The Effect of Training Stride Length and Stride Frequency on Increasing Sprint Speed

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Abstract

In running events, especially sprints, there have been many good forms of training in improving sprint performance, such as downhill sprint training, towing, elastic assists, and orders. This training is used to improve stride length and stride frequency quality. Although in this study we tried to see with one among these training that contributes the most to improving running speed. The research method is an experiment using a design in the form of a pretest - posttest group design. The research subjects involved as many as 60 students of the physical education, health and recreation study program STKIP Pasundan, divided into two groups (A & B), group A was given stride frequency exercises, group B was given stride length exercises. From the results of data calculations in reality there is a significant influence from stride frequency training and also from stride length training to sprint running performance. But because stride length training has a greater positive impact on sprinting compared to stride frequency training, we as researchers recommend sprint trainers so that the exercise provides a greater proportion of the amount for stride length training.

Keywords: Athletics, Sprint, Stride Frequency, Stride Length.

Introduction

Running is one of the sports that is included in athletics and is divided into three main events, namely short, medium, and long-distance running (Callison &; Lowen, 2022), and is one of the most popular sports in the world, easy to do and has good accessibility (Shi et al., 2019), especially in Indonesia this sport is also always given in schools (Sobarna &; Hambali, 2020), where the fastest time is the main determining factor in achievement (Rivanta &; Agus, 2019), especially in sprints, the speed of a runner's feet and hands is the main factor to quickly get to the finish line (Macadam et al., 2018).

In sprint running, the main factor in the acceleration of the center of gravity when running is determined by the reaction force on the ground or commonly known as the Ground Reaction Force (GRF) (Hunter et al., 2005). Sprint athletes are required to have the ability to configure their bodies so that they can move effectively when sprinting at maximum

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speed. Therefore, the movement patterns of athletes are very important and have a significant effect on increasing sprint speed (Gittoes & Wilson, 2010). Relevant previous research revealed that there is a high correlation between athlete's joints and sprint segment kinematics with GRF (Hunter et al., 2005; von Lieres und Wilkau et al., 2020). Besides that, the lower leg has a role like a continuous chain as long as the running movement is carried out, which means that the running movement is the coordination of movements between the joints in the upper leg to the lower leg, which of course has a big influence on movement performance. running athletes. Furthermore, Krell & Stefanyshyn (2006)provide recommendations that plantar flexion of the ankle and proper extension of the knee before takeoff from the running track surface will determine sprint velocity.

In simple terms, running speed is influenced by stride speed and stride length (Hunter et al., 2004), runners who want to achieve optimal results and become reliable need to program an increase in stride length and stride frequency (IAAF, 2009), because running speed is generated by stride length and stride frequency (Walaszczyk & Iskra, 2006), and this is referred to as the horizontal velocity resulting from the speed or stride frequency as well as the stride length (Mosses, 2002). Horizontal speed is conceptually the product of stride length and stride frequency. Thus, if one of them increases, it will also have an impact on increasing sprint speed, provided that the other one does not decrease (Hunter et al., 2004). Speaking of a direct relationship between stride length and stride frequency, both have a negative influence on one another. This is proven if an athlete has a long stride length then tends to have a low step frequency or vice versa (Hunter et al., 2004).

An athlete's maximum speed can only be achieved by using the correct ratio between stride length and stride frequency (Rimmer & Sleivert, 2000), and significant changes in stride length or frequency will cause a decrease in speed (Mattes et al., 2014). The stride length and stride speed increase with an increase in running speed (Bailey et al., 2017), these two aspects are often described as two factors that are interrelated and influence each other in sprint running (Schubert et al., 2014). But until now it has not really been conclusive about the role of stride length or stride frequency on sprint speed, whether it makes the most important contribution or not.(Bezodis, 2012).Referring to the research that has been done, that which has a more significant influence on sprint running speed is stride length compared to stride frequency.

It is interesting that there is also a view through research findings that based on intra-subjects, step frequency is a very important factor for the best performance for sprint athletes (Hunter et al., 2004). Until several researchers have conducted research on which factors have more impact on sprint speed, whether stride length or stride frequency. One of them is Hay & Fung (1982) which reveals a model that divides stride length and stride frequency into subcomponents distance, flight distance, stance time, and flight time, which then identified the determination of the subcomponents (Hay & Fung, 1982). Furthermore, Kakehata et al. (2021) explained that in order to achieve a high stride frequency, smoother transitions and well-coordinated muscle activity between the legs are required. Besides that, what needs more attention is the negative interaction between stride length and stride frequency when coaches provide training programs to sprint athletes to increase stride length, stride frequency, or even both (Hunter et al., 2004). This is based on the fact that the factors that affect stride length or stride frequency do not necessarily have an effect on running speed due to their negative interactions. Conversely, there are several factors in increasing sprint speed that can be achieved by influencing stride length and stride frequency. So, Novacheck (1998) provides recommendations that increasing sprint speed can be associated with increasing maximum hip flexion, which will result in a longer stride length. Therefore, the correlation between motion coordination and sprint speed is also caused by stride frequency or stride length. In analyzing some of these problems, a study conducted by Liew et al. (2021)shows that using media analysis can identify candidate biomechanical factors. In addition, mediation analysis can help determine the effect of stride length or stride frequency on the

correlation between movement coordination and sprint speed.

Based on this, it can be interpreted that in all forms of running speed training, the key is still related to stride length and stride frequency (Mercer & Chona, 2015), running speed is largely determined by stride length and a number of steps per second (Meyers et al., 2015), the maximum speed can only use the exact ratio between stride length and stride frequency (Miller et al., 2012), trainers focus their training programs for sprinters on increasing stride length and stride frequency (Cissik, 2005). However, there are still those who think that training in strength and technique can affect stride length quite a lot (Lockie et al., 2014), generally stride frequency and stride length has an inverse relationship with a maximum effort which is equivalent to the strength of the runner's limbs (Abdurrahman et al., 2022), whereas strength training had very little effect on stride frequency (Van der Meijden, 2019), although there is a theory that stride length and frequency can be increased (Hak et al., 2013). This means that the frequency training factor can still be prioritized as the main part of the training menu. But to that extent is there really any benefit in improving sprint performance and how much effect does it have compared to stride length training? A very good question and at the same time intrigues the author to see how far the results of this stride frequency exercise have on sprint performance and to what extent stride length training can increase sprint speed.

