Activities in Physical Education and Sport
2016, Vol. 6, No. 1, pp. 45-47

CYCLISTS SADDLE HEIGHT IMPORTANCE ON THE RESULTS OF BICYCLE ERGOMETER TEST "ASTAND & RHYMING"

(Original scientific paper)

Lachezar Stefanov and Ivan Kolev
Nacional Sports Academy, Coaches Faculty, Sofia, Bulgaria

Abstract

The aim of the following study is to analyze the mechanical efficiency on heart rate frequency and oxygen consumption during exercise bicycle test. The following study included seven respondents (men) aged 19-28 years, all students in the National Sports Academy "Vassil Levski" (Sofia, Bulgaria) – specialists in cycling. During two consecutive days, they were administered to sub maximal bicycle ergometer test of "Astrand & Rhyming" for determining VO2 max. Two test were conducted on two consecutive days with 100% and 70% saddle height set using the heel method. Received heart rate and VO2max data provided by our study were used as indexes for physical work efficiency. Results showed that in 70% saddle height HR values are higher compared to 100% saddle height. In contrast, of this VO2max levels of 70% saddle height are relatively lower compared to 100% height. When comparing results from the two tests we used two-sample Mann-Whitney test showing statistical significance at $p=0,05$ at $\alpha=0,05$.

Keywords: *cycling, HR-test, maximum oxygen consumption, bicycle ergometer test*

INTRODUCTION

Cycling is sport that requires a high level of aerobic capacity of the human body. This can be achieved with a properly built training process which is using as the technical device – bicycle.

Cycling consists of a set of motor actions aimed at developing optimal speed required for each cyclist appropriate for the track (Kolev (Колев), 2011).

The riding body position is different. Body inline depends on riders' body posture, by the nature of the physical effort performed and the structure of the bike (Kolev (Колев), 2012).

The proper or perfect cycling posture depends also on the seat height. The interaction between cyclists muscle strength and bicycle physical parameters determines cyclists work efficiency. Very important but not deeply studied so far in the methodical literature is the bicycle seat height as physical parameter. Incorrect seat configuration may predispose cyclists to injuries or significantly reduce their performance. There are disagreements on this matter and there is still no single answer from the sport scientific community and coaches on the optimal seat configuration (height) for cyclists.

Bini, Hume, & Croft (2011) summarize the methodical literature since 1960. on methods for determining saddle height and its effect on cyclists performance and the reducing the risk of injuries on cyclists lower limbs. They conclude that the methods for determining the optimal saddle height vary and they are not described in details. They are all based on the relationship between the saddle height and cyclists leg length or the knee flexions.

Some authors describe experiments in which the results show that at lower saddle height is observed lower oxygen consumption (VO2), i.e. the mechanical efficiency is higher. Nordeen-Snyder, KS. studied three saddle height levels – 95, 100 and 105% of trochanter height and found that most efficient is the 100% saddle position because VO2 for 95, 100 and 105% are respectively 1,69, 1,61 and 1,75 l/min (Nordeen-Snyder, (1977). The overall efficiency is significantly lower and the oxygen consumption is significantly higher with saddle height increase (Ventura et al., 2014)

Other group of researchers found no influence between the saddle height and pedaling mechanical efficiency. Titlow, L., Ishee, J., & Anders, A., (1986) showed that the knee angle during pedaling does not affect the heart rate frequency (HR) at submaximal bicycle ergometer physical loads. According to them, all respondents should be allowed to use knee angle and saddle height that are comfortable for them (Titlow, L., Ishee, & Anders, (1986).

Interesting study on the saddle height (96, 100 and 104% of trochanter height) effect on heart rate frequency, VO2 and lower limbs kinematics of 14 cyclists at submaximal physical load road cycling on exercise bike using different angles of the seat tube (68, 74 and 80 degrees). The authors reported the effect of researched indexes only regarding the seat tube position but did not mention the saddle height (Price, & Donne, (1997).

