Proceeding

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Removing the division into categories between cycling and para-cycling (Handbike category H) by designing a single performance and training activity

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ABSTRACT

Cycling and all categories of para-cycling including Handbike are cyclical sports, that is, sports characterized using a specific skill, continuous skill. To separate competitions between cyclists and paracyclists, there is a classification system. The study in aims to design one activity performance and training, to eliminate the division into categories between cycling and para-cycling (Handbike), since this does not favour the integration and sporting inclusion of the two groups of athletes. The differences in performance will be identified between: cyclists and paracyclists with spinal cord injury or amputation of the lower limbs (H). Then will proceed to design and verify an activity capable of making the two categories compete and train together, eliminating the differences in performance through the use of a "*counterweight*" and using a mixed training, HIIT (High Intensity Interval Training) and Endurance. The sample taken into consideration is composed of 5 cyclists and 5 paracyclists (H) aged between 19 and 38 years. To achieve the goal, the study was based on the method of analysing the scientific literature, detecting the various parameters in the race and using mathematical statistical methods, such as Multiple Regression and the T-Test for independent samples. The analysis of the results of this study shows that; between cyclists and para-cyclists who participated, there are substantial differences in performance, thanks to the data obtained from multiple regression, in which we find an R-squared value that is .999975008, also the only positive coefficient among the independent variables is that of power (6.760634791). This means that of all the reported values, it is the only one that directly affects performance.

Keywords: Sports integration; Sports inclusion; Counterweight; High intensity interval training; Endurance.

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INTRODUCTION

Cycling is one of the most followed and practiced sports in Italy. It is a sport that is practiced both indoors, or in specialized structures called velodromes, or as it is more commonly practiced outdoors, or on the street. The practice of the latter, like all outdoor practices, has recently been severely tested by the COVID-19 emergency that has affected the whole world (Raiola et al., 2020). A preliminary investigation was also made on this topic; how has the practice of physical activity changed during the COVID-19 quarantine?

Cycling and all categories of para-cycling including handcycling (the difference of which lies in the fact that the driving force is released from the arms), are cyclical sports, that is, sports characterized by the use of a specific skill; continuous skill. Continuous skill, in this case pedalling, is a characteristic gesture that is performed continuously over an extended time and in a stable environment, in the case of cycling on a track or circuit (Antunes et al., 2021; Dyer, 2016).

As seen in the literature, in a study on the evaluation of sports performance, we know that a high development of maximum strength is not required in this sport, since a particular type of force is mainly used, the resistant force at concentric regime (Ungerer, 2018). In some race situations, however, it may happen that you also have to resort to the use of fast force; to increase speed if you find yourself in the midst of other cyclists and try to overtake them or stretch on them. And of explosive force; used in the final sprint, in the case in which two cyclists are in the same position (in a head-to-head for the victory), in which you try to reach a maximum level of power in order to win. Thanks to an experimental study on aerobic gymnastics, it can be said that cyclists, practicing an endurance sport, that is a sport in which a single race (consequently also the performance) lasts hours, mainly use that energy recruitment mechanism. aerobic (Raiola et al., 2013), which provides him with the energy necessary to complete the entire race. In addition to the aerobic one, in certain situations we can also find the anaerobic lactic acid; this is activated in the event that a cyclist decides to increase the pace in order to overtake the opponents, using fast force. And the anaerobic alactacid; this is activated in the final sprint, when a cyclist decides to use explosive force in the last meters in order to overtake an opponent with whom he is competing in the race. To separate competitions between cyclists and para-cyclists, there is a classification system.

The para-cycling classification system has the task of minimizing the impact of an athlete's disability on the result of the competition, this is to ensure that the success of an athlete in the competition is based on technique, physical fitness, personal athletic talent and for the enhancement of diversity in sport (Tafuri et al., 2017). Classification is a process whereby all athletes are regularly vetted by classifiers to ensure consistency and fairness for all. An athlete's functional capacity is assessed based on the level of spinal cord injury or corresponding disability (Leprêtre et al., 2012). The classification of an athlete must be carried out with the uniform and the competition equipment, using the following criteria: medical documentation of the athlete's disability, functional tests and observation during training or competition (Raiola et al., 2016). This is also the case of the "*H*" category of para-cycling, or the Handbike category, one of the four categories in which para-cycling is divided. But since this classification does not favour the integration and sporting inclusion of the two groups of athletes, as also suggested by a study on the sport evaluation of sport for the disabled, held at the University of Salerno (Sanseviero et al., 2019), thus removing the possibility for athletes with disabilities, but also vice versa, to be able to measure themselves fairly in a single race (Cassese et al., 2017). The study therefore decided to design and evaluate a unique performance and training activity, which involves both categories of cyclists (Mannion et al., 2018). As was done in a recent study, which aims to reorganize the academic disciplines of physical training and sports sciences in the Italian university body (Raiola, 2020). To design an activity capable of making the two categories compete and train together fairly,