Method

The method used is an experiment using a pretest – posttest group design, where each group will be given a test at the beginning, then given a different treatment, and then given another test at the end of the meeting (Jack R. Fraenkel et al., 2012), the following is the research design:

Table 1. Research Design

Group	Pretest	Treatment	Post test
A	HI	X1	HI
B	HI	X2	HI

Participants

The research subjects involved in this study were 60 students of the physical education, health and recreation study program at STKIP Pasundan who were taken by simple random sampling. In accordance with the research design, the subjects were divided into two groups (A &; B) with the number of each group being 30 people. Group A is a group that practices with step frequency. The trick is to pass through the target which is marked with used bicycle tires that are already thin, or by using wooden slats, or by using used cardboard. These used tires or wooden slats or cardboard are stored in a row at a predetermined distance. Group B is a group that trains with long-step exercises. The trick is to run as fast as possible or do a bounding stride past the target marked with old or slim bicycle tires, or by using wooden or cardboard slats. Tires or wooden slats, or boxes are stored in a row at a predetermined distance. The distance from one sign (old tire, wooden plank or cardboard) to another was farther than the frequency training group.

Protocol

The research subjects did enough warm-up. Then all research subjects use a standing stratum. Each subject has three opportunities to do a successful sprint, that is, the subject does his job as needed. All data was successfully collected with their respective maximum speeds. Between three times the opportunity to sprint in a row given a rest period of 2 minutes.

Procedure

In this study, the researcher divided the two procedures based on the two predetermined groups of participants, as follows:

Step Frequency Exercise Procedure

Step frequency training, aims to improve the ability to perform running movements with a high frequency of steps or fast step movements or exercises to increase the ability of several steps per second. This means that the distance of the signs specified in gymnastics must be able to make it easier for people who are trying to do running steps with a fast rhythm or frequency. This means that the stride length must be shorter than the average stride length during the 100 m sprint.

To increase the frequency of steps per second, the distance that the author determines starts from the shortest distance, which is 10% of the average stride length, then gradually increases the percentage to 20%, 30%. and 40%. The way to carry out activities in traffic signs that are made/arranged with an arrangement of bicycle tires, wooden slats or cardboard is to try to pass these signs with optimal step frequency, posture must be straight and tall, knees raised to hip level and foot contact with the ground made with a football.

From the results of the initial test it can be seen that the average number of steps in group A (step frequency training group) for the 100 m run test was 54.89 steps, this means that the average step length of group A was 100: 54.89 = 1.821 m.

Then the determination of stride length in both groups A (step frequency training group) is as follows:

1)   10 % x 1.82 m = 0.182 m rounded up to 0.20 m

2)   20 % x 1.82 m = 0.364 m rounded up to 0.40 m

3)   30 % x 1.82 m = 0.546 m rounded up to 0.60 m

4)   40 % x 1.82 m = 0.728 m rounded up to 0.70 m

The following is a picture regarding the implementation of maintenance using wooden slats, used tires and cardboard:

Distance 20 Cm   Distance 40 Cm   Distance 60 Cm   Distance 70 Cm
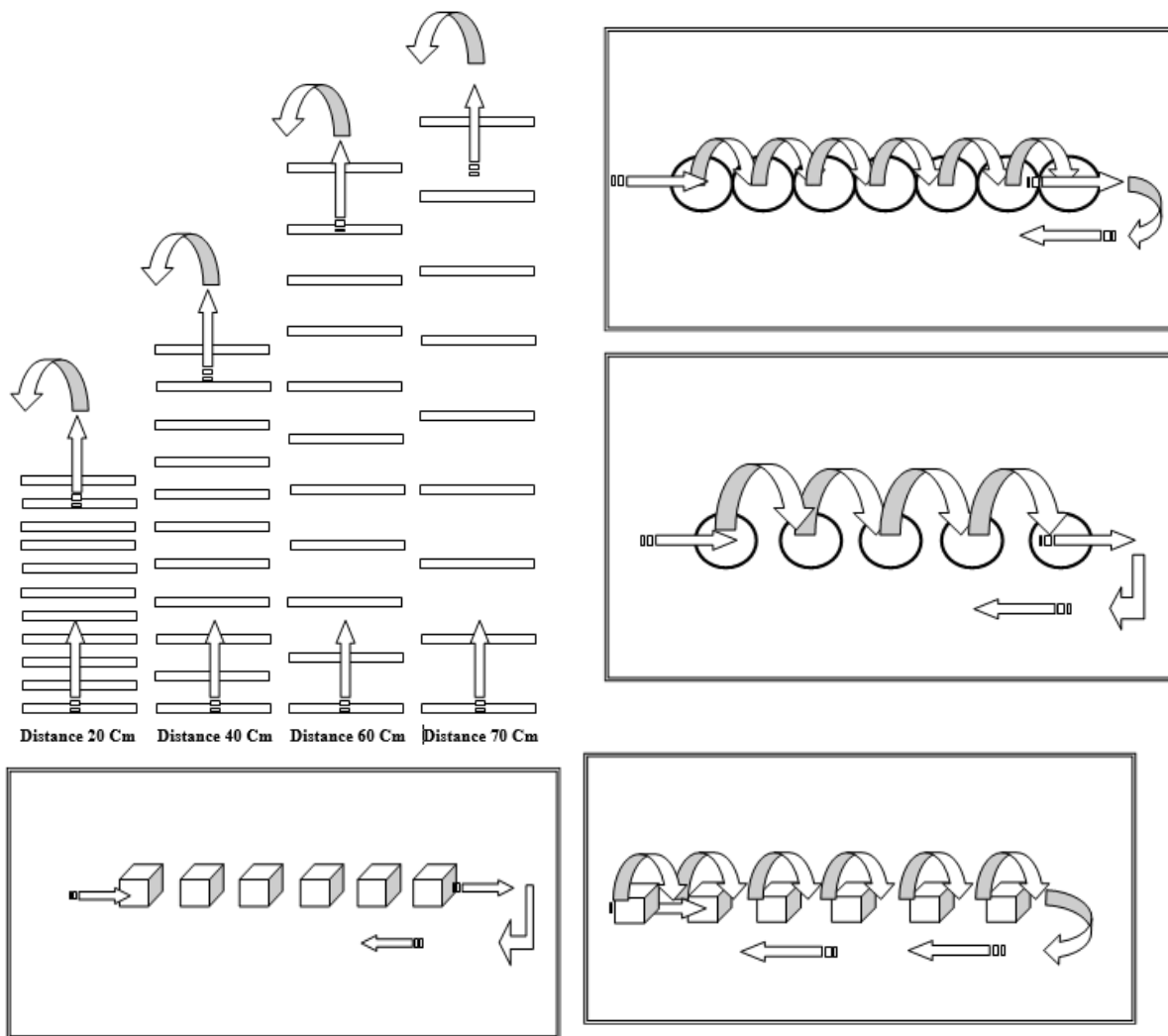
Step Length Exercise Procedure

