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Physical Activity and Injury Affect Peak of Heigh Velocity In Children Aged 9-14 Year

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Abstract. Peak of Height Velocity is the peak of height growth in children, physical activity in children with low - high levels who are at risk of injury can hinder the child's growth period, but do high activity and injuries also affect the Peak of Height Velocity. This research is to find out 1) the condition of Peak High-Velocity Athletes of S3 Football School, Tugumuda Semarang and Children of Elementary School 04 Karangjati; 2) find out whether there is a relationship between physical activity and injury with Peak High Velocity; 3) to find out the difference between Peak High Velocity of Football Athletes and non-athletes. The research data was taken from 57 respondents consisting of 14 Football School S3 athletes, 21 Football School Tugu Muda athletes and 22 Children of Elementary School 04 Karangjati. The variables studied were physical condition and injury as the independent variables and PHV as the dependent variable. The data obtained were analyzed using multiple regression analysis and t test. The results showed that the size of the sports activity value was not followed by a change in the PHV value, as evidenced by the significance value for the PAQ variable of 0.441 > 0.05. The significance value of the injury variable is 0.736 > 0.05, which means that there is no significant relationship between injury and the PHV value. The average PHV in Football School reached 13.94 while those in non-Football School was 14.17 with a significance value of 0.070 > 0.05 which means that there was no difference in PHV between Football School and non-Football School. There is no difference in PHV between Football School and Non-Football School, there is no relationship between physical activity and PHV, and there is no relationship between injury and PHV.

Key words: growth, physical condition, school children

Abstract in Indonesia. Peak of Height Velocity adalah puncak pertumbuhan tinggi badan pada anak, aktivitas fisik pada anak dengan tingkat rendah - tinggi yang beresiko cidera dapat menghambat masa pertumbuhan anak, namun apakah aktivitas tinggi dan cidera juga berpengaruh pada Peak of Height Velocity. Penelitian ini bertujuan untuk mengetahui 1) Kondisi Peak Height Velocity Atlet Sekolah Sepakbola S3,Tugumuda Semarang dan Anak SD 04 Karangjati; 2) Untuk Mengetahui apakah ada hubungan antara aktivitas fisik dan cidera dengan Peak High Velocity; 3) Untuk mengetahui perbedaan Peak Height Velocity dari Atlet Sepakbola dan bukan atlet. Data penelitian diambil dari 57 responden terdiri dari 14 responden atlet SSB S3, 21 atlet SSB Tugu Muda dan 22 siswa SD Karangjati. Variabel yang diteliti adalah kondisi fisik dan cidera sebagai variabel bebas dan PHV sebagai variabel terikat. Data yang diperoleh dianalisis menggunakan analisis regresi ganda dan uji t. Hasil penelitian menunjukkan bahwa besar kecilnya nilai aktivitas olahraga tidak diikuti dengan perubahan nilai PHV, terbukti dari nilai signifikansi untuk variabel PAQ sebesar 0,441 > 0.05. Nilai signifikansi dari variabel cedera sebesar 0,736 > 0,05, yang berarti bahwa tidak ada hubungan yang signifikan antara cedera dengan nilai PHV. Rata-tata PHV pada SSB mencapai 13,94 sedangkan yang non SSB sebesar 14,17 dengan nilai signifikansi 0,070 > 0,05 yang berarti bahwa tidak ada perbedaan PHV antara SSB dan non SSB.

Kata Kunci: pertumbuhan, kondisi fisik, anak sekolah

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INTRODUCTION

Every human being performs physical activity or exercise to improve fitness and maintain a healthy body(Bi et al., 2023; Farrell et al., 2023; Lim et al., 2023; Menghani et al., 2023; Robinson et al., 2022). Physical activity at the age of children is very important because it can make antibodies or red blood cells circulate more quickly, so they can detect disease earlier. An increase in body temperature levels during and immediately after physical activity can prevent the growth of bacteria, helping the body fight infection better (Dong & Beynnon, 2023; Singh et al., 2023; Sit et al., 2022; Tang et al., 2023; Williamson et al., 2023). Physical activity or sports other than for fitness, also to achieve achievements as done by athletes. Achievement sports training programs are very important for improving physical

performance (Danarstuti, 2015). Recommendations from (WHO, 2012) physical activity by age group, namely for the age group 5 to 17 years, the age group 18 to 64 years and for the age group over 65 years. For the 5-17 year age group, a good duration of physical activity is 60 minutes of moderate-high physical activity regularly, aerobic activity is recommended. There are risks that are often experienced when carrying out physical activities or sports such as mild to severe injuries caused by accidents, improper training techniques, inadequate equipment, and continuous use of certain body parts (Elmagd, 2016).

