Anaerobic Power among Able-bodied Individuals versus Disabled Persons during arm cranking and Its Relationship to Hand-Grip Strength

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ABSTRACT

Aim: This study assessed Wingate test performance among disabled individuals compared to able-bodied. It also assessed the relationship between arm cranking anaerobic power and hand-grip strength.

Methods: Fifteen able-bodied men (age, 21.5 ± 1.2 y; height, 178 ± 7 cm; body mass, 77.7 ± 10.5 kg) and 11 disabled men (age, 33.6 ± 8.5 y; height, 158 ± 27 cm; body mass, 88.3 ± 22.7 kg) volunteered to take part in the study. Able-bodied participants completed two Wingate exercise tests; one leg cycling and one arm cranking. Disabled persons completed only the arm cranking Wingate exercise test. Hand-grip strength was measured for both hands for both groups.

Results: Wingate test peak (801 ± 131 W vs. 481 ± 117 W, respectively $P < 0.001$) and mean (613 ± 107 W vs. 346 ± 75 W, respectively $P < 0.001$) power output during leg cycling were significantly higher than arm cranking. Peak (481 ± 117 W vs. 410 ± 146 W, respectively $P > 0.05$) and mean (346 ± 75 W & 311 ± 111 W, respectively $P > 0.05$) power output of able-bodied participants during arm cranking Wingate test were higher than disabled persons. There was a significant relationship between peak and mean Wingate test power output during arm cranking and hand-grip strength for both hands ($P < 0.01$).

Conclusion: Wingate test performance was greater during leg cycling compared to arm cranking and in able-bodied participants compared to disabled individuals during arm cranking. There was a significant relationship between hand-grip strength and Wingate test performance for both groups. These findings indicate differences between able-bodied and disabled individuals in Wingate test performance and reveal aspects of fitness to be improved in disabled individuals.

Keywords: Wingate; Anaerobic power; Arm cranking; Disabled individuals.

1. INTRODUCTION

Anaerobic capacity is the maximal amount of ATP turnover permissible by anaerobic metabolism (by the whole organism) during a specific type of short-duration, maximal exercise (Green, 1994; Alrob, 2017). Compared to aerobic metabolism, the power produced using anaerobic metabolism is high, but can only be sustained for a short period of time (McArdle et al. 2007). Anaerobic capacity is essential in sports involving sprints, jumping and throwing such as high jump, long jump and shot put (Bajes & Al-Dujaili, 2017). Therefore, assessing anaerobic capacity in such sports is more informative than cardiovascular and endurance assessments. There are different exercise tests used to assess anaerobic capacity, such as vertical jump and long jump; however, the Wingate anaerobic exercise test might be the most used.

Before the advent of the Wingate anaerobic exercise test, a 40 s exercise test with 6 kg for men and 5 kg for women loads were applied to the flywheel of a mechanically-braked cycle ergometer was used to assess anaerobic capacity in leg cycling (McArdle et al. 2007). The Wingate exercise test was established in the 1970s (Bar-Or, 1987). The Wingate exercise test requires

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maximal (all-out) pedalling for 30 seconds against a constant braking force in leg cycling and arm cranking (Driss, & Vandewalle, 2013). In leg cycling, a frictional resistance of 7.5% body mass has been used to determine Wingate test performance; whereas in athletes 12% body mass has been used (McArdle et al. 2007). On the other hand, 4% - 5.5 kg of body mass has been used during arm cranking Wingate exercise for healthy able-bodied individuals (e.g., Ogonowska et al., 2009; Price et al., 2014). Jacobs et al. (2005) used 1%, 2% and 3% kg of body mass during arm cranking Wingate exercise test for tetraplegic persons with 5, 6, and 7 cervical spinal cord injuries. Hutzler et al. (1998) employed 3.5% of body mass during arm cranking Wingate exercise test for individuals with lower limbs impairment.

Arm exercise is an established mode of exercise testing and prescription for people who use their upper body regularly during exercise, such as rowers, swimmers and kayakers (Franklin et al., 1983; Hill et al. 2019). Arm exercise is also an adequate mode of exercise testing for those who often complete some form of work which requires significant use of the upper body, such as digging and snow shovelling (Franklin et al., 1983). It is also an appropriate mode of exercise testing and prescription for individuals who are unable to use their legs during exercise (Janssen & Hopman, 2005). For instance, individuals with paraplegia as a result of Spinal Cord Injury (SCI) or spina bifida or poliomyelitis, as well as for those with bilateral above-knee amputees (Hopman, 1994).

