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ANALYSIS OF EFFECT SIZE OF OVERWEIGHT IN FLEXIBILITY AMONG ADOLESCENTS: REFERENCE VALUES FOR PHYSICAL EDUCATION ACCORDING TO GENDER, AGE AND BMI

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ABSTRACT

The aim of this study was to quantify the effect of being overweight on flexibility in adolescents. The study sample consisted of 10036 Spanish students (4920 girls; 5116 boys) aged 12–16 years from 42 secondary schools. Flexibility was assessed using the sit-and-reach test. The effect size was analysed with the adjusted Hedges' ğ. Girls had higher flexibility scores compared to boys, regardless of their weight class. When compared to participants of the same gender (all ages combined), overweight girls and boys did not have greater flexibility scores that their normal-weight peers. However, the average flexibility scores of 59.8% and 61.4% for overweight girls aged 12 and 13 years old, respectively, were found to be higher than their normal-weight peers of the same age were. The differential effect size between normal-weight and overweight adolescents was no higher than that between boys and girls for the flexibility test analysed. Overweight girls aged 12–13 years had higher average flexibility scores (60%) than their normal-weight peers. BMI remains a predictor of sit-and-reach test performance. The percentile values for gender, age and BMI are reported.

Keywords: Paediatrics; Fitness; Obesity; Sit-and-reach test; Physical Education.

INTRODUCTION

Flexibility is a health-related fitness component defined as a muscular ability to move freely through a full range of motion (Castro-Piñero *et al.*, 2013). Flexibility has been positively associated with better range of movement and physical functionality, improvements in coordination and athletic performance, reduction of injury risk or post exercise soreness (Castro-Piñero *et al.,* 2013), and with lower risk of low back pain and neck tension during adolescence and later in adulthood (Sjolie, 2004; Mikkelsson *et al.,* 2006; Mayorga-Vega *et al.,* 2015). In addition, flexibility has a positive association with other key variables for integral development in young people, like cognitive performance or academic achievement in math or science (Wittberg *et al.,* 2008).

The sit-and-reach test is one of the most widely used tests for evaluating hamstring flexibility and recent researches have shown its criterion-related validity in young people (Castro-Piñero *et al.,* 2009; Mayorga-Vega *et al.,* 2014). This test has a simple procedure, is easy to administer and requires minimal skills training (Castro-Piñero *et al.,* 2013). In the current studies, normative reference values are mostly shown based on the parameters of gender and age. It has been widely demonstrated that girls usually achieve higher flexibility scores than boys and this variable changes significantly for both genders as age advances (Ortega *et al.*, 2005; Baquet *et al.*, 2006; Chen *et al.*, 2006; Casajus *et al.*, 2007; Fogelholm *et al.*, 2008; Castro-Piñero *et al.*, 2013).

In the last years, the prevalence of overweight has progressively increased (Freedman *et al.*, 2016). The majority of studies, focused on the analysis of the relationship between weight status and flexibility, show that there are no significant positive associations between the two variables (Chen *et al.*, 2006; Casajus *et al.*, 2007; Fogelholm *et al.*, 2008; Artero *et al.*, 2010; Botelho *et al.*, 2013; Woll *et al.*, 2013). Nevertheless, another recent study shows controversy, and concludes that overweight-obese boys and girls have significantly lower scores in flexibility than their normal-weight peers (Castro-Piñero *et al.*, 2013). Thus, Body Mass Index (BMI), the most standardised measure globally and clinically equal to, or even more reliable than, other measures of weight status (Ortega *et al.*, 2016), could mediate flexibility results. This fact is of interest because the most important somatic determinants of the subjects' motor abilities were body height and subcutaneous adiposity (Puciato *et al.*, 2011).

To the best of our knowledge, no study has yet quantified the magnitude of the differences by analysing the effect size of a high BMI on adolescent flexibility. Only one recent study has quantified the effect size of overweight on physical fitness results in adolescents, specifically on muscular strength. This research showed that, in spite of the differential effect size between boys and girls is higher than between normal-weight and overweight adolescents, it is important to take into account BMI, in addition to gender and age (Martínez-López *et al.*, 2018).