Boys are injured twice as often as girls. But in certain sports such as horse riding, girls are injured four times more than boys. Sports with a high frequency of jumping and physical contact between players are sports with the greatest level of risk for injury (Ismunandar, 2020). Based on activities that can cause sports injuries to children, namely: 30% due to training, 35% during competitions, 20% during physical education classes, and 15% due to informal sports activities (Ismunandar, 2020). Sports injuries occur differently for each athlete in certain sports, ranging from minor injuries to serious injuries that result in leaving the world of sports competition (Ismunandar et al., 2020). There are many ways that can be done to minimize the occurrence of injuries to athletes, one of which is the measurement of Peak High Velocity to determine an appropriate training program for the conditions of athletes and minimize the risk of injury to young athletes.

The physical growth and development of each individual is different, genetic or hereditary factors, nutritional factors, health status and activity factors of each individual can affect growth (Handayani et al, 2017). In the case of athletes, most of them shine at a young age but slowly fade with age, whether it's due to an injury or training that is done inconsistently. The development of athletes needs to be monitored and identified to determine the level of maturity of athletes, so that training programs are designed according to the level of development of athletes and not adjusted to the athlete's chronological age (Robianto, 2019). In maturation there is the term Age of Peak Height Velocity (PHV) this refers to the maximum age of height growth during adolescent acceleration, PHV is a basis for determining exercise programs for children (Mauluddin, 2016). Children who are active in achievement sports need Peak High Velocity measurements to determine training programs that suit the athlete's condition and minimize the risk of injury to young athletes. The growth spurt in adolescent height coincides with puberty and occurs two years earlier in girls around 11 years and boys around 13 years. Even though men experience later Peak High Velocity (PHV), the growth spurt in men is often greater than in women (Walker, 2016). Calculating the onset of PHV in children allows coaches or sports scientists to tailor training programs to suit the athlete's biological age rather than their chronological age. This can result in more suitable results and more effective training programs (Sluis, 2015).

Based on the description above, the coach must really pay attention to the time of the match and the portion of practice for young athletes. Measuring Peak High Velocity is very necessary for young athletes to determine the right training program adapted to the conditions of their biological age which are expected so that athletes can develop optimally and minimize the risk of injury. Researchers are interested in identifying Peak High Velocity, so that it can be predicted using a formula taking into account: gender, date of birth, time of measurement, standing height, sitting height and body weight. This study aims to determine: 1) the condition of Peak High Velocity Athletes of S3 Football School, Tugumuda Semarang and Children of Elementary School 04 Karangjati; 2) find out whether there is a relationship between physical activity and injury with Peak High Velocity; 3) to find out the difference between Peak High Velocity of Football Athletes and non-athletes.

METHODS

This study uses a descriptive correlation research method, in which this study aims to obtain real facts from the state of the research object supported by data in the form of numbers resulting from existing formula calculations. The method used in this study uses the measurement method. The aim is to find out 1) the condition of Peak High Velocity Athletes of S3 Football School, Tugumuda Semarang and Children of Elementary School 04 Karangjati; 2) determine the relationship between physical activity and injury with Peak High Velocity; 3) to find out the difference between Peak High Velocity of Football Athletes and non-athletes.

The variables studied consisted of independent variables of physical activity and injury and the dependent variable PHV. The population is S3 soccer school athletes, tugumuda Semarang and SD 04 Karangjati students. The sample studied was 57 respondents. The data obtained were analyzed using

multiple regression analysis and t test.

