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An Active Lifestyle Explains Sex Differences in Physical Performance in Children before Puberty

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A B S T R A C T

The aim of this study is to analyze differences according to sex in physical performance in children before puberty, as well as other health-related variables. Study population was 137 boys and 156 girls (9.99±0.79 years). We measured weight and height, physical performance using five field tests previously validated in children, habitual physical activity and diet quality. A multinomial logistic regression coefficient was established to calculate odd ratios (OR's) and 95% confidence intervals (CI's), to determine sex differences in performance, weight status, habitual physical activity and diet quality, and a t-test was calculated between active boys and active girls in order to establish differences in performance fitness test taking account habitual physical activity. Boys were more actives (OR 1.90, CI 1.03–3.49) and had better weight status than girls, while there was no difference in diet quality between sexes (OR 1.13, CI 0.67–1.89). In total sample, it was more probable to find greater physical fitness values in boys in all test performed. However, when both groups had a similar physical activity pattern, assessed physical fitness variables reached similar values and girls had better results only in flexibility. Sedentary patterns were more frequent in girls although there were no differences in diet quality between sexes. Girls tended to overweight more than boys did. Both sexes had a similar fitness performance before puberty for the same reported physical activity, except for flexibility, inferior in male subjects independently of their physical activity pattern.

Key words*: exercise, childhood, physical fitness, sports, diet, Spain*

Introduction

Women do less physical activity and sport in their leisure time than men[1], and these differences appear to be significant since early years, being girls and adolescent women less active than boys of their same age[2]. Lower female participation in games, sports, and other kinds of physical activities may be explained by certain cultural topics and beliefs, according to which the practice of sports may be perceived as part of the accepted manliness. In addition, there seen to be »more suitable« sports modalities for each sex, and it has been reported that among women there is some reluctance to sport practice, especially some of them, because women are not expected to get engage with them. This phenomenon has been called »queer resistance«[3], which in contrast may lead the boys to show a higher motivation to engage in sporting activities[4].

These differences in the amount of leisure time physical activity by sex could explain the differences that some authors have found between boys and girls in physical performance, lower in girls in general[5], although before puberty there are no differences in cardio respiratory fitness between sexes for an equal amount of leisure time physical activity[6]. It is also important not to forget that the status of maturation of individuals can affect physical performance[7] and boys and girls begin to show physically greater differences since puberty[8].

The aim of this study is to analyze the differences in physical performance and other variables related with a healthy lifestyle (diet quality and overweight) in prepubertal boys and girls, taking into account the amount of self reported physical activity.

Materials and Methods

Study design

This study was conducted in Extremadura, an inland region situated in the centre-west of Spain with a popula-

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tion of 1,073,050 inhabitants. In order to ensure that the sample was representative of the population of interest, sample studied (9.99±0.79 years old, 137 boys and 156 girls between 9 and 10 years old, apparent healthy) was obtained from five schools randomly selected by a four-stage stratified sampling design, taking into account population size, age, sex and type of school (public or private). The estimated sample size was 349 individuals (5% error, 95.5% CI), see Table 1 for participants' characteristics. The study was conducted during regular school hours in school year 2006–2007.

Procedures took place during morning school visits from May to June 2007. Written informed consent was obtained from all participants and their parents or guardians. This work received a positive report of the Commission of Bioethics at the University of Murcia.

Measurements

Body mass index (BMI) was calculated from weight and height. Standing height was measured to the nearest 0.01 m using a Seca Stadiometer (Seca, Hamburg, Germany), with the subject's shoes off and head in the Frankfort horizontal plane. Body mass was assessed to the nearest 0.1 kg (Seca Beam Balance 710). Participants were classified into two groups, »normal weight« and »overweight«, and identified as having normal weight or overweight according to the age- and sex-specific BMI cut-offs from international guidelines[9].

Physical fitness was assessed using five field tests previously validated for their use with children[10]: sit and reach (cm), handgrip strength (N), horizontal jump (cm) agility 10×5 m run (s), 20 m shuttle run (step). For all but the last test, two trials were allowed and the best score was recorded for further analyses. Demonstrations of each test were given to children prior to testing. All measurements were conducted by the same investigators, following the same order of testing, and allowing 5–10 min rest intervals between tests. These measurements and tests are presented in this text in the same order they were conducted.

A previously validated seven-days diary was employed to estimate weekly physical activity[11]. Physical activity was registered daily by temporal segments of 15 minutes. For each segment, the participant was asked to report the type and amount of performed activity. Participants completed the questionnaire themselves and they were also asked to report the number of spent hours in sleeping, and any other time of the day was assumed to be spent in low intensity activities. Daily physical activity was scored by evaluating the average number of minutes of activity (sum of moderate, hard, and very hard) that was performed each week, taking into account values of energetic cost compendium of physical activities in children[12]. Subjects were classified in two groups, »Sufficiently actives« or »Insufficiently actives«, according to compliance with Spanish physical activity guidelines for children, ≥60 min, ≥5 d/wk of moderate to vigorous physical activity (MVPA, ≥3 METS)[13].

