A League of Their Own: The Effect of Female Youth Sports Participation on Health Behaviors and Outcomes from Adolescence to Retirement Age

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Abstract

Given the substantial public health costs associated with physical inactivity, it is important to understand how government policies and institutions alter the incentives to adopt and maintain a lifestyle that includes regular exercise and other forms of activity. However, patterns of physical activity often reflect ingrained habits that may be difficult to change.

In this study, we estimate the effects of increased access to organized sports during adolescence on health outcomes and behaviors throughout adulthood and into retirement. To study these effects, we use the implementation of Title IX of the Education Amendments of 1972 as an instrument for increased access to sports opportunities for girls in high-school settings. This piece of legislation increased high-school athletic opportunities for girls by banning gender discrimination in educational programs in the United States. We use retrospective physical activity information before age 50, and data on health behaviors and outcomes after age 50 from the Health and Retirement Study.

We find that increased sports opportunities for girls during high school had lasting effects on physical activity levels over the life course, from adolescence to retirement ages. We also find that girls with increased sporting opportunities did more physically vigorous activities when aged under 50. Later, women shifted towards more physically moderate activities such as walking. Interestingly, we find that the women who benefited the most from increasing sporting opportunities in adolescence were those with a lower genetic propensity to be more physically active. Finally, we find that increased access to sporting opportunities during adolescence led to a decline in the probability of being obese, having heart problems, diabetes, cancer, and high blood pressure when women are aged over 50.

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1 Introduction

Physical activity is robustly associated with longevity and overall health. Analyzing over twenty years of research, Mokdad *et al.* (2004) conclude that inadequate physical activity is one of the leading causes of preventable death in the United States. Inactivity is pervasive, with the Centers for Disease Control estimating that approximately 80 percent of American adults and adolescents are insufficiently active. Moreover, this public health challenge appears to be intensifying. Indeed, Ng and Popkin (2012) estimate that physical activity among American adults declined by 32 percent between 1965 and 2009.

Given the substantial public health costs associated with physical inactivity, it is important to understand how government policies and institutions alter the incentives to adopt and maintain a lifestyle that includes regular exercise and other forms of activity. However, patterns of physical activity often reflect ingrained habits that may be difficult to change. Programs that incentivize exercise, for example, often produce short-run improvements that fade out over time (Gneezy *et al.*, 2011; Harris and Kessler, 2019). Alternately, interventions earlier in life might be particularly effective if habit formation and other sources of persistence work to set life-time behavioral patterns. Unfortunately, we have little empirical evidence on the long-run effects of interventions that promote physical activity at earlier stages of the life-cycle.

In this study, we estimate the effects of increased access to organized sports during adolescence on health outcomes and behaviors throughout adulthood and into retirement. The implementation of Title IX of the Education Amendments of 1972 acts as a plausibly exogenous source of variation in high-school sports opportunities for girls. Title IX banned gender discrimination in federally funded educational programs in the United States, effectively equalizing sports participation for boys and girls in high school. The program led to a dramatic increase in sports participation by girls, which increased 600% between 1972 and 1978 (Kaestner and Xu, 2010).

Title IX legislation provides a unique opportunity to measure the potential effects of an early-life intervention on later-life health outcomes. First, because 50 years have passed since the implementation of Title IX, we now have the ability to examine a host of long-run behavioral and health outcomes for women affected by the policy. Second, Title IX provided sports opportunities to women during high school (as adolescents), a time in which engaging in sports may well lead to habit formation and potential long-term behavioral change.

We use self-reported retrospective data on women's engagement in physical activity, spanning from high school ages until age 50, from the Life History Mail Survey of the Health and Retirement Study (LHMS-HRS), and longitudinal physical-activity, health-behaviors, and health-outcomes data from HRS surveys after these same women reached age 50 (the youngest age in the HRS) until retirement ages.

Using the LHMS-HRS data, we are able to identify whether or not girls participated in high-school sports around the implementation of Title IX. Using data from the High School Participation Survey (NSPS) of the National Federation of State High School Associations (NFSHSA) and high-school enrollment from the National Center for Education Statistics (NCES), we are able to obtain the high-school sport participation rates by gender for each census division and year. Combining this with information on the total number of students in high school in each year from the National Center for Education Statistics we obtain the boys high-school sports participation rate in 1971, the year before Title IX was implemented. We use this as an instrument for increased sporting opportunities for girls.

This identification strategy, first defined by Stevenson (2010), has been widely used to measure the causal effect of participating in sports on a range of outcomes (Callison and Lowen, 2022; Guldi, 2016; McNichols *et al.*, 2020; Schulkind, 2017; Clarke and Ayres, 2014). The use of the boys' high-school sports participation rate in the year before the introduction of Title IX as an instrument for girls' high-school sports participation relies on the fact that Title IX required schools to provide girls with the same sports opportunities as they provided to boys. Following this strategy, schools that had a higher boys sports participation rate before Title IX had to increase female sports participation by a larger amount than schools that had a lower boys sports participation rate.[1]

We find that increased sports opportunities for girls during high school had lasting effects on physical activity levels over the life course, from adolescence to retirement ages. By contrast, prior studies were limited to short-term impacts of Title IX (Kaestner and Xu, 2006, 2010; Callison and Lowen, 2022). For example, a 10 percentage point increase in high-school sports participation led to a statistically significant 13.6 percentage points increase in the probability of engaging in vigorous sports at least once a week during ages 18 to 29, and this probability increased by 8.5 and 7.1 percentage points, respectively, during ages 30 to 39 and ages 40 to 49. These results are robust to various alternative specifications and alternative identification strategies.[2] After age 50, we find a smaller but still statistically significant increase of 2.3 percentage points in vigorous activities from a 10 percentage point increase in sports participation in high-school. Further, after age 50 women with enhanced sporting opportunities during high school remained physically more

[1]Female sports participation rates in the year before Title IX was introduced cannot be used due to a lack of precision in the data for girls at the state level before 1972 (Stevenson, 2007, 2010). In particular, because we cannot know if the reason why some states have no information for girls is because there was no sports participation or the information was not collected for girls at that time.

