The Relationship between Core Strength Performance with Sprint Acceleration

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Abstract. The objectives of this study were to determine the relationship between average core strength and sprint acceleration performance. Besides that, this study also intended to determine the relationship between body height and body weight with average core strength and sprint acceleration performance. Sixty-three male sport science students (height 1.67 ± 0.07 m; body mass 63.25 ± 13.90 kg) from variety of sport background participated in this study. To test the relationship, core strength (7-stage abdominal strength test and prone-bridge test) and sprint acceleration (35-m sprint test) performance was measured and a Pearson’s correlation coefficient was used to analyse the results. Sprint was found to be significantly correlated with prone bridge performance, r (63) = -0.43, p = 0.00). The relationship between body height with sprint performance stated significant relationship (r (63) = -0.48, p = 0.00) and body weight with 7-stage abdominal strength values reveal a significant relationship (r (63) = -0.28, p = 0.03). In conclusion, this finding has suggested an optimum core strength may influences sprint acceleration performance which would give greater advantages in order to improve physical performance or optimize sport performance.

1. Introduction
Sprint performance is one of the key indicators to success in various of sports either for individual or team sports. A basic physical fitness to test and measure sprint performance is straight-line acceleration. Theoretically, acceleration defined as a rapid change of velocity at maximum speed usually in a short distance at minimum time as possible which athletes can attain [1], [2]. In performance terms, initial phase of acceleration (~0 – 10m) is a crucial part of the most athletes’ in many sports. Acceleration ability is to move quickly in short distance as fastest time possible generally determine the excellent performance [3], [1]. The ability to enhance the speed and acceleration is an essential for athletics success. Fundamentally, it is important to develop strength and power especially lower limb muscles groups including quadriceps, hamstring and calf muscles for enhance running speed. An interaction between physical characteristics such as technique, strength, leg power and musculotendinous stiffness were effects on sprint acceleration [4], [5]. Strength and conditioning experts and coaches should clearly understand these factors that may contribute to sprint performance.

Strength and conditioning professional widely focused on core strength exercises for improving physical appearances and reduce risk of injuries. In many sports, athletic body require optimum core
strength which influence the performance. Normally, traditional sit-up, abdominal and oblique crunch, back extension and static prone bridge common core exercises used in the strength and conditioning program. The most trending core exercise known as prone bridge or plank which use to isolate the abdominal muscles [6], [7]. In past years, physical exercises such as fitness ball training, balance training and weight training has become popular trend among general population ([8], [9]. Theoretically, people performed core strength exercises as part of basic physical activity that give advantage to the physical functional performance and injury prevention.

In scientific literature, question regarding sprint performance and core strength are still reported and have attention among sport researchers. However, the problem is during training more emphasis always been given to the improvement of leg muscles capabilities rather than on core muscles development. This may be due to lack of information available on how much core strength actually influence sprint acceleration performance. Thus, determining of how much core strength effect and influence sprint acceleration performance may assist solving this problem. There is unclear study on the relationship between core strength performances with sprint acceleration performance use by institution students especially from sport background. Therefore, the purpose of this study to determine the relationship of core strength performance with sprint acceleration performance among sport science students. This study also intended to determine the relationship between body height and body weight of participants with their with average core strength and sprint acceleration performance.

2. Methodology
2.1. Participant
Sixty-three male sport science students from variety of sport background was recruited for this study. The participants were free from any physical or mental illness and injury, none of the participants were highly trained individual or professional athletes. The participants were briefed verbally and clearly informed the purposes of the study. This study was conducted at UiTM Pahang, Jengka campus due to accessibility of the samples, facilities and instrumentations.

2.2. Procedure
This test was conducted at two different places; outdoor synthetic running track at mini stadium for 35-meter sprint test and indoor gymnasium for both of the core strength test. Due to the reliability and validity reasons, all testing session were performed after 24 hours of rest and recovery time under supervised the same fitness instructors. During the testing sessions, participants required to wearing proper sport shoes and attires. The use of spikes shoes not allowed for sprint performance testing. Participants then was asked to performed individual warm up before any testing sessions start and cooling down after finished each testing sessions. Before the testing sessions start, all participant was briefed the procedures and protocols of the test followed by measuring their height, weight and Body Mass Index (BMI) for recorded purposes which this measurement was conducted at indoor gymnasium as stated.

