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ESTIMATING THE EFFECT OF PHYSICAL EXERCISE ON CHILDREN'S HEALTH STATUS AND SUBJECTIVE WELL-BEING IN CHINA

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Estimating the Effect of Physical Exercise on Juveniles' Health Status and Subjective Well-Being in China

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Abstract

This study estimates the causal effect of physical exercise on health and happiness for Chinese junior high school students. We use a longitudinal database from the China Education Panel Survey (CEPS) which allows us to deal with the potential endogeneity of physical exercise by considering the use of instrumental variables and propensity score matching. Our findings suggest that physical exercise has a significantly positive effect on health, and also marginally improves students' happiness. Moreover, these improvements affect all types of students, even those relatively unhappy or in poor health. It is also found that the positive impact on health is higher for females, rural and low-income students and for students attending to schools subjected to high academic pressure.

Keywords: Health; Happiness; Endogeneity; Instrumental variables; Propensity score; China
Jel classification: I10, I31, C26, C14, Z29

1. Introduction

The analysis of determinants of health status and subjective well-being has increasingly attracted the attention of both academics and politicians for obvious reasons. Their economic importance stems from the fact that health and happiness are not only consumption goods, which can be considered the ultimate target of many human actions, but also investment goods, which potentially affect concentration and productivity. Moreover, the macroeconomic literature has found a positive impact of health on economics growth that is consistent across many different countries; see, for example, Narayan, Narayan and Mishra (2010), Hartwig (2010) and Bloom et al. (2010) among others.

The economic relevance of health investments was highlighted in Grossman (1972) in his seminal paper which indicates that the stock of health of an individual is not intrinsically different from other investment goods that depreciate with age and it can be improved by lifestyle choices such as physical exercise. Thus, the positive effect of this instrument on health and happiness has been corroborated both with experimental intervention research and observational studies. Some examples of experiments that found a positive effect of physical exercise on health and mental health are Sherwood and Jeffery (2000); Brown, Burton, and Rowan (2007); Tsang, Chan, and Cheung (2008). Moreover, reviews in Janssen and LeBlanc (2010) and Biddle, Gorely, and Stensel (2004) summarized experimental intervention research among school-aged children and young people and similar benefits of doing physical exercise were found. However, on most occasions, having random assignment and control groups is impossible or inadequate, which renders the use of methodologies used in observational studies a relevant method of analysis with which to draw general conclusions in health economics. The related literature, which will be more specifically outlined in the following section, shows examples of improvement in happiness as a consequence of physical exercise for people in South Korea (Lee & Park, 2010), nineteen European countries (Pawlowski, Downward, & Rasciute, 2011), Germany (Lechner, 2009; Ruseski et al., 2014), twenty-eight European countries (Wicker & Frick, 2015), England (Forrest & McHale, 2011) and the US (Huang & Humphreys, 2012). From Canada, there is also evidence that physical exercise also improves health status for people (Humphreys, Mcleod, & Ruseski, 2014; Sarma, Anne, Gilliland, & Campbell, 2015). Lechner (2009), Rasciute and Downward (2010) and Pawlowski, Schüttoff, Downward, and Lechner (2018) are probably the only three papers that estimate the impact of physical activity on both health and subjective well-being for West Germany, UK, and Peru finding positive impacts in all cases.

However, to our knowledge, with the sole exception of Pawlowski, Schüttoff, Downward and Lechner (2018), previous observational studies have focused almost exclusively on the adult population in developed countries. But interest in the juvenile population is economically relevant since adverse health effects on lower-income children are likely to accumulate over their life, see Case, Lubotsky and Paxson (2002). There is little reason to believe that results for the adult population can be extrapolated to juveniles as their motivations, confounding variables and stock of health are radically different. Moreover, an analysis of the juvenile population provides a cleaner econometric environment as some variables typically used in these analyses that can be thought to be endogenously determined by exercise such as, for example, income and marital status, are exogenous for the child population. Further, people from some developing countries are more likely to be inactive (NHS Digital, 2017). Previous analysis for developed countries cannot be generalised for their developing counterparts as the latter are more likely to suffer shortages of sports facilities, sports matches and low-quality physical education (Andreff, 2001). As the most populous country and the second largest economy in the world, but one with relatively low per capita income, China is one of the most interesting cases to study.