[2]Although we focus mainly on the Instrumental Variables identification strategy in this paper, we also measured the effect of Title IX on high-school sports participation using a difference in differences (DiD) approach. The DiD approach compares birth cohorts of girls to boys of the same age, before and after Title IX legislation was enacted. Details are provided in the Appendix.

active but transitioned from vigorous to more moderately physically active activities as they aged. For example, a 10 percentage point increase in high-school sports participation led to an increase of 1.5 hours of walking per week on average. Thus, while the intensity of engagement in physical activity decreased over time, women who were exposed to increased sporting opportunities during high-school exhibited behavioral persistence in physical activity more than fifty years after the implementation of Title IX.

In a second set of results, we estimate the effects of high-school sports participation on later-life health outcomes. In particular, we focus on health outcomes that are considered sedentary behavior-related risk factors in the long run. We find that a 10 percentage point increase in high-school sports participation led to a statistically significant 2.2 percentage point decrease in the probability of being obese, and a non statistically significant effect in waist circumference. Further, an increase in the high-school sports participation rate led to a statistically significant decline in the probability of having high blood pressure, having diabetes, a decline in having heart problems, and a decline in the probability of having cancer. We found no statistically significant results for the probability of having a stroke.

We look at the effects of increased sports participation in youth on risky behaviors where find no statistically significant effect on drinking behaviors later in life. However, we find that a 10 percentage point increase in the sports participation rate led to a 2.9 percentage points increase in the probability of having ever smoked, and a 1.5 percentage point increase in the probability of being a current smoker. The magnitude of this result needs further explanation. We hypothesize that increased sporting opportunities during adolescence also led to increased socialization and hence the heightened probability of engaging in some risky health behaviors - such as smoking - during adolescence that may have persisted during adulthood given the addictive nature of these behaviors.

Last, we explore genetic heterogeneity in these effects. We find that sports participation is mediated by the genetic propensity to be more physically active. Increased participation in high-school sports and the probability of engaging in vigorous sports once a week for women at any age is mainly driven by women who had a lower genetic propensity to be physically active. This suggests that increasing sports participation for girls had an equalizing effect, in that it reduced genetic inequality in sports participation, and thereby may improve overall population health.

We make contributions to several literatures. First, in estimating the long-run effects of high-school sports participation using Title IX. To the best of our knowledge, we are the first to look at the long run effects of increased sporting opportunities in youth given that 50 years have occurred since Title IX legislation was passed. We are also able to do a direct identification of the effect of

Title IX on individual girls sports participation in high-school using retrospective data from HRS which makes for a more precise estimation of the effects of Title IX. Also, another contribution is that we are able to use as our instrument the boys high-school sports participation rate of 1971 and match it to the census division in which girls attended school. Most of previous literature used data that linked the participation rates to locations where individuals were either born or where they resided at the moment they were surveyed. This also allows for a more precise estimation of the effect of Title IX on health behaviors and outcomes in the long run.

Our results complement an existing literature that shows how government policies that affect conditions early in life can shape health behaviors associated with long-run chronic conditions. Kueng and Yakovlev (2021) show that Russian teenagers exposed to an anti-alcohol campaign in the late 1980s reduced their consumption of hard alcohol and had lower rates of alcohol-related deaths. Studying smoking behavior, Bedard and Deschênes (2006) find that exposure to military supplied cigarettes increased mortality rates of WWII veterans from heart disease and lung cancer. These studies demonstrate the power of government policies to shape preferences and habits related to health behaviors with long-run health impacts.

Our results also relate more generally to the literature on the long-run health consequences of early-life family resources and policy environments. As Hoynes *et al.* (2016) point out, much of the literature on the importance of early-life conditions centers on the effects of extreme shocks. While these results are no doubt important, it is also useful to assess the long-run consequences of interventions that more closely match feasible, incremental reforms. Our results add to a growing literature documenting such effects. A series of papers find positive effects of family financial resources during childhood on later-life health outcomes (Aizer *et al.*, 2016; Hoynes *et al.*, 2016; Banerjee *et al.*, 2010) Exposure to specific government policies, including health insurance coverage (Brown et al 2020; Goodman-Bacon (2021); Wherry *et al.* (2018)), infant health programs (Bhalotra et al 2022), and nutritious school lunch programs (Lundborg *et al.*, 2022) have been shown to produce long-run improvements in health and longevity.

Our paper proceeds as follows. Section 2 provides background on the relationship between physical activity, habit formation, health behaviors, and health outcomes. Section 3 provides summary statistics, describes and documents the data and empirical methods. Section 4 presents results for physical activity and assesses the robustness of our findings. Section 5 presents results for health behaviors and related risk factors. Last, Section 6 discusses the implications of our findings and concludes.