Arm exercise elicits lower peak values for oxygen consumption, heart rate, pulmonary ventilation, power output and a higher systolic and diastolic blood pressure during maximal exercise compared to leg cycling or treadmill running (Åstrand et al., 1965; Aminoff et al., 1997). Similar ratings of perceived exertion values were reported at the termination of arm cranking and leg cycling maximal exercise tests (Al-Rahamneh, 2010). However, at the same sub-maximal work rate or at the same percentage of VO_2peak, arms elicit higher values for oxygen uptake, heart rate, pulmonary ventilation, systolic and diastolic blood pressure, blood lactate concentration and rating of perceived exertion (Åstrand et al., 1968; Franklin et al., 1983). McArdle et al. (2007) indicated that these differences in the maximal and sub-maximal values between the two modes of exercise may be attributed to the relatively smaller muscle mass activated during upper body compared to lower body exercise.

The hand is the most dynamic and interactive part of the upper limb (Martin et al. 2015). The hands are important for sport and/or physical activity that involves catching, throwing and lifting. During arm cranking Wingate exercise test participants are requested to hold the handlebars of the arm cranking ergometer throughout the exercise test. Therefore, measuring hand-grip strength is essential in this study. Hand-grip strength is measured by the amount of the static strength that the hand generates around a dynamometer (Massy-Westropp et al. 2011). If the measurement is conducted accurately using a reliable and valid device, hand-grip strength measurement is one of the well established and approved measurements of static strength (Mathiowetz, 2002). Hand-grip strength is positively associated with body mass index (Koley et al. 2009). These authors showed that thin individuals (BMI <18.5 kg·m^{-2}) have low hand-grip strength compared to individuals with a normal body mass index. However, since it is unclear whether hand-grip strength correlates positively with anaerobic power during upper body exercise, further research is required to address this.

It is well established that able-bodied participants have significantly higher peak values for power output and oxygen uptake (Hopman, 1994; Janssen & Hopman, 2005; Al-Rahamneh, 2010; Al-Rahamneh & Eston, 2011; Al-Rahamneh & Eston, 2012). However, it has yet to be determined whether anaerobic power is comparable among able-bodied individuals and disabled individuals and there are no studies assessing the relationship between hand-grip strength and anaerobic power during arm cranking exercise. Since anaerobic power is important for both able-bodied and disabled persons especially in track and field events such as shot put and weight lifting. Therefore, the aim of the current study was to assess whether there was a significant difference in anaerobic power between able-bodied and disabled individuals. The second aim of the current study was to assess the relationship between anaerobic power of arm cranking exercise and hand-grip strength. It is hypothesized that able-bodied individuals would have higher anaerobic power than disabled persons. It is hypothesized that there will be a significant positive relationship between arm cranking anaerobic power and hand-grip strength.

Methods

Participants

Fifteen able-bodied men (age, 21.5 ± 1.2 y; height, 178 ± 7 cm; body mass, 77.7 ± 10.5 kg) and 11 disabled men (age, 33.6 ± 8.5 y; height, 158 ± 27 cm; body mass, 88.3 ± 22.7 kg) volunteered to take part in the study. Inclusion criteria were: (a) being physically active ≥3 times per week; (b) free of acute illnesses (e.g., flu), chronic diseases, and sport injuries; and (c) not arm-trained. Able-bodied participants were sport sciences students studying at School of Sport Sciences at the University of Jordan. Regarding the disabled participants, three had lower limbs flaccid paralysis as a result of poliomyelitis infection, four had lower limbs amputation, one had spina bifida, two had SCI with a neurological level below T6 and more than 7 years since injury and one had lower limbs paralysis as a result of cerebral palsy. Able-bodied participants were physically active (> 3 h per week), but not specifically arm-trained (e.g. swimmer) and participated in sports such as taekwondo, football and handball at both professional and recreational levels. Disabled persons were physically active and participated in sports such as wheelchair basketball, weight lifting and track and field events at both professional and recreational levels.

As arm ergometry was not a familiar mode of exercise training for both groups, a familiarization trial was conducted before the Wingate exercise test was performed. In this familiarization trial, after a proper warming up, participants were asked to exercise for 5 minutes at 30 W. Able-bodied participants visited the lab twice whereas disabled persons had one visit. On the first visit, all participants provided written informed consent and were measured for body mass (SECA, Hamburg, Germany) and height. Disabled participants were measured for height while lying down on the floor. This study was conducted with institutional ethics approval from the School of Sport Sciences at the University of Jordan. Able-bodied participants and wheelchair users performed their exercise tests in the exercise physiology laboratory at the School of Sport Sciences at the University of Jordan.