counterweights can be used. As sometimes happens in the design and teaching practices of physical education for young people and children (D'Elia et al., 2020). Counterweights can benefit or disadvantage some athletes, in order to eliminate the differences in performance in competition induced by the situation of disability, as a strategic contribution of sport to the management of diversity (Di Palma et al., 2017). Instead, to train the various components of strength, aerobic and anaerobic of all athletes, different methodologies can be used. This study refers specifically to two types of training: HIIT (High Intensity Interval Training) and Endurance. HIIT can be considered as a hybrid between aerobic and anaerobic training, because it works by exploiting both aerobic energy systems and anaerobic energy systems, thanks to the constant variation of intensity, it is also very useful for training explosive strength, as he also states the study on the relationship between intermittent stamina and performance (Knechtle et al., 2004).

Endurance is the method that involves keeping the heart rate constant, generally using a physical effort that varies between moderate and medium-high intensity. Approximately between 60 and 80% of the maximum heart rate (HR_{max}), or between 50 and 75% of the maximum oxygen consumption VO_{2max}.

METHODS AND MATERIALS

Subjects

The sample used to carry out this study is made up of 5 cyclists and 5 para-cyclists (H), for a total of 10 athletes: (age: between 19 and 38 years; weight: between 67 and 80kg; training experience: from 3 to 12 years). Circuit length 30km. All the participants were in full health and participated in all the competitions and all the training sessions. All relevant procedures and information were provided to the participants who gave their consent to proceed.

Experimental design

Taking a cue from a work by Coppola C. "*Interest in the capacity of VO_{2Max}: Comparison between Norwegian and Italian training*", the VO_{2Max} values of all athletes are first detected by means of a cycle ergometer (Coppola et al., 2019). Then the 10 cyclists competed in a 30 km circuit, with vehicles and equipment of the same weight, the only difference that distinguished the two categories was the fact that the para-cyclists competed on hand bikes and therefore in this case the necessary strength movement was released from the arms, rather than the legs. In this first race quantitative data of the athletes were collected, such as; the time taken to complete the race expressed in seconds, the average speed expressed in km / h, calculated thanks to the formula speed = space "*m*" / time "*s*" x 3.6 and the power released by pedalling during the performance expressed in watts, detected in the race thanks to a potentiometer, as done in a study on the evaluation of some quantitative aspects in the training process of young players (Faupin et al., 2006). These were added to the other data collected previously by the cyclists themselves, namely: age and weight. The 10 athletes then made a second race, in the same circuit and with the same equipment used in the first race. The difference between the second and the first race lies in the fact that in the second race a counterweight was applied to the cyclists. The counterweight used consisted in delaying the departure of all cyclists who competed on bikes by 15%. Also, in this race the data collected in the first race were taken, that is: the time taken, the average speed and the power released. Subsequently, the athletes underwent a mixed training program of HIIT (High Intensity Interval Training) twice a week, and Endurance three times a week.

HIIT training, referred to in the work "*physiological and mechanical response to the specific intermittent activity of calcium*" consisted of half an hour of pedalling at alternating speed, 1 minute to 60 / 70% of VO_{2Max} as active recovery and 30 seconds at 110/120% of VO_{2Max} (Koontz et al., 2021). Endurance training (Federici et al., 2019) consisted of 2 continuous hours of pedalling at a constant speed between 70 and 80% of

maximum power. The training lasted a total of four weeks, which is a mesocycle. At the end of the training mesocycle, the VO_{2Max} values of all the athletes were measured again by means of a cycle ergometer and the power values in watts measured in the same 30km circuit used for the races.