This paper estimates the causal impact of physical exercise on health and subjective well-being of Chinese children. The study uses data from the China Education Panel Survey (CEPS), a comprehensive longitudinal database with contains information on the physical and socioeconomic characteristics of individual children in 28 counties, including more than 20,000 pupils. Although it is a short panel covering only two years, the longitudinal nature of our database is especially relevant as it allows us to control for the presence of time-invariant effects by observing the same person before and after being involved in physical exercise. Moreover, we deal with the potential endogeneity between exercise and health and happiness by using propensity score and instrumental variable estimation methods. To preview, we find that, on average, exercise has a significantly positive effect on health and also marginally improves students' happiness. Moreover, these improvements affect all types of students, even those in relatively unhappy or poor health.

Our analysis is subsequently extended by estimating the differential impact of physical exercise on the different health and happiness levels by means of ordered logit models. Further, we estimate the impact of our treatment variable depending on the student's gender and income as well as the type and location of the school. Our results are consistent with the view that exercise has a more positive effect on health for rural and low-income students and for students attending schools subject to high academic pressure.

This paper proceeds as follows. Section 2 explores the related literature. Section 3 describes our database and the variables considered in the paper. Section 4 discusses the econometric models employed in the paper. Main results and extended analysis are contained in Sections 5 and 6 respectively. Section 7 concludes.

2. Related literature

The impact of exercise on health status and subjective well-being has been widely discussed in experimental interventions research studies; for example, exercise could reduce a variety of chronic diseases including diabetes, heart disease and cancer (Sherwood & Jeffery, 2000). There was also strong evidence of a role for physical exercise in the primary prevention of many of these diseases in women and young people (Brown, Burton, & Rowan, 2007; Janssen & LeBlanc, 2010). Exercise could also reduce depression levels or depressive symptoms and improve mental health (Tsang, Chan & Cheung 2008; Biddle, Gorely & Stensel, 2004). A limitation of experimental interventions research studies in our particular context is that it is difficult to randomize treatment allocation as physical exercise is a voluntary decision that can hardly be imposed and monitored. Another issue of concern is that the size of the sample used in experiments is usually insufficient to draw general conclusions.

Observational studies typically use samples that are representative of the whole population and consider alternative econometric techniques to deal with the fact that treatment allocation is not random. Many of these papers have focused on adult population in developed countries using a cross-sectional database. A general approach in these papers is to control for individual unobserved characteristics in cross-sectional analyses by considering a system of two bivariate probit model equations for health and exercise and allowing the error terms to be correlated in the two equations, see for example Humphreys, Mcleod and Ruseski (2014), Sarma, Anne, Gilliland and Campbell (2015). To address identification problems in bivariate probit models, they used instrument variables and found that physical exercise could reduce specific diseases, obesity, and chronic conditions, as well as reduce the chance of being poor or only fair health among Canadian adults. Rasciute and Downward (2010) considered two seemingly unrelated equations for health and happiness regressed on the full set of covariates.

The second form of endogeneity relates to possible reverse causality between exercise and response variables. This has also been widely discussed in previous studies. A common way to control for it in cross-sectional studies is by using instrumental variable methods, see for example Pawlowski, Downward and Rasciute (2011), Forrest and McHale (2011), Huang and Humphreys (2012), Ruseski et al. (2014), Wicker and Frick (2015) and Brechot, Nüesch and Franck (2017). Some instrumental variables came from individual decisions in other contexts. For example, Pawlowski, Downward and Rasciute (2011) found a positive impact of exercise on well-being in 19 European countries and significant age-specific differences by instrumenting sports participation with the frequency of attending sports events and sports associations/groups. Wicker and Frick (2015) found that moderate intensity exercise has a significant and positive effect on well-being in twenty-eight European countries by instrumenting exercise with sports opportunities, club membership and time spent sitting. Forrest and McHale (2011) studied the impact of sport on happiness in the English adult population using distance to the nearest sports facility and parental encouragement during childhood as instruments. Other examples are Huang and Humphreys (2012) who found that, in the United States, the more people practice physical exercise, the happier. They used the county sports establishment count as instrument. Ruseski et al. (2014) detected a positive impact of sports on well-being in German adults using the distance between an individual's home and the nearest sports facility as instrument. Brechot, Nüesch and Franck (2017) did not find a significant effect of exercise on health outcomes for Sweden after considering the local density of sports facilities as their instrumental variable.

