

Preschoolers' Delay of Gratification Predicts their Body Mass 30 Years Later

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Objective To assess whether preschoolers' performance on a delay of gratification task would predict their body mass index (BMI) 30 years later.

Study design In the late 1960s/early 1970s, 4-year-olds from a university-affiliated preschool completed the classic delay of gratification task. As part of a longitudinal study, a subset (n = 164; 57% women) were followed up approximately 30 years later and self-reported their height and weight. Data were analyzed using hierarchical regression.

Results Performance on the delay of gratification task accounted for a significant portion of variance in BMI (4%; $P < .01$), over and above the variance accounted for by sex alone (13%). Each additional minute that a preschooler delayed gratification predicted a 0.2-point reduction in BMI in adulthood.

Conclusion Longer delay of gratification at age 4 years was associated with a lower BMI 3 decades later. Because this study is correlational, it is not possible to make causal inferences regarding the relationship between delay duration and BMI. Identifying children with greater difficulty in delaying gratification could help detect children at risk of becoming overweight or obese. Interventions that improve self-control in young children have been developed and might reduce children's risk of becoming overweight and also have positive effects on other outcomes important to society. (*J Pediatr* 2012; ■: ■-■).

Over the last 30 years, the prevalence of overweight and obesity has risen substantially, and we now face a global obesity epidemic.¹ Contributing factors include people adopting more sedentary lifestyles and consuming more calories than in the past, due in part to the ready availability of supersized portions of cheap, easily consumed, calorie-dense foods and sweetened beverages.¹ Within this obesogenic environment, protective factors—including high self-control and ability to delay gratification—may help some people resist overeating and maintain a healthy weight.

The ability to delay gratification develops as children mature and learn to forgo less-valued short-term pleasures in favor of pursuing valued long-term goals. This ability depends on executive function (ie, cognitive control), the cognitive functions underlying effective attention deployment, self-monitoring, and planning. The preschool delay of gratification task assesses preschoolers' self-control by asking them to choose between a small immediate reward (eg, 1 marshmallow) or waiting for an unspecified time to earn a somewhat more desirable reward (eg, 2 marshmallows). A longitudinal study of children attending Stanford University's Bing Nursery School found that longer delay of gratification in the task at preschool age was associated with important outcomes (eg, adolescent academic strength, social competence, planfulness, ability to handle stress).² In some children, it was also associated with higher Scholastic Aptitude Test scores in adolescence and less illegal drug use in adulthood.^{3,4}

Recent research in other samples has identified a longitudinal association between children's self-control and weight.⁵⁻¹⁰ Results from a longitudinal study following children into adolescence found that children scoring low on self-control tasks at age 3 and 5 years had higher body mass index (BMI) and greater increases in BMI through age 12 years compared with children scoring high on these tasks.⁶ A study of 1000 New Zealanders found that levels of self-control in childhood (age 3-11 years) predicted health outcomes at age 32 years, including having at least 3 of 6 metabolic risk factors (eg, being overweight).¹⁰

In the present study, we used a longer (30-year) lag between assessment of self-control and measurement of BMI to test the a priori hypothesis that delaying gratification for a longer time in early childhood is associated with having a lower BMI in middle adulthood.

Methods

Between 1968 and 1974, 653 4-year-olds (52% female) attending the Bing Nursery School completed at least one version of the delay of gratification task. This

BMI Body mass index

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cohort has been followed longitudinally.^{11,12} As part of a recent follow-up (approved by the Columbia University Institutional Review Board), we sent participants 2 mailings asking them to report their height and weight. The first follow-up, which also included demographic questions, was mailed in December 2002/January 2003 to all participants for whom we had a valid address ($n = 306$). The second follow-up was mailed approximately 17 months later in May 2004. (We sent 2 mailings in an effort to obtain data from as many subjects in the original sample as possible.) All participants provided written informed consent for the follow-up. The current study includes the 164 participants (57% women) who completed the delay of gratification task at age 4 and reported their height and weight approximately 30 years later at the first follow-up ($n = 146$; 58% women) and/or the second follow-up ($n = 97$; 60% women). Seventy-nine participants (62% women) responded to both follow-ups. One woman's BMI data from the first follow-up and 2 women's BMI data from the second follow-up were not included in the analyses because these women had recently been pregnant and their weight might not have reflected their typical nonpregnant weight.

At the first follow-up, the mean age of participants was 39.0 ± 2.0 years (range, 34.0-42.9 years). The majority were married or engaged (72%), had one or more children (63%), and had a college degree or higher (44.5% with a bachelor's degree, 28.8% with a master's degree, and 21.2% with JD, MD, or PhD as their highest level of education).

