MOTOR COORDINATION OF PREPUBERTAL CHILDREN IN RELATION TO BMI

Ingrid **RUŽBARSKÁ**

International College of Management ISM Slovakia
Department of Social Science

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- childhood,
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Abstract:
Introduction: There is a lack of studies oriented on relationship between physical parameters and motor coordination in children. *Aim:* The purpose of the study was to compare and analyse the motor coordination between normal weight children and their overweight or obese counterparts. *Methodology:* Data were collected from 436 children (boys N = 214, girls N = 222) between 7 and 10 years of age. All children were attending primary schools in the region of the East Slovakia. Motor coordination was evaluated with the Kiphard-Schilling body coordination test, Körperkoordination-Test-für-Kinder (KTK) (Schilling, Kiphard 1974, 2007). One way ANOVA was applied to measure differences between normal-weight group and overweight + obesity group. *Results:* The analysis of variance ANOVA showed statistically significant differences between normal-weight children and their overweight or obese counterparts in some of studied coordination parameters – dynamic balance, speed of locomotor coordination, and motor quotient - total coordination parameter. Excess body weight is probably a more important factor negatively determining motor coordination both in girls. *Conclusion:* It may be concluded that the excess body weight has a negative effect on the domain of motor coordination at this age. Findings support frequently presented conceptual models hypothesizing that low level of motor coordination may result in limited opportunities for engagement in physical activities, poor health-related fitness and overall lower level of motor skill competence leading to overweight or obesity.

INTRODUCTION

Over the past few years excess body weight of children living especially in economically developed regions has become a growing epidemic [17]. This increase is alarming because health risks related with obesity together with personal psychosocial consequences are no longer only seen in adults. Prevalence of excess body weight in European prepubertal and pubertal children ranges from 10 to 36% [1]. It is evident that in addition to genetic dispositions and inadequate diet composition excess adiposity of children is caused primarily by physical inactivity and sedentary lifestyle [12]. It may be assumed that lower physical activity level together with lower level of motor abilities and skills decreases with age below level that may have critical effect on body weight.

In the long term, obese children are more likely to become obese adults [5, 6]. Longitudinal studies show a risk that obese children will become obese adults who are consequently exposed to increased risk of comorbidity and premature mortality.

It has also been confirmed that obese children display lower fitness levels. However, it is difficult to specify a cause-and-effect relationship, which would scientifically justify this knowledge. The answer probably lies in a biocultural matrix of factors affecting the development of children and youth and resulting in a cycle that involves the interactions of fatness, physical inactivity and fitness. Overweight or obese children are less fit and are more likely to experience less positive experiences and success when performing physical activities. Consequently, their motivation, participation and preferences related to physical activity will reduce, which may naturally lead to decline in fitness, motor competences and formation of a sedentary and less active lifestyle [15, 11]. This may determine negative changes in the level of somatic parameters [14]. Effects of excess body weight in children are known and affect not only the domain of physical health. These effects are complex and negatively affect social and emotional side of a child's personality, decrease self-assessment and self-concept, which during puberty may induce the risk of eating disorders, etc.

Despite lack of evidence related to the association between coordination abilities and somatic development, [10] confirm moderately inverse correlation between coordination abilities (KTK-test) and Body Mass Index. To be explained is the causal relationship and answer to the question whether overweight and obesity result in declined motor performance and motor deficits. The design of cross-sectional studies cannot provide the answer to this question. However, studies show that physically active children, who in their leisure time participate in either organized or non-organized forms of physical activity, demonstrate higher level of motor abilities especially in the domain of motor coordination.

METHODOLOGY

Data were collected from 436 children (boys n = 214; girls n = 222) between 7 and 10 years of age. These data were combined from several research projects conducted by the author within 2013 - 2015. All children were attending primary schools in the region of the East Slovakia. Parents and children were informed about the aims of the research project and gave their consent.

Body height was measured using portable stadiometers (Harpenden, Holtain Ltd.) and body mass using a digital scale (Omron HN-286). Values were recorded to the nearest 0.1 cm and 0.5 kg, respectively. Body mass index (BMI) was calculated [BMI = weight (kg)/height (m^2)]. Motor coordination was evaluated with the Kiphard-Schilling body coordination test, Körperkoordination-Test-für-Kinder (KTK) [16]. The test battery includes the following items:

1. *Backward balance (BAB)*: Child walks backward on a 3 balance beams 3 m in length, of different widths: 6 cm, 4.5 cm, and 3 cm.
2. *Hopping obstacles (HO)*: Child is instructed to hop on one foot at a time over a stack of foam square (50 cm x 20 cm x 5 cm). After a successful hop with each foot, the height is increased by adding another square.
3. *Laterally jumping (LJ)*: Child makes consecutive jumps from side to side over a small beam as fast as possible for 15 s.
4. *Sideways moving (SM)*: Child begins by standing with both feet one platform (25 cm x 25 cm x 2 cm, supported on 3.7 cm high). Places the second platform alongside the first and steps on to it. Then the first platform is placed alongside the second and the child steps on to it. This sequence continues for 20 s.