Procedures

Able-bodied participants performed two Wingate exercise tests. The first was performed during leg cycling to assess anaerobic power of lower limbs. The second was performed during arm cranking to assess anaerobic power of upper limbs. Disabled individuals performed only the arm cranking Wingate exercise tests to assess anaerobic power of upper limbs. For able-bodied participants, the two exercise tests were separated by 48 h. All participants were asked to avoid moderate and heavy intensity exercise prior to and between the exercise tests.

Exercise tests

Leg cycling Wingate exercise test

Before the exercise test commenced, subjects warmed up for 5 min with 30 W frictional selected-load being applied to the flywheel of the ergometer using a self-selected cadence. All exercise tests were performed on the same mechanically-braked cycle ergometer (Ergomedic 894 E Monark Exercise, Varberg, Sweden). The saddle height was set to allow a slight flexion (~20°) in the knee when the leg was extended. The handlebar height was set to achieve greatest comfort. Participants were informed to remain seated throughout the test and were given strong verbal encouragement to maintain an all-out effort throughout the test. Based on previous studies (e.g., Bar-Or, 1987) 7.5% of body mass was selected for the leg cycling Wingate exercise test. The weight was dropped automatically when 120 RPM was reached.

Arm cranking Wingate exercise test

Before exercise commenced, subjects warmed up for 5 min with 20 W frictional selected-load being applied to the flywheel of the ergometer using a self-selected cadence. For able-bodied and disabled individuals, all exercise tests were performed on the same adapted Monark bike (Ergomedic 894 E Monark Exercise, Varberg, Sweden). The bike was stabilised on a table and a Biodex chair (Biodex Medical Systems, New York, USA) was used during all exercise tests for both able-bodied and disabled individuals. This chair has the advantage of moving forward, backward and upward. The bike was loaded with some bags of sand to minimize any rocking movements. For able-bodied participants, straps were used to stabilise the legs and to minimise their contribution during the arm cranking exercise tests. The midpoint of the ergometer was set at shoulder level and the distance was set to allow a slight flexion in the elbow when the arm was extended. Participants were given strong verbal encouragement to maintain an all-out effort throughout the test. Ogonowska et al. (2009) employed 5.5% and 4.5% kg of body mass in hand cycle exercise for males and females, respectively. In addition, Price et al. (2014) employed 4% of body mass during upper body Wingate exercise test for untrained-arm male participants. Therefore, 5% body mass was chosen for the arm cranking Wingate exercise test in the current study. The mass was dropped automatically when participants reached 120 RPM.

Hand-grip strength

For able-bodied participants, hand-grip strength was measured while standing with the arm fully extended and away from the body to avoid body strength contribution to the measurement. For disabled persons, hand-grip strength was measured while seated on a braked wheelchair with the arm fully extended and away from the body to avoid trunk strength contribution to the measurement. For both groups the same dynamometer was used to measure hand-grip strength (Takei Scientific Instruments, Japan). The results were recorded as kilograms taken from the digital display of the dynamometer to the nearest 0.1 kg. The digital display of the dynamometer displayed the maximum strength within a trial and the value was reset to zero before each subsequent measurement. Hand-grip strength was measured 3 times for each hand and the best of the 3 readings was recorded. More details of hand-grip strength measurement can be found in Al-Rahamneh et al. (2020).

Statistical *analysis*

Driss, & Vandewalle, (2013) indicated that peak power and mean power output were the main focus of most studies as fatigue index was the least reliable of the three Wingate test indices as it depends on aerobic performance. Therefore, the focus of this study was peak and mean anaerobic power.

A series of paired samples t-tests were used to compare absolute and relative peak and mean anaerobic power values of leg cycling to arm cranking. A series of independent sample t-test were used to compare absolute and relative peak and mean anaerobic power values of able-bodied to disabled persons. A series of independent sample t-test were used to compare hand-grip strength for both hands of able-bodied to disabled persons. Pearson moment correlation coefficient was used to assess the relationship between anaerobic power of arm cranking and leg cycling. The data were analyzed using Statistical Package for Social Sciences (SPSS) for Windows, PC software, version 16. An alpha level of 0.05 was used for all statistical tests.

