

Exercise Improves Academic Performance

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In a randomized controlled trial, we test whether removal of a barrier to exercise can improve academic performance. We find strong support for this hypothesis: University students who were provided with a free gym card exercised more and had a significant improvement in academic performance. The treated students were less likely to drop out of classes and to fail at the exam. We provide evidence showing that exercise caused a healthier lifestyle and increased perceived self-control, which ultimately improved academic performance. The study

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demonstrates that removing barriers to physical activity can be an important tool for improving educational achievements.

I. Introduction

Is regular physical exercise important for educational achievements? This question relates to key debates in educational policy. In the United States, for example, there is a growing concern that physical education is no longer considered a critical element of schooling: In some areas of the country, half the students report having no physical education in an average week (De La Cruz 2017). This lack of activity may contribute to bad health and obesity and is a major concern in all OECD countries (OECD 2017).

Physical activity may also be important for academic performance through enhanced psychological health, habit formation, and changes in the brain, supporting cognitive function and learning (Centers for Disease Control and Prevention 2010; Biddle and Asare 2011; Booth, Roberts, and Laye 2012; Reiner et al. 2013; Khan and Hillman 2014; Mura et al. 2015; Wiebe and Karbach 2017; Young et al. 2018). At the same time, it may worsen academic performance by directing time and attention away from studying. While there is research suggesting a positive association between physical activity and academic performance, the evidence is mixed, and even more importantly, very little is known about the causal pathways of the association (Grissom 2005; Aaltonen et al. 2016).

In this paper, we report the results of a large randomized controlled trial that removed a barrier to exercise by providing free gym cards to university students in Bergen, Norway. We measured the effect of this intervention on the students' academic performance relative to a control group that was not offered a free gym card. We combine complete and precise administrative data on both gym attendance and academic performance with subjective survey data (baseline and follow-up) on self-control,

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lifestyle habits, study hours, and happiness. The administrative data on academic performance have zero attrition in the main variable of interest, and the randomized controlled trial therefore offers a clean identification of the causal effect of providing a free gym card on academic performance. The administrative data on gym attendance and the detailed survey data (with less than 5% attrition) further allow us to provide evidence on the underlying mechanisms of the relationship between removing a barrier for exercise and academic performance. Our analysis builds on a pre-analysis plan registered after the posttreatment data collection was completed but before the researchers had access to the data.¹

In our study, removing a barrier for physical activity by providing a free gym card generates a strong and significant increase in exercise and an improvement in academic performance. We find that the treated students completed on average 0.15 standard deviations more courses than students in the control group, which is driven by them dropping fewer classes and failing fewer exams. The finding is robust to the inclusion of a rich set of control variables and multiple-hypothesis testing. The increase in completed courses did not have a negative effect on grade average. Further analysis shows that the increase in exercise was critical in enhancing academic performance, but also highlights that there is an optimal level of exercise for promoting academic performance.

We provide two sets of evidence on the mechanism driving the effect of exercise on academic performance. First, we show that the intervention has strong positive effects on perceived self-control and lifestyle, which are well known to be important dimensions for learning. Second, a pre-specified heterogeneity analysis of the treatment effect, based on whether the students are below the median in terms of perceived self-control, lifestyle, happiness, and study hours, shows that there are consistently very strong treatment effects on academic performance for those who struggle in these dimensions at baseline. The students who struggled in all four dimensions have an estimated treatment effect of 0.5 standard deviations in completed courses. Hence, the evidence suggests that our intervention is a powerful tool for human-capital accumulation, by causing positive changes in self-control and lifestyle that ultimately lead to an improvement in academic performance.

The findings are consistent with previous research showing that exercise promotes a healthier lifestyle in terms of sleep and dietary habits (Driver and Taylor 2000; Youngstedt and Kline 2006; Fleig et al. 2011) and strengthens executive functions such as self-control, flexible thinking, working memory, and planning (Oaten and Cheng 2006; Hillman,

¹ The preanalysis plan was registered at the Registry for Randomized Controlled Trials operated by the American Economic Association (RCT ID: AEARCTR-0001949); see also app. D (apps. A–D are available online).

Erickson, and Kramer 2008; Smith et al. 2010; Audiffren and André 2015; Berryman, Pothier, and Bherer 2017; Salas-Gomez et al. 2020). There is also evidence suggesting that practicing self-control may increase self-efficacy (Bandura 1977; Muraven 2010) and that increased self-control in one domain may carry over to other domains (Oaten and Cheng 2006; Duhigg 2012; Schilbach 2019). Finally, there is a literature documenting that lifestyle and self-control affect academic performance (Ariely and Wertenbroch 2002; Duckworth and Seligman 2005; Short et al. 2013; Kim and Seo 2015; Donnelly et al. 2016; Hysing et al. 2016). Our study connects and integrates these different literatures by providing evidence of an increase in exercise improving academic performance through changes in self-control and lifestyle.

We also provide some suggestive evidence on which barriers were removed by providing the students with a free gym card. At baseline, about 20% of participants reported that they did not exercise because they found the gym card too expensive, and about 13% reported that they did not have time to exercise. We show that the treatment effect on gym visits is larger for the group that has financial constraints but no time constraints than for the rest of the sample, and smaller for the group that has time constraints. However, a large majority of students do not report having financial or time constraints at baseline, which suggests that the free gym card primarily removed psychological barriers to exercise. This is in line with the fact that many participants reported at baseline that they did not exercise at the gym because they were lazy, which may be interpreted as a sign of procrastination. The existing literature suggests different mechanisms that can explain why the free gym card contributed to removing psychological barriers to exercise. Having a free gym card may have increased the disutility from not exercising by removing an excuse for not going to the gym (Exley 2016; Lepper 2022) and by making salient the injunctive norm that one should go to the gym and exercise (Bordalo, Gennaioli, and Shleifer 2012, 2013). It may also have represented a temporal landmark that gave the students a fresh start and increased the motivation for goal setting (Clark et al. 2020).

An important issue for any field study is the external validity of the findings, which rests on the selection of study participants, attrition, naturalness of the study environment, and the possibility for scaling (the SANS conditions; List 2020). In particular, policymakers might wonder whether they can expect a similar treatment effect if the intervention is implemented at scale (Al-Ubaydli, List, and Suskind 2020; Al-Ubaydli et al. 2021), and whether it passes a benefit-cost test. We will argue that the present study indeed satisfies the SANS conditions. In terms of selection of participants, the students in our study span two different institutions and all major study programs. Hence, they can be considered largely representative of the general student population in Norway in terms of relevant

observables. Further, we have no attrition in academic performance (which is measured using administrative data) and minimal attrition in the follow-up survey. The study was also implemented in a natural environment and with a relevant time frame. Hence, the finding that providing free gym cards to students who do not exercise regularly improves their academic performance, particularly for struggling students, is likely to replicate and generalize to other student populations.

We also believe that it should be quite easy to scale up the treatment, since providing a free gym card does not require significant human involvement and is unlikely to impose any congestion in the gyms. In a simple back-of-the-envelope calculation, we can compare the costs of providing a free gym card with the additional income that the respective education institutions get from the Norwegian government because of the treated students completing more study points. The higher education institutions in Norway are on average paid 2,350 NOK for each completed study point.² We find that providing a free gym card causes an average increase of 1.74 study points in the treatment group, which translates into an estimated increase in income for the education institutions of 4,089 NOK per student. If we focus on the students who struggled at the baseline, we find an increase of 5.93 study points and correspondingly an estimated increase in income for the educational institutions of about 14,000 NOK. In comparison, the market price of a gym membership for one semester in Norway is about 1,800 NOK. Hence, given the estimated treatment effect, the increase in income for the educational institutions is greater than the cost of providing the gym card.

This back-of-the-envelope calculation is not meant to represent a comprehensive benefit-cost analysis, and we would like to highlight some important issues that need to be addressed in an overall policy evaluation of this type of intervention. First, as required in scientific studies we had to ask subjects for informed consent, which implies that we have a self-selected sample that might be more positively inclined to exercise (relative to the remaining student population without a gym membership). However, this is a genuine uncertainty of any finding from a randomized controlled trial that adheres to common ethical guidelines. Second, winning a free gym card as part of a research study might be perceived differently compared to simply receiving a free gym card from the educational institution. Third, a general question for this type of intervention and the broader benefit-cost analysis is whether to consider a universal or targeted

² See table 4.2 in the report on financing of higher education in Norway that was released by the Ministry of Education on March 17, 2022 (<https://www.regjeringen.no/no/dokumenter/finansiering-av-universiteter-og-hoyskoler/id2904847/>). The payment for study points depends on the study program and ranges from 1,400 NOK to 4,100 NOK. In our calculations, we have used the unweighted average since the universities involved in this study cover all the different study programs.

approach. A universal approach, in line with what is common in the United States, would be to offer a free gym card to all students, while a targeted approach would be to try to screen the students and offer a free gym card to those who are identified as struggling in their studies.