The majority of relevant observational studies concentrated only on either the effect of physical activity on health or on happiness. A few examples of papers that have estimated the impact of physical exercise on both self-rated health status and subjective well-being are Lechner (2009), Rasciute and Downward (2010), Pawlowski, Schüttoff, Downward, and Lechner (2018) for West Germany, the United Kingdom, and Peru respectively. Positive effects of exercise were detected in all these studies.

From these examples, the analysis in Pawlowski, Schüttoff, Downward, and Lechner (2018) is especially related to our research as they focus on the child population in a developing country such as Peru. It is remarkable that, despite the low number of observations in their database, they found strong evidence of a positive impact of physical exercise on health while no significant impact was found on subjective well-being. Whether these conclusions can be generalised to children in other developing countries can be deemed an interesting hypothesis to test.

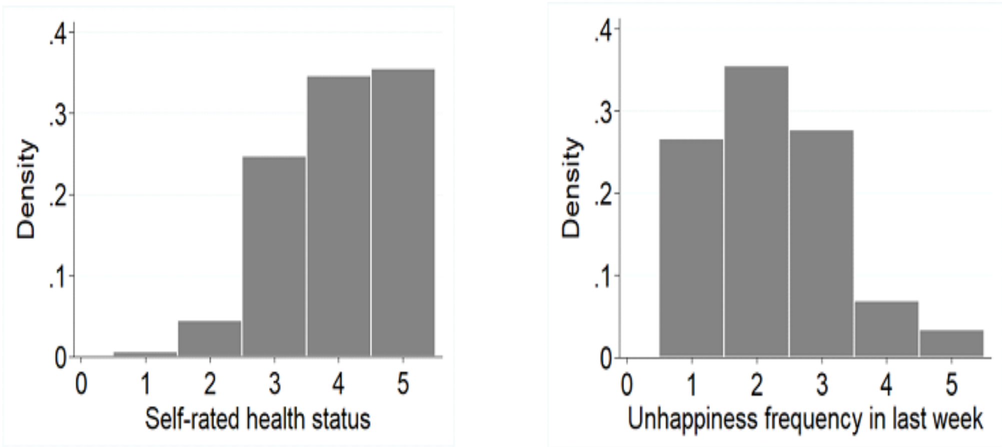
In this paper, we use instrumental variable and propensity score methods to deal with the potential endogeneity of treatment allocation. Moreover, we take advantage of our longitudinal database to control for reverse causality by comparing the same individual before and after treatment. Our focus on children in China, a developing country, is pertinent because the beneficial effect of physical exercise among children is expected to be more persistent than in the adult population. For example, Moav (2005) proposes a theoretical model to explain the persistence of poverty as a result of lack of investment in children. Moreover, the analysis of the differential impact of physical exercise in different socio-economic groups is a novel contribution of this paper which is especially relevant from a managerial perspective as it allows for the identification of specific groups which are more likely to benefit from policies that incentivize sports and physical activity.

3. Data

The study uses data from the China Education Panel Survey (CEPS) conducted by the National Survey Research Center at Renmin University of China. The CEPS is a nationally representative and school-based survey which covers 28 counties in China and includes 112 junior high schools, 438 classrooms, and over 20,000 students. It provides information at the individual, family and school levels based on five different questionnaires for students, parents, homeroom teachers, main subject teachers who are not the homeroom teacher, and school administrators. The CEPS reports demographic characteristics, health status, and household as well as school basic information. Our analysis period comprises seventh-year students in the 2013/14 academic year and subsequent observations of the same students in the 2014/15 academic year.