Statistical analysis

The following were used as statistical tools:

- Two tables, in which the data relating to the order of arrival and the times used to finish the race of all the cyclists were reported, from which two graphs were obtained which have the task of showing homogeneity and heterogeneity of the two data groups.
- Multiple Regression, a statistical tool used to predict a criterion between two or more independent or predictive variables. The Multiple Correlation Coefficient indicates the relationship between a criterion (the dependent variable, in this case the time taken to complete the race) and a weighted sum of the predictive variables (the independent variables, in this case age, weight and values) of VO_{2Max} of the athletes, then also the average speed in the race and the power released by pedalling during the performance).
- The T-test for dependent variables, a statistical tool used to compare VO_{2Max} and power values before and after the training mesocycle. The T-test for dependent variables allows you to compare the same data group before and after a given event, since it serves to assess the significance of the differences between the averages of two samples that are related to each other. With the use of the T-test you have two hypotheses made on the basis of the study, the none and the alternative one. On the assumption that nothing was expected to improve after the four weeks of work. For the alternative hypothesis, a significant improvement due to the methodology applied has been assumed.

RESULTS

Table 1. The order of arrival with the times of the first race.

Athletes	Order of arrival	Times
Cyclist D	1°	00:51:03
Cyclist A	2°	00:51:56
Cyclist C	3°	00:53:41
Cyclist E	4°	00:54:32
Cyclist B	5°	00:55:35
Paracyclist A	6°	00:58:44
Paracyclist C	7°	00:59:15
Paracyclist E	8°	01:01:50
Paracyclist B	9°	01:05:49
Paracyclist D	10°	01:07:36

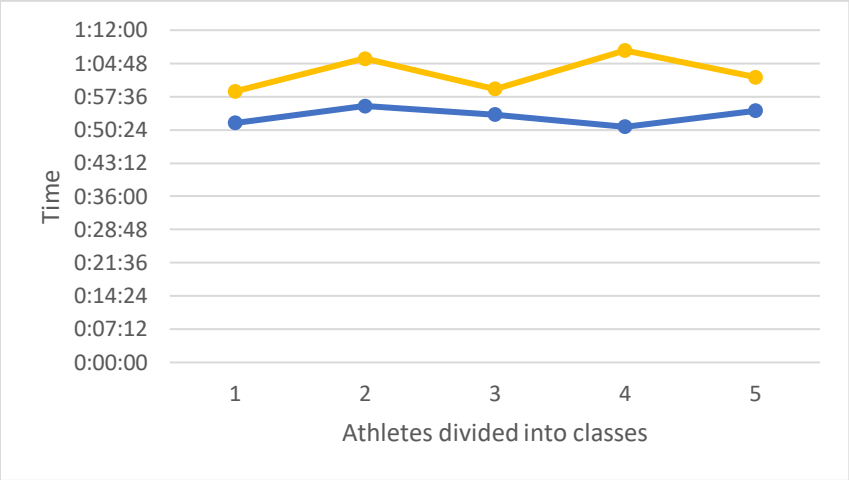

Figure 1. Graphic taken from the first table.

Table 2. Quantitative values detected after the first tender.

Cyclist	Position	Time	Time (s)	Spe. Ave. (km/h)	Weight (Kg)	Years	VO_{2Max}	Power (Watt)
Cyclist A	2°	00:51:56	3116	34.66	68	25	75.5	286.93
Cyclist B	5°	00:55:35	3335	32.38	78	38	71.9	242.84
Cyclist C	3°	00:53:41	3221	33.53	73	19	74.8	264.39
Cyclist D	1°	00:51:03	3063	35.26	71	28	77.1	302.24
Cyclist E	4°	00:54:32	3272	33.01	80	30	73.7	256.64
Paracyclist A	6°	00:58:44	3524	30.65	74	27	77.6	208.1
Paracyclist B	9°	01:05:49	3949	27.35	69	29	73.4	152.37
Paracyclist C	7°	00:59:15	3555	30.38	67	23	76.3	200.31
Paracyclist D	10°	01:07:36	4056	26.63	75	36	71.2	144.37
Paracyclist E	8°	01:01:50	3710	29.11	77	32	74.4	182.77

Table 3. Multiple regression results.