Step length training aims to improve the ability to run with steps that are longer than the average stride length that has been done before without losing too much stride frequency. That is, the distance between the specified signs must make it easier for people trying to be able to take several steps that are relatively longer than the average stride length when running 100 m. The distance of the signs determined to train stride length in this study started from 120% of the average stride length, then gradually increased to 130%, 140% to 150%.

From the results of the initial 100 m running test, the average number of steps in group B (the group that practiced stride length) was 54.72 steps. Thus, it means that the average stride length of group B is 100: 54.72 = 1.827 m. Because carrying out the exercise adheres to the principle of training, among other things, there must be an additional training load, one of the efforts made by the author is to provide a longer training distance, so that the distance that must be prepared is based on calculating the percentage distance from the known average length.

By adding/extending or lengthening the stride, it means that the person is required to expend greater energy in order to still be able to reach that mark or distance with the correct technique. Determination of the stride length in group B (step length training group) in the implementation of the study were:

a.   120 % x 1.82 m = 2.184 m rounded up to 2.20 m

b.   130 % x 1.82 m = 2.366 m rounded up to 2.40 m

c.   140 % x 1.82 m = 2.548 m rounded up to 2.60 m

d.   150 % x 1.82 m = 2.73 m rounded up to 2.70 m

The following is a picture regarding the implementation of maintenance using wooden slats, used tires and cardboard:
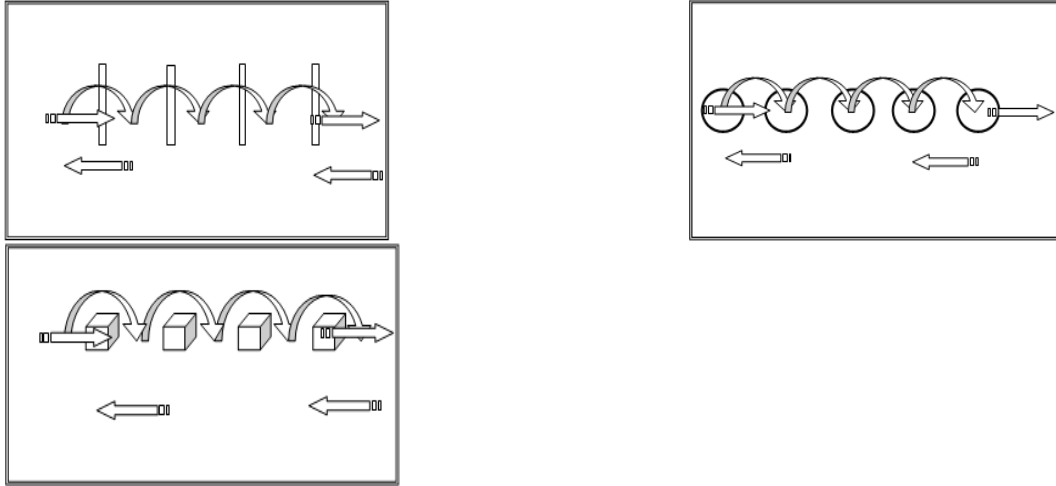
Data Analysis

The data analysis technique used the t-test statistical approach on the similarity of two paired average scores, which aims to analyze the differences in the effect of each treatment group on sprint speed in the initial test and the final test, with a level of confidence.$\alpha()$ 0.05 with degrees of freedom (dk) = n - 1. The data analysis step begins with the normality test of the data obtained, namely the data on the increase in running in the exercise group, the frequency of steps before and after being given exercise, as well as data on the increase in running in the exercise group, stride length before and after being given exercise. Then for each group data collected, an average comparison test is carried out with the following formula:

$$t = \frac{\bar{B}}{S_b/\sqrt{n}}$$

Then the next step in analyzing the research data is to test the differences in exercise improvement between groups given stride frequency and stride length exercises. However, beforehand, a variance test was carried out with the aim of determining which t statistic to use. Testing the similarity of variance is carried out using the F-test, with the following criteria for accepting the hypothesis:

Ho is accepted if $F < F_{\alpha(v_1, v_2)}$ or Ho is rejected if $F \geq F_{\alpha(v_1, v_2)}$

with the formula for calculating the variance test is:

$$s_1^2 = \frac{1}{n-1} \sum_{i=1}^{n_1} (x_i - \bar{x})^2$$

The conclusion is that if the calculated t value is less than or equal to the t table value, then the difference in the effect of each group is meaningless, otherwise, if the t count is greater than the t table, the difference in the effect of each group is significant. The formula used is as follows:

$$t = \frac{\bar{X} - \mu}{S/\sqrt{n}}$$

Information:

$\overline{X}$ = Average score

S= standard deviation ; n = Number of samples

Test criteria:

Accept Ho, if t count <t table, (dk) = n - 1 for other prices Ho is rejected.