Results

Anaerobic power

Absolute and relative peak and mean anaerobic power during leg cycling and arm cranking for both groups are presented in table 1.

Table 1: Absolute and relative peak and mean anaerobic power of leg cycling and arm cranking for both able-bodied and disabled individuals.

Group	Exercise mode	Peak power (W)	Peak power (W/kg)	Average power (W)	Average power (W/kg)
Able-bodied	Leg cycling	801 ± 131*	10.4 ± 1.3*	613 ± 107*	7.7 ± 0.8*
	Arm cranking	481 ± 117	6.2 ± 1.1°	346 ± 75	4.5 ± 0.7°
Disabled	Arm cranking	410 ± 146	4.6 ± 1.2	311 ± 111	3.5 ± 0.9

* Significantly higher during leg cycling than arm cranking. ° Significantly higher for able-bodied than disabled persons. Values are mean ± SD.

Paired sample t-test showed that absolute and relative peak anaerobic power values of leg cycling were significantly higher than arm cranking ($P < 0.001$). Paired sample t-test also showed that absolute mean and relative anaerobic power values during leg cycling were significantly higher than arm cranking ($P < 0.001$).

Independent samples t-test showed that there was no significant difference in absolute peak anaerobic power values between able-bodied and disabled individuals $t_{(24)} = 1.384$, $P > 0.05$). However, relative peak anaerobic power values of able-bodied were significantly higher than disabled individuals $t_{(24)} = 3.439$, $P < 0.01$. Independent sample t-test showed that there was no significant difference in absolute mean anaerobic power values between able-bodied participants and disabled individuals $t_{(24)} = 0.949$, $P > 0.05$). However, relative mean anaerobic power values of able-bodied participants were significantly higher than disabled individuals $t_{(24)} = 3.057$, $P < 0.01$.

Hand-grip strength

Hand-grip strength of right and left hands for both able-bodied and disabled individuals are presented in table 2. In addition, the relationships between peak and average anaerobic power of arm cranking exercise and hand-grip strength for both hands are presented in table 3.

Table 2: Hand-grip strength of right and left hands for both able-bodied and disabled individuals. Values are mean ± SD.

Group	Right hand-grip strength (kg)	left hand-grip strength (kg)
Able-bodied	52.7 ± 9.6	51.3 ± 9.1
Disabled	53.5 ± 15.4	48.6 ± 13.1

Independent sample t-test showed that there was no significant difference between able-bodied and disabled individuals in hand-grip strength of the right hand $t_{(24)} = 0.158$, $P > 0.05$ and left hand $t_{(24)} = 0.616$, $P > 0.05$.

Table 3: The relationship between peak and average anaerobic power and hand-grip strength for both hands. Values are Pearson moment correlation.

	Right hand-grip strength (kg)	Left hand-grip strength (kg)
Peak anaerobic power (W)	0.740*	0.772*
Mean anaerobic power (W)	0.749*	0.737*

* Significant relationship $P < 0.01$

There was a significant relationship between absolute peak anaerobic power and right hand-grip strength $r_{(24)} = 0.740$, $P < 0.01$ and left hand-grip strength $r_{(24)} = 0.772$, $P < 0.01$. There was a significant relationship between absolute mean anaerobic power and right hand-grip strength $r_{(24)} = 0.749$, $P < 0.01$ and left hand-grip strength $r_{(24)} = 0.737$, $P < 0.01$.

Discussion

The aim of the current study was to assess whether there was a significant difference between able-bodied and disabled individuals in anaerobic power values during arm cranking exercise. The second aim of the current study was to assess the relationship between hand-grip strength and anaerobic power during arm cranking exercise.

Arms cranking versus leg cycling

Relative peak and mean anaerobic power values were significantly higher in leg cycling (10.4 w/kg & 7.7 w/kg, respectively) than arm cranking (6.2 w/kg & 4.5 w/kg, respectively) $P < 0.05$. These findings are in agreement with Weber et al. (2006). These authors reported that peak and mean anaerobic power values of leg cycling (13.3 w/kg & 9.7 w/kg, respectively) were significantly higher than arm cranking (9.3 w/kg & 5.7 w/kg, respectively). In the current study the percentage of peak and mean anaerobic power of arm cranking to leg cycling were 59.9% and 56.6%, respectively. In Weber et al. (2006) study these percentages were 69.9% and 58.8%, respectively. Arm to leg anaerobic power ratio in the current study and Weber et al. (2006) study confirm Dotan & Bar-Or, (1983) findings who showed that mean anaerobic power ratio of arm to leg was 47.6% in female subjects and 56.8% in the male subjects.