Our two response variables are self-rated health status (Health) and unhappiness frequency in last week (Unhappiness frequency). Health measures the students' general health at present, and it is an ordinal indicator taking discrete values from 1 to 5, which correspond to student's health being self-evaluated as very poor, not very good, moderate, good or very good respectively. Happiness is typically considered a measurement of well-being and it is always measured in ordinal values (Rasciute & Downward, 2010). Here, we use unhappiness frequency, which takes values 1 to 5 meaning that the respondent has never, seldom, sometimes, often or always felt unhappy in the last week. Figure 1 shows the distributions of our response variables. It shows that the majority of students are in good health and moderately happy, and only a few students are in very poor health or unhappy status. This is reasonable as children with extremely poor health are in general unable to attend schools.

Figure 1. Distribution of response variables



Our treatment variable is the binary answer to the question of whether physical exercise is a hobby for the student (Exercise). Note that this a higher threshold for defining treatment indicator than just doing casual exercise on some days.

Control variables include age, the square of age, gender, household registration type (hukou), ethnicity, height, weight, income level, and physical disorder. These variables can be deemed important determinants of health and well-being. To be more specific, gender is a binary variable which takes the value 1 or 0 depending on whether the individual is male or not. It is included because men, in general, take more risks that are seriously hazardous to health and evidence in the prior literature shows that inequalities in access to health-promoting resources have a negative effect on women's well-being (Doyal, 2001). Hukou takes the value 1 or 0 depending on whether or not an individual has an agriculture registration type (agriculture hukou) or not. We include it since individuals with the agriculture hukou originally come from rural China and could have a more restricted access to health and recreational facilities. Ethnicity takes the value 1 or 0 depending on whether or not an individual's ethnic nationality is Han. Non-Han people are considerably less numerous than Han and usually live in remote places with a worse living environment. Height and weight are measured in centimeters and kilograms respectively. Income level takes values 1 to 5, which means an individual is very poor, somewhat poor, moderate, somewhat rich, or very rich respectively. Rich families are typically more able to get necessary medical treatments and to offer a better living environment for their children. Physical disorder takes the value 1 or 0 depending on whether or not an individual has physical disorders at present. Physical disorders include vision disorders, hearing disorders, extremity disorders, autism or other mental disorders, attention deficit hyperactivity disorder (ADHD) and others.

Table 1. Summary statistics based on whether a student has physical exercise as a hobby ('treated')

Variable	**Sample mean**	**Mean of the treated group**	**Mean of the non-treated group**	**Difference**
health	4.00	4.14	3.91	-0.22***
unhappiness frequency	2.25	2.2	2.28	0.08***
exercise	0.38	-	-	-
Age	13.41	13.46	13.38	-0.08***
age square	180.91	182.24	180.1	-2.14***
gender	0.51	0.66	0.41	-0.25***
hukou	0.52	0.52	0.52	0
ethnicity	0.92	0.91	0.92	0.02***
height	160.93	162	160.28	-1.72***
weight	71.66	73.68	70.44	-3.25***
income	2.99	2.99	2.98	-0.01
physical disorder	0.05	0.06	0.05	-0.01***
#Observations	14,679	5,537	9,142	-

Notes: * p<0.1 **p<0.05 ***p<0.01

Table 1 shows descriptive statistics for our variables. The last column shows the difference between treated and non-treated groups. We can observe significant differences between the two subgroups in terms of our response variables. On average, individuals who have exercise hobbies report both better health status and experiencing unhappiness less frequently. However, this cannot be used to conclude that exercise has a causal effect on both health status and happiness as the two groups of students are significantly different in terms of most of the explanatory variables. Therefore, a proper causal analysis would require controlling for the different confounding factors in the estimation. This is discussed in the following section.