RESULTS AND DISCUSSION

Table 1. Description data

No	Data	SSB S3 (N = 14) Mean ± SD	SSB TM (N = 21) Mean ± SD	SD KR 04 (N = 22) Mean ± SD	Total (N = 57) Mean ± SD
1	Age (Year, month)	10.0 ± 0.2	11.3 ± 0.6	10.7 ± 0.7	10.8 ± 0.8
2	Weight (kg)	27.5 ± 5.4	35.1 ± 8.0	31.2 ± 8.0	31.8 ± 7.9
3	Height (cm)	132.3 ± 4.5	145.4 ± 3.9	136.7 ± 7.7	138.8 ± 7.8
4	Body Mass Index (kg/m^2)	15.5 ± 2.3	16.3 ± 3.1	16.5 ± 2.9	16.2 ± 2.8
5	PHV (Year, month)	13.8 ± 0.4	14.0 ± 0.5	14.2 ± 0.5	14.0 ± 0.5
6	PAQ (Week)	3.3 ± 0.3	3.3 ± 0.3	2.6 ± 0.4	3.1 ± 0.5

Chronological age for SSB S3 reached 10 ± 0.2 years, for SSB Tugu Muda 11.3 ± 0.6 years while SD Karangjati 04 was 10.7 ± 0.7 years. The three study groups had almost the same average chronological age. Body weight for SSB S3 reached 27.5 ± 5.4 kg, for SSB Tugu Muda it was 35.1 ± 8.0 kg while SD Karangjati 04 was 31.2 ± 8.0 kg. The data shows that the weight of the study groups is relatively different, where SSB Tugu Muda is relatively heavier than SSB S3 and SD KR 4. The height in SSB S3 reached 132.3 ± 4.5 cm, for SSB Tugu Muda it was 145.4 ± 3.9 cm while SD Karangjati 04 was 136.7 ± 7.7 cm. The data shows that the height of the study groups is relatively different where SSB Tugu Muda has a relatively higher body compared to SSB S3 and SD KR 4. The body mass index for SSB S3 reached 15.5 ± 2.3, for SSB Tugu Muda it was 16.3 ± 3.1 while SD Karangjati 04 was 16.5 ± 2.9. The data shows that the body mass index of the study group is relatively the same.

Peak height velocity is the time period in which a child experiences the fastest height growth in their status, that is, when they grow the fastest during their growth spurt. Growth in height is fluctuating, that is, the increase in height when a baby is fast, then slows down and takes place quickly again at the age of 11-14 years. The onset of the adolescent growth spurt coincides with the onset of puberty and occurs earlier in girls around 12 years while boys around 14 years. To find out the peak height velocity in this study, anthropometric measurements were carried out, namely height, weight, leg length, sitting height and age at the time the measurement was taken. PHV is important to know because of the increase in the height of boy footballers in Brazil at the age of PHV with a vulnerability of 10-14 years ranging from 26.4 cm and body weight 24.4 kg (Hobold et al., 2017). Once the measurement results are known then calculations are carried out using the Mirwald Gender-Specific Regression Algorithms in the Microsoft Excel application.

Table 2. Peak of Height Velocity

Data	SSBS3	SSB TM	SD KR 04	Total
N (Subject)	14	21	22	57
Mean	13.77	14.03	14.17	14.03
Standard Deviation	0.37	0.46	0.51	0.47
Maximum	14.3	14.8	15.3	15.3
Minimum	13	13.1	13.1	13

The data shows that in general from 57 respondents, the average PHV reached 14.03 years with a standard deviation of 0.47, the largest PHV was 15.30 years and the lowest PHV was 13.00 years.