Moving beyond the population of students in higher education, there is growing evidence suggesting that physical activity and exercise is an efficient way to enhance neurocognitive functions throughout life (Berryman, Pothier, and Bherer 2017), which means that the type of intervention studied in this paper may have broad applicability. The insights may be especially important for child development. The World Health Organization (2019) argues that there is a global epidemic of childhood inactivity, and that the benefits of physical activity are particularly high in early childhood (under 5 years of age). In this age group, there is rapid physical and cognitive development and extensive habit formation, potentially with long-term implications. The report argues that early childhood lifestyle behaviors may have lasting effects on physical activity throughout the life course, which suggests that exercise habits should be promoted and preserved early in life (Aarts, Paulussen, and Schaalma 1997). Interestingly, the focus of the report is on the health implications of physical inactivity, while the present study provides evidence suggesting that increased physical activity in early childhood also may have important implications for human-capital accumulation.

Indeed, a growing number of studies have provided evidence suggesting that physical exercise strengthens executive functions in children (Alvarez-Bueno et al. 2017), and it is well established that executive functions, including self-control, are crucial for the formation of academic skills and more broadly also for behavioral and emotional regulation in childhood and adolescence (Berthelsen et al. 2017). In line with this, there are several studies suggesting that there is a positive association between physical activity and academic performance among children (Haapala 2012). Further, a number of studies have shown that socioeconomic status is a strong predictor of physical activity among children (Love et al. 2019). The removal of barriers for physical exercise at an early age may thus be an important dimension in policies aiming at reducing the socioeconomic gradient of human-capital formation in childhood (Heckman 2006).

Increasing physical activity in childhood is likely to involve parents, the schools, and the broader community (Mitchell 2019). Parents are important in terms of both facilitating physical activity for young children outside of school and creating lifestyle habits. They are likely to face many of the same barriers as the students in our study (financial, time, psychological), and thus there are several possible removal-of-barriers strategies that may foster increased physical activity for young children through their parents. In particular, the removal of financial barriers to exercise

may be a key strategy for reaching low socioeconomic status parents, and may also initiate some of the same psychological mechanisms discussed in the present study. In schools, a question is whether to reallocate time from academic classes to physical exercise. The present study suggests that this trade-off is more subtle than sometimes recognized, since a certain level of physical exercise is likely to be beneficial for learning. Further, the removal-of-barriers approach may also be important at the school, for example to ensure that all children have the equipment needed to take part in physical activity. Finally, at the community level, the removal-of-barriers approach may involve making parks and playgrounds more accessible for families with small children.

Our paper contributes to several literatures.³ Most importantly, it offers novel causal evidence to the literature studying the relationship between physical activity and academic achievements (Rasberry et al. 2011; Haapala 2012; Howie and Pate 2012; Singh et al. 2012; Felfe, Lechner, and Steinmayr 2016; Álvarez-Bueno et al. 2017), including the nonexperimental literature in economics reporting positive effects on educational achievement from participation in sports activities in adolescence (Lipscomb 2007; Pfeifer and Cornelissen 2010; Stevenson 2010). Haapala (2012) identified nine randomized or quasi-randomized controlled trials on the relationship between physical activity and academic performance for the period 1966–2011, all with small samples of children or adolescents and challenging designs.⁴ He concludes (p. 153), “Physical training may improve academic performance in children and adolescence, but evidence is lacking.” We show that exercise causally improves academic performance among university students, and especially among the students who struggle with lifestyle and self-control at baseline, consistent with the findings in a correlational study of 12,000 university students in Norway (Hayley et al. 2017).

Turning to the experimental literature on behavioral interventions, there is strong evidence that financial incentives can affect behavior at least while these incentives are present (Charness and Gneezy 2009; Gneezy, Meier, and Rey-Biel 2011; Volpp et al. 2011; Acland and Levy 2015; Babcock et al. 2015; Royer, Stehr, and Sydnor 2015; Carrera et al.

³ See also app. B, wherein we discuss Mischel, Shoda, and Peake (1988), Pintrich and De Groot (1990), Shoda, Mischel, and Peake (1990), Wolfe and Johnson (1995), Eshel and Kohavi (2003), Tangney, Baumeister, and Boone (2004), Vohs and Baumeister (2004), Blair and Razza (2007), Duncan et al. (2007), McClelland et al. (2007), Liew et al. (2008), and Burger, Charness, and Lynham (2011).

⁴ Five of these nine studies (McNaughten and Gabbard 1993; Zervas and Stambulova 1999; Budde et al. 2008; Budde et al., 2010; Ellemborg and St-Louis-Deschenes 2010) examined the effect of exercise, while the other four studies (Dwyer, Blizzard, and Dean 1996; Sallis et al. 1999; Ahamed et al. 2007; Davis et al. 2011) looked at physical training and academic performance. The results are mixed, and the research designs make it difficult to establish robust conclusions.

2017; Homonoff, Willage, and Willén 2020). However, on the basis of existing evidence from randomized controlled trials, there has been less success in using direct financial incentives to increase academic performance (Angrist, Lang, and Oreopoulos 2009; Fryer 2011; Levitt, List, and Sadoff 2016). Scott-Clayton (2011) and Garibaldi et al. (2012) report more positive results in the educational context using quasi-experimental approaches. A major challenge with direct incentives to improve academic performance is that many policymakers and educators object to paying students to study, arguing that this could crowd out the existing intrinsic motivation to do so. Our approach avoids this criticism by using an indirect approach. We remove the barrier to gym exercise for students and show that it has large positive spillover effects on students' academic performance. Our findings show that the rate of return of behavioral interventions may be greater than a narrow perspective may indicate (see also Bjorvatn, Ekström, and Pires 2021). Interventions may not only affect the investments in the targeted good (exercise), but they may also produce indirect spillover effects in other types of investment goods (education).

Finally, our paper contributes to the literature studying the importance of noncognitive skills for human-capital investments (Cunha et al. 2006; Heckman, Stixrud, and Urzua 2006; Heckman, Pinto, and Savelyev 2013; Alan and Ertac 2018; Alan, Bonerva, and Ertac 2019). Noncognitive skills may promote academic performance directly, for example by helping students persist with exam preparation during intense study periods. They may also have an indirect effect by helping students maintain a lifestyle that maximizes academic potential. The consensus in the literature is that self-control, broadly defined, is an important factor for academic performance, and perhaps even more important than cognitive skills (Duckworth and Seligman 2005; de Ridder et al. 2012; Heckman and Kautz 2012). Increased self-control seems directly linked to improved focus and concentration (facilitating regulatory behaviors that put aside distractions and unhelpful thoughts) and to healthy lifestyle choices.⁵ We contribute to this literature by showing that exercise induces improved perceived self-control and a healthier lifestyle, which ultimately causes improvements in academic performance. Several mechanisms may explain our findings, including self-signaling (e.g., Benabou and Tirole 2004) and habit formation.

The paper proceeds as follows. Section II describes the experiment in more detail, section III outlines the hypotheses and the empirical strategy, section IV presents the main results, section V discusses possible mechanisms, and section VI concludes. Supplementary analysis and material are reported in appendixes A–D, which are available online.

⁵ See, e.g., Best (2010), Muraven (2010), Diamond (2012), Ozdenoren, Salant, and Silverman (2012), Loprinzi (2015), Schöndube et al. (2017), and Tian et al. (2018).

II. The Experiment

We recruited undergraduate students at the campuses of the University of Bergen (UIB) and Bergen City College (HIB), both located in Bergen, the second largest city in Norway. The students were randomly assigned to a treatment or a control group, where the treatment provides free membership at the student gym (SIB). Gym membership is not free at universities in Norway, and the present study thus investigates a different environment than a typical US university, where most previous studies of exercise were conducted.

A. Recruitment

The recruitment took place across the campuses of the UIB and HIB. Students who were interested in participating received a booklet containing an information sheet, a consent form, and a baseline survey. Each participant was asked to sign the consent form and upon returning the booklet was paid 100 NOK (equivalent to \$12.50 at the time of the experiment). We informed participants that everyone who fulfilled the stated requirements would have at least a 40% probability of winning a free gym card at SIB for the spring term of 2016. The main requirements were that they be registered as students at UIB or HIB and not presently members of any gym. The regular price of a gym card at SIB was 1,100 NOK in 2016; for comparison, the compulsory membership fee to the student welfare organization is 550 NOK. Participants were also informed that they would have the opportunity to participate in paid follow-up surveys via text messages or emails (see app. C for the information sheet and baseline and follow-up surveys).