First day of the testing session, 35-meter sprint test were measured. Participants were required to stand behind the starting line and could choose an individual start-up technique in ready state, when the whistles were blows participants should run in a straight line as fast as possible, they can execute from starting point to the finishing line. Two run trials were performed for each participant, 5-minute break time were given before next trial began and then personal best sprint time was recorded.

The next days, participants were performed 7-stage abdominals strength test. There has a 7-stage stage to complete and each stage has different methods. Stage 1; participants must lie down on the floor which covered with mattress and on their back with knee at the right angles and feet flat on the floors. The participants were asked to perform one complete sit-up for each stage with the methods mentioned. In stage 2; lying position same as stage 1 and performed one complete sit-up with arms extended than the wrists reach the knees. Stage 3; lying position same as stage 1 and performed one complete sit-up with arms extended than the elbows reach the knees. In stage 4; lying position same as stage 1 and performed one complete sit-up with arms held together across abdominals than the chest
touched the thighs. Stage 5; lying position same as stage 1 and performed one complete sit-up with hands held behind head than the chest touches the thighs. In stage 6; lying position same as stage 1 and performed one complete sit-up with a 2.5 kg weight plate held behind head and chest touching the thighs. Lastly for stage 7; lying position same as stage 1 and performed one complete sit-up with a 5 kg weight plate held behind head and chest touching the thighs.

Last day of the testing sessions, prone bridge was tested. Participants has to lies down in prone position with elbows, forearms and legs straight with the weight place by the toes to the supported upper body off the ground. The head facing on the floors, lifting the hips off the floor by created a straight-line posture from head to toes. When participants in the correct posture and position, they must hold an elevated position for as long as possible and personal best time were recorded. The test time were ended when participants was unable to hold the back straight, hip is lowered and fall off the ground.

2.3. Data and Statistical Analyses
Software Package for Statistical Analysis (SPSS) version 23.0 was used to perform all statistical analysis of the data collected with alpha stage for significant was set at p < 0.05. The descriptive statistic was used and calculated to describe the mean and standard deviation of the variables. To measure all variables of the relationship between core strength and sprint acceleration performance, a Pearson’s correlation coefficient was used to analyse the results.

3. Result
The total number of participants who voluntarily in this study were 63 male students. As showed in Table 1, results of mean body height was 1.67 ± 0.07, mean body weight was 63.25 ± 13.90 and mean body mass index (BMI) was 22.53 ± 3.91.

Table 1. Descriptive Statistics of Mean and Standard Deviation of Body Height, Body Weight and Body Mass Index (BMI) of the Participants.

| Variables          | Mean ± SD  |
|--------------------|------------|
| body height (m)    | 1.67 ± 0.07 |
| body weight (kg)   | 63.25 ± 13.90 |
| body mass index    | 22.53 ± 3.91 |

Table 2 showed mean and standard deviation results for 35-meter sprint test (5.49 ± 0.60), 7-stage abdominal strength test (5.91 ± 0.91) and prone bridge test (7.21 ± 3.42). The 35-meter sprint test (second) mean values of the participants was 5.49 ± 0.60, with the fastest time recorded was 4.64 seconds and 7.09 seconds was the slowest. The mean values for 7-stage abdominal strength test of the participants was 5.91 ± 0.91, with the highest scores recorded was 7th stage and 3rd stage recorded as a lowest. The mean values for prone bridge test (minute) of the participants was 5.91 ± 0.91 with the longest time recorded was 11.00 minutes and 1.00 minute was the shortest time.