There are risks that are often experienced when carrying out physical activities or sports such as mild to severe injuries caused by accidents, improper training techniques, inadequate equipment, and continuous use of certain body parts (Elmagd, 2016). Reviewing the journal on Sports Injuries in

Children and Their Prevention" shows that the most common areas of injury that occur are the ankles (48%), hands (19%), knees (10%), thighs (7%), arms (5%), shoulders and head (4%), and feet (3%). The most common types of injuries were sprains 61%, fractures 23%, strains 9%, and abrasions 7%. Based on activities that can cause sports injuries to children, namely: 30% due to training, 35% during competitions, 20% during physical education classes, and 15% due to informal sports activities (Ismunandar, 2020). There are many ways that can be done to minimize injury to athletes, one of which is the measurement of Peak High Velocity to determine a training program that suits the athlete's condition and minimizes the risk of injury to young athletes. The following is injury data :

Table 3. Injury

Data	SSBS3	SSB TM	SD KR 04	Total
N (Sum)	14	21	22	57
Sprains	3 (21%)	9 (43%)	4 (18%)	16 (28%)
Wound	0	6 (29%)	4 (18%)	10 (18%)
Bruise	1 (7%)	2 (10%)	1 (5%)	4 (7%)
Strain	0	1 (5%)	1 (5%)	2 (4%)
No injuries	10 (71%)	3 (14%)	12 (55%)	25 (44%)

The data shows 10 respondents (71%) players in SSB S3 were not injured, the rest had sprains and bruises. For SSB TM, on the contrary, most of them were injured. Of the 43% sprains, 29% injuries, 10% bruises and 5% strains, only 14% were uninjured. For SD KR 04 as much as 55% did not experience injuries, the remaining 18% were sprains, 18% were injured, 5% were bruised and 5% were strains. Overall 44% were not injured, the remaining 28% were sprains, 18% were injured, 7% were bruised and 4% were strains.

Table 4. Extremity Injury

	SSB S3		SSB TM		SD KR 04		Total	
Extremities	N	%	n	%	n	%	N	%
No Injuries	10	71.4	4	19.0	13	59.1	27	47.4
Lower Extremities	4	28.6	14	66.7	8	36.4	26	45.6
Upper extremities	0	0.0	3	14.3	1	4.5	4	7.0
Total	14	100.0	21	100.0	22	100.0	57	100.0

The majority of respondents experienced injuries to the lower limbs, reaching 45.6%, while the upper extremities were only 7%. For SSB S3, 28.6% experienced lower extremities, for SSB Tugu Muda, 66.7% experienced lower extremities and 14.3% experienced upper extremities, while for SD KR 04, 36.4% experienced lower extremities, while 4.5% experienced upper extremities.

Table 5. Location Injury

Location of Injury	SSB S3		SSB TM		SD KR 04		Total	
	N	%	n	%	N	%	N	%
No injuries	10	71.4	4	19.0	15	68.2	29	50.9
Foot	3	21.4	2	9.5	3	13.6	8	14.0
Knee	1	7.1	3	14.3	2	9.1	6	10.5
Angkle	0	0.0	8	38.1	2	9.1	10	17.5
Arm	0	0.0	2	9.5	0	0.0	2	3.5
Nose and hands	0	0.0	1	4.8	0	0.0	1	1.8
Neck and legs	0	0.0	1	4.8	0	0.0	1	1.8
Total	14	100.0	21	100.0	22	100.0	57	100.0

The majority of injuries occurred at the ankle location which reached 17.5%, followed by the foot location by 14% and the knee by 10.5%. For SSB S3, 21.4% had injuries to their feet, for SSB TM, 38.1% had injuries to their ankles, 14.3% to their knees and 9.5% to their feet. For the SD KR 04 group, 13.6% experienced injuries to the feet, 9.1% to the knees and 9.1% to the ankles.

Regular physical activity is needed to improve blood flow, build muscle, and prevent obesity (Wiradnyani et al., 2016). At the age of growth and development of children, balanced physical activity can accelerate the growth process, if physical activity is lacking, it can increase the risk of overweight and obesity, but if physical activity is too high without balanced nutritional adequacy, it can also increase the risk of children getting stunted or malnutrition. Physical activity at the age of elementary school children is positively related to their physical and mental functions, children who are classified as active can receive learning effectively both inside and outside the school environment (Gu et al., 2016).

