



The Substitution Effect of Exercise Intensity and Wage Income: Evidence from China Full-time Workers

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CONTENT



- Ø1 Introduction
- Ø2 Literature Review
- Ø3 Method

总结



Introduction

Physical inactivity is the main behavior that contributes to the leading causes of morbidity and mortality. As a specific subcategory of physical activity, engaged in exercise may lead to many benefits, such as reduce cardiovascular disease, type 2 diabetes, metabolic syndrome, and improve quality of life (Centers for Disease Control and Prevention, 2021). In 2016, the Chinese government has formulated and implemented a wide range of sports policy documents and laws, including the Sports Law, three versions of the Strategic Olympic Glory plan, several editions of the Five-Year Plan for Sports Development in China, and the National Fitness Program (Zheng, et al., 2018; Gao & Cao, 2021). Nevertheless, only 30.3% adults often take exercise in China according to a national survey in 2020.

Following the framework of Grossman's health capital model (Grossman, 1972), time spend on exercise can be regarded as an investment in individuals' health. Therefore, **income level plays an important role in affecting individuals' exercise behavior as health could be deemed as normal goods**. A utility maximising individual more likely to choose the optimal level of exercise in pursuit of future health benefits. At the same time, **income represents the opportunity cost of time in doing exercise as those who have a higher wage income may face a higher opportunity cost to do exercise**. Meanwhile, exercise can be conceptualized in terms of frequency, intensity, and duration (Courneya & McAuley, 1994). However, little previous studies have been devoted to estimating the effect of wage income on exercise intensity, frequency and duration, which need to be improved further. High wage income individuals may reduce the time spent on moderate-intensity exercise and increase the time spent on vigorous one which generate a substitution effect between exercise intensity and wage income. Thus, **when wage income is high and time is costly, what is the relationship between wage income and exercise behavior?**



Literature Review

Analyzing the effects of income on exercise behavior has been receiving much attention from previous studies.

Humphrey and Ruseski (2006) analysis the economic determinants of participation in physical activity and sport. Their study analyzes the consumer choice model of participation by testing the predictions of the model using the data of BRFSS. Empirical analysis found that higher income is associated with a higher probability of participating in physical activity.

Hu and Stowe (2016) in accordance with Humphrey and Russeki, investigate the relationship between household income level and individual physical activity participation behavior. Their results indicated that participation in physical activity is positively related to income.

Puciato et al (2018) examine the relationship between physical activity levels and income status of working-age city residents in Wroclaw, Poland. The results reveal positive correlations between the level of physical activity and income status of both working-age males and females.

It is obvious that higher income level is associated with higher physical activity participation (Powell et al., 2004; Kamphuis et al., 2008; Eime et al., 2015; Heradstveit et al., 2020; Pharr et al., 2020; Stalsberg & Pedersen, 2010; Ford et al., 1991). However, the studies on above are only focus on individuals' participation or the duration of physical activity.



Literature Review

Exercise energy expenditure can be used to express the volume of exercise performed during a certain period of time, which is widely used in evaluating ones' total exercise level by multiplying the dimensions of intensity, duration, and frequency over a given time period (Strath et al., 2013). In our study, a utility maximising individual more likely to adjust and change their exercise behavior to choose the optimal level of exercise duration, frequency and intensity, which jointly determines the producing of desired exercise energy expenditure. **Therefore, Higher wage income individuals would likely to generate more exercise energy expenditure for the future health benefits (H1).**

However, exercise is a time-cost activity. **People with higher income may face a higher opportunity cost to exercise as the marginal cost of exercise increases as the cost of time increases.** In this setting, the utility maximizing solution thus depends on the individual's choices of the amount of time used in exercise and other activities. Moreover, exercise can be performed in a variety of intensities. For instance, vigorous-intensity exercise is difficult but can improve health over a short period of time, whereas moderate-intensity exercise is less difficult but needs a longer period of time to reap similar health benefits. Therefore, it will be important to further explore the association between wage income and intensity levels of exercise.

The effects of income on exercise intensity can be explained in different two ways. On the one hand, as wage income increases, the budget allocated for exercise in the future also increases. Therefore, individuals with a higher wage income may tend to spend more time on both vigorous- and moderate-intensity exercise than individuals with a lower income, which was regarded as '**income effect**'. On the other hand, wage income also represents the opportunity cost of time in doing exercise, so the marginal cost of exercise increases as individuals' wage income increases. Hence, to get the benefits of exercise in a short time, high wage income individuals may reduce the time spent on moderate-intensity exercise and increase the time spent on vigorous one, which generate a '**substitution effect**' between exercise intensity and wage income.



Literature Review

Hallal et al. (2005) found that poor and uneducated participants had a lower likelihood of walking than higher-income and more educated people. These individuals were also more likely to be engaged in other vigorous- and moderate-intensity activities. Meltzer and Jena (2010) and Maruyama and Yin (2012) found that income is **positively associated** with the intensity of physical activity based on data from the USA and Australia respectively. In contrast, compared to those in developed countries, the data in Malaysia proved that income is **negatively associated** with the time spent on both vigorous- and moderate-intensity physical activities (Cheah, et al., 2017). It can be seen that the effects of income on different intensity levels of exercise are more complex and complicated than expected.

Therefore, if the ‘substitution effect’ is greater than the ‘income effect’, individuals with a higher income are more likely to participate in vigorous-intensity exercise than moderate-intensity exercise (H2).

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Method

Data

The China Health and Retirement Longitudinal Study (CHARLS) is a nationally representative longitudinal survey of persons who are 45 or older and their spouses in China, including assessments of social, economic, and health circumstances of community-residents. CHARLS examines health and economic adjustments to rapid ageing of the population in China (Zhao et al., 2014). The CHARLS national baseline survey was conducted on site in 28 provinces, 150 counties/ districts, 450 villages/urban communities across the country in 2011-2012, with wave 2 in 2013, wave 3 in 2015, and wave 4 in 2018.

Restrict our attention to the population of 45-64 years old who have full-time job.

Reasons:

- 1) Identify the intensity, frequency and duration of exercise.
- 2) Exclude all the physical activity on the purpose of working to get the pure time effect of exercise.



Method

Definition of variables

Dependent variable

Exercise energy expenditure (log): as exercise time in CHARLS is measured as a range rather than an exact figure, we define it as a category variable (from 10 minutes to 30 minutes=1, from 30 minutes to 2 hours=2, from 2 hours to 4 hours=3, above 4 hours=4). Then we calculate the exercise energy expenditure for each individual using the following formula: degree of minutes (one day) \times number of times (in a week) \times coefficient (9 for vigorous, 5 for moderate, and 3 for light intensity exercise corresponding to the MET) (Scarmeas et al, 2009).

Whether taking vigorous- intensity exercise for at least 10 minutes every week/ Whether taking vigorous- intensity exercise for at least one day every week/ Whether taking moderate- intensity exercise for at least 10 minutes every week/ Whether taking moderate- intensity exercise for at least one day every week

Independent variables

Wage income: focus on personal annual wage income, which is the most sensitive income corresponding to time committed compared to other asset income.

Other control variables

The **demographic variables** in our study are age, gender, marital status and hukou type. Other **health and lifestyle variables** including whether have physical disability, habit of smoking and alcohol consumption. Moreover, **individuals' work condition** is also be considered, including type of workplace (government/ public institution/ NGO, firm, individual firm, farmer, individual household and other) and working hours.

Model: OLS, Tobit model, Logit model



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Thanks for listening

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