PURPOSE OF RESEARCH

The question whether BMI should be used for the assessment of flexibility alongside gender and age is open to debate for several reasons, namely the current high levels of overweight-obesity, previous evidence in other physical fitness components, and the unknown effect size of weight status in flexibility, to name but a few. It was hypothesised that the effect size obtained from the difference between normal-weight and overweight young people could be similar to, or higher than, the result obtained from the differences between the genders within the same age group. Therefore, the purpose of this study was to quantify the effect size of overweight in the results of the sit-and-reach flexibility test in adolescents. It was also intended to report percentile tables for Physical Education classes, adapted for gender, age and BMI in a relatively large sample of Spanish girls and boys aged 12 to 16 years.

METHODOLOGY

Participants

A total of 10036 Spanish adolescents (48.8% girls) from 42 secondary schools (4.87%) were selected for convenience from among the 165 (19.2%) schools that expressed interest in this study. The participants were categorised as normal-weight and overweight according to the International Obesity Taskforce criteria (Cole *et al.*, 2000) and the specific cut-offs for each gender and age proposed by Cole and Lobstein (2012). Participation was voluntary, authorised and unrewarded. The data were collected during 2013/14 and 2014/15.

Ethical clearance

This study acquired reported consent from parents and was approved by the Bio-ethics Committee of the University. The design complies with the Spanish regulations for clinical research with humans (*Law 14/2007, 3rd July, of Biomedical Research*), and with the principles of the Declaration of Helsinki (2013 version, Brazil).

Measures

Weight was measured where participants were dressed in underwear and without shoes using an electronic scale (ASIMED® Elegant type B – class III, precision=100g). Height was measured barefoot in the Frankfort horizontal plane with a telescopic height-measuring instrument (SECA® 214, precision=0.1cm). BMI was calculated as body weight (in kilograms) divided by height^2 (in metres). Waist circumference (WC) was measured using a Seca SE201 ergonomic circumference-measuring tape (Seca, Germany, precision=1mm). To measure upper-thigh and lower-back flexibility, the sit-and-reach test was administered (Castro-Piñero *et al.*, 2009). The sit-and-reach test was performed with a special box of 33cm with a slide ruler attached to the top. Subjects were seated on the floor with knees extended, shoulder width apart, and feet situated on the box. Participants were asked to bend the trunk and reach forward as far as possible and held the final position for at least two seconds. The test was performed twice and the best result was recorded in centimetre. Higher scores indicated better performance (Castro-Piñero *et al.*, 2009; Castro-Piñero *et al.*, 2013; Mayorga-Vega *et al.*, 2014).

Procedure

Prior to the testing session, the participants performed a typical warm-up (5 minutes running + 5 minutes of general exercises, such as skipping, lateral running, front to behind arm rotations, and ballistic stretching). After that, the sit-and-reach test was performed. The research team demonstrated the test and took part in some familiarisation trials. The adolescents were encouraged to achieve the best possible score. A week later, 112 participants were randomly selected to perform the same test (retest). The data were registered during PE classes. All adolescents in a standard class group were included in the study, except those with muscle or joint pathologies or any other physical impairment that militated against physical activity practice. The sit-and-reach test showed an excellent intra-class correlation (ICC=0.949, 95% CI: 0.941–0.956).

Although there are several procedures for estimating effect size, such as the coefficient of determination, η^2, ω^2, or φ (Sink & Stroh, 2006), this study used the standardised difference of means obtained by the adjusted Hedges' ğ (Ledesma *et al.*, 2008). The Hedges' ğ estimates the difference between the means of the groups and expresses a typified value that allows to infer by means of the table of the normal curve, the percentage of cases that one group is below the average of the another group. This decision was based on three favourable criteria: (1) Accurate and unbiased estimation; (2) Simplicity of calculation; and (3) Easy interpretation of the results (Greenwald *et al.*, 1996).