Table 6. Physical Activity

Data	SSBS3	SSB TM	SD KR 04	Total
N (Sum)	14	21	22	57
Average	3.35	3.34	2.61	3.05
Standard Deviation	0.29	0.34	0.44	0.51
Maximum	4	3.8	3.7	4
Minimum	3	2.6	1.8	1.8

The average value of PAQ in SSB S3 reached 3.35 with the highest score of 4 and the lowest 3. For SSB TM PAQ it reached 3.34 with the highest 3.8 and the lowest 2.6, while for SD KR 04 it was 2.61 with the highest value 3.7 and the lowest 1.8. Overall, the average PAQ is 3.05 with the highest being 4 and the lowest being 1.8.

Table 7. Multiple Regression Analysis

No	Free Variable	Analysis	Sig (p)
1	PAQ (Physical Activity)	Multiple Regression	441
2	Injuries	Multiple Regression	736

The significance value for the PAQ variable is 0.441 > 0.05, which means there is no relationship between PAQ and PHV. This shows that the size of the sports activity value is not followed by a change in the PHV value. The significance value of the injury variable is 0.736 > 0.05, which means that there is no significant relationship between injury and the PHV value. This means that the condition of the injury is not followed by a change in PHV in the athlete.

Table 8. T Test

Group	N	Mean	Variance	t_{hitung}	Sign
SSB	35	13.94	0.190	-1.845	0.070
Non SSB	22	14.17	0.256		

The average PHV in SSB reached 13.94 while those in non-SSB was 14.17 with a significance value of 0.070 > 0.05 which means that there was no difference in PHV between SSB and non-SSB.

CONCLUSION

Based on the results of the study it was found that the 57 children studied had an average age of 10.8 ± 0.8 years and of the 57 research samples the average age of the children would experience their peak height acceleration at the age of 14.0 ± 0.5 years. can have implications for the risk of injury to young athletes (Loyd et al., 2011), it is hoped that after knowing the age of PHV of children, coaches can provide the right portion of training for each child, so it does not hinder their growth. Research conducted by Mauluddin (2019) on the male athletes of the swimming club in Surabaya explained that this study included age, height, sitting height, body weight, leg length which had an influence on the physical maturation or biological age of children. The Mirwald Gender Specific Regression Algorithm method can be used as a method for predicting Age Of PHV. Trainers can use this method as a reference material in developing training programs according to the biological age of athletes in training sensitive periods. Furthermore, there is research from Van Der Sluis et al. (2015) explained that, the importance

of PHV to determine the risk of susceptibility to injury in talented football athletes. Soccer athletes who have a slower maturation time than their peers are significantly susceptible to overuse injuries. Coaches and coaches must be careful about the training and match loads they give players. The period between 13.5-14.5 years seems to be a difficult period to balance training and competition loads.

The results showed that the sports activity of the 57 samples reached 3.05 ± 0.51 which means that overall the sports activity was classified as good, because it was in the range 3 to 4. However, when viewed from the SSB and non-SSB groups, there was a tendency that sports activity in SSB was higher than non-SSB. The PAQ value for SSB S3 reached 3.35 ± 0.29, for SSB TM it was 3.34 ± 0.34 while for SD KR 04 it was 2.61 ± 0.44. These sporting activities turned out to be unrelated significantly to PHV, as evidenced by the significance value of 0.441 > 0.05. This means that changes in PAQ are not followed by changes in PHV. From the data, although there are differences in sports activities for SSB and non-SS students, the PHV values of the three groups are relatively the same, namely at the age of 13-14 years.

Whether or not the respondent was injured or not in the study was not related to PHV, as evidenced by the significance value at 0.736 > 0.05, which means that those who were injured and those who were not injured had relatively the same PHV. Of the 32 injured respondents, the average PHV was 14.01, while the 25 respondents who were not injured had a PHV of 14.04. Judging from the injury, it is classified as mild so it does not affect the PHV. The results of this study are different from those of Sluis (2016), because this study only collected data once in a while, while Sluis conducted the study for 6 months and was taken over 3 time periods, namely pre PHV, PHV and post PHV.

The results also showed that there was no difference in PHV between the SSB and non-SSB groups. From the SSB group, although the average PHV was relatively earlier, namely age 13.94, while in the non-SS group, namely at age 14.17, the difference was not significantly different, as evidenced by the significant value of 0.07 > 0.05.

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