EFFECTS OF SPORT ON SKELETAL DEVELOPMENT IN ADOLESCENTS

EFEITOS DO ESPORTE NO DESENVOLVIMENTO ESQUELÉTICO DE ADOLESCENTES

EFECTOS DEL DEPORTE EN EL DESARROLLO DEL ESQUELETO EN LOS ADOLESCENTES

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ABSTRACT

Introduction: Incomplete skeletal development in adolescents and children depends on several factors such as genetic load, diet, and environment. Appropriate physical exercise can improve youth's physical fitness, but its effect on bone density is still questioned. Objective: Verify the influence of appropriate physical activity on adolescents' bone development. Methods: Among 3240 students aged 12 to 16 years from 4 schools, 96 students (52 males) were selected for observation. They were divided into a control and an experimental group, with a sports activity protocol inserted into the latter. Family and student questionnaires, physical examinations, and X-rays were used for data collection. Statistical analysis of factors including sports and development of adolescents' height quality was extensively documented. Results: The skeletal development in adolescents on regular participation in sports is better than that in adolescents not involved in sports. Conclusion: Physical exercise can promote skeletal development in adolescents. ***Evidence Level II; Therapeutic Studies - Investigating the result.***

Keywords: Sports; Skeleton; Teenager; Bone development.

RESUMO

Introdução: O desenvolvimento incompleto do esqueleto de adolescentes e crianças depende de vários fatores como carga genética, alimentação e ambiente. O exercício físico apropriado pode melhorar a aptidão física do jovem, porém ainda há interrogações de seu efeito sobre a densidade óssea. Objetivo: Verificar a influência da atividade física apropriada sobre o desenvolvimento ósseo em adolescentes. Métodos: Entre 3240 estudantes com 12 a 16 anos de 4 escolas, selecionou-se 96 estudantes (52 homens) para observação. Divididos entre grupo controle e experimental, com protocolo de atividades esportivas inseridos nesse último. Para a coleta de dados foram utilizados questionários familiares e estudantis, exames físicos e radiografia. A análise estatística de fatores como esportes e desenvolvimento da qualidade da altura dos adolescentes foi amplamente documentada. Resultados: O desenvolvimento esquelético de adolescentes que participam regularmente de esportes é melhor do que o de adolescentes que não participam de esportes. Conclusão: O exercício físico pode promover o desenvolvimento ósseo nos adolescentes. ***Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.***

Descritores: *Esportes; Esqueleto; Adolescente; Desenvolvimento ósseo.*

RESUMEN

Introducción: El desarrollo incompleto del esqueleto de los adolescentes y los niños depende de varios factores como la carga genética, la nutrición y el entorno. Un ejercicio físico adecuado puede mejorar la forma física de los jóvenes, pero su efecto sobre la densidad ósea sigue siendo cuestionado. Objetivo: Comprobar la influencia de una actividad física adecuada en el desarrollo óseo de los adolescentes. Métodos: Entre 3240 estudiantes de 12 a 16 años de 4 escuelas, se seleccionaron 96 estudiantes (52 varones) para observación. Se dividieron entre los grupos de control y los experimentales, insertando el protocolo de actividad deportiva en estos últimos. Para la recogida de datos se utilizaron cuestionarios de la familia y de los alumnos, exámenes físicos y radiografías. El análisis estadístico de factores como el deporte y el desarrollo de la calidad de la estatura de los adolescentes se documentó ampliamente. Resultados: El desarrollo del esqueleto de los adolescentes que practican regularmente un deporte es mejor que el de los adolescentes que no lo practican. Conclusión: El ejercicio físico puede promover el desarrollo óseo en los adolescentes. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Deportes; Esqueleto; Adolescente; Desarrollo Óseo.*

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INTRODUCTION

The growth and development of children and adolescents are affected by many factors such as genetics and environment.[1] Different individuals have obvious differences in growth and development, maturity type, and final development level. We conducted this study on short stature junior high school students from 4 middle schools from March to April 2021. The purpose is to explore the relationship between sports and the height development of adolescents.

METHOD

Object

We screened 3,240 students aged 12 to 16 in 4 middle schools. According to the height standard of the "Study on the Physical Fitness and Health of Henan Province Students" in 2020, we set the observation group as the observation group of people with 2 standard deviations below the local average height of the same age and sex.[2] At the same time, we used students from the same school, same grade, same ethnic group, same-sex, and same age and height as the control group for 1:1 matching. One hundred four students with short stature were screened out of 3240. After the physical examination, 96 students were selected as the subjects of the investigation. After the pairing, there are 52 pairs of boys and 44 pairs of girls. There are 94 pairs of verified data. There were 52 pairs of boys and 42 pairs of girls. The pass rate was 95.8%.