Regression statistics	
R multiple	0.999987504
R squared	.999975008
R square correct	.999943768
Standard error	2.561259768
Remarks	10

Table 3. Multiple regression results (cont.).

	Coefficients
Intercepts	9727.449244
Km/h	-239.1101382
Kg	-2.729810622
Years	-0.231224178
VO_{2max}	-0.975081134
Power	6.760634791

Table 4. The order of arrival with the times of the second race.

Athletes	Order of arrival	Time
Cyclist A	1°	00:58:51
Paracyclist C	2°	00:59:23
Paracyclist A	3°	00:59:55
Cyclist D	4°	01:00:11
Paracyclist E	5°	01:01:30
Cyclist B	6°	01:02:46
Cyclist C	7°	01:03:37
Cyclist E	8°	01:04:02
Paracyclist D	9°	01:04:59
Paracyclist B	10°	01:06:16

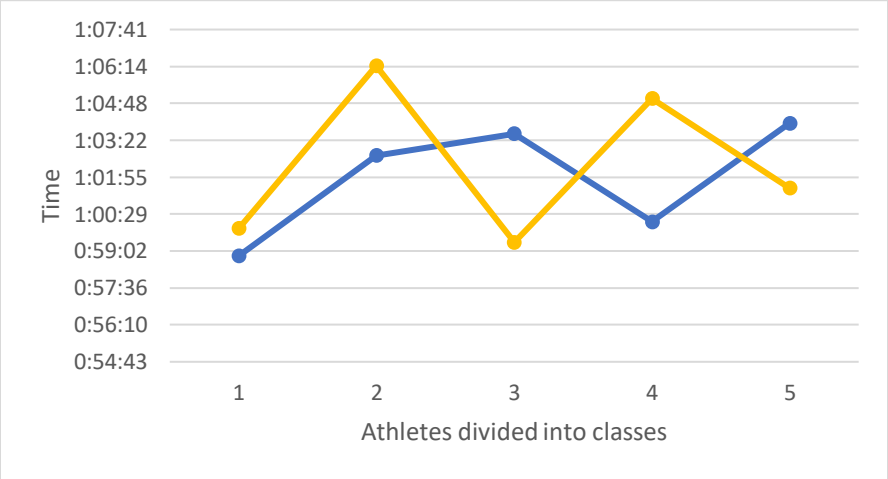

Figure 2. Graph taken from the second table.

Table 5. VO_{2Max} and pre-workout Power values.

Athletes	VO_{2Max}	Power (Watt)
Cyclist A	75.5	286.93
Cyclist B	71.9	242.84
Cyclist C	74.8	264.39
Cyclist D	77.1	302.24
Cyclist E	73.7	256.64
Paracyclist A	77.6	208.1
Paracyclist B	73.4	152.37
Paracyclist C	76.3	200.31
Paracyclist D	71.2	144.37
Paracyclist E	74.4	182.77

Table 6. VO_{2Max} values and post workout power.

Athletes	VO_{2Max}	Power (Watt)
Cyclist A	83.5	314.85
Cyclist B	78.4	263.78
Cyclist C	82.8	295.54

Cyclist D	80.5	334.22
Cyclist E	76.6	291.84
Paracyclist A	84.3	229.15
Paracyclist B	80.2	175.61
Paracyclist C	82.1	226.83
Paracyclist D	78.9	158.41
Paracyclist E	79.7	197.34

Table 7. *t*-test result of VO_{2Max} values.

Test t: two samples assuming equal variance	**Pre-work out**	**Post-work out**
	VO_{2Max}	*VO_{2Max}*
Average	74.59	80.7
Variance	4.458777778	5.977777778
Remarks	10	10
Variance overall	5.218277778	
Difference assumed for the means	0	
Gdl	18	
Stat t	-5.98084594	
p (T<=t) a one tail	5.86057E-06	
t critic a one tail	1.734063607	
p (T<=t) two tails	1.17211E-05	
t critic two tails	2.10092204	

Table 8. Test result *t* of the Power values.