Results

In this study, the presentation of research data was in the form of total scores, average values and standard deviations of each group. The following is the data from group A's test results, namely the group that was given step frequency exercises:

Table 2. Description of Group A Test Results

Test results	Amount	Average	SD
Pretest	453,230	15.108	0.909
Posttest	426,560	14,219	0.813
Obtain	-26,670	-0.889	0.143

From table 2 it can be seen that the average running speed calculated in the initial test was 15,108 while in the final test the average running speed increased by 0.889 to 14,219. To see the significance of the increase in running speed, a comparison test was carried out on the average between the initial test and the final test (gain) of group A's running speed.

$$t = \frac{\overline{B}}{S_b / \sqrt{n}}$$

$$= \frac{-0,889}{0,143 / \sqrt{30}} = -34,130$$

he t-table value for dk = n – 1 = 30 – 1 = 29 is 2.04.

Because t < -t-table (-34.130 < -2.04) Ho is rejected, it can be concluded that there is a significant increase in running speed after step frequency training.

To test the normality of the data on the increase in the running frequency of the exercise group, the steps before and after being given the exercise are as follows:

Table 3. Results of the Normality Test for Group A's Running Speed Gain

Average	-0.889
Standard deviation	0.143
l-count (Lo)	0.105
l-table (L)	0.162
Decision	Normal

From table 3 shows that the Lo value is 0.105 while the L value at the 95% confidence level is 0.162; because Lo < L (0.105 < 0.162) it can be said that the running speed gain of group A has a normal distribution. Thus, parametric average comparison tests can be carried out using the t-test.

The following is a description of the test results in group B, namely the group that was given the stride length exercise:

Table 4. Description of Group B Test Results

Test results	Amount	Average	SD
Pretest	452,900	15,097	0.960
Posttest	409,720	13,657	0.771
Obtain	-43,180	-1,439	0.269

From table 3 it can be seen that the average running speed calculated in the initial test was 15,907 while in the final test the average running speed increased by 1,439 to 13,657. To see the significance of the increase in speed, an average comparison test was carried out between the initial test and the final test (gain) of group B's running speed:

$$t = \frac{\bar{B}}{S_b/\sqrt{n}}$$

$$= \frac{-1,439}{0,269/\sqrt{30}} = -29,281$$

The t-table value for dk = n – 1 = 30 – 1 = 29 is 2.04.

Because t < -t-table (-29.281 < -2.04) then Ho is rejected, so it can be concluded that there is a significant increase in running speed after stride length training.

To test the normality of the data on the increase in running the stride length training group before and after being given the exercise are as follows;

Table 5. Results of the Normality Test for Group B's Running Speed Gain

Average	-1.439
Standard deviation	0.269
l-count (Lo)	0.118
l-table (L)	0.162
Decision	Normal

From table 5 it can be seen that the Lo value is 0.120 while the L value at the 95% confidence level is 0.162; because Lo < L (0.120 < 0.162) it can be said that the running speed gain of group B has a normal distribution. Thus, parametric average comparison tests can be carried out using the t-test.

Based on the results of the analysis shown in table 2 and table 3, it can be seen that the increase in group A was 0.889 while in group B it was 1.439, meaning that the increase in running speed in group B (step length training) was greater than in group A (step frequency training). To see whether the difference in increase was significant, a comparison test was performed on the average gains of the two groups. The hypothesis tested is:

Ho: mA = mB

H1: mA < mB

Because the two data groups come from two different (independent) groups, the test is carried out using an independent T-test. Calculation results can be presented as follows:

$$t` = \frac{\overline{x}_A - \overline{x}_B}{\sqrt{\dfrac{s_A^2}{n_A} + \dfrac{s_B^2}{n_B}}}$$

Based on the previous information, we get

$$t` = \frac{-0,889 - (-1,439)}{\sqrt{\dfrac{0,020}{30} + \dfrac{0,072}{30}}} = 9.893$$

$$w_A = \frac{0,020}{30} = 0,001; \quad w_B = \frac{0,072}{30} = 0,002$$

with $t_A = t_{(0,975),(29)} = 2,04; \quad t_{(0,975),(29)} = 2,04$

then obtained $\dfrac{w_A t_A + w_B t_B}{w_A + w_B} = \dfrac{0,001*2,04 + 0,002*2,04}{0,001 + 0,002} = 0.489$

Ho is accepted if –0.489 < t' < 0.489; because t' does not exist at -0.489 < t' < 0.489 then it is rejected, or it can be concluded that the difference in increasing running speed between group A and group B is different, where step training (group B) has a better effect than step frequency training (group A) on an increase in sprint speed. This is shown by the results of the different test of the increase in the average step frequency training group with the average increase in the stride length training group, namely the increase in the average speed of group A by 0.889, and the increase in the average speed of group B by 1.439. After testing the average increase in the two groups, a t-count of 9.893 was obtained. The hypothesis proposed is that Ho is accepted if –0.489 <t'<0.489. Because t' (9.893) does not exist at –0.489 <t'<0.489 then ho is rejected, or it can be concluded that the difference in increasing running speed between group A and group B is different, where stride length training (group B) has a better effect than on step frequency exercise (group A) on increasing sprint speed.