Statistical analysis

Anthropometric and physical fitness characteristics of the study sample are presented as mean±SD, unless otherwise indicated. The normality and homoscedasticity of the data were verified using the Kolmogorov–Smirnov and Levene tests, respectively. Percentile values were identified and smoothed using the Lambda-Mu-Sigma (LMS) method, which adjusts for the asymmetry of the percentile distribution (L=symmetry coefficient; M=median; and S=variation coefficient) (Cole & Green, 1992). The software TLMSchartmaker Light (version 2.54) was used in this case (Pan & Cole, 2011). Gender and age group differences in the anthropometric and physical fitness variables were analysed by means of the two-way analysis of variance. To analyse the differences in the flexibility test according to gender (male and female) and weight status (normal-weight and overweight+obesity) in each age group, a Student's t-test was used.

Due to the practical interest in this kind of work, the effect size was calculated using the adjusted Hedges' ğ, because it maintains a greater independence of statistical significance with regard to the sample size (Tejero-González *et al.*, 2012). In addition, the value of the probability was calculated of each difference using the standardised normal distribution table (Vincent, 2005). A Pearson correlation analysis and a multiple linear regression analysis were performed between the sit-and-reach test and anthropometric variables. The reliability of sit-and-reach test was analysed by pre-post-test through the intra-class correlation coefficient (ICC). The accepted level of significance was $p<0.05$. The data were analysed using the Statistical Package for the Social Sciences (SPSS, version 22.0), except for the adjusted Hedges' ğ, which was carried out in the Excel spreadsheet provided by Microsoft.

RESULTS

Anthropometric characteristics and flexibility parameters of the study sample are shown by gender in Table 1. Boys had higher values of weight, height, waist-hip index, and lower values in sit-and-reach than girls. All anthropometric variables tend to increase for both genders as age advances except the waist-hip index.

***Table 1*. ANTHROPOMETRIC CHARACTERISTICS AND FLEXIBILITY PARAMETERS ACCORDING TO GENDER**

Variables	**All** N=10036 M±SD	**Boys** n=5116 M±SD	**Girls** n=4920 M±SD	**Gender differences** M±SD	**Age trend** M±SD
Age (years)	13.61±1.42	13.76±1.43	13.69±1.43	=	–
Weight (kg)	59.73±13.75	63.16±15.01	56.18±11.36	>	>
Height (m)	1.64±0.08	1.68±0.08	1.60±0.07	>	>
BMI (kg/m^2)	22.03±4.14	22.16±4.32	21.88±3.93	=	>
Waist-hip index (m)	0.79±0.07	0.83±0.06	0.75±0.06	>	<
Sit-and-reach (cm)	16.89±8.53	15.02±8.19	18.86±8.44	<	>

M=Mean SD=Standard Deviation >=significantly higher for boys than girls (p<0.05) <=opposite relevant
>=increases with age <=decreases with age = no significant differences – =Not applicable

The results obtained in the sit-and-reach test are presented in Table 2. Data did not show significant differences between flexibility in normal-weight and overweight boys aged 12-16 years (all $p>0.05$). In girls, differences between normal-weight and overweight were only significant in ages 12 and 13 years ($p=0.003$ and $p=0.007$, respectively).