Table 2. Descriptive Statistics of Average Core Strength and Sprint Acceleration Performance.

| Variables               | Mean ± SD  |
|-------------------------|------------|
| 35-meter sprint         | 5.49 ± 0.60 |
| 7-stage abdominal strength | 5.91 ± 0.91 |
| prone bridge            | 7.21 ± 3.42 |

As reported in Table 3, a Pearson’s correlation coefficient statistically revealed no significant correlation between sprint with 7-stage abdominals strength (r(63) = -0.09, p = 0.50). However, sprint with prone bridge results may have limited correlation values as stated statistically significant differences for this variables (r(63) = -0.43, p = 0.00).
Table 3. Correlations between Average Core Strength and Sprint Acceleration Performance

| Variables                      | R   | P value |
|--------------------------------|-----|---------|
| sprint with 7-stage abdominals strength | -0.09 | 0.50    |
| sprint with prone bridge       | -0.43** | 0.00    |

**correlation is significant at the stage 0.01 (2-tailed)

The correlation coefficient was computed to assess the relationship between body height and body weight of the participants with average core strength and sprint acceleration performance. Table 4 showed statistical analysis values between body height with sprint stated that nearly significant relationship ($r (63) = -0.48, p = 0.00$). However, there are no significant differences in relationship between body height with 7-stage abdominal strength ($r (63) = -0.004, p = 0.98$) and body height with prone bridge ($r (63) = 0.06, p = 0.62$). Respectively, body weight with 7-stage abdominal strength values reveal a significant relationship ($r (63) = -0.28, p = 0.03$) but the remaining variables had no significant differences between body weight with sprint ($r (63) = 0.06, p = 0.62$) and body weight with prone bridge ($r (63) = 0.19, p = 0.15$).

Table 4. Relationship between Body Height and Body Weight of the Participants with Average Core Strength and Sprint Acceleration Performance.

| Variables                      | R   | P value |
|--------------------------------|-----|---------|
| body height (m) with sprint (sec) | -0.48** | 0.00    |
| body height (m) with 7-stage abdominal strength | -0.004 | 0.98    |
| body height (m) with prone bridge (sec) | 0.06  | 0.62    |
| body weight (kg) with sprint (sec) | -0.06  | 0.62    |
| body weight (kg) with 7-stage abdominal strength | -0.28* | 0.03    |
| body weight (kg) with prone bridge (sec) | -0.19  | 0.15    |

**correlation is significant at the stage 0.01 (2-tailed)

*correlation is significant at the stage 0.05 (2-tailed)

4. Discussion and Conclusion

Nowadays, sprint performance generally accepted can improves with appropriate training variables and strategies, like speed strength specific and movement specific. In any sprint events, initial acceleration phase is the keys to excel the sprint performance capacity. The 35-meter sprint time recorded indicated quite similar performance with what have been recorded in other studies [10], [11]. Therefore, to measure variables focusing on specific phase of the sprint must take into consideration based on the individual demands and performance capacity.

In addition to facilitate greater transfer to sports performance, adequate abdominal muscles and others core muscles strength would contribute to any sports related activities. The 7-stage abdominal strength results indicate slightly higher scores compared with other studies due to limited finding literature in the same age group [12], [13]. In general, current finding used to compared with previous study reported as a guideline and important to new researchers to suggest the validity and reliability of the instrumentations as they are made available.

In healthy adults, core strength and stability can be assessed with one of the test batteries that has developed for the evaluation of health-related fitness. A recent study found prone bridge test scores indicated better performance because most of the previous study recorded lowest time in the test [14], [15]. These findings may suggest that this variable one of appropriate methods to measure core strength and stability (e.g., rectus abdominus groups, erector spinae groups) used by fitness professional.
That was doubt in literature stated sprint speed and time is a key performance index to successful sports performance. In the present finding, the negative correlations recorded cannot be said as actually negative effect in nature. In reality the lesser the sprint time, the better the sprint performance is. In other words, the smaller the numbers (time) recorded indicate the faster the participants sprint performance. Thus, negative correlations found here is actually indicating a positive impact, where a faster sprinter actually have a better core strength performance. This make sense as abdominal or core muscles are actually the stabilizers for any types of movements. Every force generations are actually generated from the Ground Reaction Force (GRF) [16], which needed to be transferred to and from any needed body parts via the middle intersection of the body, which is the core area covered include rectus abdominis muscles group, erector spine muscles group and obliques muscles groups [8], [17]. It is a solid foundation strong core strength has impact on sprint performance because most of arms and leg muscles tied within torso areas.