Discussion

Based on testing and data analysis conducted by researchers, it was found that the two forms of exercise, namely step frequency exercise and stride length exercise, were given to students of the physical education, health, and recreation study program at STKIP Pasundan for six weeks with a frequency of exercise. three times a week has a significant effect on increasing sprint speed. Exercises that are carried out as much as eight to sixteen weeks and done three times a week will have an impact on physical improvement (Fox, 2003)Anaerobic and aerobic exercise will basically have an impact after doing appropriate exercise for 12-16 weeks (D'hooge et al., 2011), a good exercise is done at least 3 times a week with no more than 2x24 hours of rest (Soylu et al., 2021). This shows that the training program provided refers to the principles of training that have been able to show good results, including the principles of overload, individualism, and specialization (Kraemer & Ratamess, 2004). Other sources mention several training principles, namely the principle of increasing training load, the principle of recovery, setting the intensity and volume of training, and presenting a variety of exercises (Bompa & Buzzichelli, 2019).

Step frequency and stride length exercises are performed to increase running speed, which is a type of lactic anaerobic exercise. This activity is carried out explosively and takes no more than 10 seconds (Boullosa et al., 2022), Anaerobic exercise is short-lived and provides most of the energy when a person is performing an instant, high-intensity

activity such as a 10-second sprint (Millioni et al., 2017). The exercises in this study were also successful by paying attention to the number of repetitions and rest intervals, where according to anaerobic exercise the energy in the muscles will return to normal after about 2-3 minutes of rest (Beyer et al., 2020), and rest intervals between sets can be done in a span of 8-10 minutes (Manchado-Gobatto et al., 2020). Significant results also occur due to increased reaction speed and acceleration of the runner, because the treatment subjects are given stride length and step frequency exercises which in this case will indirectly increase leg strength and speed (limb power), where power comes from strength and speed (Karomatovich &; Todzhiddinovich, 2022). Running speed can also be influenced by several things such as strength and power, reaction speed, acceleration, maximum speed, endurance, flexibility, and coordination (García-Pinillos et al., 2017; McCall et al., 2020; Nagahara et al., 2018). Besides that, another factor that can increase running speed is when the sprint athlete swings on the ankle pattern which can help to get a faster speed because the swinging phase factor can contribute to the transition of the athlete's movement when stepping on a sprint.

Exercises that increase stride frequency can also significantly increase leg strength (Swinnen et al., 2021), so indirectly the strength of the limbs also contributes to the increase in running speed (Prieske et al., 2018). This study also proves that stride length training can affect the increase in the average step frequency (rhythm) (Zrenner et al., 2018). However, based on the results of this study, the stride length exercise has a greater effect than the step frequency exercise. This is due to the characteristic of the stride which is longer than the average stride (longer than normal stride), as well as the characteristic of the stride in the form of plyometrics exercises with Speed bounding or alternate bounding (Zisi et al., 2023), and this tends to require greater strength readiness to withstand the load that the leg muscles receive. Exercises that require more energy will require more energy which it is carried out by the body's muscles to receive it (Elnagar, 2022).

The training load received by the leg muscles in the stride length group was heavier than the load received by the leg muscles in the stride frequency group (Tuttle, 2018), so the leg muscles in the stride training group have to expend more strength to overcome the training load (Diez et al., 2018). Because the stride length training group the increase in leg strength and the increase in average stride length will be better than the increase in the same aspect in stride frequency training (Quinn et al., 2021). However, in stride length training, the length of the activated muscle and the force exerted during maximal voluntary eccentric contraction are conceptually different from the resulting eccentric action. Benefits of shorter strides include improved balance and posture (step frequency exercises); however, the impact frequency and eccentric braking are increased. Longer stride length can increase speed, but the eccentric strain on the knee extensors will be greater, because the force of gravity causes an increase in body acceleration (Eston et al., 2000).

The findings of this study indicate that stride-length exercises are more effective and have a greater impact than stride-frequency exercises. This is in line with the results of the study Wang et al. (2023), which reveals that the stride length factor is more effective in achieving sprint speed, which in this case has a correlation between hip angle during the stride phase and sprint speed. This means that the greater the hip angle, the longer the stride so that the impact on running speed increases. Also note that maximum hip flexion can result in a longer stride in the sprint, which occurs in the mid-swing to the starting point, and also that maximum hip extension occurs during takeoff (Novacheck, 1998). Messier et al. (1986) revealed that the level of energy use or strength felt by sprint runners would be greater when the stride length was increased by about 7% or 14% over the chosen stride length or reduced by 14%. The results of his research show that Messier's research subjects in terms of metabolic needs have increased as a result of overstriding and understriding, therefore the level of actual and felt energy use by sprint

runners has also increased. However, this is different from the findings of Duverney-Guichard & Van Hoecke (1994) which revealed that the volume of oxygen and the frequency of steps can increase the optimal speed for the subject by 10%. Referring to the opposite correlation between stride frequency and stride length, the subjects in Duverney-Guichard & Van Hoecke's study. It is more economical to use a longer stride length compared to running using a stride frequency.

Based on the findings in this study, it is clear that stride length mediates the correlation between hip coordination and produces sprint speed that is higher than stride frequency. Even though the actual step frequency also has an increasing impact on sprint speed. On the other hand, it turns out that the important role of hip flexion can also have an impact on achieving faster stride frequency (Dorn et al., 2012). Whereas other studies show that faster sprint speed and step frequency can be achieved through the coordinated role of the rectus femoris and biceps femoris muscles in both athletes' legs (Kakehata et al., 2021). From the two studies, it can be seen that the findings are not in line with the research we conducted because referring to the findings of the research revealed that there is a positive effect of hip movement and coordination on step frequency.

It can be explained that the fact that we found from the results of this study there is no significant correlation between stride frequency and sprint speed, so that can be observed in the complete results of the analysis of the effects of stride length and stride frequency training. As already stated, the current consensus has not been reached in terms of which factors are more important in contributing to sprint speed (Bezodis, 2012). A significant correlation exists between sprint speed and stride length or stride frequency depending on the study design determined by the researcher. A significant correlation between sprint speed and stride length or stride frequency was found when subjects were in groups, with records by subject. Dominant athletes make their fastest attempts with a higher stride frequency (Hunter et al., 2004). Although this study did not aim to examine the correlation between stride length, stride frequency, and sprint speed, this is due to the possibility that it is related to the lack of a mediating effect of stride frequency found in this study (Wang et al., 2023). This difference is due to the participants' motor skills not being as good as Olympic athletes who have a sprint time of 10.90 seconds, because in this study researchers used student participants whose abilities were heterogeneous with one another.