B. Timeline

Table 1 gives an overview of important dates and events in the study. The semester started the second week of January. Recruitment for the experiment was done in the first week of February 2016, which has two advantages. First, 30%–40% of the student population at both institutions pays the membership fee at the student gym in each semester. By targeting students who were not yet members of the gym 3 weeks into the semester, we were able to recruit participants who are less likely to have a regular exercise regime. Second, the deadline for course registration was February 1, which implies that the announcement of the study, participation, and treatment assignment cannot influence the courses for which students chose to register.

The students who won the free gym card could collect it from February 16. Since the academic semester ended June 17, the relevant exercise

TABLE 1
TIMELINE

Date	Event
January 11, 2016	Start of spring semester
February 1, 2016	Deadline for course registration
February 1–8, 2016	Recruitment of participants and baseline survey
February 10–12, 2016	Screen out preexisting SIB members and randomize to treatment
February 15, 2016	Inform participants on whether they won gym card at SIB or not
February 16, 2016	Possible to pick up gym card and begin exercise
March 21–28, 2016	Easter break
May 2–June 17, 2016	Exam period
May 9, 2016	Follow-up survey sent via email and SMS to participants
June 17, 2016	Academic semester ends
June 30, 2016	Gym card expires

NOTE.—Entries in bold indicate key events in the experiment.

period is roughly 4 months. The academic semester is divided in two parts: the teaching period (January–April) and the exam period (May–June). The follow-up survey was distributed to participants in the middle of May.

C. *The Sample*

In total, 817 students signed the consent form and returned the booklet. Six students filled in the booklet twice; we only included the first booklet turned in. We excluded 32 students who already had a gym card at SIB according to the administrative records. Another two students were registered at other educational institutions than UIB and HIB, for which we did not have administrative data on academic performance, and one student withdrew from the study after handing in the booklet. After these exclusions, we were left with 782 participants who were included in the study.

We randomly selected 400 students out of the 782 to receive a free gym card, and they constitute the treatment group.⁶ The remaining participants constitute the control group. All participants in the treatment group received an email and a text message on February 15, in which

⁶ The total student population at the two universities included in this study is about 25,000 students. Since the students offered a gym card only represent less than 2% of the total student population at these institutions and the intervention did not introduce any capacity constraints at the student gym, we find it reasonable to assume that the potential outcomes for any student do not vary with the treatment assigned to other students (the SUTVA assumption). We had three subtreatments in our study design, with some students being assigned a personal trainer or a bonus scheme in addition to the free gym card. We do not have statistical power to detect differences across the subtreatments, as prespecified, and therefore focus on the full treatment sample in the main analysis. In table A13 (tables A1–A17 are available online), we report the results for the subtreatments, where we in each subtreatment observe the same patterns as in the main analysis.

we informed them that they had been randomly selected to receive a gym card that they could pick up at one of SIB's gyms. After the randomization had taken place, one participant from the control group withdrew from the study, and three other participants, one control and two treated, turned out not to be registered as students at either UIB nor HIB. We base the analysis on the remaining 778 participants.

Table 2 presents the background characteristics, measured at baseline, for the full sample (col. 1), and separately for the treatment group and the control group (cols. 2 and 3). In column 4, we show that all background characteristics are balanced between the treatment group and the control group. Participants were on average 22 years old and in their second year at the university; about 50% of the sample is female and about 50% studies at each of UIB and HIB.

Self-control, lifestyle, study hours, and happiness are prespecified self-reported background variables used in the discussion of mechanisms. "Self-control" is an index based on four questions taken from a larger set of questions that assess the stated willingness to wait in the preference survey module on time discounting by Falk et al. (2016): (1) "I am a person who often acts too hastily." (2) "I have difficulties resisting temptations." (3) "I have a tendency to procrastinate on things, even though it would be best to take care of them quickly." (4) "I am a person who follows my plans." Each question was answered on a scale of 1–10, expressing the extent to which the participant agreed with the statement (1 = completely disagree, 10 = completely agree). The index is the rescaled

TABLE 2
BALANCE TEST

	Overall (1)	Control (2)	Treatment (3)	<i>p</i> -Value (Treatment-Control) (4)
Age	22.258	22.316	22.204	.640
Female (1/0)	.533	.550	.518	.366
Year of study	2.008	2.034	1.982	.561
UIB (1/0)	.519	.500	.538	.294
Self-control (1–10)	5.814	5.751	5.875	.249
Lifestyle	.004	–.025	.032	.703
Study hours	22.599	22.884	22.330	.475
Happiness (1–10)	7.340	7.287	7.391	.412
Registered study points	33.838	33.868	33.809	.955
Observations	778	380	398	

NOTE.—Age and year of study are in years. UIB = 1 if the student is at the University of Bergen (0 if at Bergen City College). "Self-control" comprises four questions; a higher number means more self-control. "Lifestyle" is a standardized measure of sleeping habits and satisfaction with health; a higher number means better lifestyle. "Study hours" is total hours spent studying (including lectures) the week prior to the baseline survey. "Happiness" is the answer to a question about general life satisfaction; a higher number means higher life satisfaction. "Registered study points" is the number of course credits in graded courses for which a student was registered.

average of the responses to questions, with a higher value corresponding to having more self-control. As shown in table A1, the components of the index are significantly correlated.

“Lifestyle” is the combination of the responses to three questions in the baseline survey, where each response is standardized to have a zero mean and a standard deviation of 1. The three questions are as follows: (1) “How many days last week did you go to bed after midnight?” (2) “How many days last week did you feel tired/unrested?” (3) “How satisfied are you currently with your health?” (The scale was 1–10; 1 = very unsatisfied, 10 = very satisfied.) On average, students report at baseline going to bed after midnight and being tired more than 3 days every week, with more than 30% of the students reporting this for at least 5 days every week; they also self-report being somewhat happy with their health. The index is the sum of the responses to these three questions with the values of questions 1 and 2 rescaled such that a higher number means going to bed earlier, feeling less tired, and being more satisfied with your current health. Hence, a higher value on the index serves as a proxy for a healthy lifestyle. In table A1, we show that the components in the lifestyle index are significantly correlated at baseline, and are also significantly correlated with most of the self-control questions.

“Study hours” is the self-reported number of hours studied, including attended lectures the week prior to the baseline survey. On average, participants reported having spent 23 hours studying that week. “Happiness” is the answer to the question, “How satisfied are you currently with your life in general?” (The scale again was 1–10; 1 = very unsatisfied, 10 = very satisfied.)

“Registered study points” is the sum of course credits that a student signed up for at the beginning of the semester. On average students registered for courses worth 34 ECTS (European Credit Transfer and Accumulation System) credits, which indicates that students sign up for slightly more course credits than the 30 ECTS credits that correspond to full-time study (likely reflecting some uncertainty among students about which courses to focus on at the beginning of the semester). Table A2 provides an extended version of the balance table, including variables that were not part of the preanalysis plan. We show that academic performance in the fall semester prior to the intervention balances across treatments.

D. Data Sources

We draw on four data sources in the analysis. First, from the baseline survey we have the background characteristics of the participants, including gender, age, and year of study. In addition, to further explore the underlying mechanisms, we use a battery of questions related to self-control, lifestyle habits, study hours, and happiness at baseline.

The second data source is the scanner data on each occasion a participant swiped their gym card at one of the SIB gyms, which gives us the total number of gym visits during the semester. The student gym created a unique identifier within its IT system for each student participating in the study, which enabled SIB to keep track of whether students in the control group bought a gym card at SIB and began to exercise.

Third, from UIB and HIB we have the complete administrative data related to the academic performance of each student. These include records of which courses a student registered for at the beginning of the semester, which exams a student registered for later in the semester, the number of completed study points that the student obtained at the end of the semester, and the grade received on each exam. In figure 1, we show the link between the variables “registered study points” (RSPs), “exam study points” (ESPs), and “completed study points” (CSPs). The difference between RSPs and ESPs captures the extent to which students *drop out* of courses during the semester, whereas the difference between ESPs and CSPs captures the extent to which students *fail* at exams. “Grade average” (GA) is the average grade in a given semester for the courses that the student passes, weighted by study points.⁷

Our final data source is the follow-up survey, which provides self-reported data on relevant outcomes that are not captured in the administrative data. It includes (as the baseline) questions related to self-control, lifestyle, study hours, and happiness, which allows us to identify the causal effect of the intervention on these dimensions.