2 Physical Activity, Habit Creation, and Health Behaviors, and Outcomes

Levels of physical activity in the United States have declined considerably over time (Johnson *et al.*, 2014). Between 1965 and 2009 physical activity levels among adults declined by 32.2% (Ng and Popkin, 2012). According to the 2018 Physical Activity Guidelines Advisory Committee, approximately 80% of US adults and adolescents are insufficiently active (Piercy *et al.*, 2018).

These trends are a source of concern. Physical activity is associated with significant short- and long-term benefits for both individuals and society as a whole. Immediate benefits from exercise include better quality of sleep, reduced anxiety, lower blood pressure, and increased immune function. Longer-term benefits include better brain health and reduced risk of heart disease, stroke and type 2 diabetes. Inadequate levels of physical activity are known to increase the risk of cardiovascular diseases, diabetes, colon and breast cancer, and depression among other adverse health outcomes (WHO (2017)). Exercise also reduces the risk of weight gain and improves bone health (Piercy *et al.*, 2018) and exercise is considered to be potentially protective of Alzheimer's disease and related dementias (Livingston *et al.*, 2017).

Lack of physical activity is also costly for society. Health care expenditures associated with inadequate physical activity levels alone are estimated to be 177 billion dollars per year in the United States in 2017 (CDC) and 53.8 billion dollars per year worldwide in 2013 (Ding *et al.*, 2016). Further, having a more sedentary, less productive, and less healthy workforce also affects economic productivity. Physical inactivity related deaths contributed to 13.7 billion dollars in productivity losses (Ding *et al.*, 2016).

Given the high individual and societal costs of inadequate physical activity, identifying policies and interventions that promote adequate activity levels is of great importance. Saint-Maurice *et al.* (2022) suggest that some 110,000 US deaths per year could be avoided if adults aged 40 to 85 years of age increased their moderate to vigorous physical activities by as little as 10 minutes per day. This suggests interventions may be effective. For this to be true, interventions should have long-term persistent effects. It is thus important to study the extent to which policies affect habit formation and behavioral persistence throughout life. Yet, there is limited qualitative and quantitative evidence on the extent to which early engagement in physical activity can lead to lifelong increases in physical activity and better health. For instance, previous research has found limited effects of increased sports opportunities on long-term activity levels (Kaestner and Xu, 2010; Callison and Lowen, 2022), or has focused more on the short-term effects of such policies (Kaestner and Xu, 2006).

3 Data and Identification Strategy

3.1 Data

The data for this analysis comes from four main sources. The Health and Retirement Survey (HRS) Core data, the Life History Mail Survey from HRS (LHMS-HRS), the Cross-Wave Consumption and Activities Mail Survey (CAMS), and the High School Sports Participation Survey of 1971.

The HRS is a longitudinal panel survey that is representative of the population aged 50 and over in the United States. We use the HRS core data from 2004 to 2018 to identify where individuals resided when they were born, when they went to school, and where they currently live. These geographic locations allow us to identify the existing boys sports participation rates where girls lived when they went to school and before Title IX was implemented. To identify our instrument, we use the geographical location of respondents at the census division level. In addition to location information, HRS contains data related to girls health behaviors and outcomes for when they were aged over 50. We use this data to identify health behaviors such as the level of engagement in moderate or vigorous physical activity, smoking, and drinking behaviors. In addition, we identify relevant health outcomes to be used in the analysis including body weight outcomes, waist circumference, sedentary-lifestyle-related risk factors such as having diabetes, heart conditions, high blood pressure, having a stroke, and having cancer.

The LHMS-HRS comes from a sample of HRS respondents that was surveyed in 2015 and 2017. This survey contains information on life events that occurred before age 50 for individuals we can identify in HRS when they were aged over 50. In particular, this data contains self-reported retrospective data on women's engagement in physical activity behaviors, spanning from high-school ages until age 50. This data source allows us to identify at the individual level the take-up to increased sporting opportunities from girls after Title IX legislation passed (first-stage results). In addition, we use LHMS-HRS data to study whether increased sporting opportunities in high-school has an effect on physical activity levels for when the same girls were aged 18 to 29, 30 to 39, and 40 to 49.

We use the CAMS data to identify two variables of interest related to activity levels for the analysis: the number of hours individuals engaged in sporting activities and hours walked last week. These outcomes are relevant because they add a different dimension to whether individuals engaged more in physical activity or not and the nature of these activities. For example, according to Janke *et al.* (2016) for many adults walking is the only form of regular exercise which makes it so it is relevant to know whether increased sporting opportunities during youth have any effect on walking behaviors for women in the long run.

Using data from the High School Participation Survey (HSPS) of the National Federation of State High School Associations (NFSHSA) and high-school enrollment from the National Center for Education Statistics (NCES), we calculate the high-school sport participation rates by gender for each state and year as done in Stevenson (2010). Combining this with information on the total number of students in high school in each year from the National Center for Education Statistics we obtain the boys high-school sports participation rate in 1971, the year before Title IX was implemented. We aggregate this data at the census division level to combine with HRS respondents census division of residence for when respondents were aged 10 or were in school. We use this variable as the instrument for increased sporting opportunities for girls.

We combine all sources of information mentioned above so that we have information from 5,870 women who answered the LHMS-HRS which then combined with HRS longitudinal results in 61,663 individual by year observations that include women who were born between 1930 and 1965.