Some authors studied the knee angle influence on the oxygen consumption as an index of physical work efficiency. Greater knee angles require a lower saddle position. Mandroukas, Angelopoulou, Christoulas, & Vrabas, (2000) reported that cycling with your knees bent shows lower oxygen consumption. Opposite results were obtained by Peveler, (2008) – he states that VO2 was significantly lower for saddle height corresponding to 25 degrees in the knee joint compared to 35 degrees.

From the analysis of the available methodical literature, we found conflicting statements and results regarding saddle height and muscle work efficiency in certain matters. That prompted us to perform the following study.

The aim of the following research is to study the mechanical efficiency effect on heart rate frequency and oxygen consumption during the exercise bicycle test.

METHODS

The following study included 7 respondents (men) aged 19-28 years all students in the National Sports Academy "Vassil Levski" (Sofia, Bulgaria) – specialists in cycling. During two consecutive days, they were administered to sub maximal bicycle ergometer test of "Astrand & Rhyming" for determining VO2 max. All the conditions during the two testing were identical except the saddle height. During the first day of testing the saddle was set using the heel method – most common method for saddle height setting in Bulgaria. This saddle height information was taken as 100% height value. On the next day of testing were conducted with 70% of saddle height from the first testing.

At the beginning of the experiment were measured the height and weight of the respondents. During the testing heart rate frequency was recorded and it was used to determine the VO2 max according to the methodology described by Astrand & Rhyming. The recorded heart rate and VO2 max were used as indexes of training work efficiency.

For registering heart rate frequency were used Sigma Sport – PC14 and exercise bicycle Monark 618E with mechanical breaking system. All collected data was statistically analyzed by software product XLSTAT 2015.

ANALYSIS OF RESULTS

The hypothesis that we tested is connected to linear relationship between the training loads and VO2. For higher mechanical efficiency, VO2 should be lower. Appropriate saddle height will results in lower levels of oxygen consumption.

On the Table 1. we present respondents' anthropometric data including the two saddle height used in our experiment and corresponding heart rate levels (HR-test) and also the maximum oxygen consumption (VO2max m-1. kg1. min-1).

Figure 1. and 2. presents the heart rate frequency (HR) and maximum oxygen consumption (VO2max) for 100% and 70% saddle height.

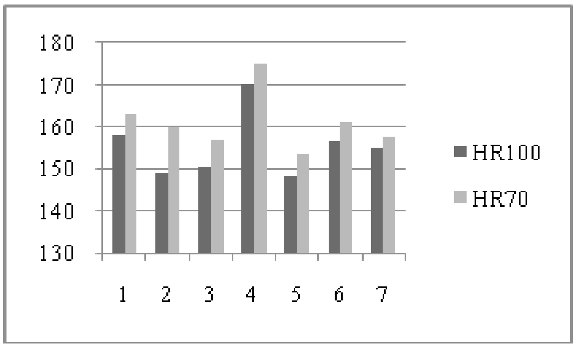
For results processing we used nonparametric statistical methods due to the limited number of respondents. For the current number of respondents it is not accurate to use the standard tests for normality distribution.

The two-sample test of Mann-Whitney revealed that both samples for HR at 100% and 70% saddle height differ by a probability – $p=0,031$ when $\alpha=0,05$. The two-sample test of Mann-Whitney revealed that for VO2max index results differ for 100% and 70% saddle height is as follows – $p=0,031$ at $\alpha=0,05$. What is noteworthy is that at correct saddle height the oxygen consumption is notably higher and at lower saddle height the consumption is

Table 1. The investigated persons

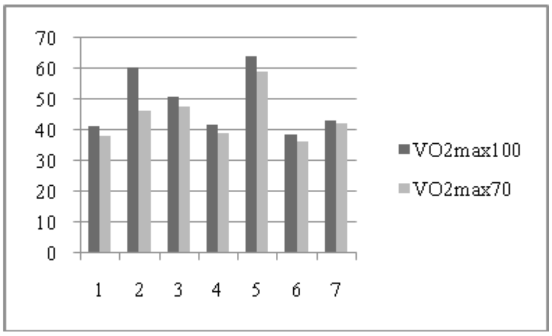
Name	Age	Weight	Height	Sport experince	Saddle height (%)	HR-test	VO_{2max}
		kg	cm				$ml^{-1}, kg^{-1}, min^{-1}$
S. Tz.	28	77	180	4	100%	158,00	41,55844
					70%	163,00	38,31169
I. R.	23	73	178	4	100%	149,00	60,27397
					70%	160,00	46,57534
S. P	19	67	170	6	100%	150,50	50,74627
					70%	157,00	47,76119
B. P	19	74	183	8	100%	170,00	41,89189
					70%	175,00	39,18919
M. S.	19	70	191	3	100%	148,00	64,28571
					70%	153,50	59,28571
P. S.	26	83	172	9	100%	156,50	38,55422
					70%	161,00	36,14458