Diet quality was established by a self-administered questionnaire, the KIDMED questionnaire[14]. After calculating the KIDMED index values, two groups were established in accordance with the Mediterranean diet guidelines: low KIDMED index (poor Mediterranean diet) or high KIDMED index (good Mediterranean diet).

Statistics

Multinomial logistic regression coefficient was established to estimate odd ratios (OR's) and 95% confidence intervals (CI's) to determine sex differences between good physical fitness status group (≥ percentile 75) and poor physical fitness status group (≤ percentile 25) for each fitness test, body mass index, physical activity and Mediterranean diet index. The Kolmogorov-Smirnov test was used to test the normality of the variables. Finally, a t-test was ran between sufficiently active boys and girls in order to establish differences in performance fitness test. Statistical treatment of the data was performed using the program package SPSS 15.0 for Windows.

Results

After data acquisition, we could determine that boys showed minor overweight prevalence than girls did, as shown in Table 2. Boys were more actives than girls, while there was no difference in diet quality between sexes. For a healthy weight status maintenance, in this study physical activity appears to be more important than diet quality, and when describing the risk of being

TABLE 1
PREVALENCE OF PARTICIPANTS' CHARACTERISTICS (BOYS, n=137; GIRLS, n=156)

Compliance with physical activity guidelines	% Boys	% Girls	% Total
Sufficiently active	22.6	13.5	17.7
Insufficiently active	77.4	86.5	82.3
Mediterranean diet index (KIDMED index)			
High index	28.5	26.3	27.3
Low index	71.5	73.7	72.7
Weight Status (Body Mass Index)			
Normal	74.5	62.8	68.3
Overweight	25.5	37.2	31.7

overweighed, in the present study, the odds ratio (CI) of having an unhealthy BMI is 0.14 (0.05–0.41) as far as the compliance with physical activity recommendations is concerned and 0.25 (0.13–0.51) as far as having a high Mediterranean diet index is concerned.

As seen in the multinomial logistic regression model for differences in physical fitness status (percentile 25 *versus* percentile 75) as a function of sex (see Table 2), it is probable to find greater physical fitness values between boys in every test performed, except for sit and reach and left handgrip strength test.

TABLE 2
MULTINOMIAL LOGISTIC REGRESSION MODEL EXAMINING SEX DIFFERENCES AS A FUNCTION OF PHYSICAL PERFORMANCE (≥75 PERCENTILE *VERSUS* ≤ 25 PERCENTILE) AND SELECTED HEALTH-RELATED VARIABLES IN TOTAL SAMPLE

Variable	OR (95% CI)[a]
Physical Activity – Sufficiently active	1.90 (1.03–3.49)
Mediterranean Diet Index – Low index	1.13 (0.67–1.89)
Weight Status (Body Mass Index) – Overweight	0.58 (0.35–0.97)
Sit and reach[b]	0.38 (0.22–0.66)
Handgrip – right[b]	2.04 (1.15–3.63)
Handgrip – left[b]	1.34 (0.77–2.31)
Horizontal jump[b]	2.11 (1.17–3.79)
Agility 10×5 m[b]	2.73 (1.51–4.92)
20 m shuttle run[b]	3.08 (1.69–5.61)

[a]Comparison group is »girls«.
[b]Comparison is ≥75 percentile *versus* ≤ percentile 25.

Table 3 shows differences in physical performance between boys and girls who meet physical activity guidelines. We could see that most of the assessed physical fitness variables reached similar values in the two groups that meets physical activity guidelines, except for sit and reach test. Being a girl seems to be an advantage in the flexibility test, independently of the amount of habitual physical activity performed.

Discussion and Conclusion

Health-related lifestyle variables differ between sexes. Like in this study, in Spain women and girls do not usually meet physical activity guidelines during their leisure time in the same level as men and boys[15]. Girls could be in disadvantage in health terms because it's widely known that physical activity is one of the most relevant factors affecting quality of life and well-being[16] and that maintaining a good fitness status since an early age means better health during growth and adulthood[16].

Diet quality appears to be the same in both sexes in this research, as described previously in other studies for these groups of age[17,18]. It has also been reported by other authors that sex differences in feeding patterns appear after puberty, being adolescent girls more conscious about their own nutrition[19].

In this study, compliance with physical activity recommendations happens to be more important than diet quality in explaining a healthy BMI. Both factors are necessary to maintain a healthy weight status and it has been reported that a combination of proper nutrition and physical activity is required to preserve an optimal BMI[20]. Overweight is more frequent in the girls studied, as described by other authors[21], although this phenomenon reverses in the last school years, when they are closer to adulthood and boys appear to be more overweighed than girls[22]. In this sense, more research is needed to better understand this process.

