercise among individuals and between people assigned to different classrooms. The adjusted difference between the loss-protection and control groups was 15.8% (95% CI [0.5%, 31.2%], $p < .05$). We used the statistical approach known as randomization inference to evaluate the significance of the adjusted results. Table 2 shows the adjusted data comparing the effects of loss protection against the effects of a direct cash reward on the rate of class attendance. Unadjusted differences can be seen in Table S3 of the Supplemental Material.

Not surprisingly, participants in both groups were more likely to attend the first than the second class of the week. The adjusted difference between attendance rates on the first and second days—15.5% (95% CI [11.2%, 19.8%], $p < .001$)—no doubt stems from the fact that the lottery voucher earned at the first class of the week came with an expected value of $18, whereas attending the second class would be

Table 2. Rate of exercise class attendance, by study arm & day (exercise session N = 3,655)

Variable	*M*	*SE*	*p*[a]
Overall attendance			
Proportion loss protection	0.75	0.04	
Proportion control	0.59	0.06	
Difference	0.16	0.05	.0485
First day attendance			
First day loss protection	0.81	0.03	
First day control	0.68	0.04	
Difference	0.13	0.05	.0693
Second day attendance			
Second day loss protection	0.69	0.04	
Second day control	0.50	0.04	
Difference	0.19	0.05	.0415

Note. SE = standard error. Participants in the loss-protection arm attended a greater proportion of the offered classes than did participants in the control arm. The data shown were adjusted to account for such factors as first-day attendance levels of individuals and people assigned to different classrooms.

[a]For scientists: The p value for group differences was calculated using randomization inference with 10,000 permutations of linear combination of regression coefficients corresponding to each comparison. Unadjusted analysis used t test for group differences. See the Supplemental Material for more information.

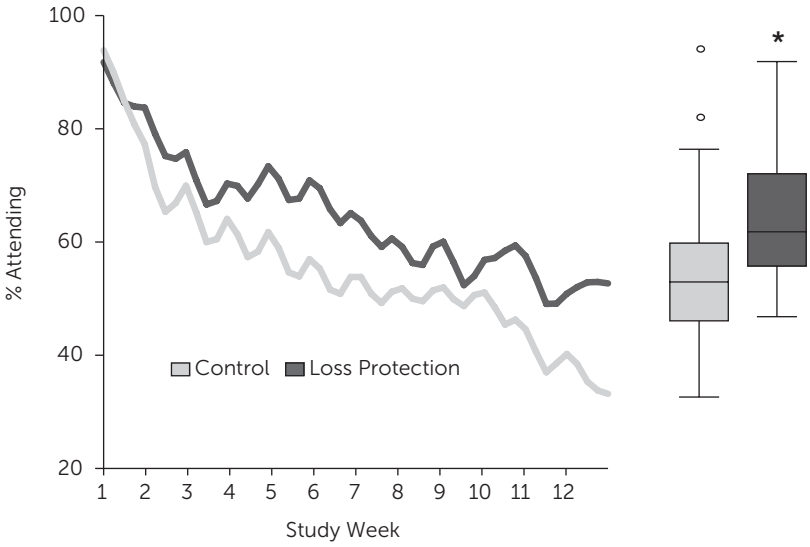
expected to add just $2 on average in a week. The participants in the loss-protection group did, however, attend more of the first-day and second-day classes than did the participants in the control group, although only the second-day differences retained significance after adjustment. The adjusted data show that participants in the loss-protection group attended 68.6% of the second-day classes and participants in the control group attended 50.0% of those classes, a difference of 18.6% (95% CI [0.006%, 36.01%], $p < .05$). In the early weeks of the study, the control and loss-protection treatment arm participants were more similar in their attendance patterns than they were in later weeks, as can be seen in Figure 2 here and in Figure S2 of the Supplemental Material (which breaks out attendance according to whether the class was the first or second of the week). Experiencing a lottery loss did not affect future class attendance.

Figure 3 depicts the mean expected earnings by week for the lottery protection and control conditions. The lottery protection group's expected earnings (that is, earnings based on probabilities rather than on whether they were actually lucky on the day of the drawing) are consistently higher than those of the control group, indicating that sponsors of an exercise program would have no reason to give people a choice between a loss-control or direct-reward incentive plan. Lottery insurance is favored each week to produce the greatest number of people willing to exchange exercise for a reward.