4. Methodology

Our purpose is to estimate the causal impact of exercise on children's health and unhappiness frequency. We identify the two equations by assuming that happiness does not affect individuals' health status but health status could influence happiness. In fact, it is reasonable to think that unhappiness would only affect health in very extreme cases and in the very long run. These two assumptions imply that health indicators enter in the well-being equation as exogenous variables. More specifically, for the determination of well-being, we considered an additional control variable, poor health, which takes values 1 or 0 depending on whether or not an individual's self-rated health status is lower than 3 or higher than 2 respectively.

For robustness, the two equations are estimated under three alternative methodologies. The first estimation is from fixed effects (FE) regressions based on the following model

$$Y_{it} = \alpha_1 Exercise_{it} + \alpha_2 X_{it} + T_t + \gamma_i + \varepsilon_{it}, \quad (1)$$

where Y_{it} is the response variable for individual i in year t; $Exercise_{it}$ and X_{it} correspond to our treatment and control variables respectively for year t and individual i; T_t and γ_i are year and individual fixed-effects that control for unobservable time-invariant characteristics of years and individuals respectively; ε_{it} is the error component and α_{i}, for *i*=1 and 2 are parameters to be estimated. Our focus estimation is a_1 which represents the estimate of the causal impact of exercise on children's health status or well-being.

An important issue concerning the estimation of the causal impact of physical exercise relates to the fact that our treatment variable is not randomly allocated. One possible way to tackle this problem is by finding an instrument that is correlated with treatment but uncorrelated with the error terms of the two equations. Here, we use an indicator of whether the school has a swimming pool as instrument. The interpretation is that this variable is a good proxy for access to sports facilities as schools are, in general, better equipped with fundamental exercise facilities when they have swimming pools as their construction are more expensive than other sports facilities. Our data shows that for schools with swimming pools, all of them provide students with standard playgrounds and 88% of them provide gymnasia. This instrument satisfies the two basic requirements to be valid. First, it significantly explains the probability of exercise in the first step model[1]. The second requirement is the exogenous nature of swim facilities relative to the children's health and unhappiness frequency. In fact, construction of swimming pools is mostly based on government subsidies and school profitability rather than on its student's characteristics (Ministy of Finance People's Republic of China, 2015).

An alternative to the instrumental variable estimation described above is to make use of the ignorability-of-treatment assumption by comparing treated and non-treated individuals according to observables by propensity score methods; see Rosenbaum and Rubin (1983). Here, we obtain similar individuals in the treated and control groups by using the kernel matching method. This approach constructs the counterfactual individual in the control group by giving them different weights. In general, closer individuals always receive higher weights (Mensah, Oppogng, & Schmidt, 2010). Under this approach, we consider a person belongs to the treatment group if Exercise takes values 0 and 1 in the first and second waves respectively while she/he belongs to the control group if Exercise=0 in both waves. Therefore, the specified estimation is similar to a difference-in-difference approach with propensity score matching as, controlling for the confounding variables defined in the previous section, for each individual, we compare the values of the response variables before and after practicing physical exercise with a similar person who did not practice exercise in any of the two waves[2].

5. Results

Table 2 shows the estimated impact of physical exercise on children's health and unhappiness frequency under the three approaches described in the previous section. For the sake of brevity, only the estimation of the focus parameter is reported[3]. For our last

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[1] We also considered instruments such as whether a school has a gymnasium or standard playground. However, none of them could (significantly) explain treatment in the first step of IV estimation. One of the most commonly used instruments, distance between the individual's home and the nearest sports facility, cannot be applied in this context as students spend most of their time in campuses, and the sports facilities are located in schools. Therefore, the distance could be considered as zero.

[2] We restrict our sample to common support by deleting all observations with probabilities larger than the smallest maximum and smaller than the largest minimum of treated and untreated groups defined by Exercise.

[3] Almost all our control variables have a significant impact on the response variables. To be more specific, males, Han people, students with high family incomes and without body disorders have both

approach, we show the average treatment effect estimation. However, similar results were obtained when the average treatment effects on the treated and nontreated were considered.