A concern in any field experiment is a Hawthorne effect, according to which an improvement in the performance of participants could result from their response to the feeling that they are being accorded some attention.⁸ Several features of our study make it unlikely that there would be a strong Hawthorne effect. First, the students were only given explicit attention when we conducted the surveys at the beginning and at the end of the semester; there was no focus on this study throughout the semester. Second, the emphasis in the interaction with the students was

⁷ In the calculation of GA, we use a numeric scale (1–5) where A equals 5 and E equals 1; F = 0 means that the student fails the course and these courses are not included in GA. The majority of students take four courses per semester, each worth 7.5 study points, but study points may differ between courses. Some courses are only graded pass/fail. The analysis focuses on ordinary exams and courses graded A–F, but, as we show in table A14, there are no significant differences between the treatment group and control group in re-take exams and pass/fail courses. The students do not have the option to change their enrollment in a graded course to pass/fail.

⁸ The term “Hawthorne effect” is due to Landsberger (1958), who reanalyzed the 1924–32 experiments at the Hawthorne plant in Cicero, Illinois. Levitt and List (2011) find that the original effect was largely illusory, reporting, “Perhaps fittingly, a meta-analysis of the research testing the enormous body of research into Hawthorne effects triggered by this initial study yields equally mixed results (Adair, Sharpe, and Huynh 1989).”

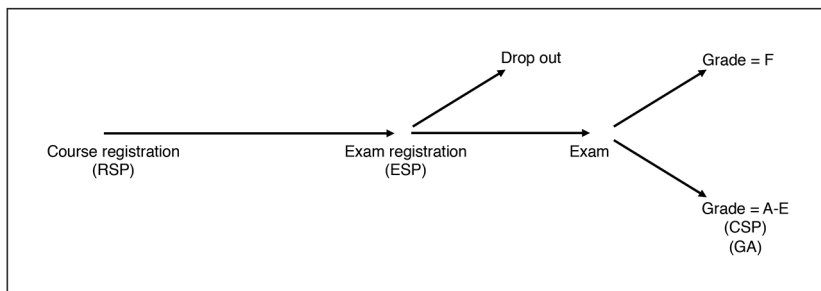


FIG. 1.—Overview of academic variables. The figure shows the timeline for when registered study points (RSPs), exam study points (ESPs), completed study points (CSPs), and grade average (GA) are recorded.

on exercise, not on academic performance, which makes it unlikely that there could be a Hawthorne effect in our main variable of interest.

III. Hypotheses and Empirical Strategy

This section outlines our main hypotheses and the regression model specifications employed in the analysis.⁹

A. Gym Attendance

On the basis of past research and in line with our preanalysis plan, we expect that the treatment increases gym attendance.

HYPOTHESIS 1. Offering a free gym card has a positive causal effect on gym attendance.

We test hypothesis 1 by estimating the following OLS regression equation:

$$G_i = \alpha + \beta \text{Treated}_i + \delta \mathbf{X}_i + \varepsilon_i, \quad (1)$$

where G_i is the number of gym visits (standardized) of individual i in the spring semester of the intervention, or a dummy variable equal to 1 if the student visited the gym at least once. “Treated” is an indicator variable taking the value 1 if individual i were assigned to the treatment group, and \mathbf{X}_i is a vector of prespecified covariates (age, gender, institution, year of study, and dummies for being above the median in terms of the lifestyle index, hours studied, happiness, or the self-control index at baseline). The estimated causal effect of the treatment on gym attendance is given by β in (1), which we expect to be positive.

⁹ The analysis follows the preanalysis plan with some minor adjustments listed in app. D.

B. Academic Performance

Our main hypothesis, as stated in the preanalysis plan, is that offering a free gym card improves academic performance.

HYPOTHESIS 2. Offering a free gym card has a positive causal effect on academic performance.

We test hypothesis 2 by estimating the following OLS regression equation:

$$A_i = \alpha + \beta \text{Treated}_i + \delta \mathbf{X}_i + \varepsilon_i, \quad (2)$$

where A_i is a measure of academic performance of individual i . Throughout the analysis, we standardize the outcome measures by dividing the respective variable with its standard deviation, without subtracting the mean. We include registered study points (RSPs) in \mathbf{X}_i to improve the precision of the estimates. The estimated causal effect of offering a free gym card on academic performance is given by β in (2). We focus on the two prespecified main dimensions of academic performance reported on students' grade transcript: the number of completed study points (CSPs) and grade average (GA).

C. Lifestyles

To shed further light on underlying mechanisms, we provide two types of analysis. First, we study whether the intervention affects dimensions that we hypothesize are important for succeeding as a student: lifestyle, self-control, happiness, and study hours. Second, we study whether the intervention has a stronger impact on academic performance for people who at the baseline score low on these dimensions.

Formally, we test the following two prespecified hypotheses.

HYPOTHESIS 3. Offering a free gym card has a positive effect on lifestyle, self-control, happiness, and study hours.

HYPOTHESIS 4. Offering a free gym card has a stronger causal effect on academic performance for students who score low on lifestyle, self-control, happiness, or study hours than for those who score high on these dimensions.

We test hypothesis 3 by estimating the following OLS regression equation separately for each of the four dimensions:

$$Y_i = \alpha + \beta \text{Treated}_i + \delta \mathbf{X}_i + \varepsilon_i. \quad (3)$$

In (3), Y_i represents the standardized value of the lifestyle index, the self-control index, happiness, or study hours, and the estimated causal effect of the intervention on each of these dimensions is given by β in the corresponding regression.

We test hypothesis 4 by estimating the following OLS regression equation:

$$A_i = \alpha + \beta_1 \text{Treated}_i + \beta_2 \text{Above} \times \text{Treated}_i + \delta \mathbf{X}_i + \varepsilon_i. \quad (4)$$

In (4), we interact the treatment dummy with a dummy variable for being above the median at baseline in terms of the lifestyle index, the self-control index, happiness, and study hours, where the dummy variable for being above median is included in \mathbf{X}_i . In (4), the estimated coefficient β_2 shows whether the intervention worked differently for those who were below the median in all dimensions and those who were above the median in at least one of the dimensions at baseline. In the analysis, we also report specifications that study each subgroup separately.

D. Robustness Analysis

In the analysis, we report p -values correcting for multiple-hypothesis testing, using the Holm–Bonferroni (Holm 1979), Romano–Wolf (Romano and Wolf 2005), and List–Shaikh–Vayalinkal (List, Shaikh, and Vayalinkal 2023) methods. In appendix A, we report further analysis and robustness checks.

IV. Main Results

We report the main results in this section, with supporting analysis in appendix A.

A. Effect on Exercise

We start by studying whether the intervention, which directly targeted physical exercise, induced students to visit the gym more frequently (hypothesis 1). Figure 2 shows the cumulative distribution of gym visits by treatment. We observe a large difference in gym visits between the treatment and control groups: Few students in the control group visited the gym at all, while the majority of those in the treatment group did visit the gym. The cumulative distribution of gym visits for the treatment group first-order stochastically dominates the cumulative distribution of the control group. On average, treated students visited the gym 7.5 times in the semester, which is a more than 300% increase relative to the 1.8 visits in the control group. We also note that 30% of the students in the treatment

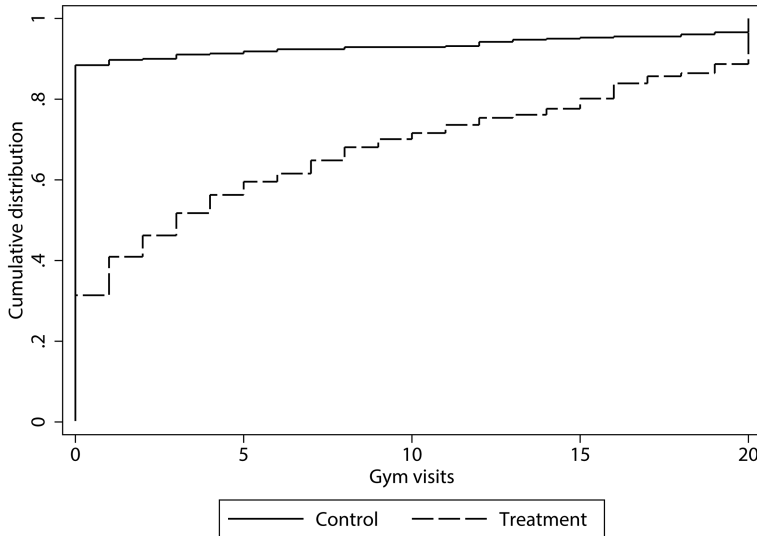


FIG. 2.—Gym visits by treatments. The figure provides the cumulative distribution of gym visits by treatment arm, censored at 20 gym visits.

group exercised 10 times or more, compared to 7% in the control group. Table 3 reports the effect of the treatment intervention on gym exercise using OLS regression analysis. Column 1 reports the effect on the number of gym visits (standardized) for the whole semester, where we find an average treatment effect of more than 0.6 standard deviations ($p < .001$).¹⁰ We see from columns 2 and 3 that the effect is robust to adding control variables. In columns 4–6, we report the effect of the intervention on the extensive margin, where we observe a highly significant and robust increase in the share of students exercising at least once, from 11.6% in the control group to 68.6% in the treatment group. In the lower rows, we show that the estimated treatment effects are robust to multiple-hypothesis correction.