Table 2. **SIT-AND-REACH SCORES FOR AGE, GENDER AND WEIGHT STATUS**

Age	**BOYS** (n= 5116)				**GIRLS** (n= 4920)				**BOYS vs. GIRLS**			
	N-weight (n=3752) M±SD (n)	**Overweight** (n=1364) M±SD (n)	p	ğ (M)	**N-weight** (n=3484) M±SD (n)	**Overweight** (n=1436) M±SD (n)	p	ğ (M)	**N-weight** p	**N-weight** ğ (M)	**Over-weight** p	**Over-weight** ğ (M)
12	12.73±6.82 (978)	12.91±8.57 (390)	0.679	0.024 (0.508)	15.79±8.35 (990)	17.96±9.14 (434)	0.003	0.252 (0.598)	< 0.001	0.401 (0.655)	< 0.001	0.569 (0.712)
13	13.92±7.93 (744)	14.66±6.38 (300)	0.153	0.098 (0.539)	18.13±7.32 (604)	20.29±7.10 (276)	0.007	0.298 (0.614)	< 0.001	0.549 (0.705)	< 0.001	0.836 (0.796)
14	15.62±7.94 (716)	16.24±8.08 (268)	0.125	0.078 (0.527)	20.05±8.35 (796)	20.75±7.62 (204)	0.159	0.085 (0.531)	< 0.001	0.543 (0.705)	< 0.001	0.572 (0.715)
15	16.09±8.88 (688)	16.65±8.53 (212)	0.514	0.064 (0.523)	19.37±7.74 (700)	19.68±7.38 (196)	0.597	0.043 (0.513)	< 0.001	0.394 (0.661)	< 0.001	0.299 (0.614)
16	18.74±8.48 (676)	18.36±7.19 (144)	0.618	0.046 (0.516)	19.44±10.81 (524)	19.92±7.12 (196)	0.343	0.048 (0.516)	0.016	0.218 (0.583)	0.007	0.218 (0.583)

ğ=adjusted Hedges' ğ (M)=Effect magnitude (expressed in text as a percentage) M=Mean SD=Standard Deviation N-weight=Normal-weight.

The values of the magnitude of the effect size are shown as a percentage. These values are compared with the average results of the comparison group. More concretely, the analysis of effect size through Hedges' ğ showed that 59.8% y 61.4% of girls overweight of 12 and 13 years respectively had flexibility scores higher than the average for their normal-weight peers (17.96±9.14 vs. 185.79±8.35cm, ğ=0.252, effect magnitude (M)=0.598, and 20.29±7.10 vs. 18.13±7.32cm, ğ=0.298, M=0.614, respectively).

With regard to gender, and in all ages, normal-weight girls showed higher scores in flexibility than normal-weight boys (p=0.016 for the highest). The flexibility scores for normal-weight girls were between 70.5% and 58.3% (highest and lowest values, respectively) of normal-weight girls who had higher flexibility scores than the average for boys (ğ=0.549, M=0.705 and ğ=218, M=0.583). Similarly, and for all ages, overweight girls showed higher scores in flexibility than boys (p=0.007 for the highest). The flexibility scores for overweight girls were between 79.6% and 58.3% (highest and lowest values, respectively) and higher than the boys' average (ğ=0.836, M=0.796 and ğ=0.218, M=0.583).

Figure 1 shows the average of the magnitudes of means obtained for those aged 12–16 years in the sit-and-reach flexibility test. The results show higher percentages for effect magnitude between boys and girls than between the normal-weight and overweight groups. In all, 66.18% and 68.40% of girls with normal-weight and overweight, respectively, had flexibility scores higher than the average obtained by boys with a similar weight status (p=0.008 and p=0.001 for normal-weight and overweight girls, respectively). However, only 52.26% of the overweight boys and 55.44% of overweight girls had greater flexibility scores than those obtained normal-weight boys and girls, respectively (both p>0.05).

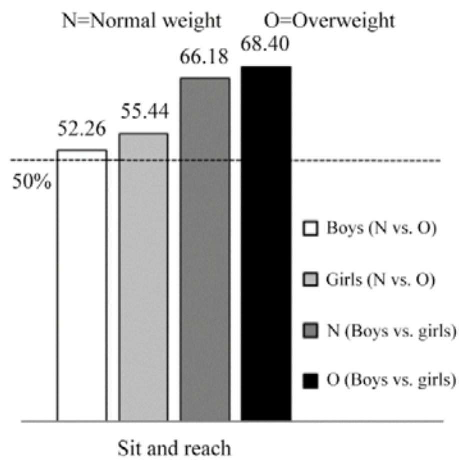

Figure 1. **AVERAGE MAGNITUDE OF EFFECT SIZE OBTAINED BETWEEN AGES 12 AND 16 YEARS FOR SIT-AND-REACH TEST**

The values for boys and girls indicate the percentage of overweight young people with results higher than the average for their normal-weight peers (50%). The values for normal-weight (N) and overweight (O) groups indicate the percentage of girls with scores higher than the boys' average (50%).