Table 2. Impact of exercise on children's health status and unhappiness frequency by using linear regression methods

	Fixed effect	**Instrumental variable**	**Propensity score**
Panel 1: Health			
Exercise	0.202***	0.203***	0.161***
	(12.91)	(6.41)	(2.95)
R-squared	0.050	0.051	0.063
#observation	14,679	14,313	7,290
Panel 2: Unhappiness frequency			
Exercise	-0.056***	-0.029	-0.116*
	(-3.16)	(-0.78)	(-1.93)
R-squared	0.039	0.040	0.035
#observation	14,679	14,313	7,350

Notes: T statistics in parentheses
* p<0.1 **p<0.05 ***p<0.01

It can be seen that the three estimation methods consistently show that exercise significantly increases children's health status. In addition to this, there is some evidence that exercise decreases students' unhappiness frequency. However, this result is not significant under the instrumental variable approach, and only marginally significant under the propensity score matching estimation.

Although the previous literature finds non-significant differences between happiness models estimated with linear and models adapted for categorical response variable (see Ferrer-i-Carbonell and Frijters (2004) for a discussion), the advantages of taking account of the discrete and non-gaussian nature of our response variables are twofold. First, a non-linear regression that takes into account the specific nature of the response variables provides a more precise and reliable estimation of the effects. Second, and more importantly, the possibility of estimating marginal causal effects for the different health states and

better health status and happy mood. Further, students with non-agriculture registration type and who are taller enjoy a better health status.

happiness allows us to get a richer interpretation of the results by identifying which levels are more affected by changes in treatments.

Therefore, we will continue our analysis by using ordered logit models applied to our third approach: propensity score matching regression. The reason for this is that, although the previous estimation shows no significant differences in main conclusions regardless of methodology, it is impractical to adapt our instrumental variable approach for an ordered logit estimation as it contains individual fixed effects. These models can be estimated by means of the procedure described in Chamberlain (1980). However, given that the individual effects are not identified in this type of regression, it is not possible to compute the residuals in the first stage regression or estimate marginal effects unless an arbitrary value for the individual effects is imposed. Unfortunately, estimated results may change depending on these arbitrary decisions.

Table 3 presents the marginal effects at means of exercise on children's health and unhappiness frequency from using ordered logit models. The results show that exercise significantly decreases the probability of individuals reporting their health as very poor, not very good, moderate or good by 0.2 percentage points (pp), 1.3pp, 5.3pp, and 0.5pp, respectively. In addition, exercise significantly increases the probability of reporting very good health status by 7.3pp. These results must be interpreted relative to the proportion of people in each group from Figure 1. Therefore, a 0.2pp reduction in the probability of being in very poor health, which only represents a 0.67% of the total population, would be proportionally higher than a 5.3pp reduction in the probability of being in moderate health condition, which represents a 24.76% of the total population.

Table 3. Marginal Effects at means of the impact of exercise on children's health and unhappiness frequency using PSM approach

	(1)	(2)	(3)	(4)	(5)
Panel 1: Health					
	Very poor	Not very good	Moderate	Good	Very good
Exercise (a: 7290; b: 0.03)[(1)]	-0.002**	-0.013***	-0.053***	-0.005**	0.073***
	(-2.53)	(-2.87)	(-2.86)	(-2.11)	(2.87)
Panel 2: Unhappiness frequency					
	Never	Seldom	Sometimes	Often	Always
Exercise (a: 7350; b:0.01)	0.041*	0.008*	-0.032*	-0.012*	-0.006*
	(1.92)	(1.86)	(-1.91)	(-1.92)	(-1.90)

Notes: Z statistics in parentheses.

* p<0.1 **p<0.05 ***p<0.01

(1) a: Estimation size; b: Pseudo R-squared

Regarding unhappiness frequency, exercise marginally significantly increases the probability of an individual reporting never and seldom feeling unhappy in the previous week by 4.1pp and 0.8pp respectively. Additionally, it also marginally decreases the probability of reporting sometimes, often and always feel unhappy in the previous week by 3.2pp, 1.2pp, and 0.6pp respectively. Similar to health status, these changes must be considered in relation to the proportion of people in each group. This suggests that physical exercise has a higher impact on 'Always', 'Often' feel unhappy groups.