Active card users made about one additional gym visit per week from the start of the intervention to the start of the exam period. To put this effect into perspective, Charness and Gneezy (2009) report significant improvements in weight, waist size, BMI, body fat percentage, and pulse rate from a similar treatment effect on gym attendance. Clinical trials in the medical literature also document positive health effects from exercising 60 minutes per week in periods from 4 to 20 weeks (Janssen and

¹⁰ Figure A3 (figs. A1–A4 are available online) provides an overview of gym visits by week and treatment. In table A12, we report the heterogeneity analysis for gym visits, where we observe that there is a significant increase in gym visits in all subgroups.

TABLE 3
REGRESSION RESULTS ON GYM ATTENDANCE

	Outcome Variable					
	Visits (Standardized)			Visited (1/0)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated	.629*** (.0676)	.625*** (.0677)	.627*** (.0678)	.570*** (.0285)	.571*** (.0285)	.571*** (.0288)
Age		-.0175** (.00855)	-.0145 (.00899)		-.00445 (.00428)	-.00438 (.00436)
Female		-.0131 (.0691)	-.0176 (.0700)		.0635** (.0289)	.0644** (.0297)
Year of study		-.0614*** (.0208)	-.0607*** (.0214)		-.00357 (.0124)	-.00429 (.0123)
UIB		-.0403 (.0687)	-.0527 (.0698)		.0164 (.0289)	.0213 (.0302)
Above_Study			-.0135 (.0712)			.0171 (.0303)
Above_Lifestyle			-.123* (.0660)			-.0412 (.0300)
Above_Happiness			.0365 (.0791)			.00421 (.0348)
Above_Self-control			.0473 (.0686)			.00785 (.0298)
Constant	.199*** (.0390)	.741*** (.229)	.715*** (.250)	.116*** (.0164)	.179* (.0974)	.181* (.102)
HB <i>p</i> -value: Treated			.0003			.0007
RW <i>p</i> -value: Treated			.0001			.0001
LSV <i>p</i> -value: Treated			.0003			.0003
Observations	778	778	758	778	778	758

NOTE.—The table reports on OLS regressions of the number of visits to the gym (Visits, standardized) or a dummy variable for whether the student visited the gym at least once in this semester (Visited) on an indicator variable for treatment status (Treated) and a set of background controls. Age and year of study are in years. UIB is equal to 1 if the student is at UIB (0 at HIB). Above_Study, Above_Lifestyle, Above_Happiness, and Above_Self-control are dummy variables that equal 1 if the student is above the median on the respective baseline measure. HB/RW/LSV *p*-value reports the *p*-value for the point estimate of Treated using the Holm–Bonferroni/Romano–Wolf/List–Shaikh–Vayalinal correction method. The difference in observations across columns is explained by missing data on some of the background variables. Robust standard errors are given in parentheses.

* *p* < .10.

** *p* < .05.

*** *p* < .01.

LeBlanc 2010), and similar levels of exercise can generate positive effects in terms of depression (Mammen and Faulkner 2013), impulse control (Oaten and Cheng 2006) and memory (Roig et al. 2012).¹¹

¹¹ It is unlikely that exercising more at SIB crowded out exercise at other gyms, since it is rare for students to exercise at other gyms. The price of the SIB card is subsidized, and SIB has gyms across the city of Bergen, including close to students' dorms in the outskirts of the city (see map provided in fig. A4). Students do not need to visit the campus to exercise at the gym. More generally, we find no evidence in our data that the increased exercise at SIB

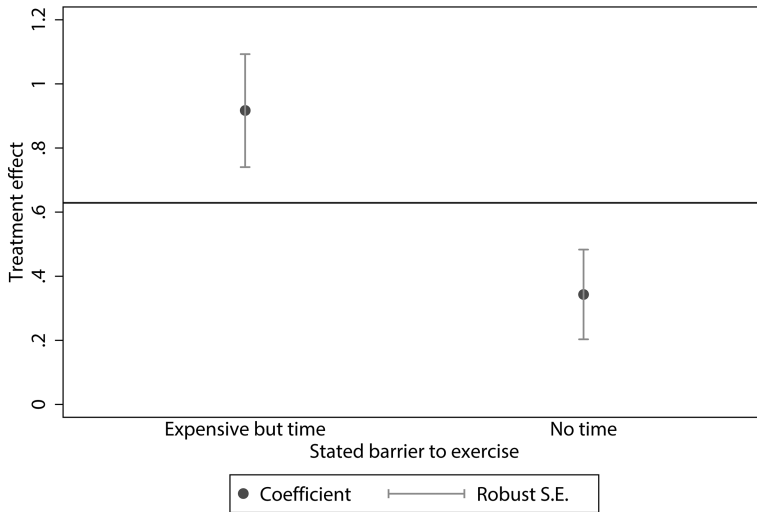


FIG. 3.—Treatment effect on gym visits by barrier to exercise. The figure shows the unconditional standardized treatment effects on gym visits for people who found the SIB card expensive but were not constrained by time (left), and for people who were constrained by time (right). We define the constraint as binding if the answer to the specific question is 8 or higher on a scale from 1 to 10. The horizontal line indicates the average treatment effect in the full sample (0.629 standard deviations).

To provide some evidence on which barriers were removed by providing the students with a free gym card, we consider how the estimated treatment effects on gym visits depend on whether the students expressed that they did not exercise at the gym at baseline because they were financially constrained or time constrained. In figure 3, we show the estimated treatment effects for those who were financially constrained but not time constrained and for those who were most time constrained, compared to the rest of the students. In table A3, we report the corresponding regression analysis. We observe that the estimated effect of providing a free gym card on gym visits for those who were financially constrained but not time constrained is significantly larger than for the rest of the students

crowded out other exercise. In tables A15 and A16, we report the analysis for the self-reported overall number of times a student exercised in the last week. Since the follow-up survey was conducted during the final exam period, we should not expect a large difference and this outcome was not prespecified. However, it is interesting to note that the patterns are the same as for the administrative data, where we also in the self-reported data find a positive treatment effect on whether they have exercised or not last week (col. 3, table A15). The estimated treatment effect on the self-reported overall number of times a student exercised in that week is almost identical to the estimated treatment effect on the number of gym visits in the administrative data in the week of the survey (0.181 vs. 0.197, $p = .930$).

($p = .098$), and the effect for those who were time constrained is significantly smaller ($p = .066$). The difference between these two groups is also highly significant ($p = .018$). This analysis was not prespecified and is therefore exploratory, but it provides some suggestive evidence of the free gym card being particularly powerful in increasing exercise among the most financially constrained, while having a smaller effect on those who were most time constrained.

However, about 65% of the students were not financially constrained or time constrained at baseline, and we show in figure A1 that there is a highly significant estimated treatment effect on gym visits also for these students. We interpret this as suggestive evidence of the free gym card not only removing a financial barrier, but also contributing to reducing psychological barriers to exercise. Potential mechanisms may be that the free gym card removes an excuse to exercise, makes more salient the injunctive norm that one should go to the gym and exercise, or provides students with a fresh start and puts them on a path of goal setting. In line with psychological barriers being an important explanation for why they do not exercise, many students stated at baseline that they were not a member at SIB because they were lazy.

B. Effect on Academic Performance

We now turn to investigate whether the intervention that targeted exercise also had an impact on the students' academic performance (hypothesis 2).

Figure 4 shows the standardized treatment effect on completed study points (CSPs) and grade average (GA). We see an increase in the CSPs of 0.13 standard deviations in the treatment group, without it affecting GA. In figure A2, we show the cumulative distributions of CSPs and GA. The treatment group first-order stochastically dominates the control group in terms of CSPs. Significantly fewer students achieve 30 CSPs in the control group than in the treatment group, which means that the students in the control group are more likely to delay study progress than students in the treatment group. Given that the education literature stresses the value of completing college, it is important that exercise enables students to avoid delays in their studies.