Discussion

We found that using an incentive structure with features of both reward and deposit contract programs led to better results than a reward program alone. Participants in an exercise program who were randomized to a loss-protection condition incorporating both features engaged in exercise 16% more often than did those in the reward-only control condition, even though participants in both conditions expected equivalent amounts of money for full participation. The ability to procure protection against losing a low-risk lottery each week by doing added exercise (attending the second

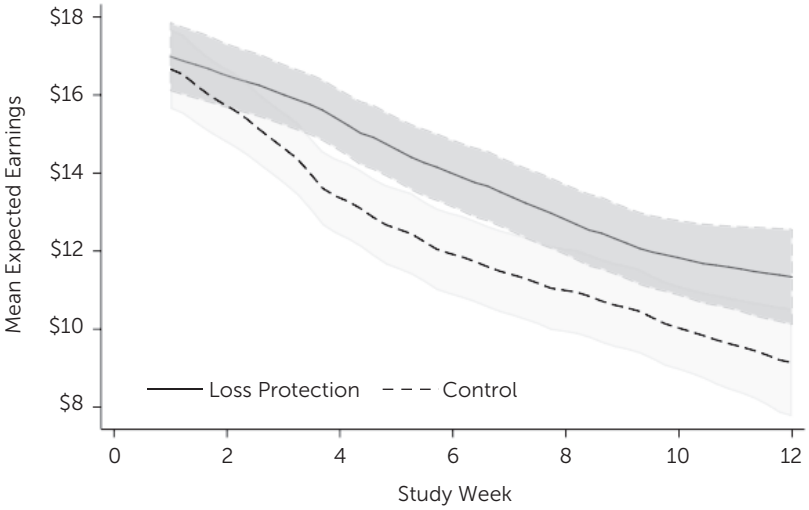
Figure 2. Average attendance by participants in the loss-protection & control groups, by week of study & overall



Note. Using adjusted data, the left plot shows that across the 12 weeks of the study, both groups had attrition, but fewer people in the loss-protection group than in the control group skipped classes each week. The right plot shows that overall, people in the loss-protection group attended more classes than those in the control group did. The plot at the right displays the interquartile range and median values (box boundaries and horizontal bars, respectively), high and low values (capped lines), and outliers (open circles). For nonscientists: The interquartile range is a measure of the overall attendance of the middle 50% of each group after its data were divided into four quartiles.

*For the difference between medians, $p < .01$.

Figure 3. Weekly mean expected earnings per person for the classes attended



Note. Despite being offered the same potential rewards, people in the loss-protection arm had higher expected earnings than did those in the control group—a reflection of the loss-protection group's harder work. (Anticipated earnings were $18 for attending the first class of the week, $20 for attending the first and second classes of the week, and $0 for attending no classes or only the second class.) The shaded areas represent 95% confidence intervals for the mean of expected earnings. The data are unadjusted.

"loss-protection incentive structures might combat the typical attrition seen in exercise and diet programs"

exercise class in a week after receiving a lottery ticket as a reward for attending the week's first class) appeared to promote overall greater attendance at the second class.

It is possible that factors beyond avoiding loss per se helped to increase the motivation of participants in the loss-protection group. For instance, the ability to take action to protect themselves from loss may have boosted participants' self-efficacy—that is, their sense of command over a situation (the lottery outcome) that would otherwise have been out of their control. Greater attendance at the first class of the week might have been spurred in part by a combination of knowing that control over obtaining the expected reward was in their hands and optimism bias: that is, they were confident that they would do what it took to earn insurance against losing the lottery.[22] As for the second session of the week, loss aversion or anticipated regret over losing the lottery for lack of effort could have helped to motivate attendance. Attendance at the two classes of the week, then, may have been spurred by somewhat different combinations of factors. These speculations may be fruitful areas for future research.

Risk aversion might also have played some motivating role in the loss-protection group, although theoretical models do not all agree on this point. Classic economic models of decisionmaking explain most insurance purchases, such as homeowner's protection, but they do not predict insurance-buying behavior well when the risks are low (as in our experiment).[23] Newer behavioral models, however, predict that risk aversion can indeed lead people to purchase insurance against small risks, and these predictions have been borne out in empirical investigations.[24] In prospect theory,[18] insurance purchase might be modeled as underweighting of a high probability gain relative to a certain gain. Or, alternatively, insurance could represent a payment to rid oneself of a potential loss of the lottery's value prior to it being played.[25] Each of these two approaches models the reference point differently. Our experiment cannot distinguish loss aversion from aversion to small risks.