Overall, our estimations show that exercise significantly improves children's self-rated health status. We also find some evidence of a decrease of unhappiness frequency after doing exercise. A more disaggregate inspection using ordered logic models allows us to find that the improvements of health and happiness are significant in almost all subgroups.

6. Extended analysis

This section estimates the differential causal impacts of exercise on health and well-being for different groups of children regarding their gender, type and location of schools and family income.

Gender differences can be motivated as, apart from biological differences, males are, in general, more interested in group sports like basketball and football – that give them more opportunity for social interaction – than females (Sabo & Veliz, 2008).

The type of school, regarding academic pressure, is also relevant. In particular, key high schools in China can guarantee high admission rates to top universities, which is regarded as a guarantee of a better future. Therefore academic pressure could not only influence exercise decisions but also affect children's well-being. We differentiate between high and low academic pressure schools by using an indicator of whether a school's academic pressure is higher than average. The academic pressure is measured by the percentage of students admitted to key senior high schools out of the total number of graduates in the junior high department in each school.

Due to the urbanisation of China, more and more rural Chinese students have moved to urban areas. This has made urban schools more and more popular. In addition, good school locations also relate to good school facilities and community environments which include better medical facilities, recreation facilities, and standard of living. These could enable students to get more involved in sports. Better medical facilities and living environments might lead to better health status. We divide our samples into two groups depending on whether a school is located inside of the city/town (Urban) or outside (Rural). Urban schools include those in the centre or the outskirts of a city/town. Rural schools include the ones located in the rural-urban fringe zone of the city/town, settlements outside of the city/town, and rural areas.

Income is another relevant characteristic to consider as, in principle, poor students have less access to hospitals and sports facilities. A student belongs to a high or low-income group depending on whether or not his/her family income level is higher than 3 (the median value).

Table 4. Marginal effect of exercise on health status and well-beings using PSM approach and ordered logit regression in different subgroups

	(1)	(2)	(3)	(4)	(5)		(6)	(7)	(8)	(9)	(10)
	Health status						**Unhappiness frequency**				
	Very poor	Not very good	Moderate	Good	Very good		Never	Seldom	Sometimes	Often	Always
Males (a:3920;b:0.03) (1)	-0.002*	-0.013*	-0.047*	-0.006	0.068*	Males (a:2920;b:0.01)	0.056*	0.006	-0.039*	-0.014*	-0.009*
	(-1.76)	(-1.92)	(-1.92)	(-1.61)	(1.92)		(1.78)	(1.55)	(-1.77)	(-1.75)	(-1.74)
Females (a:3370;b:0.02)	-0.002*	-0.014**	-0.061**	-0.003	0.080**	Females (a:4430;b:0.01)	0.025	0.008	-0.022	-0.008	-0.003
	(-1.81)	(-2.21)	(-2.20)	(-1.16)	(2.21)		(0.89)	(0.89)	(-0.89)	(-0.90)	(-0.90)
High pressure (a: 3294; b: 0.03)	-0.002*	-0.017**	-0.068**	-0.012**	0.099**	High pressure (a: 3330; b:0.02)	0.065*	0.007	-0.046*	-0.017*	-0.009*
	(-1.90)	(-2.48)	(-2.43)	(-2.00)	(2.44)		(1.86)	(1.64)	(-1.85)	(-1.85)	(-1.83)
Low pressure (a: 3349; b: 0.03)	-0.001	-0.008	-0.032	-0.001	0.042	Low pressure (a:3371; b:0.01)	0.009	0.002	-0.007	-0.003	-0.001
	(-1.12)	(-1.17)	(-1.18)	(-0.52)	(1.18)		(0.29)	(0.29)	(-0.29)	(-0.29)	(-0.29)