Physical examination

The physical examination includes the measurement of the student's height, weight, sitting height, shoulder width, pelvic width, and the height and weight of their parents.[3] We use height and sitting meters, weight scales, and diameter gauges for national physical fitness surveys. We carry out the measurement methods stipulated in the national physical fitness survey.

Questionnaire survey

The main content of the questionnaire survey includes two parts: family situation and student situation. The student situation mainly includes a birth method, feeding history, diet, physical activity, sleep, and personality type. Among them, sports activities are bound by 3 hours of exercise per week. We classify students who exercise less than 3 hours a week as the infrequent sports group. The students who exercise more than or equal to 3 hours per week are listed as the regular participation in sports group. The main object of the survey was mothers, and the parents themselves wrote and filled in. The staff is on the side to guide and answer questions.[4] If the mother is indeed unable to be present or is in a divorced family, the father can be substituted. The questionnaire is completed and handed over to a dedicated person for careful review.

X-ray positive film

Bone age survey subjects all took positive X-rays of their left wrists. The range includes the metaphysis of the ulna and the distal radius to the fingertips.[5] Two trained and qualified readers read the film simultaneously, calculate the bone age, and then use "time age minus bone age" to get the difference.

Research on bone age evaluation system based on ASM model

First calculate the covariance matrix $C=\frac{1}{N}\sum_{i=0}^{N-1}(X_i-X)(X_i-X)^T$ of N shape vectors in the sample space. Then obtain the N eigenvalues of C and the corresponding eigenvectors.[6] Then take the first M largest eigenvalues from the N eigenvalues to form a vector $M = (\lambda_0, \cdots, \lambda_{M\text{-}1})$ and the corresponding eigenvectors to form a matrix $P = (P_0, \cdots, P_{M\text{-}1})$. Here, the value of M is determined by the fact that $\sum_{i=0}^{M-1}\lambda_i/\sum_{i=0}^{N-1}\lambda_i$ is greater than a certain value (for example, 98%).

The M of the third metacarpal bone in this article is taken as 17, at this time $\sum_{i=0}^{M-1}\lambda_i/\sum_{i=0}^{N-1}\lambda_i=98.3\%$. For 58 shape vectors, only the first 17 feature vectors can represent most of the information (98.3%). It is known from a principal component analysis that any shape vector X in the shape vector space can be approximately expressed as $X = X + PB$. Where $B = (b_0, \cdots, b_{M\text{-}1})^T$ and $-3\bar{\lambda}_i < bi < 3\bar{\lambda}_i$. This is the parameter representation of the ASM model of the bone shape vector. Among them $B = (b_0, \cdots, b_{M\text{-}1})^T$ is the variable parameter of the shape vector X. Since the change of B can produces bone shapes with different edge shapes, its restriction can ensure the rationality of the edge shape.[7] In this way, the ASM model with the shape vector can perform bone edge detection.

The ASM model is a parametric deformable model about the shape vector. The ASM model is a process of continuously adjusting and modifying its parameters. The main basis of parameter adjustment is the gray-scale characteristics of the calibration points obtained by learning. Find the best matching point step by step on the X ray image of the target hand bone according to the gray-scale feature of the calibration point.[8] This makes the edge represented by the ASM model shrink to the target edge. In actual detection, the initial shape vector is obtained by giving an initial value of the ASM model parameters. The initial shape vector is initially positioned on the target image. Then according to the gray-scale characteristics of the calibration points and the gray-scale information of the target image, the target image is continuously matched. The purpose of edge detection is achieved by adjusting the position of each edge point on the shape vector. The specific edge detection steps are as follows:

1. Determine the initial position according to the bone positioning result. We translate, rotate, and scale the shape vector $X = X + PB$ in the model to initially match the bone position on the target image. That is, the bone shape vector $X_0 = T(s_0, \theta)\ [X + PB_0] + t_0$ of the target image is obtained. $B_0 = (0, \cdots, 0)^T$ is acceptable here. That is, the average shape vector is used as the initial vector.
2. Gray-level feature matching analyzes the j point (x_j, y_j) in X_0 on the target image. Take this point as the center and take the length $L'(L' > L)$ along the normal direction, for example, a line segment of 20) pixels. When the gray-scale feature is matched, the gray-scale feature of each sub-line segment with a length of L pixels on the line segment is first calculated.[9] Then compare with the gray-scale feature G_j of the j calibration point in the model. The center of the best matching sub-line segment is the j new point $(x_j)\ y_j$ found. Finally, X' can be obtained by searching all the points of H as above.
3. From X', X_0, the change Δs, $\Delta\theta$, Δt of parameter s, θ, t when changing from X_0 to X' and the change ΔB of edge shape parameter B can be calculated, and then

$$X_1 = T(s_0+\Delta s, \theta_0+\Delta\theta)[X+P(B_0+\Delta B)]+t_0+\Delta t \quad (1)$$