This ratio of peak and mean anaerobic power of arm cranking to leg cycling are comparable to those reported for aerobic power. Franklin et al. (1983) and McArdle et al. (2007) reported that VO_2peak values of arm cranking exercise is about 60%-70% of leg cycling values. Franklin et al. (1983) also reported that heart rate max values of arm cranking exercise is about 11 beats per minute lower than leg cycling. These differences in peak and mean anaerobic power values between the two modes of exercise can be attributed to the smaller muscle mass activated during arm cranking exercise compared to leg cycling (McArdle et al. 2007). This is confirmed by Reiser et al. (2002) who showed 8% improvements in Wingate exercise test performance in standing compared to seating position. Driss & Vandewalle (2013) indicated that this increase in peak power in a standing compared to a seating position can be attributed to the additional power from the upper body which can be transferred to the lower limbs.

The peak and mean anaerobic power values during arm cranking for able-bodied subjects in the current study (6.2 w/kg & 4.5 w/kg, respectively) were lower than those values (7.96 w/kg and 5.97 w/kg, respectively) reported by Ogonowska et al. (2009). This difference might be due to the fact that Ogonowska et al. (2009) recruited 9 male swimmers for their study where this type of sport (i.e., swimming) involves arm exercise predominantly which in turn leads to higher values of anaerobic power during arm cranking exercise. Peak and mean anaerobic power of leg cycling reported in the current study (801 w & 613 W, respectively) were lower than those values (980 W & 656 W, respectively) reported by Grant et al. (2014). This difference might be attributed to the fact that leg cycling is not a familiar mode of exercise in our daily life activities like walking whereas cycling is part of daily life activities in developed countries.

Able-bodied versus disabled individuals

Relative peak and mean anaerobic power values of able-bodied subjects were significantly higher than disabled persons ($P < 0.05$). Absolute peak and mean anaerobic power values of disabled persons were 410 W and 311 W, respectively. These values are comparable to those values reported by (Hutzler et al. 1998). These authors reported that peak and mean anaerobic power among individuals with lower limbs impairment as a results of polio, spinal cord injury and amputees were 429 W and 341 W, respectively. These differences in anaerobic power are comparable to VO_2peak and peak power output values. For example, Amari & Al-Rahamneh, (in press) reported that peak power output values for able-bodied and paraplegic participants were

(114 w & 92 w, respectively). Similar findings were reported for VO_2peak (35 ml/kg/min & 29 ml/kg/min, respectively).

These differences between able-bodied and disabled individuals might be attributed to the fact that able-bodied participants are able to use their legs for stabilization and as a fulcrum from which to push (Hopman, 1994; Janssen, & Hopman, 2005). Jacobs et al. (2005) reported that peak anaerobic power was 207 w/kg, 120 w/kg and 57 w/kg among tetraplegic persons with complete spinal cord injury at the seventh, sixth and fifth cervical levels, respectively. Jacobs et al. (2005) findings confirm the fact that the greater muscle mass engaged during the exercise, the higher the work rate that can be achieved, especially for tetraplegic and paraplegic individuals.

The relationship between anaerobic power and hand-grip strength

There were no significant differences between able-bodied and paraplegic individuals in hand-grip strength values for both hands ($P > 0.05$). All able-bodied and paraplegic individuals were right-handed. The mean of hand-grip strength values reported in the current study for both groups are similar to those values (52 kg) which were reported by Baker & Davies, (2009) for fifteen healthy male participants. However, the mean of hand-grip strength values reported in the current study for both groups are much higher than those values (32 kg) which were reported by Atabek, (2014) for female handball players.

There was a significant relationship between absolute peak and mean anaerobic power and hand-grip strength for both hands ($P < 0.05$). This strong and significant relationship between hand-grip strength and anaerobic power of upper limbs is expected and not surprising as arm cranking exercise involves some type of gripping such as handlebars gripping. In addition, hand-grip strength also involves anaerobic power as participants try to squeeze the dynamometer maximally and as such they can sustain this for only a few seconds. Furthermore, the Wingate exercise test lasts for 30 s. That means in both the hand-grip strength and the Wingate exercise test assessments, the source of energy is principally anaerobic. To our knowledge, this is the first study which has assessed the relationship between hand-grip strength and anaerobic power during arm cranking exercise. However, these findings are in agreement with findings by Atabek, (2014) who reported a significant relationship between hand-grip strength and absolute peak anaerobic power (0.535, $P < 0.05$) and absolute mean anaerobic power (0.612, $P < 0.01$) during leg cycling among female handball players. In addition, Baker & Davies, (2009) observed a significant linear relationship between hand-grip strength and leg power ($r = 0.75$, $P < 0.05$).