Urban schools (a:3850; b:0.03)	-0.001	-0.010	-0.041	-0.007	0.059	Urban schools (a:3878; b:0.01)	0.060*	0.006	-0.039*	-0.017*	-0.008*
	(-1.50)	(-1.57)	(-1.56)	(-1.44)	(1.57)		(1.83)	(1.59)	(-1.83)	(-1.82)	(-1.82)
Rural schools (a:3352;b:0.03)	-0.003**	-0.018**	-0.068**	0.000	0.089***	Rural schools (a:3382;b:0.02)	0.025	0.008	-0.022	-0.007	-0.003
	(-2.05)	(-2.54)	(-2.55)	(0.01)	(2.57)		(0.86)	(0.85)	(-0.86)	(-0.86)	(-0.85)
High income (a:899;b:0.01)	-0.004	-0.012	-0.048	-0.063	0.127	High income (a:902;b:0.02)	0.121*	-0.010	-0.084*	-0.014	-0.013
	(-1.24)	(-1.53)	(-1.60)	(-1.60)	(1.62)		(1.67)	(-1.15)	(-1.66)	(-1.61)	(-1.63)
Low income (a:6391;b:0.02)	-0.002**	-0.013**	-0.050**	0.001	0.064**	Low income (a:6448;b:0.01)	0.032	0.008	-0.025	-0.010	-0.005
	(-2.18)	(-2.43)	(-2.42)	(0.36)	(2.42)		(1.42)	(1.40)	(-1.41)	(-1.41)	(-1.41)

Notes: Z statistics in parentheses.

* p<0.1 **p<0.05 ***p<0.01

(1) a: estimation sample; b: Pseudo R-squared

For each group, we specified an ordered logit estimation in a similar way to the propensity score matching regression considered in the previous section. Table 4 presents the causal impact of exercise for each of the student's groups described above. When we look at gender differences, it can be seen that exercise significantly improves students' health status in both gender groups, however, the improvement in males is marginal and minor after the consideration of the proportion of students in each gender group (male population: 53.77%; female population: 46.23%). Additionally, exercise appears marginally to decrease unhappiness frequency in males but no effect is found for females. This result is consistent with Chen, Jiang, and Huang (2009) who also found that playing sports increase males' happiness.

Regarding the type of school, physical exercise can significantly improve students' health status and well-being but only for students who are subject to high academic pressure. This is interesting because usually, students under high academic pressure are short of time for sports activities as they devote most of their time to study. Exercise appears to play a key role in improving their health and well-being.

Physical exercise also significantly improves students' health status among rural school students and marginally decreases the probability of feeling unhappy among urban school students. A plausible explanation for this is that urban school students have easier access to medical services as well as better food and nutrition supplies. Therefore, compared to rural students, physical exercise could not, on the margin, be as beneficial in improving their health and well-being.

The estimation for different income groups clearly indicates that exercise significantly improves students' health status in the low-income group, and marginally decreases students' unhappiness frequency in high-income groups. The explanation for this may be similar to the previous case as sports facilities and health services are more restricted for low-income students.

Overall, the analysis suggests that exercise plays a valuable role in improving the health status of students in relatively disadvantaged economic groups.

7. Conclusions

Incentivising physical exercise can be deemed an efficient instrument by school managers and politicians for improving students' health and happiness. Health investments are similar to other economic investments as they have associated costs, but provide benefits in terms of increments in the stock of health. In this sense, it seems a fruitful alternative to the medical purchase of health.

This paper shows that the exercise exerts a significantly positive impact on Chinese students' health status and well-being, although the latter effect is more marginal. This improvement in health status is found to be especially significant for females and low-income students as well as for those in an environment with high academic pressure and in rural schools. This indicates that disadvantaged economic groups benefit more from doing exercise and suggests that managerial decisions should be devoted to increasing the availability of sports facilities for them. For example, more sports facilities should be available for rural schools and low-income communities as they might face difficulties to develop exercise hobbies due to financial limitations and more restricted access to sports facilities. In addition, the analysis shows that physical exercise mainly affects all types of students, even those with a very poor health status.

More research will be needed to evaluate the impact of physical activity on the health and subjective well-being of children in other developing countries. A comparative analysis between children and adult population is also desirable. However, our experience shows that to guide managerial decisions, these studies should not be based on aggregated analyses but on estimations for each specific group.

Disclosure statement

No potential conflict of interest was reported by the authors.

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