In conducting this research until the data findings were produced there were several research limitations, due to the limitations of the situation and conditions. First, we used sports student participants who have different sports backgrounds, so it is not yet known if this research is applied to sprint athletes who have higher skills. Second, this research is a study that has an inconsistent correlation between stride length or stride frequency and sprint speed by increasing the complexity of the mediation analysis. Therefore, future studies are expected to determine the true mediating effect of stride length and stride frequency exercises on the relationship between sprint speed or other aspects of ability such as movement coordination patterns of sprint athletes.

Conclusion

In general, this research has achieved the goal, where the form of stride frequency training (group A) and stride length training (group B) both can increase sprint speed. However, the results of the study concluded that stride length training has a greater effect on sprint performance compared to frequency training. Another finding obtained from this study is that by doing long stride exercises, the subject's leg strength and power also increase, this is evidenced by the theory explained in the discussion section.

Recommendations

Suggestions that can be submitted by researchers on this occasion because stride length training has a greater influence on increasing sprint running speed compared to stride frequency exercises, it is to the coach especially that in preparing the sprint training program to increase the portion of stride length training, however, do not eliminate the frequency of the training program. Then also for researchers who want to research this matter, it is necessary to pay attention to be more thorough and with a more specific population and sample and sufficient time to get more meaningful results.

Notes

This research is independent research conducted by the researcher in the Physical Education Study Program at STKIP Pasundan Cimahi.

References

Abdurrahman, E., Lowry, H., Sebayang, L., & Ramadhan, F. (2022). KORELASI FREKUENSI DAN PANJANG LANGKAH SERTA KEKUATAN TUNGKAI DENGAN KEMAMPUAN LARI (SPRINT). Jurnal Olahraga Dan Kesehatan Indonesia (JOKI), 3(1), 66–73. https://doi.org/https://doi.org/10.55081/joki.v3i1.733

Bailey, J., Mata, T., & Mercer, J. A. (2017). Is the Relationship Between Stride Length, Frequency, and Velocity Influenced by Running on a Treadmill or Overground? International Journal of Exercise Science, 10(7), 1067–1075.

Beyer, K. S., Stout, J. R., Redd, M. J., Baker, K. M., Church, D. D., Bergstrom, H. C., Hoffman, J. R., & Fukuda, D. H. (2020). Effect of somatic maturity on the aerobic and anaerobic adaptations to sprint interval training. Physiological Reports, 8(9), 1–12. https://doi.org/10.14814/phy2.14426

Bezodis, I. (2012). Investigations of the Step Length-Step Frequency Relationship in Sprinting : Applied Implications for Performance. 30th Annual Conference of Biomechanics in Sports – Melbourne 2012.

Bompa, T. O., & Buzzichelli, C. A. (2019). Periodization: Theory and Methodology of Training (Sixth Edit). Human Kinetics.

Boullosa, D., Dragutinovic, B., Feuerbacher, J. F., Benítez-Flores, S., Coyle, E. F., & Schumann, M. (2022). Effects of short sprint interval training on aerobic and anaerobic indices: A systematic review and meta-analysis. Scandinavian Journal of Medicine and Science in Sports, 32(5), 810–820. https://doi.org/10.1111/sms.14133

Callison, K., & Lowen, A. (2022). The long-run effects of adolescent athletic participation on women's health. Economics & Human Biology, 44, 101087. https://doi.org/https://doi.org/10.1016/j.ehb.2021.101087

Cissik, J. M. (2005). Means and methods of speed training: Part II. Strength and Conditioning Journal, 27(1), 38–39. https://doi.org/10.1519/00126548-200502000-00006

D'hooge, R., Hellinckx, T., Van Laethem, C., Stegen, S., De Schepper, J., Van Aken, S., Dewolf, D., & Calders, P. (2011). Influence of combined aerobic and resistance training on metabolic control, cardiovascular fitness and quality of life in adolescents with type 1 diabetes: A randomized controlled trial. Clinical Rehabilitation, 25(4), 349–359. https://doi.org/10.1177/0269215510386254

Diez, L. E., Bahillo, A., Otegui, J., & Otim, T. (2018). Step Length Estimation Methods Based on Inertial Sensors: A Review. IEEE Sensors Journal, 18(17), 6908–6926. https://doi.org/10.1109/JSEN.2018.2857502

Dorn, T. W., Schache, A. G., & Pandy, M. G. (2012). Erratum: Muscular strategy shift in human running: Dependence of running speed on hip and ankle muscle performance (Journal of Experimental Biology 215 (1944-1956)). In Journal of Experimental Biology. https://doi.org/10.1242/jeb.075051

Duverney-Guichard, E., & Van Hoecke, J. (1994). The effect of stride frequency variation on oxygen uptake and muscular activity in running. Journal of Biomechanics. https://doi.org/10.1016/0021-9290(94)90963-6

Elnaggar, R. K. (2022). Effects of plyometric exercises on muscle-activation strategies and response-capacity to balance threats in children with hemiplegic cerebral palsy. Physiotherapy Theory and Practice, 38(9), 1165–1173. https://doi.org/10.1080/09593985.2020.1833389

Eston, R. G., Lemmey, A. B., McHugh, P., Byrne, C., & Walsh, S. E. (2000). Effect of stride length on symptoms of exercise-induced muscle damage during a repeated bout of downhill running. Scandinavian Journal of Medicine and Science in Sports. https://doi.org/10.1034/j.1600-0838.2000.010004199.x

Fox, K. R. (2003). The effects of exercise on self-perceptions and self-esteem. In Physical activity and psychological well-being (pp. 100–119). Routledge.