In the delay of gratification task, the child was seated at a table with a bell in an experimental room. The experimenter asked the child if he or she would prefer a smaller or larger reward. The reward offered varied depending on the study condition; almost all of the conditions used food rewards (eg, 1 vs 2 cookies, marshmallows, or pretzels), but some conditions used pennies. (To the best of our knowledge, all participants in the current follow-up were offered food rewards in the task.) The experimenter explained that if the child could wait until the experimenter returned, then he or she could have the larger reward. Alternatively, the child could ring the bell on the table to bring the experimenter back immediately, but then the child would have to settle for the smaller reward. The experimenter then exited the room and returned if the child rang the bell. If the child continued waiting without ringing the bell, the experimenter returned after the preset maximum waiting time was reached (15 or 20 minutes, depending on the study). Delay duration was measured in seconds and durations exceeding 15 minutes were recoded as 15 minutes, to allow us to combine data across different versions of the delay task.

Most children completed more than one version of the task. Thus, to eliminate practice effects, only performance on the first task was analyzed, as had been done in previous studies.^{2,4} The delay task was used in a series of experimental studies examining the effects on delay times of reward visibility (eg, rewards visible vs covered by a tray) and of strategies for waiting (eg, focusing on the shape vs the taste of the rewards). Because delay times from these different experi-

mental conditions were not comparable and because the experimental condition for the first task varied, we followed the procedure used by Shoda et al³ and centered the delay times by subtracting from the participant's delay time the mean delay time of children from the same experimental condition.

We calculated participants' BMI (weight in kg/height in m²) from their self-reported height and weight at each follow-up and created a composite BMI measure by calculating the mean of the 2 BMI scores. If a participant reported his or her BMI at only one follow-up, this number was used. We created a composite measure because the 2 BMI scores were highly correlated ($r = 0.97$), preschool delay time did not predict the change in BMI in the 17 months between the follow-ups, and the composite provided the largest and most reliable sample.

Results

Descriptive statistics of participants' BMI scores are presented in **Table I**. We used hierarchical regression to examine the hypothesis that the number of seconds that preschoolers delayed gratification would account for a significant amount of variance in BMI 30 years later, over and above that accounted for by sex. For this purpose, sex was entered at step one of the regression (male = 0; female = 1), and the duration of delay was entered at step two. Increments in variance accounted for, overall R^2 , and standardized regression coefficients (β) for the final model are presented in **Table II**. Sex accounted for a significant portion of variance (13%) in the composite measure of BMI; that is, women tended to report a lower BMI than men. In addition, the duration of delay of gratification accounted for a significant portion of variance (4%) in the composite measure of BMI over and above the variance accounted for by sex, such that the longer a child was able to delay gratification at age 4 years, the lower his or her self-reported BMI tended to be approximately 30 years later. Specifically, each additional minute that a child delayed gratification predicted a 0.2-point reduction in BMI in adulthood.

Even when only the BMI scores from the first follow-up ($n = 146$) were used, the duration of delay accounted for

Table I. Descriptive statistics for participants' BMI and frequencies within BMI categories

	First follow-up (n = 146)	Second follow-up (n = 97)	Composite (n = 164)
BMI, mean \pm SD	23.9 \pm 3.8	24.2 \pm 4.8	24.3 \pm 4.4
Median	23.6	23.1	23.7
Range	17.2-35.7	17.2-46.0	17.2-46.0
Underweight (BMI <18.5), n (%)	7 (4.8)	5 (5.2)	8 (4.9)
Normal weight (18.5 \leq BMI <25), n (%)	93 (63.7)	57 (58.8)	101 (61.6)
Overweight not obese (25 \leq BMI <30), n (%)	33 (22.6)	29 (29.9)	40 (24.4)
Obese (BMI \geq 30), n (%)	13 (8.9)	6 (6.2)	15 (9.1)

Table II. Hierarchical regression analyses controlling for sex predicting BMI approximately 30 years later from duration of preschoolers' delay of gratification

	ΔR^2	β
Step 1	0.13*	
Sex		-0.36*
Step 2	0.04†	
Delay duration		-0.19†
Total R^2	0.17*	

Sex was coded as male = 0, female = 1.

* $P < .001$.

† $P < .01$.

a significant portion of variance in BMI (4%; $P = .009$), over and above the variance accounted for by sex alone (16%). Using only BMI scores from the second follow-up, with a smaller sample ($n = 97$), the effect was in the expected direction, but the amount of variance in BMI delay accounted for (3%) over and above the variance accounted for by sex alone (14%) was significant only at the $P < .10$ level (2-tailed; the β for delay with sex in the model was -0.16 ; $P = .099$.)