In the early weeks, rates of attendance by participants in the control and loss-protection arms were more similar than in later weeks. This pattern suggests that loss-protection incentive structures might combat the typical attrition seen in exercise and diet programs.[26] Habit formation may have a role to play here. Attending more classes would have increased the likelihood that attendance would become more of a habit in the loss-protection group. And developing the habit of attending class as frequently as possible would ease the decision of whether to go each time by reducing the cognitive burden of calculating the value of attendance before each session. Greater habit formation in the loss-protection group might also result in exercise coming to have more intrinsic value for those individuals. Once ingrained, the habit might reduce the risk that when the external rewards are removed, competing activities will crowd out the motivation to exercise. Future work may help to better understand these dynamics.

Loss protection may be particularly suited to people who, as was true of our participants, have low incomes. People who are financially strapped might not be able to afford to put down money that they may then lose, but they may be willing to take nonmonetary steps that insure against losing a potential reward. Moreover, those who face financial stress also have to spend significant mental energy managing complex allocations of limited resources, often juggling resources to avoid the severe consequences of missing billing deadlines.[27] They may respond better to incentives that relieve these attentional demands than to incentives that strain their attentional resources. Low-income consumers may also be more open to the attractions of loss protection than other consumers are, if past findings are a guide. They

are more likely to purchase extended warranties and buyer protection plans than consumers in wealthier groups are,[28] even though these protection plans often end up costing more than they are worth. (The products being protected often have a low probability of failure, and any needed repairs often cost less than the purchase price of the protection plans.)

This study had several limitations. We did not evaluate health outcomes or have the power to detect clinically significant improvements in health status. We did not conduct a long-term follow-up or have a comparison group that did not receive lottery vouchers. And the design cannot distinguish whether the loss protection had a positive effect on attendance or whether the relatively low $2 reward for the control group on the second day discouraged attendance. However, such negative effects of low rewards have been observed only with much smaller rewards than the ones in this study.[29] Future longitudinal studies that include a control group and a maintenance phase could address many of the open questions.

The generalizability of the program also requires additional evaluation. As implemented, our program was relatively "high touch," with substantial effort devoted to training participants in the incentive schedule and verifying comprehension. If personal contact was necessary to achieve the treatment effect, this requirement might threaten the feasibility of applying the approach elsewhere. Further, we do not know whether our loss-protection intervention would be effective only in a low-income group. In prior work, we did find loss protection enhanced the response to a one-time activity in a broader sample,[20] but adherence to an exercise plan may be more challenging to maintain. Before the approach can be applied broadly, researchers will need to evaluate how well it fares in middle-income groups and in online programs (such as SticKK.com and SPAR) that can deliver incentives without extensive personal contact.

Follow-up studies should evaluate the effect of different incentive structures on habit formation and on long-term adherence in groups across levels of the socioeconomic spectrum. Lotteries have been shown to be effective in promoting behaviors useful to maintaining weight loss.[14] Some evidence shows that commitment contracts result in a lasting change in exercising.[9] A recent evaluation of incentive structures that sought to dispose gym members to view nonattendance as a loss produced only small, nonsignificant effects on attendance during the project and no impact on attendance later on.[30] Contrary to the one-time-incentive design of that study, our design involves a repeated (weekly) and public lottery that may make losses more salient to participants. The public nature of the lottery could also potentially increase participants' perception of the cost of a loss in a loss-protection group if peers and friends who are enrolled in the same exercise class have established a norm of procuring the loss protection. Whether loss protection, by increasing overall attendance, leads to greater habit formation is not yet known, but the lower attrition rates and implied differences in the intrinsic value of exercise in our study suggest that they may.

Exercise program participation rates are **29%–96%** when deposit programs mitigate against large losses, at the expense of motivation strength

The participation rate in deposit contract programs is **11%–14%** when required deposits are large

There is a **16%** increase in exercise engagement from a loss-protection approach over a reward-only approach

endnote

A. From the editors to nonscientists: For any given data set, the statistical test used depends on the number of data points and the type of measurement, such as proportions or means. The p value of a statistical test is the probability of obtaining a result equal to or more extreme than would be observed merely by chance, assuming that there are no true differences between groups under study (this assumption is referred to as the *null hypothesis*). Researchers traditionally view $p < .05$ as the cutoff for statistical significance, with lower values indicating a stronger basis for rejecting the null hypothesis. A 95% confidence interval (CI) for a given metric indicates that in 95% of random samples from a given population, the measured value will fall within the stated interval.