Table 4 presents the results from OLS regressions of the intention-to-treat effect on academic performance.¹² We observe from columns 1–3 that the treatment affects positively CSPs, with an estimated effect of about 0.15 standard deviations when including control variables ($p = .027$), which is robust to multiple-hypothesis correction (lower rows).

¹² In table A17, we show that the treatment effects are not significantly different for students from HIB and UIB.

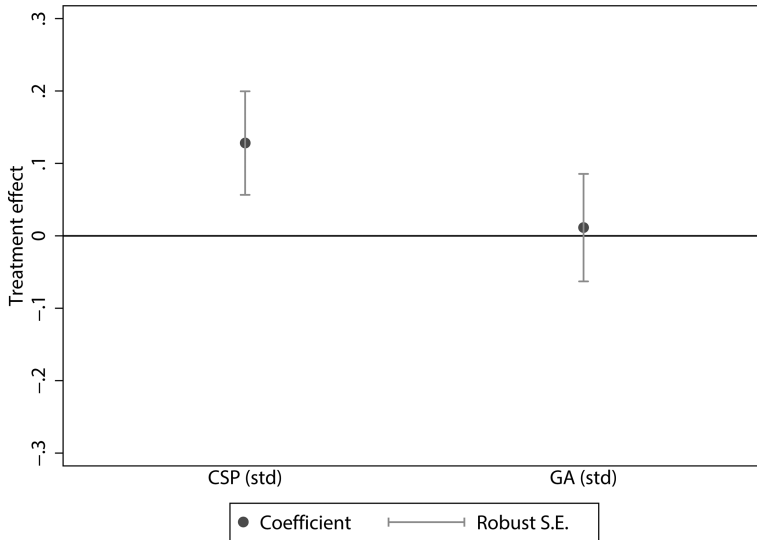


FIG. 4.—Treatment effects on academic outcomes. The figure shows the unconditional standardized (std) treatment effects on completed study points (CSPs) on the left and grade average (GA) on the right.

To study whether the increase in CSPs reflects that treated students are less likely to drop out from courses or less likely to fail on the exam, we decompose completed study points as follows (see also fig. 1):

$$\text{CSPs}_i = \text{RSPs}_i - (\text{RSPs}_i - \text{ESPs}_i) - (\text{ESPs}_i - \text{CSPs}_i). \quad (5)$$

Completed study points (CSPs_i) are given by the study points that the student registered for at the start of the semester (RSPs_i), minus the study points that the student does not receive because he or she drops out from courses ($\text{RSPs}_i - \text{ESPs}_i$) or fails on exams ($\text{ESPs}_i - \text{CSPs}_i$). As shown in table 2, there is no difference between the treatment group and the control group in terms of RSPs_i , and it turns out that 62% of the treatment effect on completed study points comes from treated students dropping fewer courses and 38% from them failing less at exams.

A potential concern is that an increase in completed study points may decrease the grade average (which is derived conditional on passing the exam), but this is not what we observe. As shown in columns 4–6 in table 4, the estimated treatment effect on GA is marginally positive, though not statistically different from zero. The analysis thus shows that the treated students managed to complete more courses, without suffering in their grade average. In appendix A, we show that these results are robust to

TABLE 4
REGRESSION RESULTS ON ACADEMIC PERFORMANCE

	Outcome Variable (Standardized)					
	CSPs			GA		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated	.128* (.0715)	.139** (.0658)	.146** (.0664)	.0113 (.0742)	.0358 (.0720)	.0327 (.0728)
Age		-.0355*** (.0128)	-.0328** (.0134)		-.0356*** (.0114)	-.0301*** (.0114)
Female		.0894 (.0657)	.0901 (.0661)		.118 (.0729)	.115 (.0751)
Year of study		.0142 (.0313)	.00242 (.0327)		.140*** (.0301)	.138*** (.0312)
UIB		-.248*** (.0680)	-.221*** (.0707)		-.337*** (.0739)	-.289*** (.0764)
RSPs (standardized)		.363*** (.0618)	.368*** (.0639)		-.0486 (.0371)	-.0549 (.0374)
Above_Study			.0853 (.0707)			.0960 (.0777)
Above_Lifestyle			.0736 (.0665)			-.0194 (.0788)
Above_Happiness			.0646 (.0743)			.0465 (.0847)
Above_Self-control			.180*** (.0672)			.161** (.0787)
Constant	2.097*** (.0495)	2.105*** (.300)	1.863*** (.322)	3.349*** (.0517)	4.060*** (.276)	3.811*** (.283)
HB <i>p</i> -value: Treated			.0553			.6380
RW <i>p</i> -value: Treated			.0562			.6529
LSV <i>p</i> -value: Treated			.0487			.6380
Observations	778	778	758	726	726	707

NOTE.—The table reports on OLS regressions of completed study points (CSPs) or grade average (GA) on a dummy variable for treatment status (Treated) and a set of background controls. Age and year of study are in years. UIB equals 1 if the student is at UIB (zero if at HIB). Above_Study, Above_Lifestyle, Above_Happiness, and Above_Self-control are dummy variables, which equal 1 if the student is above the median on the respective baseline measure. RSPs (standardized) is the standardized number of study points a student was registered for at the beginning of the semester. HB/RW/LSV *p*-value reports the *p*-value for the point estimate of Treated using the Holm–Bonferroni/Romano–Wolf/List–Shaikh–Vayalinal correction method. The difference in observations across columns for the same outcome variable is explained by missing data on some of the background variables. Column 4 contains fewer observations than the total sample because of the definition of the outcome variable. Robust standard errors are given in parentheses.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

controlling for academic performance in the previous semester (table A4) and to including alcohol consumption in the lifestyle index (table A5).¹³

¹³ Alcohol consumption was also part of the lifestyle index specified in the preanalysis plan, but 27 participants were unwilling to answer the questions on alcohol consumption. Of the students who answered this question, 10.2% consumed more than 14 units of

TABLE 5
ASSOCIATION BETWEEN GYM ATTENDANCE AND COMPLETED STUDY POINTS

	Outcome Variable: CSPs (Standardized)				
	Full Sample			Treated Sample	
	(1)	(2)	(3)	(4)	(5)
Gym visits (standardized)	.0610** (.0288)	.212*** (.0608)	.179*** (.0684)	.0537 (.0355)	.175** (.0885)
Gym visits (standardized) ²		-.0402*** (.0111)	-.0346*** (.0121)		-.0324* (.0170)
Treated			.0775 (.0749)		
Constant	1.880*** (.323)	1.868*** (.324)	1.839*** (.325)	1.324*** (.490)	1.291*** (.498)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	758	758	758	388	388

NOTE.—The table reports on OLS regressions of completed study points (CSPs, standardized) on the number of gym visits (gym visits, standardized) and the quadratic term of standardized gym visits (gym visits (standardized)²) and a set of control variables (age, female, year of study, UIB, Above_Study, Above_Lifestyle, Above_Happiness, Above_Self-control, and registered study points (standardized)); see table 4 for definitions). Columns 1 and 2 report the results for the full sample; cols. 4 and 5 for the treated sample. Column 3 reports the model for the full sample that also includes a dummy variable for treatment status (Treated). Robust standard errors are given in parentheses.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

Considering the educational production function with respect to exercise, table 5 reports results from both a linear and a quadratic specification of the correlation between gym visits and completed study points, for the full sample in columns 1 and 2 and for the treated sample in columns 4 and 5. We observe that the estimated pattern is similar in the two samples: a concave relationship between exercise and academic performance that peaks at about 24 gym visits per semester (corresponding to twice a week in the teaching period) and becomes negative at 48 gym visits. In column 3 of table 5, we show that the estimated educational production function is almost unaffected by adding the treatment dummy, and the estimated coefficient for the treatment dummy is much smaller than the estimated treatment effect in column 3 of table 4; this is consistent with the positive effect on academic performance working through an increase in exercise.¹⁴ Overall, table 5 provides suggestive evidence of

alcohol per week, which is the recommended maximum units of alcohol by the National Health Service. See also Singleton and Wolfson (2009) for a discussion of the relevance of alcohol consumption for academic performance.

¹⁴ The regressions in table 5 are correlational in nature, as they include an independent variable that is affected by treatment, and thus should only be seen as providing suggestive evidence of the underlying mechanism driving the treatment effect (Judd and Kenny 1981; Angrist and Pischke 2008).

an increase in exercise causing an increase in academic performance, but also highlights that too much exercise may be detrimental to academic performance (possibly by directing time and attention away from studying).