The motor quotient *(MQ)* adjusted for age and gender was calculated using the four items. The MQ allows an assessment of the gross motor development in the following categories: *not possible (MQ < 56), severe motor disorder (MQ 56 - 70), moderate motor disorder (MQ 71 – 85), normal (MQ 86 -115), good (MQ 116 - 130) and high (MQ 131 -*

145). Test – retest reliability coefficient for the raw score on the total battery is 0.97. Coefficients for individual test items range from 0.80 to 0.96.

The normality test by *Shapiro Wilk* was used to verify the data distribution. The significance level established was 5 % ($p < 0.05$) or 1% ($p < 0.01$). In this study, BMI was used to identify normal-weight individuals and overweight, or obese individuals. The sample distribution was assessed according to international BMI standards (BMI) for the population between 2 and 18 years of age, which corresponds with standards for adult population over 18 years of age [4]. The sample was split by the gender and BMI cut values.

One way ANOVA was applied to measure differences between normal-weight group and overweight + obesity group. The data were processed in the software IBM SPSS Statistics Version 20.

AIM

The aim of this study is to thoroughly understand internal relations between motor coordination abilities and somatic development of prepubertal children and to determine the effect of excess body weight on motor coordination by comparing motor ability levels of children with different BMI values.

RESULTS

Of the entire sample (n = 436), 347 children (79.6%) were normal-weight and 89 children (20.4%) were overweight or obese. For both boys and girls, percentage of obese individuals equaled 5%. Of the sample of girls (n = 222), 169 girls were normal-weight (76.1%) and 53 girls (23.9%) were overweight or obese. Of 214 boys, 83.2% (n = 178) were normal-weight and 16.8% (n = 36) were overweight or obese. These findings point to the prevalence of obesity in girls by almost 7%, which corresponds with actual European trend for incidence of overweight and obesity in children aged 7 to 11 years according to which approximately 21% of Slovak girls are overweight and 4% of girls are obese. Percentage of overweight boys in current sample was slightly lower than Slovak nationwide average for overweight and obesity, which equals 20% and 5%, respectively (IOTF – International Obesity Tack Force, 2012).

Table 1. Motor parameters of *Girls* according to BMI

Test items	Girls (7 - 10 years)		$F_{(1,221)}$	Sig.
	Normal-weight	Overweight + Obesity		
	x ± s	x ± s		
BAB *(n)*	47,20 ± 13,39	38,11 ± 13,60	18,43	**0,000**
HO *(n)*	47,76 ± 16,38	44,70 ± 16,58	1,40	0,238
LM *(n)*	50,22 ± 15,13	46,92 ± 16,27	1,85	0,176
SM *(n)*	39,54 ± 8,68	36,70 ± 9,20	4,20	**0,042**
MQ	95,37 ± 12,34	86,32 ± 14,85	19,61	**0,000**

The analysis of variance revealed statistically significant differences between normal-weight girls and their overweight and obese counterparts in several motor coordination parameters (Table 1). Overweight or obese girls demonstrated significantly lower level in dynamic balance and speed of locomotor coordination (BAB, SM) and also in the overall coordination parameter – motor quotient (MQ: $F = 19.61$; $p = 0.000$; $d = 0.70$). An important finding is that the average value of motor quotient (MQ), which almost reached a boundary value (86.32) in overweight girls, fell into the category of individuals with a moderate motor disorder. On the other hand, normal-weight girls showed an average value of motor quotient falling in the interval identifying individuals with normal level of body coordination.

For *Boys* (Table 2), overweight had both practically and statistically negative effect on dynamic balance (BAB: F = 7.27; p = 0.008; d = 0.49). Motor quotient value is most probably affected by an unfavorable ratio of body weight to body height. Average motor quotient found in normal-weight boys was both practically and statistically higher (MQ: F = 16.82; p = 0.000; d = 0.75). Average motor quotient of both normal-weight and overweight boys indicated normal motor development [16].