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Daniella Meeker and Jason M. Doctor had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors substantially contributed to the article. Financial support for this research was provided by Grants 1RC4AG039115, P30AG024968, and R33AG057395 from the National Institute on Aging of the National Institutes of Health. The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the article. The Institutional Review Board at the University of Southern California approved all study procedures (HS-11-00478), and the study was registered with ClinicalTrials.gov (NCT01823458) prior to study commencement. All participants were referred to the exercise classes by their physicians. We thank COPE Health Solutions and QueensCare Family Clinics for their collaboration on this project.

supplemental material

- http://behavioralpolicy.org/publications
- Methods & Analysis

references

1. Bijnen, F. C., Caspersen, C. J., & Mosterd, W. L. (1994). Physical inactivity as a risk factor for coronary heart disease: A WHO and International Society and Federation of Cardiology position statement. *Bulletin of the World Health Organization, 72*(1), 1–4.
2. Shiroma, E. J., & Lee, I.-M. (2010, August 17). Physical activity and cardiovascular health: Lessons learned from epidemiological studies across age, gender, and race/ethnicity. *Circulation, 122*(7), 743–752. https://doi.org/10.1161/CIRCULATIONAHA.109.914721
3. Yang, Q., Cogswell, M. E., Flanders, W. D., Hong, Y., Zhang, Z., Loustalot, F., Gillespie, C., Merritt, R., & Hu, F. B. (2012, March 28). Trends in cardiovascular health metrics and associations with all-cause and CVD mortality among US adults. *JAMA, 307*(12), 1273–1283. https://doi.org/10.1001/jama.2012.339
4. Lee, I.-M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., & Katzmarzyk, P. T. (2012, July 21). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *Lancet, 380*(9838), 219–229. https://doi.org/10.1016/S0140-6736(12)61031-9
5. Volpp, K. G., Asch, D. A., Galvin, R., & Loewenstein, G. (2011). Redesigning employee health incentives—Lessons from behavioral economics. *New England Journal of Medicine, 365*(5), 388–390. https://doi.org/10.1056/NEJMp1105966
6. Volpp, K. G., Levy, A. G., Asch, D. A., Berlin, J. A., Murphy, J. J., Gomez, A., Sox, H., Zhu, J., & Lerman, C. (2006). A randomized controlled trial of financial incentives for smoking cessation. *Cancer Epidemiology, Biomarkers & Prevention, 15*(1), 12–18. https://doi.org/10.1158/1055-9965.EPI-05-0314
7. Patel, M. S., Asch, D. A., Rosin, R., Small, D. S., Bellamy, S. L., Heuer, J., Sproat, S., Hyson, C., Haff, N., Lee, S. M., Wesby, L., Hoffer, K., Shuttleworth, D., Taylor, D. H., Hilbert, V., Zhu, J., Yang, L., Wang, X., & Volpp, K. G. (2016). Framing financial incentives to increase physical activity among overweight and obese adults: A randomized, controlled trial. *Annals of Internal Medicine, 164*(6), 385–394. https://doi.org/10.7326/M15-1635
8. Strohacker, K., Galarraga, O., & Williams, D. M. (2014). The impact of incentives on exercise behavior: A systematic review of randomized controlled trials. *Annals of Behavioral Medicine, 48*(1), 92–99. https://doi.org/10.1007/s12160-013-9577-4
9. Royer, H., Stehr, M. F., & Sydnor, J. R. (2012). *Incentives, commitments and habit formation in exercise: Evidence from a field experiment with workers at a Fortune-500 company* (NBER Working Paper 18580). National Bureau of Economic Research. https://doi.org/10.3386/w18580
10. Kullgren, J. T., Troxel, A. B., Loewenstein, G., Norton, L. A., Gatto, D., Tao, Y., Zhu, J., Schofield, H., Shea, J. A., Asch, D. A., Pellathy, T., Driggers, J., & Volpp, K. G. (2016). A randomized controlled trial of employer matching of employees' monetary contributions to deposit contracts to promote weight loss. *American Journal of Health Promotion, 30*(6), 441–452. https://doi.org/10.1177/0890117116658210