García-Pinillos, F., Soto-Hermoso, V. M., & Latorre-Román, P. A. (2017). How does high-intensity intermittent training affect recreational endurance runners? Acute and chronic adaptations: A systematic review. Journal of Sport and Health Science, 6(1), 54–67. https://doi.org/10.1016/j.jshs.2016.08.010

Gittoes, M. J. R., & Wilson, C. (2010). Intralimb joint coordination patterns of the lower extremity in maximal velocity phase sprint running. Journal of Applied Biomechanics. https://doi.org/10.1123/jab.26.2.188

Hak, L., Houdijk, H., Beek, P. J., & Van Dieë, J. H. (2013). Steps to take to enhance gait stability: The effect of stride frequency, stride length, and walking speed on local dynamic stability and margins of stability. PLoS ONE, 8(12). https://doi.org/10.1371/journal.pone.0082842

Hay, J. G., & Fung, Y. C. (1982). The Biomechanics of Sports Techniques, 2nd Edition. Journal of Biomechanical Engineering. https://doi.org/10.1115/1.3138310

Hunter, J. P., Marshall, R. N., & McNair, P. J. (2004). Interaction of Step Length and Step Rate during Sprint Running. Medicine and Science in Sports and Exercise, 36(2), 261–271. https://doi.org/10.1249/01.MSS.0000113664.15777.53

Hunter, J. P., Marshall, R. N., & McNair, P. J. (2005). Relationships between ground reaction force impulse and kinematics of sprint-running acceleration. Journal of Applied Biomechanics. https://doi.org/10.1123/jab.21.1.31

IAAF. (2009). Coaches Education & Certification System Level I/II, Sprint & Hurdles Event Textbook. Development Programe.

Jack R. Fraenkel, Norman E. Wallen, & Hyun, H. H. (2012). How to Desain and Evaluate Research in Education (Eight Edit). McGraw-Hill, Inc.

Kakehata, G., Goto, Y., Iso, S., & Kanosue, K. (2021). Timing of Rectus Femoris and Biceps Femoris Muscle Activities in Both Legs at Maximal Running Speed. Medicine and Science in Sports and Exercise. https://doi.org/10.1249/MSS.0000000000002497

Karomatovich, I. A., & Todzhiddinovich, S. U. (2022). Methodology for Developing Speed and Strength Abilities for Novice Boxers Method of Development of Speed-Power Abilitiesat Beginning Boxers Ibragimov Alisher Karomatovich Bukhara State Pedagogical Institute , head of the department of physical education a. Web of Scholars : Multidimensional Research Journal, 1(6), 185–190. https://doi.org/https://doi.org/10.17605/OSF.IO/N9X45

Kraemer, W. J., & Ratamess, N. A. (2004). Fundamentals of Resistance Training: Progression and Exercise Prescription. Medicine and Science in Sports and Exercise, 36(4), 674–688. https://doi.org/10.1249/01.MSS.0000121945.36635.61

Krell, J. B., & Stefanyshyn, D. J. (2006). The relationship between extension of the metatarsophalangeal joint and sprint time for 100 m olympic athletes. Journal of Sports Sciences. https://doi.org/10.1080/02640410500131621

Liew, B. X. W., Sullivan, L., Morris, S., & Netto, K. (2021). Lower-limb stiffness mediates speed but not turning angle during unplanned side-step cutting. Journal of Biomechanics. https://doi.org/10.1016/j.jbiomech.2020.110132

Lockie, R. G., Murphy, A. J., Callaghan, S. J., & Jeffriess, M. D. (2014). Effects of Sprint and Plyometrics Training on Field Sport Acceleration Technique. The Journal of Strength & Conditioning Research, 28(7). https://doi.org/10.1519/JSC.0000000000000297

Macadam, P., Cronin, J. B., Uthoff, A. M., Johnston, M., & Knicker, A. J. (2018). Role of Arm Mechanics during Sprint Running: A Review of the Literature and Practical Applications. Strength and Conditioning Journal, 40(5), 14–23. https://doi.org/10.1519/SSC.0000000000000391

Manchado-Gobatto, F. B., Marostegan, A. B., Rasteiro, F. M., Cirino, C., Cruz, J. P., Moreno, M. A., & Gobatto, C. A. (2020). New Insights into Mechanical, Metabolic and Muscle Oxygenation Signals During and After High-Intensity Tethered Running. Scientific Reports, 10(1), 1–14. https://doi.org/10.1038/s41598-020-63297-w

Mattes, K., Habermann, N., Schaffert, N., & Mühlbach, T. (2014). A longitudinal study of kinematic stride characteristics in maximal sprint running. Journal of Human Sport and Exercise, 9(3), 686–699. https://doi.org/10.14198/jhse.2014.93.02

McCall, A., Pruna, R., Van der Horst, N., Dupont, G., Buchheit, M., Coutts, A. J., Impellizzeri, F. M., Fanchini, M., Azzalin, A., Beck, A., Belli, A., Dupont, G., Fanchini, M., Ferrari-Bravo, D., Forsythe, S., Iaia, M., Kugel, Y. B., Martin, I., Melotto, S., … Tibaudi, A. (2020). Exercise-Based Strategies to Prevent Muscle Injury in Male Elite Footballers: An Expert-Led Delphi Survey of 21 Practitioners Belonging to 18 Teams from the Big-5 European Leagues. Sports Medicine, 50(9), 1667–1681. https://doi.org/10.1007/s40279-020-01315-7

Mercer, J. A., & Chona, C. (2015). Stride length-velocity relationship during running with body weight support. Journal of Sport and Health Science, 4(4), 391–395. https://doi.org/10.1016/j.jshs.2015.01.003

Messier, S. P., Franke, W. D., & Jack Rejeski, W. (1986). Effects of altered stride lengths on ratings of perceived exertion during running. Research Quarterly for Exercise and Sport, 57(4), 273–279. https://doi.org/10.1080/02701367.1986.10608087