Discussion

As we hypothesized, our data show that delaying gratification longer at age 4 is associated with having a lower BMI approximately 30 years later. Although the effect was not particularly large, the presence of any effect 3 decades later is noteworthy. In addition, given the severity and intractability of the obesity epidemic, accounting for any of the variance in BMI may have practical implications. The magnitude of the effect in the current study is consistent with the finding of Duckworth et al.⁵ that self-control assessed in fifth grade (a composite measure that included performance on 2 delay tasks) accounted for 4% of the variance in BMI in eighth grade over and above the variance accounted for by demographic variables. Our results are also consistent with previous studies reporting a relationship between the duration of delay in early childhood and BMI status in early adolescence,^{6,7} and consistent with the longitudinal study of 1000 New Zealanders that found an association between childhood self-control and the presence of multiple metabolic risk factors (eg, being overweight) as an adult.¹⁰

Excess weight results when people consume more calories than they expend. Given the wide availability of appealing, calorie-dense foods, maintaining a healthy weight in the long term may require resisting the more immediate impulse to overeat. One explanation for our present findings may be that those who are more successful at delaying gratification at age 4 also may be more successful in regulating their caloric intake throughout life.

Indeed, successfully delaying gratification has been related to the use of attentional strategies that should also be helpful in regulating caloric intake. These strategies include not looking at the rewards, distracting oneself, and reminding oneself why one is waiting (ie, motivationally "cool" processing). Delaying gratification is also related to the inhibition of

such strategies as smelling the reward and thinking about how good the reward would taste (ie, motivationally "hot" or tempting processing).^{12,13} In general, performance on the delay of gratification task is considered to reflect cognitive control (ie, executive function), which enables people to suppress attention and inhibit responses to irrelevant information in the service of a desired goal.^{14,15} Thus, cognitive control should help people maintain a healthy weight by, for example, enabling successful implementation of strategies to regulate caloric intake. Identifying children who exhibit greater difficulty with cognitive control in general and with delaying gratification in particular could help detect children at risk of becoming overweight or obese.

Difficulty with cognitive control is a potentially modifiable risk factor. Interventions that improve cognitive control in young children exist^{16,17} and theoretically could reduce children's risk of becoming overweight. (Interventions designed specifically to help preschool children and obese children better self-regulate their caloric intake have also shown somewhat promising effects.¹⁸⁻²⁰) Interventions that improve children's cognitive control/self-control could be quite cost-effective because they could have positive effects on many outcomes important to society, including having a healthy adult BMI, general health, financial stability, and a reduced likelihood of being convicted of a crime (all outcomes associated with higher childhood self-control).¹⁰ Such interventions might lead to only modestly lower adult BMI—a decrease that might not be particularly clinically meaningful for a single individual but that on a population level could be quite meaningful from a public health perspective. Indeed, even at the individual level, preventing a modest amount of excess weight gain may be clinically meaningful, given that in obese individuals, even a 5% loss of body weight can have significant health benefits.²¹

Some important limitations of this study should be mentioned. First, the study relied on self-reported height and weight, and people tend to underestimate their weight somewhat, with heavier people underestimating their weight to a greater extent than lighter people.²² Self-reported height and weight tend to be fairly accurate, however²³⁻²⁵; one study ($n = 4808$) found that participants only somewhat underestimated their actual measured BMI (women by a mean of 0.72 BMI units and men by a mean of 0.96 BMI units).²² In the present study, BMI scores from the 2 follow-ups were highly correlated ($r = 0.97$), even though participants were unlikely to remember the height and weight that they reported 17 months earlier. Based on the reliability of the 2 BMI scores, we would not expect to see different results had BMI been calculated from measurements rather than from self-report.

A second limitation is related to the study's correlational nature, precluding causal inferences regarding the relationship between delay scores and BMI. A third limitation is that the study sample was primarily white and not representative of the US population. The sample also generally had relatively high socioeconomic status (which is presumably associated with stronger executive function and thus lower BMI). Moreover, only 24.4% of the participants were

overweight but not obese, and 9.1% were obese. In contrast, in 2007-2008, 34.2% of US adults were overweight but not obese and 33.8% were obese.²⁶

A fourth limitation of the study is that we were not able to control for risk factors for obesity, such as maternal and childhood BMI. It seems likely, however, that most participants were of normal weight when they completed the preschool delay task, given the time period (late 1960s and early 1970s) and the fact that only approximately one-third were overweight or obese by their mid-30s. Finally, this study used a single measure of executive function. Future longitudinal studies should use multiple objective measures of executive function and also assess possible mediators (eg, childhood and adolescent diet and physical activity) and moderators (eg, maternal BMI, parental social class, intelligence) of the relationship between executive function and adult BMI.

Obesity prevention efforts have begun to focus on changing food environments and societal norms that encourage a sedentary lifestyle.¹ Instituting changes to the obesogenic environment should be the primary focus of prevention, but implementing interventions to enhance young children's ability to self-regulate and delay gratification may be fruitful as well. ■

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