V. Mechanisms

The evidence so far shows that an increase in exercise is causing improvement in academic performance. In this section, we provide further analysis of the underlying mechanisms. The preanalysis plan specified that we would study whether a treatment effect on academic performance worked through changes in students' lifestyle, self-control, happiness, and study hours. We outlined two approaches: first, to study whether the intervention causally affected each of the dimensions (hypothesis 3, sec. V.A), and second, to study whether the treatment effects are larger for those who scored low (below the median) on these dimensions at baseline (hypothesis 4, sec. V.B).

A. *Intermediary Outcomes*

Table 6 reports regressions on how the intervention affected lifestyle, self-control, happiness, and study hours. We observe from columns 1 and 4 that there are positive estimated treatment effects on lifestyle and self-control. On both dimensions, we observe an increase in the treatment group of the same size as the increase in academic performance, about 0.15 standard deviations. These effects are robust to the inclusion of control variables (cols. 2 and 5), to correcting for multiple-hypothesis testing (lower rows), and to calculating bounds on the treatment effects to account for potential nonrandom attrition in the follow-up survey (lowermost rows). Our data thus provide strong evidence of the intervention affecting the perceived feeling of self-control and the lifestyle of the students. In columns 3 and 6, we show that the treatment effects on lifestyle and self-control are reduced when we control for exercise, which provides suggestive evidence of exercise causing a change in lifestyle and self-control.

Tables A6 and A7 show that the treatment effects on the subcomponents of the lifestyle and self-control indexes consistently are positive. In terms of self-control, treated students report that they are more likely to identify themselves as individuals who do not procrastinate, think before acting, resist temptations, and stick to their plans. In terms of lifestyle, treated students report that they are more satisfied with their health, go to bed earlier, feel less tired, and drink less alcohol. Apart from going to bed before midnight, the effects are not statistically significant when we consider each of the subcomponents separately, which suggests that the treatment effects on self-control and lifestyle come from exercise

affecting jointly all the subcomponents. This finding is in line with the fact that these subcomponents are strongly correlated, as shown in table A1.

In columns 7–12 of table 6, we report the corresponding analysis for happiness and study hours, where we do not observe significant treatment effects. The lack of an effect on the number of hours studied (last week) may reflect that the follow-up study was conducted during the exam period when students in general work hard, and so we may have missed a positive effect on the number of hours studied earlier in the semester. Alternatively, it may suggest that the positive effects on academic performance are obtained from more efficient studying.

The absence of an effect on general happiness may reflect that this is a complex concept that encompasses many different aspects in daily life. Table A8 reports the effect on happiness on academic performance, health, social life, and one's economic situation, respectively. We observe that the largest and only significant effect is for happiness with academic performance, which improves by 0.12 standard deviations, in line with the observed treatment effect on academic performance in the administrative data.

Overall, this analysis suggests that the intervention caused an increase in academic performance through a strengthening of executive functions, in particular self-control, and the adoption of a lifestyle better suited for academic studies. In table A9, we provide further evidence that supports this interpretation of the findings by showing that self-control and lifestyle at baseline are strongly correlated with academic performance in the same semester in the control group. We also find the same relationship when considering the relationship between self-control and lifestyle at baseline and prior academic performance for the full sample.

B. Heterogeneity Analysis

We now turn to studying whether the treatment effect on academic performance is larger for those who scored low on lifestyle, self-control, happiness, and study hours.

In figure 5A, we show that the treatment effect on CSPs is large and highly significant for the students who were below the median in all four dimensions at baseline, while we find no significant treatment effect for the students who were above the median in at least one dimension. In column 1 of table 7, we show that this difference in treatment effect is highly significant and robust to the inclusion of control variables ($p < .05$). The estimated treatment effect on CSPs for the students who struggled most at baseline is about 0.5 standard deviations ($p < .01$), while it is insignificant and close to zero for the other students. In table A10, we show that this analysis is robust to controlling for academic performance in the previous semester. In columns 2–5 of table 7, we consider

TABLE 6
REGRESSION RESULTS: INTERMEDIARY OUTCOMES

	Outcome Variable (Standardized)											
	Lifestyle			Self-Control			Happy			Study Hours		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Treated	.157** (.0734)	.156** (.0641)	.0374 (.0720)	.177** (.0732)	.151** (.0624)	.0996 (.0710)	.0506 (.0737)	.0629 (.0689)	-.00320 (.0761)	-.00765 (.0736)	-.00143 (.0709)	-.0341 (.0773)
Age		.00249 (.0104)	.00484 (.0106)		-.00766 (.0110)	-.00657 (.0111)		-.0191 (.0128)	-.0182 (.0129)		-.00346 (.0124)	-.00321 (.0125)
Female		.310*** (.0645)	.300*** (.0647)		-.0416 (.0629)	.0388 (.0630)		.0521 (.0694)	.0411 (.0696)		.0365 (.0709)	.0272 (.0714)
Year of study		-.0271 (.0265)	-.0178 (.0267)		-.00430 (.0283)	.00856 (.0286)		.0107 (.0315)	.0148 (.0315)		.0291 (.0291)	.0303 (.0295)
UIB		-.0674 (.0672)	-.0615 (.0667)		-.00114 (.0639)	.00465 (.0640)		-.303*** (.0703)	-.304*** (.0700)		-.0851 (.0690)	-.0887 (.0689)
Above_Study		.0477 (.0665)	.0518 (.0656)		.150** (.0645)	.152** (.0645)		-.0590 (.0706)	-.0582 (.0702)		.574*** (.0690)	.573*** (.0692)
Above_Lifestyle		.808*** (.0670)	.821*** (.0663)		.211*** (.0677)	.217*** (.0681)		.247*** (.0741)	.251*** (.0740)		-.00670 (.0741)	-.00766 (.0747)
Above_Happiness		.0880 (.0738)	.0866 (.0727)		.0521 (.0762)	.0512 (.0761)		.714*** (.0755)	.715*** (.0757)		.232** (.106)	.233** (.106)
Above_Self-control		.325*** (.0682)	.317*** (.0672)		.980*** (.0665)	.977*** (.0667)		.0901 (.0753)	.0851 (.0753)		.0480 (.0715)	.0453 (.0715)

Gym visits (standardized)	.230*** (.0670)	.0925 (.0683)	.153* (.0803)	.0954 (.0682)
Gym visits (standardized) ²	-.0237 (.0153)	-.00720 (.0125)	-.0254 (.0197)	-.0221* (.0132)
Constant	-.0804 (.0532)	- .825*** (.243)	3.317*** (.249)	3.813*** (.274)
HB β -value: Treated	.0613	3.268*** (.252)	3.601** (.0550)	1.678*** (.0550)
RW β -value: Treated	.0606	.0490	.7547	.9887
LSV β -value: Treated	.0590	.0606	.5926	.9846
Lower bound: Treated	.119	.144	.6063	.9887
Upper bound: Treated	.187	.210	-.0596	-.0357
Observations	740	723	740	741
		723	723	724
				724

NOTE.—The table reports results from standard OLS regressions. The outcome variables are all measured in the follow-up survey (i.e., after the intervention), whereas all the controls are based on answers to questions in the baseline survey (i.e., before the intervention). Age and year of study are in years. UIB = 1 if the student is at the University of Bergen (0 if at Bergen City College). Above_Study, Above_Lifestyle, Above_Happiness, and Above_Self-control equal 1 if the student is above the median on the particular baseline measure. HB/RW/LSV β -value reports the β -value for the point estimate of Treated using the Holm–Bonferroni/Romano–Wolf/List–Shaikh–Vayalinal correction method. Lower and upper bound refers to the lower and upper bound of the treatment effect using the method proposed by Lee (2009) to account for attrition in the outcome variable. The difference in observations across columns is explained by missing data on some of the background and outcome variables. The attrition rate in the follow-up survey explains the lower number of observations in some columns. Robust standard errors are given in parentheses.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