Regarding physical performance, in our study boys attained higher values in most of physical tests performed (with exception of sit and reach and left handgrip strength tests), but these differences between sexes disappeared when boys and girls reported levels of physical activity that met the recommended guidelines. Moreover, girls showed higher values in the sit and reach test, as described previously in other studies[23].

TABLE 3
SEX DIFFERENCES IN WEIGHT, HEIGHT AND LEVEL ATTAINED IN THE DIFERENTS PHYSICAL FITNESS TEST IN THOSE CHILDREN WHO MEET PHYSICAL ACTIVITY GUIDELINES (T-TEST)

Variable	Boys $\overline{X}$±SD	Girls $\overline{X}$±SD	t	p
Weight (kg)	34.63±9.47	33.86±7.73	0.310	0.860
Height (m)	1.43±0.08	1.45±0.09	–0.599	0.340
BMI ($kg \cdot m^{-2}$)	16.61±2.92	16.08±2.92	0.646	0.521
Sit and reach (cm)	–0.49±5.77	4.21±6.62	–2.718	0.009*
Handgrip – right (N)	178.34±41.10	189.33±39.82	–0.955	0.344
Handgrip – left (N)	175.99±42.77	175.59±40.41	0.035	0.972
Horizontal jump (cm)	137.86±50.00	126.09±56.83	0.783	0.438
Agility 10×5 m run (s)	22.09±4.10	22.31±3.31	–0.199	0.843
20 m shuttle run (step)	7.01±1.12	6.47±1.06	1.730	0.090

*$p<0.001$

The absence of differences of performance in strength and muscular-dependent tests could be explained by growth and development. Other studies described that in this age, before puberty, anabolic hormones production and muscular development are very similar in boys and girls, not being the same in adolescence[24]. Endocrine changes after puberty onset and different patterns of muscular growth and development could explain differences observed by other authors in physical performance between sexes[23,24]. In this work, we have not completed a protocol to establish the maturity degree of the subjects studied, but it is well described that puberty onset is over 10.5 years in Spain[25].

Unlike in this research, it has been described in several studies that aerobic fitness is higher in boys even when setting the assessment body size and energy expenditure and when both factors are similar for both sexes[26]. However, the results of another study[6] that employs similar functional assessment tests to those used in our study are consistent with those showed by the school children here evaluated: there are not sex differences in physical fitness in stages prior to puberty, for the same amount of physical activity practice. Regardless of the sex, these levels of physical activity practice benefit boys and girls equally, improving their physical condition and assuming a lower risk of health problems during this stage and later, during adolescence, such as described above[16].

As a conclusion, this study shows that girls are more often inactive and tend to show overweight more than boys of their own age do, and with no differences in diet quality, as described by some other authors. We can confirm that boys and girls have a similar fitness performance before puberty when reported the same physical activity, except for performance in the sit and reach test, inferior in male subjects independently of their physical activity pattern.

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AKTIVAN STIL ŽIVOTA OBJAŠNJAVA SPOLNE RAZLIKE PRI FIZIČKOJ IZVEDBI DJECE PRIJE PUBERTETA

S A Ž E T A K

Cilj ove studije je analizirati spolne razlike pri fizičkoj izvedbi djece prije puberteta, kao i određene druge varijable povezane sa zdravljem. Ispitana populacija sastojala se od 137 dječaka i 156 djevojčica (9,99±0,79 godina). Mjereni su težina i visina, fizička izvedba s obzirom na testove iz pet područja (prethodno vrednovanih kod djece), svakodnevna fizička aktivnost te kvaliteta prehrane. Koeficijent multinomijalne logističke regresije utvrđen je kako bi se izračunala vjerojatnost (OR) i 95%tni interval pouzdanosti (CI) te kako bi se utvrdile razlike u izvedbi s obzirom na spol, težinu, svakodnevnu fizičku aktivnost i kvalitetu prehrane. T-test je izračunat s obzirom na aktivne djevojčice i dječake kako bi se ustanovila razlika u testu izvedbene sposobnosti uračunavajući i svakodnevnu aktivnost. Dječaci su bili aktivniji (OR 1,90, CI 1,03–3,49) i imali su optimalniju tjelesnu težinu od djevojčica, dok kod kvalitete prehrane nije bilo razlike između spolova (OR 1,13, CI 0,67–1,89). U ukupnom uzorku očekivano je da će dječaci pokazivati veću fizičku sposobnost nego djevojčice u svim testiranjima. No kada su obje skupine bile podvrgnute sličnom obrascu fizičke aktivnosti, varijable su dosezale približno jednake vrijednosti kod oba spola, osim što su djevojke imale bolje rezultate u fleksibilnosti. Sjedenje je bilo prisutnije kod djevojčica, no nikakve razlike u kvaliteti prehrane nisu zapažene. Djevojčice su češće bile više tjelesne težine. Oba spola su pokazala slične izvedbene sposobnosti prije puberteta za isti raspon fizičkih aktivnosti, osim za fleksibilnost koja je inferiorna kod muškaraca bez obzira na obrazac fizičke aktivnosti.