Table 1 shows basic descriptive statistics for the main three data sources used in this analysis. It breaks down information by whether women were born before 1955 or after 1954. We use 1954 as a threshold because we want to be able to identify women who had at least one year of exposure to heightened sporting opportunities during high-school given the year they were born.

3.2 Identification Strategy

We use the Title IX Education Amendments of 1972 as an exogenous shock to evaluate whether increased access to athletic opportunities for girls in high-schools had an effect on health behaviors and other outcomes during the life course. To measure these effects, we use the 1971 boys high-school sports participation rate from 1971 - the year before Title IX was implemented - at the census division level.

This identification strategy, first defined by Stevenson (2010), has been widely used to measure the causal effect of participating in sports on a range of outcomes (Callison and Lowen, 2022; Guldi, 2016; McNichols *et al.*, 2020; Schulkind, 2017; Clarke and Ayres, 2014). The use of the boys' high-school sports participation rate in the year before the introduction of Title IX as an instrument for girls' high-school sports participation relies on the fact that Title IX required schools to provide girls with the same sports opportunities as they provided to boys. Following this strategy, schools that had a higher boys sports participation rate before Title IX had to increase female sports participation by a larger amount than schools that had a lower boys sports participation rate.

Using retrospective data from LHMS-HRS, we are able to identify whether girls participated in high-school sports, or not, around the implementation of Title IX. We regress this outcome to the boys high-school sports participation rates from 1971 to measure the effect of increased boys participation rates before Title IX on female sports participation in high-school once the legislation was in effect. Therefore, our first stage to identify the effect of Title IX on high-school sports participation is as follows:

$$FemaleSportsPart_{ist} = \beta_0 + \beta_1 TitleIX_{it} * BoysSportsPart_s^{1971} + \beta_2 X_{ist}\delta_s + \gamma_t + \epsilon_{ist}$$

Where i denotes individuals, s is the census division where girls attended school, and t denotes time. $FemaleSportsPart_{ist}$ is a variable that takes the value of one if an individual engaged in high-school sports, $TitleIX_{it}$ takes the value of one if an individual was born after 1954. This way we identify the effect for girls who had at least one year of exposure to increased sporting opportunities during high-school due to the passage of Title IX given their birth-year. $BoysSportsPart_s^{1971}$ is the value of boys sports participation in 1971 at the census division level. Hence, β_1 measures the effect of Title IX on high-school sports participation for girls.

Using the estimates from this equation, we can subsequently identify the effect of female sports participation in high-school on a diverse set of outcomes using the following second stage model:

$$y_{it} = \alpha_0 + \alpha_1 Female\hat{Sports}Part_{ist} + \alpha_2 X_{ist} + \delta_s + \gamma_t + \epsilon_{ist}$$

Where y_{it} can be physical activity levels at a certain age, health outcomes such as diabetes, obesity, high blood pressure,etc. $Female\hat{Sports}Part_{ist}$ is the estimated female sports participation during high-school from the the first stage. For this specification, we use census division fixed effects to control for non time-varying differences in regions. We also include survey year fixed effects, to control for variations over time that are not location specific. In addition, we control for age at interview and for race and ethnicity. We do not control for other socio-demographic characteristics because they may well be impacted by sports participation in high-school (e.g. education level). We use robust standard errors to account for potential heteroskedasticity.

Finally, to look at the effect of a change in the boys high-school sports participation rate on the same set of outcomes, our reduced form equation is as follows:

$$y_{it} = \alpha_0 + \alpha_1 TitleIX_t * BoysSportsPart_s^{1971} + \alpha_2 X_{ist} + \delta_s + \gamma_t + \epsilon_{ist}$$

Because we are able to observe the take-up of the intervention at an individual level, we can use different identification strategies that allow us to confirm the causal nature of the relationship between access to athletic opportunities and health behaviors. In this paper, we focus mainly on the instrumental variables identification strategy, but also include results in the appendix (which are similar in direction and significance) using a difference in differences approach. In that approach we compare high school sports participation levels from girls before and after Title IX and compare it to boys outcomes in the same birth cohorts.

4 Results

4.1 Physical Activity from Adolescence to Retirement Ages

An advantage of the data and identification strategy we use in this paper lies in the ability to measure individual response to high school sports participation after Title IX legislation directly. Figure 1 shows the average sports participation during high-school by gender, and birth years from 1930 to 1965. The figure depicts the gap in sporting opportunities by gender before Title IX, where boys sports participation was consistently higher to that of girls. The participation rate for boys was pretty much constant over the entire period shown. On the contrary, for girls who were born after 1954 we observe a upward change in trend where school sports participation increases steadily until it reaches very similar levels to boys. This trend shows the narrowing gap in sporting opportunities created by the 1972 Title IX amendment.

Figure 1

Table 2 presents the estimation results for engagement in vigorous sports at least once a week by age intervals encompassing when individuals were aged 18 to 29, 30 to 39 and 40 to 49. Panel B shows that for all outcomes and specifications the first-stage is statistically significant, an increase in the boys high-school sports participation rate lead to a statistically significant increase in girl high-school sport participation. Also, including socio-demographic characteristics such as race and ethnicity to our controls does not change our point estimates in a significant way. Results also show a high value for the first-stage F-statistic.