Test t: two samples assuming equal variance	**Pre-work out**	**Post-work out**
	Power (w)	*Power (w)*
Average	224.096	248.757
Variance	3013.22116	3662.74369
Remarks	10	10
Overall variance	3337.982425	
Difference assumed for the means	0	
Gdl	18	
Stat t	-0.954451055	
p (T<=t) a one tail	.176249297	
t critic a one tail	1.734063607	
p (T<=t) two tails	.352498595	
t critic two tails	2.10092204	

DISCUSSION

Analysing the results of this study it is clear that; between cyclists and para-cyclists who participated in the first race, there are substantial differences in performance, in this case a study on the analysis and evaluation of young players gave a lot of support (Stephenson et al., 2021), while competing all together in the same circuit and with vehicles of the same weight. All this can be seen in the first table, which shows the order of arrival with the times of the first race and from which the first graph was drawn, this shows the 10 athletes divided into two categories on the x-axis; the yellows are the paracyclists while the blue are the cyclists; and on the ordinate axis are the arrival times.

The table shows that the ranking is divided into two, first the cyclists arrived and then the para-cyclists, this is also reflected in the graph. If there had been no substantial differences, the two lines would have crossed at least in one point, showing a heterogeneous order of arrival.

The second table was drawn up to report all the quantitative values, as done in a pilot work on training for the quantitative aspects of performance recorded previously and during the first tender for understand if this disparity in performance is caused by the situation of disability (Raiola et al., 2015).

The statistical tool of multiple regression was applied to these values, as done for a statistical study on communication and body skills in volleyball to improve teaching methods this to understand which variable produces disparity in performance (Stone et al., 2019). The first thing that can be noticed by analysing the values of the reg. multiple, reported in table number three, is that the value of R squared is .999975008. R squared represents the coefficient of determination, to be considered valid it must not be < .5. From this table it can be seen that the only positive coefficient among the independent variables is that of the power (6.760634791), while all the others are negative. This means that among all the reported values, it is the only one that directly affects the circuit time, which in this case represents the performance evaluation parameter.

This difference in the power values is therefore to be attributed to the only difference that was in the race, namely that the cyclists performed the cyclic pedalling gesture with their legs, while the para-cyclists with their arms (Mann et al., 2019). The legs, therefore, are able to give more power to pedalling than the arms. From the values shown in table number four and graph number two, which joins the order of arrival and the times of the second race, which took place in the same conditions as the first, with the only difference that in this second race it was once a counterweight has been applied to the cyclists, it is noted that the difference in performance has been cancelled because the graph shows a more homogeneous order of arrival. In fact, it can be seen that the two crosses more than once. It can be said that the difference between the two categories caused by the handicap of para-cyclists has been eliminated thanks to the help of the counterweight (Tweedy et al., 2016).

Starting from a study on the evaluation of aerobic endurance in young players, it was possible to lay a basis for understanding tables five and six, which show the values of VO_{2Max} and Power measured pre (Table n. 5) and post (Table n. 6) training mesocycle of all 10 athletes (Maki et al., 1995), the T-Test was then performed from these values, both for the VO_{2Max} and power values. The results are found in tables seven and eight. From these tables, to understand if the null hypothesis is to be accepted or not, we take as a reference the Stat t value, which is -5.98084594 in the first table (VO_{2Max}) and -0.954451055 in the second (Power), and we correlate with the two-tailed T-Test value, which is 1.17211E-05 in the first table and 0.352498595 in the second. For a two-tailed T-test, the critical value of the T distribution for 10 of and $\alpha = .05$, is equal to 2.23. So, the range for accepting the null hypothesis is between -2.23 and 2.23. The result obtained in the Stat t boxes is equal to -5.98084594 and -0.954451055, which are both in the rejection region, so the null hypothesis is to be rejected in both cases.

The null hypothesis, which was rejected, stated that the averages had no pre- and post-workout variation. Rejecting the null hypothesis, we therefore accept the alternative hypothesis, which stated that the averages would change because they were influenced by the event (training).

CONCLUSION

With the data obtained in this study, it can be said that in this case: the division into categories that exists between cycling and para-cycling can be eliminated by designing a unique performance activity using counterweights. Furthermore, again in this case, the HIIT and Endurance training to which all cyclists underwent, produced an improvement in VO_{2Max} and power in pedalling. Therefore, with the elimination of the division into categories, it is possible to promote sports integration and the inclusion of athletes with a certain type of disability. A validation of this study can be carried out, also increasing the sample taken into consideration, or the sample could be implemented by adding para-cyclists with other types of disabilities.

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