Research shows that anthropometry characteristic determines optimum performance in sport specific skills and performance. Based on current findings, negative correlation found significantly but not strong relationship between body height and sprint performance variables. In this context, body height of the participants found to be related with the sprint performance. It is suggesting that body height relatively generate higher forces and peak power output during sprint performance [18], [19]. Therefore, height definitely effects sprint performance by mastering the technique at the different stages. The possible factor may affect the stride length, stride frequency and stride rate of the participants. To produce faster run, short distance acceleration requires bursts of energy with shorter foot-strike contact to the ground. In fact, no specific height standard to determine people run faster.

In sport performance, it is important to have an athlete with ideal height and core strength to improve balance and movement control ability. This study found that the body height of the participants was not related to average core strength (7-stage abdominal and prone bridge) including abdominal muscle groups and erector spine muscle groups. Core strength performance does not depend on body height, but it helps to practice good posture stability and optimize performance [20]. Nevertheless, individual height and core strength beneficially influences others physical condition and capabilities when performing any physical activities.

Individual weight either heavy or lighter was not the indicator running faster. This study found no correlation body weight with sprint performance. Lean muscle mass typically helps sprint performance compared to body fat that can has negative repercussion on qualities such speed and agility [21], [22]. Increase body weight due to excess fat tissue essentially decrease performance abilities and some may suggest small amount of weight lost may affect sports performance [23], [24]. Ideal weight based on body composition calculation especially athletes is the best way required in certain sports activities.

In general, underlyng belief the individual weight does not reflect their core strength. It can be said that the heavier a person, he or she needs strong core to allow the ability to maintain stability of the body posture. Data from this study found no significant relationship body weight and plank performance. However, there was a significant correlation between body weight and abdominals performance shown slightly relationship in the variables. Core strength covered abdominal muscle group has more impact on sports performance compared to erector spine muscles group [8], [25]. The roles of specific core muscles strength must clearly understand for most trainer and coachers, which may effective training program to be implementing in order to optimize sport performance.

Most of researchers has clearly understand that effect size parameter reported from previous findings may be used as a guideline for further investigation of the relevance study. According to [26], [27] says that interpretation and assumption of similar variables of research may lead to miss use of effect size statistics. One of the easiest methods to identify the size of the different between two group by knowing the reported effect size values. The use of effect size values found inconsistently and remain confused which not easy to compare from different sources of finding results [28], [29]. It is important to note that effect size values occur in sport science study should be reported clearly and transparent as possible to inform the outcome of the results for further researcher use as a reference. In sport sciences research design, correlation coefficients for relationships between variables measure is
the most popular estimates of effect size parameter. Based on the experimental research model, the need to report estimation of effect size commonly uses to test the hypothesis may contribute positive benefits to the sport science researchers.

In conclusion, this study has concluded that the relationship between core strength and sprint acceleration performance reported minor influences on physical improvement. The average finding of some variables has reported similarity with past research and can be considered as general guidelines which may help coaches and fitness experts. The finding suggested sprint performance can be improve not only result from having optimum core strength but had influences by other variables such as height and physical characteristics. It would give greater advantages to strength and conditioning expert when designing and planning a dynamic sport specific movement training to improve sprint performance. For future study and implementation, 3-stage abdominal strength test a no longer relevance and dated battery test to measure core strength for sprint performance. This is because due to limitation of validity and reliability of the test procedures, instrumentation and source of references. Consequently, a wide variety of speed training and strength training models and protocols have been used to improve sprint acceleration and core strength performance. Nevertheless, investigate on how body composition and core strength may have benefits on sport performance for all suggestion for better outcome.

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