4. Calculate the distance $D(X_0, X_1)$ between the shape vectors X_0, X_1. If $D(X_0, X_1)$ is less than a certain threshold δ, then X_1 is the final detection result. Otherwise, let X_0, X_1 go to step 2 to continue iterating.

RESULTS

The impact of sports on the height of adolescents

We analyzed the relationship between physical exercise and height in the observation and control groups.[10] The study found that the proportion of the observation group who regularly participated in sports (44.68%) was significantly lower than that of the control group (62.11%, χ2=5.765, P<0.05). This shows that sports have a greater impact on height (Table 1).

The impact of weekly exercise time on the height of adolescents

We analyzed the weekly exercise time of 47 short stature students and 52 control students (Table 2). Then the χ2 test of pairwise comparison was performed on each group. Results: There was no significant difference in the length of weekly exercise time between the observation and control groups. That is, exercise can promote growth and development, but the length of exercise time is not linearly related to the height of adolescents. And the height of adolescents does not increase continuously with the increase in exercise.

Table 1. The effect of sports on the height of adolescents.

Group	n	Exercise regularly	Do not exercise regularly
Short stature group	92	41	51
Control group	92	57	35
χ2		5.765	
P		<0.05	

The impact of sports on height and bones

The average bone age of the infrequent exercise group is lower than that of the regular exercise group, and the average difference between the time and bone age of the infrequent exercise group is higher than that of the regular exercise group. This suggests that regular participation in sports can promote bone development, and the difference between bone age and time age is young. There is a big difference between the bone age and the time age of people who do not exercise regularly (Table 3).

Table 2. Time distribution of regular sports participants in the observation group and the control group.

Group	Number of cases	<3h/week	3~(h/week)	6~(h/week)	≥9h/week
Short stature group	41	9	12	7	3
Control group	57	25	21	8	3

Table 3. Comparison of the mean value of bone age and age difference between the infrequent and regular exercise groups.

Group	N	Bone age	Age bone age difference
Infrequent exercise group	86	11.05±0.76	2.35±1.31
Regular exercise group	98	11.94±0.95	1.68±1.00
P value		<0.01	<0.01

DISCUSSION

Sports play a role in promoting the height development of adolescents

The survey found that the proportion of the short stature group who often participates in sports (44.68%) is significantly lower than that of the control group (62.11%). This shows that sports have a greater impact on height. After three years of early exercise for junior high school students, the average growth of all major morphological development indicators (height, weight, chest circumference) was greater than that of the control group.[11] Therefore, strengthening physical exercise has become a necessary measure to improve children's height. In the past, it was believed that exercise was positively correlated with the growth and development of children. However, this survey found that exercise time has no obvious effect on the height of adolescents. A moderate amount of exercise time can promote the height development of adolescents. One class hour of exercise a day can ensure the normal growth and development of children. Increasing exercise time does not make it grow taller.

The skeletal age and age difference of the adolescents who exercise regularly are significantly different from those in the infrequent exercise group

The subjects of this survey are students aged 12-16. Although most of them are in the growth spurt stage of puberty, we use case-control research methods. Early or delayed physiological development will not affect the results of the study.[12] Therefore, it can be considered that exercise can promote bone development. In the final analysis, the increase in height is the growth of bones. Bone age is a direct indicator of bone development. The older the bone ages, the more mature the bone development. The survey found significant differences in the average age and bone age difference between the regular and infrequent exercise groups. This condition is called delayed physical development or delayed puberty. The skeletal age of children with short stature of this type often lags behind the age of time. However, once such children reach puberty, their growth speed will increase rapidly after excluding other pathological factors, and their height will often reach a normal level. A considerable part of the short stature children in this survey belonged to those with physical growth delays.

CONCLUSION

The phenomenon of short stature in children and adolescents is significantly affected by the regularity of sports. It is affected by the length of exercise time

Not obvious. However, more physical exercise is essential for children's height and bone development.

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