Figure 1.



lower (Bini, et al., 2011; Mandroukas, et.al., 2000.; Titlow, et al., 1986.). According to the findings above, at 70% saddle height due to the decrease of physical performance HR and VO2max levels should be higher compared to 100% saddle height. As seen from the data, however the oxygen consumption at 70% saddle height is lower. The explanation of this fact is in the principle of determining the VO2max in the current submaximal test as well as others used in sport practice. Astrand & Rhyming test, as well as other from the group using linear relationship between the power, HR and VO2 at equal power for both saddle height and increasing HR levels is normal to register lower levels of VO2max. Therefore, from the presented data is correct to discuss only the HR levels as an index for mechanical work efficiency. The oxygen consumption can also be taken in account, but if determined directly from the gas analyzer.

Figure 2.



Correspondence:
Lachezar Stefanov
Nacional Sports Academy
Coaches Faculty
Studentski grad, 1700, Sofia, Bulgaria
E-mail: luchos@abv.bg

CONCLUSIONS

Statistical analysis confirms our hypothesis that the incorrect determining of saddle height reduces cyclists' mechanical efficiency during riding.

Saddle lower positions with the help of heart rate control we found aggravate pedaling efficiency. From the results we can state that only it is reliable enough indicator. If oxygen consumption is used as index, it must be ascertained directly.

The incorrect saddle position requires higher oxygen consumption and higher heart rate levels for achieving the same mechanical efficiency.

REFERENCES

Колев, Ив. (2011). *Ръководство по колоездене на писта*. [A Guide to Track Cycling. In Bulgarian.] София,НСА-Прес.

Колев, И. (2012). *Система за спортен подбор на колоездачи.* [System for Sports Selection of Cyclists. In Bulgarian.] София. НСА-Прес.

Astrand, P.O., & Rhyming, I. (1954). A Nomogram for Calculation of Aerobic Capacity (Physical Fitness) from Pulse Rate during Submaximal Work, *Journal of Appl Physiol,* (7) 218-221.

Bini, R., Hume, P.A., Croft, J.L. (2011). Effects of bicycle saddle height on knee injury risk and cycling performance. *Sports Med., 41*(6), 463-476.

Ventura Ferrer-Roca, Bescós, R, Roig, A., Galilea, P., Valero O., & García-López, J. (2014). Acute effects of small changes in bicycle saddle height on gross efficiency and lower limb kinematics. *Journal of Strength and Conditioning Research,* 28(3), 784-791.

Mandroukas, K., Angelopoulou, N., Christoulas, K., & Vrabas, I.S. (2000). Cardiorespiratory and metabolic responses during straight and bent knee cycling. *The Journal Of Sports Medicine And Physical Fitness, 40*(2), 145-149.

Nordeen-Snyder, K.S. (1977). The effect of bicycle seat height variation upon oxygen consumption and lower limb kinematics. *Medicine And Science In Sports, 9*(2), 113-117.

Peveler, W. W. .(2008). Effects of saddle height on economy in cycling. *Journal Of Strength And Conditioning Research, 22*(4), 1355-1359.

Price, D., & Donne, B. (1997). Effect of variation in seat tube angle at different seat heights on submaximal cycling performance in man. *Journal of Sports Sciences, 15*(4), 395-402.

Titlow, L., Ishee, J., & Anders, A. (1986). Effects of knee angle on submaximal bicycle ergometry. *Journal of Sports Medicine & Physical Fitness, 26*(1), 52-54.