Panel A of Table 2 shows the effect of female sports participation in high-school due to Title IX enactment on activity outcomes during adulthood. We find that a 10 percentage point increase in high school sports participation led to a 13.6 percentage point increase in vigorous sports participation when women were aged 18 to 29. This effect is equivalent to 8.5 percentage points when women were aged 30 to 39, and equivalent to a 7.1 percentage points increase when aged 40 to 49. All these results are statistically significant at the 99 percent level of confidence. These results show that although positive and statistically significant over age intervals, participation in vigorous sports fades as women age.

Table 2

To that point, Table 3 presents results for engagement in physical activity after age 50. Column 3 shows that the trend observed in Table 2 continues as women age. A 10 percentage point increase in female youth sports participation leads to a statistically significant increase in the probability of doing vigorous sports at least once a week of 2.3 percentage points. This result highlights the fact that youth sports participation has an effect on individual physical activity that spans more than 50 years.

Following the trends in a lower increase in vigorous sports participation as women age, we find that women transition from more active sports to more moderate activities as shown in Column 2 of Table **??**. To validate this result and the changing trend in the type of activity women engage more in after they age, Column 6 shows a statistically significant effect in the number of hours women walked the week before they were interviewed in HRS. This effect is equivalent to 1.5 hours increase in walking from a 10 percentage point increase in female youth sports participation.

Table 3

4.2 Female Youth Sports Participation, and the Genetic Predisposition to be more Physically Active

In addition to studying the effect of increased sporting opportunities in youth on physical activity levels, it is relevant to know who benefited the most from these increased opportunities. To do so, we explore genetic heterogeneity in these effects. We use genetic data from HRS respondents an particularly, the polygenic score for being more physically active elaborated by Doherty *et al.* (2018) using a genome-wide association study (GWAS) of device-measured physical activity for UK Biobank participants. The polygenic score for being more physically active measures how much a persons propensity to be more active compares to others that have a different genetic constitution.

To measure the genetic heterogeneity in the physical activity effects over the life course, we restrict our sample to individuals for which we have genetic data[3]. Within the sample of individuals with a polygenic score for physical activity, we divide our sample by the median value to denote low and high genetic propensity to be physically active.

Table 4 shows the results of engaging in vigorous sports at least once a week from adolescence to retirement ages given the genetic propensity to be more physically active. A result that is consistent for every outcome shown in this table is the difference in our first stage results depending on genetic

[3]Results from these estimations use a sample that limits the analysis to European heritage individuals in the HRS which is the sample for which we have genetic data that can be used for physical activity phenotype.

propensity to be more physically active. Results show that the effect of an increase in the sports participation rate led to a statistically significant increase in the probability of participating in high-school sports for girls that is always higher for girls with a lower genetic predisposition to be physically active.

Table 4, Panel A shows the effect of engaging in physical activity when aged 18 to 29 by genetic predisposition. We find that a 10 percentage point increase in youth sports participation led to a statistically significant increase in doing vigorous sports when aged 18 to 29. The results are similar but show a higher point estimate for girls with a lower genetic predisposition. Differently to when they were under 30. We find that our results for engagement in physical activity when aged 30 to 39 (Panel B), 40 to 49 (Panel C), and above 50 (Panel D) are mainly driven by women who had a lower genetic predisposition to be more physically active. This suggests that increasing sports participation for girls had an equalizing effect, in that it reduced genetic inequality in sports participation, and thereby may improve overall population health.

Table 4

Table 5 does the same analysis but looking at hours spent last week participating in sports and hours walking. As we found in the previous section, there is no statistically significant effect on hours doing sports last week but a statistically significant increase in hours walking. Consistent with results for physical activity levels above, the effect is heightened for women who have a lower genetic propensity to be physically active and statistically significant at the 90 percent level of confidence.

Table 5

4.3 Female Youth Sports Participation, Health Outcomes, and Behaviors

Lack of physical activity is in itself a determinant of body weight outcomes. We test whether increased sporting opportunities in youth had an effect on body weight outcomes and waist circumference. Table 6 presents result for having normal weight, being overweight, obese, and waist circumference after age 50. Results show that there is a statistically significant decline in obesity levels. In particular, a 10 percentage point increase in youth female sports participation led to a 2.2 percentage point decline in the probability of being obese (Panel A, Column 3). On the other hand, we observe a non statistically significant increase in the probability of having normal weight and a slight increase in the probability of being overweight that is significant at the 90 percent level of confidence. We find no effect on waist circumference.

Table 6

Next, we study whether increased sporting opportunities during youth had any long run effect with sedentary behavior linked risk factors. Table 7 presents estimation results for high blood pressure, diabetes, heart problems, stroke, and cancer for when women were aged over 50. Column 1 shows that a 10 percentage point increase in female youth sports participation led to a statistically significant 3 percentage point decline in the probability of having high blood pressure, a major risk factor associated with sedentary behaviors later in life. Another risk factor associated with lack of physical activity and obesity is diabetes. We find a decline in the probability of having diabetes that is statistically significant at the 90 percent confidence level (Panel A, Column 2).

Panel A, Column 3 of Table 7 shows that increased sports participation in high-school for girls, led to a statistically significant decline at the 95 percent level of confidence of the probability of having heart problems when aged over 50. We find the same relationship for having cancer. A 10 percentage point increase in youth sports participation led to a 2 percent decline in the probability of having cancer (Panel A, Column 5). Finally, as shown in Column 4, we find no statistically significant effect of increased youth sports participation on the probability of having a stroke.