Conclusion

Absolute and relative peak and mean anaerobic power values were significantly higher in leg cycling than arm cranking exercise ($P < 0.05$). Relative peak and mean anaerobic power values for able-bodied individuals were significantly higher than disabled individuals during arm cranking exercise ($P < 0.05$). There was a significant relationship between absolute peak and mean anaerobic power of arm cranking exercise and hand-grip strength for both hands ($P < 0.05$). Anaerobic power of upper limbs should be a focus of coaches and personal trainers for able-bodied and disabled individuals especially in short-duration events such as weight lifting.

Conflict of interest

The author declares that there is no conflict of interest. .

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القدرة اللاهوائية على الدراجة الثابتة للذراعين لدى الافراد الاصحاء مقارنة بالافراد ذوي الاعاقة وعلاقتها بقوة القبضة

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ملخص

الهدف: هدفت هذه الدراسة التعرف الى مستوى القدرة اللاهوائية على الدراجة الثابتة للذراعين للافراد الاصحاء ومقارنتها بقيم الافراد المعاقين. وهدفت هذه الدراسة كذلك الى معرفة قوة العلاقة بين القدرة اللاهوائية على الدراجة الثابتة للذراعين وقوة القبضة.

الطريقة والاجراءات: خمسة عشر شخص من الاصحاء (21.5 ± 1.2 سنة؛ 178 ± 7 سم؛ 77.7 ± 10.5 كغم) و 11 شخص من ذوي الاعاقة الحركية (33.6 ± 8.5 سنة؛ 158 ± 27 سم؛ 88.3 ± 22.7 كغم) تطوعوا للمشاركة في الدراسة. الافراد الاصحاء قاموا بتطبيق اختبارين ونجيت الاول على الدراجة الثابتة للقدمين والثاني على الدراجة الثابتة للذراعين. اما الافراد ذوي الاعاقة الحركية فقاموا بتطبيق اختبار ونجيت على الدراجة الثابتة للذراعين فقط. وتم قياس قوة القبضة لليد اليمين واليسار من وضع الوقوف والذراع مفرودة الى جانب الجسم للمجموعتين.

النتائج: اظهرت النتائج ان القدرة اللاهوائية المطلقة كانت اعلى للقدمين (801 ± 131 وات) مقارنة بالذراعين (481 ± 117 وات). واظهرت النتائج ان متوسط القدرة اللاهوائية كانت اعلى للقدمين (613 ± 107 وات) مقارنة بالذراعين (346 ± 75 وات). واظهرت النتائج ان القدرة اللاهوائية المطلقة كانت اعلى للافراد الاصحاء (481 ± 117 وات) مقارنة بالافراد ذوي الاعاقة (410 ± 146 وات). واظهرت النتائج ان القدرة اللاهوائية المطلقة كانت اعلى للافراد الاصحاء (346 ± 75 وات) مقارنة بالافراد ذوي الاعاقة (311 ± 111 وات). واخيرا اظهرت النتائج وجود علاقة دالة احصائيا بين القدرة اللاهوائية على الدراجة الثابتة للذراعين وقوة القبضة لليد اليمنى واليسرى.

الاستنتاجات: القدرة اللاهوائية للقدمين اعلى من الذراعين. القدرة اللاهوائية للافراد الاصحاء اعلى من الافراد ذوي الاعاقة. وجود علاقة دالة احصائيا بين القدرة اللاهوائية على الدراجة الثابتة للذراعين وقوة القبضة. هذه الفروق بين الافراد الاصحاء وذوي الاعاقة تؤكد الفروق الموجودة بين الفئتين وبناءا عليه يجب العمل عرى رفع مستوى اللياقة البدنية للافراد ذوي الاعاقة الحركية.

الكلمات الدالة: اختبار ونجيت؛ القدرة اللاهوائية؛ الدراجة الثابتة للذراعين؛ الافراد ذوي الاعاقة الحركية.

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