Meyers, R. W., Oliver, J. L., Hughes, M. G., Cronin, J. B., & Lloyd, R. S. (2015). Maximal sprint speed in boys of increasing maturity. Pediatric Exercise Science, 27(1), 85–94. https://doi.org/10.1123/pes.2013-0096

Milioni, F., Zagatto, A. M., Barbieri, R. A., Andrade, V. L., Dos Santos, J. W., Gobatto, C. A., Da Silva, A. S. R., Santiago, P. R. P., & Papoti, M. (2017). Energy systems contribution in the running-based anaerobic sprint test. International Journal of Sports Medicine, 38(3), 226–232. https://doi.org/10.1055/s-0042-117722

Miller, R. H., Umberger, B. R., & Caldwell, G. E. (2012). Limitations to maximum sprinting speed imposed by muscle mechanical properties. Journal of Biomechanics, 45(6), 1092–1097. https://doi.org/10.1016/j.jbiomech.2011.04.040

Moss, D. (2002). Tricks of the Trade for the Sprints, Hurdles and Relays. Physical Education Digest.

Nagahara, R., Mizutani, M., Matsuo, A., Kanehisa, H., & Fukunaga, T. (2018). Association of sprint performance with ground reaction forces during acceleration and maximal speed phases in a single sprint. Journal of Applied Biomechanics, 34(2), 104–110. https://doi.org/10.1123/jab.2016-0356

Novacheck, T. F. (1998). The biomechanics of running. In Gait and Posture. https://doi.org/10.1016/S0966-6362(97)00038-6

Prieske, O., Krüger, T., Aehle, M., Bauer, E., & Granacher, U. (2018). Effects of resisted sprint training and traditional power training on sprint, jump, and balance performance in healthy young adults: A randomized controlled trial. Frontiers in Physiology, 9(MAR), 1–10. https://doi.org/10.3389/fphys.2018.00156

Quinn, T. J., Dempsey, S. L., LaRoche, D. P., Mackenzie, A. M., & Cook, S. B. (2021). Step Frequency Training Improves Running Economy in Well-Trained Female Runners. The Journal of Strength & Conditioning Research, 35(9), 2511–2517. https://doi.org/10.1519/JSC.0000000000003206

Rimmer, E., & Sleivert, G. (2000). Effects of a Plyometrics Intervention Program on Sprint Performance. Journal of Strength and Conditioning Research, 14(3), 295–301. https://doi.org/10.1519/00124278-200008000-00009

Rivanta, T., & Agus, A. (2019). Pengaruh Latihan Acceleration Sprint Terhadap Kecepatan Lari Jarak Pendek Atlet Atletik Kabupaten Pasaman. Jurnal Stamina, 2(1), 271–279.

Schubert, A. G., Kempf, J., & Heiderscheit, B. C. (2014). Influence of Stride Frequency and Length on Running Mechanics: A Systematic Review. Sports Health, 6(3), 210–217. https://doi.org/10.1177/1941738113508544

Shi, H., Li, H., Liu, H., & Yu, B. (2019). Effects of treadmill cushion and running speed on plantar force and metabolic energy consumption in running. Gait and Posture, 69(October 2018), 79–84. https://doi.org/10.1016/j.gaitpost.2019.01.024

Sobarna, A., & Hambali, S. (2020). Meningkatkan keterampilan lompat jauh gaya jongkok siswa SD memalui pembelajaran Kids atletik. Premiere Educandum: Jurnal Pendidikan Dasar Dan Pembelajaran, 10(1), 72–80. https://doi.org/10.25273/pe.v10i1.6189

Soylu, Y., Arslan, E., Sogut, M., Kilit, B., & Clemente, F. M. (2021). Effects of self-paced high-intensity interval training and moderate-intensity continuous training on the physical performance and psychophysiological responses in recreationally active young adults. Biology of Sport, 38(4), 555–562. https://doi.org/10.5114/biolsport.2021.100359

Swinnen, W., Mylle, I., Hoogkamer, W., De Groote, F., & Vanwanseele, B. (2021). Changing Stride Frequency Alters Average Joint Power and Power Distributions during Ground Contact and Leg Swing in Running. Medicine And Science In Sports And Exercise, 53(10), 1–21. https://doi.org/https://doi.org/10.1249/MSS.0000000000002692

Tuttle, W. M. (2018). Relationship of maximal strength and relative stride length in sprinters. ProQuest.

Van der Meijden, K. (2019). Analyzing sprint features with 2D Human Pose Estimation. In Faculty of Humanities and Digital Sciences. Tilburg University.

von Lieres und Wilkau, H. C., Irwin, G., Bezodis, N. E., Simpson, S., & Bezodis, I. N. (2020). Phase analysis in maximal sprinting: an investigation of step-to-step technical changes between the initial acceleration, transition and maximal velocity phases. Sports Biomechanics. https://doi.org/10.1080/14763141.2018.1473479

Walaszczyk, A., & Iskra, J. (2006). ELITE MALE AND FEMALE SPRINTERS' BODY BUILD, STRIDE LENGTH AND STRIDE FREQUENCY. Studies in Physical Culture and Tourism, 13(1), 33–37.

Wang, L., Wang, W., Li, S., & Zhang, H. (2023). Stride length mediates the correlation between movement coordination and sprint velocity. Journal of Sports Sciences, 41(1), 72–79. https://doi.org/10.1080/02640414.2023.2197523

Zisi, M., Stavridis, I., Bogdanis, G., & Terzis, G. (2023). The Acute Effects of Plyometric Exercises on Sprint Performance and Kinematics. Physiologia, 3(2), 295–304. https://doi.org/https://doi.org/10.3390/physiologia3020021

Zrenner, M., Gradl, S., Jensen, U., Ullrich, M., & Eskofier, B. M. (2018). Comparison of different algorithms for calculating velocity and stride length in running using inertial measurement units. Sensors (Switzerland), 18(12). https://doi.org/10.3390/s18124194