Table 7

In addition to studying the effect of youth sports participation on physical activity levels and health outcomes after age 50, we also look at whether increased sports opportunities for girls in high-school led to changes in risky health behaviors. Table 8 shows results for smoking and drinking behaviors for women over 50 years of age. Results show that there is no statistically significant effect of increased youth sports participation on the probability of ever drinking alcohol or the number of days people drink in a week (Panel A, Columns 3 and 4). However, we find that a 10 percentage point increase in the sports participation rate led to a 2.9 percentage points increase in the probability of having ever smoked, and a 1.5 percentage point increase in the probability of being a current smoker. The magnitude of this result needs further explanation. We hypothesize that increased sporting opportunities during adolescence also led to increased socialization and hence the heightened probability of engaging in some risky health behaviors - such as smoking - during adolescence that may have persisted during adulthood given the addictive nature of these behaviors.

Table 8

5 Concluding Remarks

In this paper we estimate the effect of increased sporting opportunities during youth on health behaviors and outcomes during the life course. Using Title IX as an instrument, we find that increased sports opportunities for girls during high-school had lasting effects on physical activity levels from adolescence to retirement ages. We benefit from the fact that 50 years have occurred since Title IX was passed and with data from HRS, we are able to track their outcomes as they age.

We find that having more sporting opportunities in adolescence for girls leads to a statistically significant increase in the probability of doing vigorous sports at least once a week. This effect decreases over time but it is still positive after they are aged over 50. We find that women transitioned from vigorous to more moderately physically active activities as they aged. This is consistent with our finding that increased sporting opportunities for girls led to a 1.5 hour increase in walking behaviors per week.

We find that girl high-school sports participation impacted the sedentary behavior-related risk factors of women 50 years later. This results highlights the relevance of physical activity levels on overall health and the importance of having policy that helps individuals engage in more healthy behaviors.

We find that our physical activity results are mainly driven by women not genetically predisposed to be more physically active. This result implies reduced genetic inequality in sports participation from giving girls opportunities to do sports, and thereby may improve overall population health.

We find it important to highlight that school-based interventions such as the increased sporting opportunities stemming from Title IX legislation and that target young individuals may be key in creating long lasting behavioral and health outcomes. Our results depict behavioral persistence in physical activity that impacts the overall health of individuals exposed to these heightened sporting opportunities.

Title IX was passed approximately 50 years ago. It is important to ponder what a policy that mimics the effects we measure in this paper would look like in today's world. It remains to be seen what is the effect of increased sports participation in youth after retirement ages.

6 Tables and Figures

6.1 Figures

Figure 1: **Sports Participation during High School by Gender and Year of Birth, 1930-1970**

Note: The vertical line refers to 1954.
Source: Authors calculations using Health Retirement Survey's Life History Mail Surveys 2015-2017

6.2 Tables

Table 1: Overall Descriptive Statistics

	No Title IX (1)	Title IX (2)	Total (3)
Life History Mail Survey			
Participated in High School Sports	0.338	0.444	0.372
Vig. Sports Once a Week When Aged 18 to 29	0.349	0.519	0.404
Vig. Sports Once a Week When Aged 30 to 39	0.348	0.458	0.384
Vig. Sports Once a Week When Aged 40 to 49	0.322	0.401	0.348
Observations	4,378	1,492	5,870
Core Health and Retirement Survey			
African-American	0.074	0.094	0.078
Hispanic	0.035	0.059	0.040
Non-Hispanic White	0.869	0.803	0.856
Ed. Highschool or Less	0.640	0.492	0.612
Ed. Some College	0.007	0.015	0.009
Ed. College or More	0.353	0.493	0.380
Vig. Sports Once a Week	0.345	0.433	0.363
Vig. Sports Seven Days of Week	0.019	0.019	0.019
Has Children	0.883	0.830	0.873
Waist Circumference (in)	38.546	38.905	38.625
Body Mass Index	29.570	30.347	29.741
Smokes	0.090	0.148	0.101
Ever Smokes	0.465	0.522	0.476
Number of Drinking Days in Week	0.566	0.678	0.587
Ever Drinks	1.107	1.180	1.120
Has Diabetes	0.166	0.157	0.165
Lung Disease	0.087	0.080	0.086
Heart Problem	0.176	0.104	0.163
Had Stroke	0.050	0.026	0.045
High Blood Pressure	0.534	0.393	0.507
Observations	49,954	11,709	61,663
Consumption and Activities Mail Survey			
Hours Spent Walking Last Week	6.097	8.311	6.534
Hours Participating in Sports/Excercise Last Week	2.032	2.741	2.171
Observations	11,522	2,417	13,939

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using HRS CAMS 2001-2019, HRS-Core Data 2004-2020, and LHMS 2015-2017.