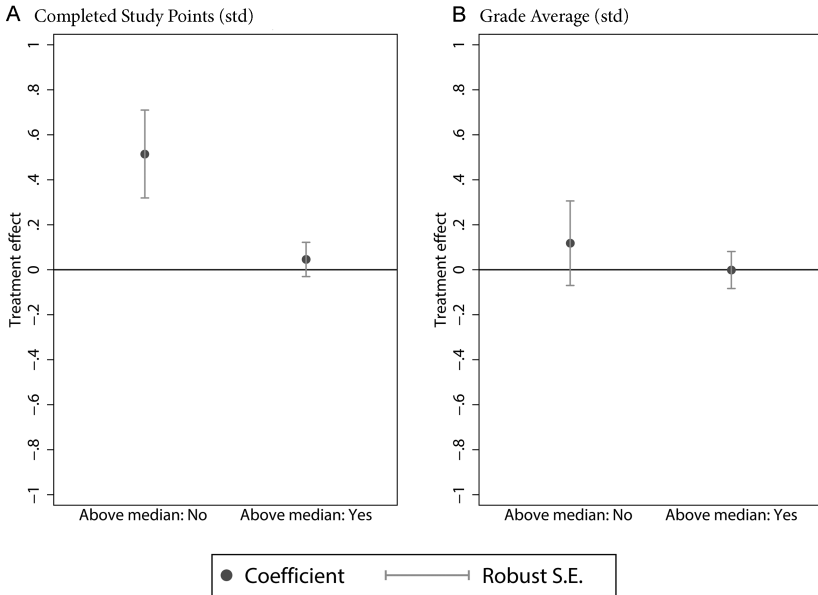


FIG. 5.—Treatment effects by above median. The figure shows the unconditional standardized (std) treatment effects on completed study points (panel A) and grade average (panel B) for people below the median in all four dimensions (“Above median: No”) and for people above the median in at least one dimension (“Above median: Yes”).

each of the dimensions separately, and consistently observe that the estimated treatment effect on CSPs is significant for those below the median.

In figure 5B, we show that the large positive treatment effect on CSPs for the struggling students did not affect their grades negatively: The estimated treatment effect on GA is positive but not statistically significant for this group; see column 6 of table 7. For the other students, we find no effect of the treatment on GA.

The heterogeneous treatment effect on academic performance could come from two different sources. First, it might be that the intervention had a larger impact on the intermediary variables for the struggling students. Second, the educational production function might be concave in these intermediary variables, such that any given change has a larger impact on academic performance for those who initially scored low on these variables. Table A11 shows no significant differences in how the intervention affected lifestyle, self-control, happiness, and study hours for those below or above the median on these dimensions in the baseline, consistent with the intervention not affecting gym visits differently for these groups (table A12). The evidence thus suggests that the heterogeneous treatment effect reflects that observed improvements in lifestyle

TABLE 7
ACADEMIC PERFORMANCE: HETEROGENEOUS EFFECTS

	Outcome Variable (Standardized)					
	CSPs					GA
	(1)	(2)	(3)	(4)	(5)	(6)
Treated	.505*** (.177)	.169* (.0978)	.207** (.0963)	.174** (.0792)	.192** (.0957)	.171 (.186)
Above	.524*** (.143)					.175 (.154)
Treated × Above	-.439** (.191)					-.165 (.203)
Above_Lifestyle		.0977 (.0927)				
Treated × Above_Lifestyle		-.0462 (.134)				
Above_Self-control			.249*** (.0881)			
Treated × Above_Self-control			-.132 (.129)			
Above_Happiness				.122 (.0956)		
Treated × Above_Happiness				-.112 (.143)		
Above_Study					.134 (.0957)	
Treated × Above_Study					-.0940 (.133)	
Constant	1.659*** (.332)	1.856*** (.323)	1.833*** (.321)	1.842*** (.323)	1.832*** (.321)	3.857*** (.304)
Treated + Treated × Above	.0660 (.0707)	.123 (.0907)	.0757 (.0876)	.0618 (.119)	.0978 (.0924)	.00575 (.0797)
Observations	758	758	758	758	758	707

NOTE.—The table reports results from standard OLS regressions of completed study points (CSPs, standardized) or grade average (GA, standardized) on an indicator variable for treatment status (Treated), a set of controls (age, female, year of study, UIB, registered study points (standardized), Above_Study, Above_Lifestyle, Above_Happiness, and Above_Self-control; see table 4 for definitions), and a set of interaction variables. The variables with the Above_ prefix equal 1 if the student is above the median on the particular baseline measure. Above is a dummy variable equal to 1 if above the median on at least one of the four baseline measures. Robust standard errors are given in parentheses.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

and self-control are more important for the struggling students than for students doing well in these dimensions to start with, suggesting a concave educational production function with respect to self-control and lifestyle.

VI. Conclusion

It is well established that exercising carries health benefits. In this paper, we test the hypothesis that exercising may also carry benefits in another realm—academic performance. While there is correlational evidence and folk expressions such as “a healthy mind in a healthy body,” there is no convincing causal evidence of this effect. We provide the first pre-registered, large-scale randomized controlled trial of the relationship between physical activity and academic performance, combining high-quality administrative data on both gym exercise and academic performance and self-reported data on lifestyle measures, well-being, and perceived self-control.

We find a strong causal effect of providing a free gym card on academic performance, with an average increase of 0.15 standard deviations in our main measure of completed study points. We show that treated students drop fewer courses and fail fewer exams, which means that they, on average, graduate earlier than the control students. To put the size of the effect in context, we note that it is comparable to the effect of a 1 standard deviation improvement in teacher quality (Rockoff 2004), a 1 standard deviation reduction in university class size (Bandiera, Larcinese, and Rasul 2010), and substantial individual incentives for academic performance in college (Angrist, Lang, and Oreopoulos 2009), which all have been shown to improve academic performance by about 0.15 standard deviations. We further show that the increase in completed study points does not have a negative effect on the grade average: The estimated average effect on grade average in completed courses is slightly positive, but not statistically significant. Finally, we provide a collage of evidence suggesting that the effect of exercise on academic performance works through improved self-control and a more productive lifestyle, in line with much of the public discourse on how to improve academic performance, for example related to sleep pattern and procrastination.¹⁵ We echo the sentiments expressed in Moffitt et al. (2011): “Interventions addressing self-control might reduce a panoply of societal costs, save taxpayers money, and promote prosperity.”

Our findings are supported by several independent studies. First, our findings are in line with the correlation evidence reported for a sample of about 12,000 Norwegian university students (Hayley et al. 2017), which established that poor sleep is strongly associated with increased odds of having failed at the exam and delayed study progress. Further, in a follow-up study to Charness and Gneezy (2009), the authors sent the participating students in the original study an email 2 years after the

¹⁵ See, e.g., the advice from the American Academy of Sleep Medicine (<https://aasm.org/college-students-getting-enough-sleep-is-vital-to-academic-success/>).

exercise intervention. In the email, students were asked about their exercising behavior as well as their academic performance. The results showed no impact on exercising, but a large effect on academic satisfaction and performance (Charness and Gneezy 2011). On the same note, Fricke, Lechner, and Steinmayr (2017) report a positive, albeit less robust, effect of incentives to exercise on academic performance. Although these two latter studies suffer from a combination of low-response rates and minor effects on exercise and statistical power, the overall impression is clearly in line with our findings.

Given the enormous importance of education and human capital, we believe our results offer a very promising avenue for future policy interventions in the realms of health and education. We show that exercise has the potential to improve more than health; it may also improve academic performance. The findings should be of broad relevance to the policy debate. In the Norwegian policy context, they provide evidence that the removal of financial barriers to exercise among students may have significant positive effects on academic performance. In the US policy context, they provide evidence for sustaining the common university policy of giving students free access to the gym. Further, our mechanism findings suggest that the positive effects worked through increased self-control and improved lifestyle, which should inspire policymakers also to consider other policies that target these dimensions, particularly in situations in which the possibility of increasing physical activity among the students is exhausted. This could for example be through recommended schedules for daily routines or providing commitment devices that force students to study continuously throughout the semester. Finally, we argue that our findings also are generalizable to other parts of the populations, and especially important for childhood development. Increasing physical activity among children is considered an urgent issue across the globe, and our findings suggest that more physical activity may have long-term implications not only for health but also for human-capital accumulation. We believe that the removal-of-barriers approach can be key to success when targeting children through their parents, school, and the local community, where the nature of the barriers to exercise is likely to vary across situations and populations.

However, many open questions remain: How persistent are the academic benefits from our intervention? Would providing a direct form of incentives for better academic performance be beneficial in combination with incentives for exercise? Would there be a synergy from such cross-incentivization or is an indirect incentive scheme best for improving academic performance? Are there other interventions targeting self-control and lifestyle that are more efficient than the removal of barriers to exercise? We hope that others will join us in the pursuit of better insights on these important questions.

Data Availability

Code replicating the tables and figures in this article and the README file can be found in Cappelen et al. (2022) in the Harvard Dataverse, <https://doi.org/10.7910/DVN/ZXRUDW>.

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