Pearson correlation analysis showed a significant correlation between the sit-and-reach test and age (0.140, p<0.001), sex (-0.225, p<0.001), height (-0.072, p<0.001), BMI (0.068, p<0.001) and waist-hip index (-0.138, p<0.001) [data not shown]. A multiple linear regression analysis between sit-and-reach was conducted with the above variables (Table 3). Age, sex, height, and BMI are predictor´s variables for sit-and-reach test. Table 4 exhibits percentiles of the sit-and-reach flexibility test by weight status (normal-weight and overweight [overweight + obesity]) and sex (male vs. female).

***Table 3*. MULTIPLE LINEAR REGRESSION ANALYSES BETWEEN SIT-AND-REACH AND AGE, GENDER AND ANTHROPOMETRIC VARIABLES**

Variables	β	SE	t	p-value	95% CI	
					Lower limit	Upper limit
Constant	12.192	2.041	5.975	<0.001	8.192	16.192
Age	0.948	0.064	14.873	<0.001	0.823	1.073
Gender	-4.174	0.237	-17.602	<0.001	-4.639	-3.710
Height	-4.687	1.116	-4.202	<0.001	-6.874	-2.500
BMI	0.354	0.031	11.316	<0.001	0.292	0.415
Waist-hip index	-2.634	1.450	-1.817	0.069	-5.476	0.207

SE=Standard Error BMI=Body Mass Index Gender 1 = boys CI=Confidence interval

***Table 4*. PERCENTILES FOR SIT-AND-REACH FLEXIBILITY TEST: ADOLESCENTS BASED ON AGE, GENDER AND WEIGHT STATUS**

Years	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{100}
	Normal-weight girls									
12	7.0	11.2	14.0	15.0	16.9	20.5	22.3	24.1	27.0	30.6
13	10.9	13.8	15.5	18.0	19.4	21.5	24.5	26.5	29.8	35.8
14	10.3	14.3	17.1	19.5	21.0	23.2	25.0	27.0	31.5	37.0
15	9.5	15.1	17.1	19.0	20.8	22.0	24.4	27.0	29.8	38.4
16	9.5	14.3	17.5	20.3	21.9	24.1	26.9	30.5	34.5	41.0
	Overweight girls									
Years	**P_{10}**	**P_{20}**	**P_{30}**	**P_{40}**	**P_{50}**	**P_{60}**	**P_{70}**	**P_{80}**	**P_{90}**	**P_{100}**
12	4.0	12.0	15.7	17.5	19.0	21.0	24.5	26.5	28.6	35.3
13	11.8	15.0	17.9	20.0	21.3	23.5	25.3	27.5	31.3	34.0
14	9.5	13.5	17.5	19.0	20.5	22.0	24.0	26.3	31.0	33.0
15	12.0	14.0	14.5	16.5	18.3	19.6	24.5	26.2	30.4	39.5
16	9.5	12.0	13.5	15.5	20.0	21.2	24.5	26.0	28.5	34.3

Continued

***Table 4*. PERCENTILES FOR SIT-AND-REACH FLEXIBILITY TEST: ADOLESCENTS BASED ON AGE, GENDER AND WEIGHT STATUS** *(cont.)*