Table 2: Estimation Results for Engaging in Vigorous Sports at Least Once a Week by Age Intervals

	When Aged 18 to 29 (1)	(2)	When Aged 30 to 39 (3)	(4)	When Aged 40 to 49 (5)	(6)
Panel A: Wald Estimator (IV)						
Part. in High School Sports	1.364***	1.358***	0.848***	0.849***	0.702***	0.711***
	(0.289)	(0.290)	(0.246)	(0.248)	(0.221)	(0.224)
Panel B: First-Stage Results (H.S. Sports Part.)						
Title IX * 1971 Boys Part.	0.216***	0.215***	0.219***	0.218***	0.227***	0.225***
	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
F-Statistic	27.839	27.405	28.379	27.807	30.446	29.800
Panel C: Reduced-Form Results						
Title IX * 1971 Boys Part.	0.295***	0.292***	0.186***	0.185***	0.159***	0.160***
	(0.042)	(0.042)	(0.042)	(0.042)	(0.041)	(0.042)
Observations	4,050	4,050	3,989	3,989	3,997	3,997
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
School Census Division FE	Yes	Yes	Yes	Yes	Yes	Yes
Sociodem. Charact.	No	Yes	No	Yes	No	Yes

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using HRS-LHMS 2015-2017.

Table 3: Estimation Results for Physical Activity Outcomes After Age 50

	Moderate Sports Once a Week (1)	Moderate Sports Every Day (2)	Vigorous Sports Once a Week (3)	Vigorous Sports Every Day (4)	Hours Doing Sports (5)	Hours Walking (6)
Panel A: Wald Estimator (IV)						
Part. in High School Sports	0.171*	0.143**	0.233**	0.016	2.881	14.664**
	(0.094)	(0.067)	(0.111)	(0.030)	(2.891)	(6.379)
Panel B: First-Stage Results (H.S. Sports Part.)						
Title IX * 1971 Boys Part.	0.197***	0.197***	0.195***	0.195***	0.188***	0.185***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.038)	(0.038)
F-Statistic	83.891	83.891	82.729	82.729	24.706	23.797
Panel C: Reduced-Form Results						
Title IX * 1971 Boys Part.	0.034*	0.028**	0.046**	0.003	0.540	2.707***
	(0.018)	(0.013)	(0.022)	(0.006)	(0.534)	(1.014)
Observations	32,754	32,754	32,733	32,733	11,354	11,224
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
School Census Division FE	Yes	Yes	Yes	Yes	Yes	Yes
Sociodem. Charact.	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using HRS data from 2004-2018, LHMS 2015-2017, and CAMS 2001-2019.

Table 4: Estimation Results for Engaging in Vigorous Sports at Least Once a Week by Age Intervals and Genetic Propensity to be More Physically Active

	Wald Estimator (IV)	First Stage (HS Sports Part.)	Reduced Form
Panel A: Vig. Sports When Aged 18-29			
Total	1.169***	0.263***	0.307***
	(0.269)	(0.051)	(0.052)
Observations	2,651	2,651	2,651
Ph. Act. PGI < Median	1.185***	0.329***	0.391***
	(0.312)	(0.072)	(0.073)
Ph. Act. PGI > Median	1.099**	0.205***	0.225***
	(0.461)	(0.073)	(0.073)
Panel B: Vig. Sports When Aged 30-39			
Total	0.731***	0.264***	0.193***
	(0.244)	(0.051)	(0.052)
Observations	2,638	2,638	2,638
Ph. Act. PGI < Median	0.919***	0.326***	0.299***
	(0.307)	(0.072)	(0.072)
Ph. Act. PGI > Median	0.412	0.208***	0.086
	(0.381)	(0.073)	(0.074)
Panel C: Vig. Sports When Aged 40-49			
Total	0.690***	0.264***	0.193***
	(0.234)	(0.051)	(0.052)
Observations	2,642	2,642	2,642
Ph. Act. PGI < Median	0.806***	0.331***	0.267***
	(0.254)	(0.072)	(0.070)
Ph. Act. PGI > Median	0.470	0.213***	0.100
	(0.400)	(0.073)	(0.073)
Panel D: Vig. Sports When Aged Over 50			
Total	0.198*	0.240***	0.048*
	(0.110)	(0.027)	(0.027)
Observations	22,426	22,426	22,426
Ph. Act. PGI < Median	0.334***	0.358***	0.119***
	(0.107)	(0.037)	(0.037)
Ph. Act. PGI > Median	-0.231	0.129***	-0.030
	(0.307)	(0.038)	(0.037)

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using HRS data from 2004-2020 and LHMS 2015-2017.

Table 5: Estimation Results for Hours Spent Last Week Participating in Sports or Walking and Genetic Propensity to be More Physically Active

	Wald Estimator (IV)	First Stage (HS Sports Part.)	Reduced Form
Panel A: Hours Doing Sports Last Week			
Total	-0.585	0.222***	-0.130
	(1.624)	(0.046)	(0.357)
Observations	8,156	8,156	8,156
Ph. Act. PGI $<$ Median	2.086	0.365***	0.761
	(1.421)	(0.068)	(0.503)
Ph. Act. PGI $>$ Median	-7.866	0.109*	-0.859*
	(6.959)	(0.063)	(0.501)
Panel A: Hours Walking Last Week			
Total	15.033**	0.218***	3.273**
	(7.428)	(0.047)	(1.403)
Observations	8,065	8,065	8,065
Ph. Act. PGI $<$ Median	15.974*	0.363***	5.800**
	(8.626)	(0.068)	(2.701)
Ph. Act. PGI $>$ Median	12.933	0.102	1.317
	(14.291)	(0.064)	(1.270)

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using CAMS data from 2001-2019 and LHMS 2015-2017.