11. Epstein, L. H., Wing, R. R., Thompson, J. K., & Griffin W. (1980). Attendance and fitness in aerobics exercise: The effects of contract and lottery procedures. *Behavior Modification, 4*(4), 465–479. https://doi.org/10.1177/014544558044003
12. Halpern, S. D., French, B., Small, D. S., Saulsgiver, K., Harhay, M. O., Audrain-McGovern J., Loewenstein, G., Brennan, T. A., Asch, D. A., & Volpp, K. G. (2015). Randomized trial of four financial-incentive programs for smoking cessation. *New England Journal of Medicine, 372*(22), 2108–2117. https://doi.org/10.1056/NEJMoa1414293
13. Giné, X., Karlan, D., & Zinman, J. (2009). *Put your money where your butt is: A commitment contract for smoking cessation* (World Bank Policy Research Working Paper 4985). APA PsycNET. https://doi.org/10.1037/e596022012-001
14. Volpp, K. G., John, L. K., Troxel, A. B., Norton, L., Fassbender, J., & Loewenstein, G. (2008, December 10). Financial incentive-based approaches for weight loss: A randomized trial. *JAMA, 300*(22), 2631–2637. https://doi.org/10.1001/jama.2008.804
15. John, L. K., Loewenstein, G., Troxel, A. B., Norton, L., Fassbender, J. E., & Volpp, K. G. (2011). Financial incentives for extended weight loss: A randomized, controlled trial. *Journal of General Internal Medicine, 26*(6), 621–626. https://doi.org/10.1007/s11606-010-1628-y
16. Cawley, J., & Price, J. A. (2013). A case study of a workplace wellness program that offers financial incentives for weight loss. *Journal of Health Economics, 32*(5), 794–803. https://doi.org/10.1016/j.jhealeco.2013.04.005
17. Kőszegi, B., & Rabin M. (2006). A model of reference-dependent preferences. *The Quarterly Journal of Economics, 121*(4), 1133–1165.
18. Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263–292.
19. Loomes, G., & Sugden, R. (1983). Regret theory and measurable utility. *Economic Letters, 12*(1), 19–21. https://doi.org/10.1016/0165-1765(83)90106-4
20. Meeker, D., Thompson, C., Strylewicz, G., Knight, T. K., & Doctor, J. N. (2015). Use of insurance against a small loss as an incentive strategy. *Decision Analysis, 12*(3), 122–129. https://doi.org/10.1287/deca.2015.0314
21. Wei, L. J., & Lachin, J. M. (1988). Properties of the urn randomization in clinical trials. *Controlled Clinical Trials, 9*(4), 345–364. https://doi.org/10.1016/0197-2456(88)90048-7
22. Sharot, T., Riccardi, A. M., Raio, C. M., & Phelps, E. A. (2007, November 1). Neural mechanisms mediating optimism bias. *Nature, 450*(7166), 102–105. https://doi.org/10.1038/nature06280
23. Rabin, M. (2000). Risk aversion and expected-utility theory: A calibration theorem. *Econometrica, 68*(5), 1281–1292. https://doi.org/10.1111/1468-0262.00158
24. Bleichrodt, H., Doctor, J. N., Gao, Y., Li, C., Meeker, D., & Wakker, P. P. (2019). Resolving Rabin's paradox. *Journal of Risk and Uncertainty, 59*(3), 239–260. https://doi.org/10.1007/s11166-019-09318-0
25. Luce, R. D. (2014). *Utility of gains and losses: Measurement-theoretical and experimental approaches.* Psychology Press.
26. Sherwood, N. E., & Jeffery, R. W. (2000). The behavioral determinants of exercise: Implications for physical activity interventions. *Annual Review of Nutrition, 20,* 21–44. https://doi.org/10.1146/annurev.nutr.20.1.21
27. Mullainathan, S, & Shafir, E. (2014). *Scarcity: The new science of having less and how it defines our lives.* Picador.
28. Chen, T., Kalra, A., & Sun, B. (2009). Why do consumers buy extended service contracts? *Journal of Consumer Research, 36*(4), 611–623. https://doi.org/10.1086/605298
29. Gneezy, U., & Rustichini, A. (2004). Incentives, punishment, and behavior. In C. F. Camerer, G. Loewenstein, & M. Rabin (Eds.), *Advances in*

behavioral economics (pp. 572–589). Princeton University Press. https://doi.org/10.2307/j.ctvcm4j8j.26

30. Carrera, M., Royer, H., Stehr, M., & Sydnor, J. (2018). Can financial incentives help people trying to establish new habits? Experimental evidence with new gym members. *Journal of Health Economics, 58,* 202–214.