	Normal-weight boys									
Years	**P_{10}**	**P_{20}**	**P_{30}**	**P_{40}**	**P_{50}**	**P_{60}**	**P_{70}**	**P_{80}**	**P_{90}**	**P_{100}**
12	4.0	8.0	10.5	12.5	14.1	15.9	17.5	19.5	23.8	28.5
13	4.5	8.5	10.6	13.0	14.8	17.0	19.0	21.9	24.5	31.8
14	5.8	9.9	12.5	14.7	17.0	18.5	21.0	23.5	27.3	33.0
15	6.3	8.9	11.3	13.8	16.6	17.8	20.5	23.3	28.3	35.1
16	8.5	12.5	15.4	17.5	19.5	21.9	24.4	26.8	31.3	37.2
	Overweight boys									
Years	**P_{10}**	**P_{20}**	**P_{30}**	**P_{40}**	**P_{50}**	**P_{60}**	**P_{70}**	**P_{80}**	**P_{90}**	**P_{100}**
12	3.5	6.3	8.5	12.3	14.0	15.3	18.5	20.5	25.2	34.8
13	7.5	9.0	12.0	13.0	15.3	17.5	18.6	21.0	23.5	31.5
14	7.8	9.5	12.0	14.7	16.8	20.3	23.0	25.5	29.0	33.8
15	6.0	10.5	12.5	13.5	16.5	18.8	20.9	23.2	28.0	31.3
16	9.3	11.5	14.2	16.0	18.9	22.0	23.3	25.6	29.2	34.0

DISCUSSION

This research quantifies the effect size of overweight status on the results of the sit-and-reach flexibility test, and reports percentile tables according to gender, age and BMI in a relatively large sample of Spanish youths aged 12–16 years.

The results demonstrate that there were no significant differences between normal-weight and overweight boys aged 12–16 years. However, 59.8% and 61.4% of overweight girls aged 12 and 13 years, respectively, had flexibility scores that were higher than the average for their normal-weight peers. These findings indicate that overweight girls aged 12 and 13 years have a higher differential effect than their normal-weight peers do. Therefore, at least 10% of overweight girls aged 12–13 years could be assessed with demanding parameters according to weight status.

Contrary to our hypothesis, the magnitude of the differential effect size between boys and girls is higher than that between normal-weight and overweight adolescents. Among normal-weight and overweight girls, 66.18% and 68.40%, respectively, had greater flexibility scores than the average obtained for boys with a similar weight status. The results also showed that BMI is positively associated with the results obtained for the sit-and-reach test at the bivariate and multivariate levels (independent of age, gender and height), therefore, it is suggested that PE teachers consider this when assessing flexibility in adolescents.

Most of the current studies on this topic have reported sit-and-reach scales according to gender and age, and BMI is only considered a possible modulating element of the test results (Castro-Piñero *et al.*, 2013). The main finding of this study was that only 52.26% and 55.44% of overweight boys and girls, respectively, achieved higher flexibility scores than the average for their normal-weight peers. However, these results increased to 59.4% and 61.4% in girls aged 12 and 13 years, respectively. This is novel evidence, as most previous research focused on analysing the relationship between weight status and flexibility show that there are no significant associations between the two variables (Chen *et al.*, 2006; Fogelholm *et al.*, 2008; Artero *et al.*, 2010; Botelho *et al.*, 2013; Woll *et al.*, 2013).

Only one study concluded the opposite of the current findings, showing that overweight and obese boys and girls have significantly lower flexibility scores than their normal-weight peers (Castro-Piñero *et al.*, 2013). It is possible that excess body fat mass in the arms and upper back will limit their range of motion, and therefore their flexibility in this area. In addition, the association between triceps skinfold width and weight status may partly explain why overweight and obese individuals performed more poorly in this test.

The findings regarding gender are similar to those of other international studies that examined flexibility in young people from Taiwan (Chen *et al.*, 2006), Poland (Dobosz *et al.*, 2015), Finland (Fogelholm *et al.*, 2008), Latvia (Sauka *et al.*, 2011) and Spain (Ortega *et al.*, 2005). These studies show that girls obtain higher flexibility scores than boys (Ortega *et al.*, 2005; Castro-Piñero *et al.*, 2013; Dobosz *et al.*, 2015). A few mechanisms could explain the differences with regard to gender at a physiological level. For example, the female pelvis presents adaptations related to reproductive functions, specifically pregnancy and childbirth. As such, the width of the pelvis is wider and more circular, conferring a greater range of motion. This creates a greater angle between the femur and tibia, known as the *Q* angle, and favours mobility of the hip joints in that area (Moral-Muñoz *et al.*, 2015).