Table 6: Estimation Results for Weight Outcomes and Waist Circumference When Aged Over 50

	Normal Weight (1)	Overweight (2)	Obese (3)	Waist Circ. (4)
Panel A: Wald Estimator (IV)				
Part. in High School Sports	0.070	0.160*	-0.216**	-1.317
	(0.066)	(0.082)	(0.101)	(2.205)
Observations	29,510	29,510	29,510	13,080
Panel B: First-Stage Results (H.S. Sports Part.)				
Title IX * 1971 Boys Part.	0.196***	0.196***	0.196***	0.197***
	(0.022)	(0.022)	(0.022)	(0.033)
Observations	29,510	29,510	29,510	13,080
F-Statistic	80.227	80.227	80.227	36.592
Panel C: Reduced-Form Results				
Title IX * 1971 Boys Part.	0.014	0.031**	-0.042**	-0.259
	(0.013)	(0.016)	(0.019)	(0.433)
Observations	29,510	29,510	29,510	13,080
Year FE	Yes	Yes	Yes	Yes
School Census Division FE	Yes	Yes	Yes	Yes
Sociodem. Charact.	Yes	Yes	Yes	Yes

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using HRS data from 2004-2018 and LHMS 2015-2017.

Table 7: Estimation Results for Low Physical Activity Related Risk Factors

	High Blood Pressure	Diabetes	Heart Problems	Stroke	Cancer
	(1)	(2)	(3)	(4)	(5)
Panel A: Wald Estimator (IV)					
Part. in High School Sports	-0.302***	-0.144*	-0.152**	-0.022	-0.198***
	(0.111)	(0.083)	(0.076)	(0.031)	(0.073)
Observations	35,224	35,234	35,247	35,247	35,234
Panel B: First-Stage Results (H.S. Sports Part.)					
Title IX * 1971 Boys Part.	0.198***	0.197***	0.198***	0.198***	0.197***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Observations	35,224	35,234	35,247	35,247	35,234
F-Statistic	86.424	85.726	86.044	86.044	85.109
Panel C: Reduced-Form Results					
Title IX * 1971 Boys Part.	-0.060***	-0.028*	-0.030**	-0.004	-0.039***
	(0.021)	(0.016)	(0.015)	(0.006)	(0.014)
Observations	35,224	35,234	35,247	35,247	35,234
Year FE	Yes	Yes	Yes	Yes	Yes
School Census Division FE	Yes	Yes	Yes	Yes	Yes
Sociodem. Charact.	Yes	Yes	Yes	Yes	Yes

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using HRS data from 2004-2018 and LHMS 2015-2017.

Table 8: Estimation Results for Smoking and Drinking Behaviors

	Ever Smoked (1)	Current Smoker (2)	Ever Drink (3)	Number of Drinks (4)
Panel A: Wald Estimator (IV)				
Part. in High School Sports	0.290**	0.151**	0.163	0.010
	(0.115)	(0.076)	(0.102)	(0.397)
Observations	35,076	35,083	35,237	35,186
Panel B: First-Stage Results (H.S. Sports Part.)				
Title IX * 1971 Boys Part.	0.198***	0.198***	0.198***	0.198***
	(0.021)	(0.021)	(0.021)	(0.021)
Observations	35,076	35,083	35,237	35,186
F-Statistic	86.300	85.940	86.228	86.131
Panel C: Reduced-Form Results				
Title IX * 1971 Boys Part.	0.058***	0.030**	0.032	0.002
	(0.022)	(0.015)	(0.020)	(0.079)
Observations	35,076	35,083	35,237	35,186
Year FE	Yes	Yes	Yes	Yes
School Census Division FE	Yes	Yes	Yes	Yes
Sociodem. Charact.	Yes	Yes	Yes	Yes

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using HRS data from 2004-2018 and LHMS 2015-2017.

Table 9: Estimation Results for Other Outcomes

	Some College (1)	Unemployment (2)	Having Any Children (3)
Panel A: Wald Estimator (IV)			
Part. in High School Sports	1.050***	-0.044	0.001
	(0.253)	(0.080)	(0.083)
Observations	4,251	14,639	35,247
Panel B: First-Stage Results (H.S. Sports Part.)			
Title IX * 1971 Boys Part.	0.219***	0.134***	0.198***
	(0.041)	(0.029)	(0.021)
Observations	4,251	14,639	35,247
F-Statistic	29.214	21.382	86.044
Panel C: Reduced-Form Results			
Title IX * 1971 Boys Part.	0.230***	-0.006	0.000
	(0.041)	(0.011)	(0.016)
Observations	4,251	14,639	35,247
Year FE	Yes	Yes	Yes
School Census Division FE	Yes	Yes	Yes
Sociodem. Charact.	Yes	Yes	Yes

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using HRS data from 2004-2018 and LHMS 2015-2017.

Table 10: Estimation Results for Unrelated Outcomes, Been displaced due to a disaster before age 50

	Been Displaced due to a Disaster before Age 50
	(1)
Panel A: Wald Estimator (IV)	
Part. in High School Sports	0.003
	(0.051)
Observations	1,863
Panel B: First-Stage Results (H.S. Sports Part.)	
Title IX * 1971 Boys Part.	0.186***
	(0.063)
Observations	1,863
F-Statistic	8.667
Panel C: Reduced-Form Results	
Title IX * 1971 Boys Part.	0.000
	(0.009)
Observations	1,863
Year FE	Yes
School Census Division FE	Yes
Sociodem. Charact.	Yes

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors in parentheses. Authors estimations using HRS LHMS 2015-2017.

7 References

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8 Appendix