Table 2. Motor parameters of *Boys* according to BMI

Test items	Boys (7 - 10 years)		$F_{(1,212)}$	Sig.
	Normal-weight	Overweight + Obesity		
	x ± s	x ± s		
BAB *(n)*	45,44 ± 15,01	37,89 ± 16,91	7,27	**0,008**
HO *(n)*	53,69 ± 16,77	48,81 ± 19,30	2,41	0,122
LM *(n)*	49,61 ± 15,11	49,75 ± 15,84	0,01	0,961
SM *(n)*	41,06 ± 9,58	39,25 ± 9,78	1,07	0,303
MQ	101,47 ± 13,59	90,81 ± 17,09	16,82	**0,000**

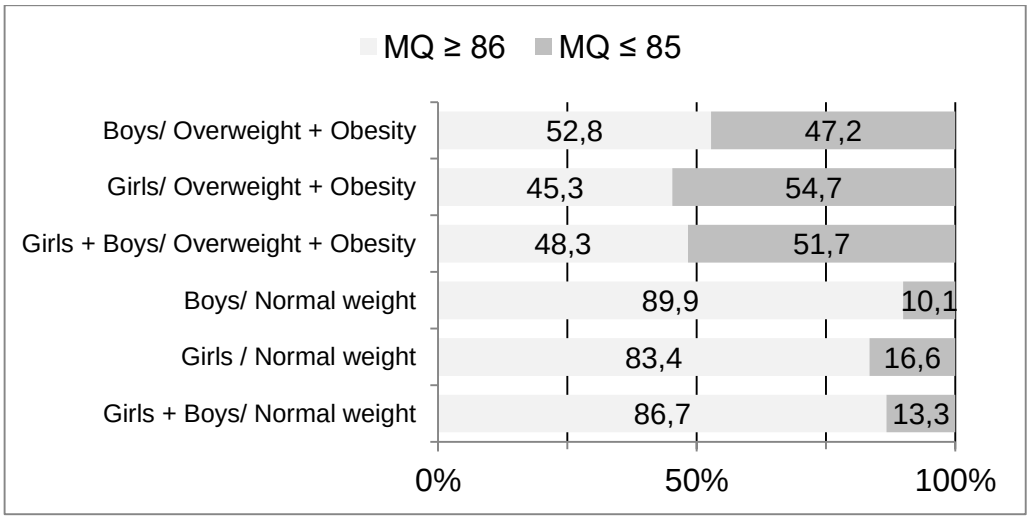

Figure 1. Distribution of the motor quotient of normal-weight, overweight and obese children

As shown in Figure 1, of normal-weight children (n = 347) 13.3% (46 children) were found to have decreased level of motor coordination. Of normal-weight girls (n = 169), 16.6% of girls showed a motor quotient below the normal level. Of normal-weight boys (n = 178), 10.1 % of boys showed a motor quotient below the normal level. A significantly different trend was observed in the sample of overweight or obese children (n = 89) of whom 51.7% showed a motor quotient MQ ≤ 85. Of the entire sample of overweight girls (n = 53) 54.7% of girls showed a motor quotient MQ ≤ 85. Of all overweight boys (n = 36) percentage of boys with a motor quotient MQ ≤ 85 equaled 47.2% (17).

As reported by [2] somatic parameters such as body height, body weight and BMI do not have significant effect on the domain of coordination abilities and basic motor skills. On the contrary, our findings suggest that somatic parameters, especially their unfavorable trend, probably result in lower fitness levels and in lower level of both conditioning and coordination abilities. Similarly, a cross-sectional study by [13] based on measurement of 7,175 children aged 6 to 14 years and a study by [3] revealed significantly lower level of motor abilities in overweight or obese boys and girls compared to normal-weight children.

Our findings are consistent with other current studies. As reported by [10], obese children demonstrate lower level of coordination abilities and basic motor skills. According to [9] lower level of motor competences is not limited to gross motor skills only, but also to conditioning motor abilities by negatively affecting fine motor skills and coordination abilities.

As reported by [7] prepubertal normal-weight children demonstrated significantly higher fitness levels than their overweight or obese counterparts in most motor tests except curl-ups. Authors hypothesize that obese children have difficulties with low level of processing and integration of sensory information.

Our findings correspond with a study by [6] who reported that overweight and obese children showed significantly lower motor coordination performance measured by KTK test battery. Normal-weight children displayed similar motor quotients across age groups (5-7, 8-9, 10-12 years). Almost 20% of normal-weight children were identified as being motor impaired according to gender and age, where percentage of overweight and obese children with motor impairment equaled 43.3% and 70.8%, respectively. Similar percentage trend was observed in our samples as well.

CONCLUSION

Our research findings support results reported by a variety of authors who emphasize early and sensitive education and support of physical activity especially in overweight and obese individuals.

Coordination abilities probably play an important role in preventing, or moderating the so-called negative trajectory leading to childhood overweight and obesity. At this age, the development of coordination abilities should become a key strategy targeted at long-term prevention of obesity and promotion of active lifestyle in adulthood.

Recording and explaining associations between motor performance, motor abilities and motor skills in prepubertal children and their physical activity levels may to a large extent face the trend of increasing incidence of overweight and obesity since early childhood.

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