Another explanation could be related to the secretion of oestrogen, a hormone that appears in girls from puberty and adolescence, which is related to flexibility (Wild *et al.*, 2013). Oestrogen is involved in the menstrual cycle, and causes greater laxity in females, especially in the hips, during this time. This hormone is also related to a lower muscle mass, and muscles are usually smaller in girls than in boys, thus, girls stretch more easily (Cromer, 2008; Wild *et al.*, 2013). In addition, oestrogen promotes fluid retention in the body and is related to reducing density in connective tissues, thereby resulting in increased flexibility (Stachenfeld, 2008).

With regard to age, previous studies have shown that flexibility usually improves in adolescents of both genders with advancing age (Ortega *et al.*, 2005; Castro-Piñero *et al.*, 2013; Dobosz *et al.*, 2015). Likewise, general physical performance and body composition also tend to increase with age (Castro-Piñero *et al.*, 2013). Nevertheless, after controlling for the maturation effect, post-menarche girls do not show higher physical performance levels despite having higher values of body composition (Coelho-e-Silva *et al.*, 2013). In addition, obese girls show greater average rates of bone aging than their chronological age, which could affect their muscular development (Freitas *et al.*, 2014). Therefore, chronological age should be used with caution when assessing obese adolescents because it may underestimate biological age.

LIMITATIONS

This research has some limitations. The cross-sectional design does not allow for the establishment of causal relationships. The normative values for flexibility status should be obtained from longitudinal studies that provide the possibility of assessing natural changes in individual growth and development. However, without this database, the cross-sectional information was carefully assessed through harmonised and standardised procedures and statistical methods.

PRACTICAL APPLICATION

From a practical perspective, our data for flexibility according to gender, age and BMI can be used as standard values for the estimation and comparison with young people from other countries in the world. Secondary schools should encourage an improvement in students' flexibility levels through PE programmes in order to prevent muscular and bone diseases and improve general musculoskeletal health (Mayorga-Vega *et al.*, 2014; Mayorga-Vega *et al.*, 2017).

Determining the influence of BMI in the assessment of any physical fitness component could be useful to ensure fairness when assessing the effort made by normal-weight and overweight youth, and to help prevent future problems associated with stigmatisation of their bodies (Martínez-López *et al.*, 2018).

Finally, the table of percentiles 10–100 (Table 4) could assist in the assessment of flexibility during PE classes. This classification allows for the intuitive assessment of a student's flexibility using a Likert scale: very poor ($X<P20$), poor ($P20\leq X<P40$), intermediate ($P40\leq X<P60$), good ($P60\leq X<P80$), and very good ($X\geq P80$) flexibility (Dobosz *et al*., 2015; Martínez-López *et al.*, 2018). In addition, values under the 30th percentile could contribute to the diagnosis and prevention of possible muscular or joint deterioration. Likewise, adolescents who score values above the 90th percentile could be considered potential talent for sports where flexibility is important (Dobosz *et al.*, 2015; Martínez-López *et al.*, 2018).

CONCLUSION

The differential effect size between normal-weight and overweight adolescents in the flexibility test analysed was no higher than that between boys and girls. Nevertheless, among girls aged 12–13 years, 60% of overweight girls had higher average flexibility scores than their normal-weight peers. The student's BMI was found to be a predictor of sit-and-reach performance, and it is suggested that the PE teacher considers this for the assessment of physical fitness components, such as flexibility in adolescents, particularly in girls aged 12–13 years. These findings suggest that while the gender of a student is most important, BMI represents another important variable when assessing flexibility in adolescents. The percentile values for gender, age and BMI are also reported for the sit-and-reach flexibility test in a large random sample of Spanish adolescents. These values will allow for the accurate and impartial assessment of sit-and-reach flexibility during adolescence. Furthermore, PE teachers and coaches can adapt this test according to BMI, in addition to the gender and age of the students.

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