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USE OF WAIST TO HIP RATIO IN THE DETERMINATION OF THE BODY COMPOSITION IN PRESCHOOL CHILDREN IN LATVIAN POPULATION

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ABSTRACT

According to the World Health Organization (WHO), in 2008, the waist to hip ratio (WHR) has been suggested superior to the body mass index (BMI) in predicting the cardiovascular disease risk in adults and adolescents. There have been studies about the WHR in preschool children in the populations of Pakistan, Chile and Mexico; and it is not the WHO which recommended it as a routine method in preschool children.

The present study includes 85 children (41 girls and 44 boys), aged 5 to 7 years, without any chronic conditions. Body height, body weight, waist circumference, hip circumference, triceps skinfold, abdominal skinfold and subscapular skinfold were measured. The WHR, the BMI, the sum of three skinfolds and the percentage of body fat (%BF) were calculated.

It was found that the WHR decreased with age in girls; there were no specific changes found in the WHR with age in boys. The present study found no correlation in boys or girls between the WHR and the BMI; the WHR and the sum of three skinfolds; the WHR and the percentage of BF. There was also no correlation between the Z-scores of the BMI and Z-scores of the WHR.

Conclusions. The WHR is a questionable body composition marker in preschool children in the Latvian population and must be evaluated separately from other body composition markers.

Keywords: *Body composition; body mass index; nutrition; waist to hip ratio*

INTRODUCTION

In children, both overweight and underweight are associated with higher morbidity and premature mortality, therefore evaluating the nutrition is an

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important topic in the primary care [3, 17]. The prevalence of overweight and obesity in children population has risen globally since 1980; however, nearly half of all the deaths in children under 5 all over the world are due to undernutrition [11, 21, 22].

The most widely used and the WHO recommended anthropometric measurements for determining childhood nutrition are body height, body weight and the BMI [4]. The body's constitution and nutrition can also be evaluated by the use of other anthropometric measurements, like waist circumference (WC), skinfold (SF) thicknesses and body fat percentage (%BF) [11, 15].

According to the World Health Organization (WHO), in 2008, the waist to hip ratio (WHR) has been suggested to be used instead the body mass index (BMI) in predicting the cardiovascular disease risk in adults and adolescents [25]. The WHR is one of the predictors in central obesity in adolescents [18]. There have been studies about the WHR in preschool children in several populations, like Pakistan, Chile and Mexico [13, 14, 24]; and it is not the WHO which recommended it as a routine method in preschool children.

MATERIAL AND METHODS

The study includes 85 children, aged 5 to 7 years, without any chronic conditions.

Anthropometric measurements. Body height, body weight, waist circumference, hip circumference, triceps SF, abdominal SF and subscapular SF were measured according to standard procedures, using the instruments of "SiberHegner&Co". Body height was measured using an anthropometer. The weight of the children, wearing minimum clothing and with bare feet, was measured using a portable digital weighing machine. The waist circumference was measured at the level of umbilicus with a flexible measuring tape. The hip circumference was taken around the widest portion of the hips with a flexible measuring tape. The SF measurements were recorded using a SF caliper. All the children were measured in mornings.

Calculations. The BMI was calculated according to the Quetelet formula (1832):

$$\text{BMI (kg/m}^2\text{)} = \text{weight (kg) / height (m}^2\text{)} \text{ [BMI Classification]}$$

The Waist to hip ratio (WHR) was calculated according to a formula by Bjorntrop, 1987:

$$\text{WHR} = \text{waist circumference (cm) / hip circumference (cm) [25]}$$

The sum of three skinfolds was calculated according to the Jackson and Pollock formula (1978):

Three site skinfold = triceps SF (mm) + abdominal SF (mm) + subscapular SF (mm) [9].

The percentage of BF was calculated according to the Slaughter formula (1988):

In boys:

- if (subscapular SF + triceps SF) = < 35 mm and age < 12 years:

  %BF = 1.21 × (subscapular SF + triceps SF) – 0.008 × (subscapular SF + triceps SF)^2 – 1.7;

- if (subscapular SF + triceps SF) > 35 mm:

  %BF = 0.73 × (subscapular SF + triceps SF) + 1.6 [19].

In girls:

- if (subscapular SF + triceps SF)) = < 35 mm:

  %BF = 1.33 × (subscapular SF + triceps SF) – 0.013 × (subscapular SF + triceps SF)^2 – 2.5;

- if (subscapular SF + triceps SF) > 35 mm:

%BF = 0.783 × (subscapular SF + triceps SF) + 9.7 [19].

Data analysis. Data analysis was performed using MS Excel 2007 and IBM SPSS Statistics 21.0 programs. Descriptive statistics and the correlation analysis of several different values were determined gender specifically.

RESULTS

41 girls and 44 boys were included in the study. The mean age of the girls was 5.95 years (±0.87 years); of boys 6.14 years (±0.67 years). One hundred percent of children were urban.

The anthropometric measurements, the BMI, the WHR, the sum of three skinfolds and the percentage of BF are displayed gender specifically in Table 1 and Table 2.

The waist and hip circumference increased with age in both boys and girls. However, the WHR decreased with age in girls ($p<0.05$); there were no specific changes found in the WHR with age in boys. There was also no correlation, positive or negative, with the age and the BMI; age and the sum of three skinfolds; and age and the percentage of BF in either boys or girls.

The BMI and the WHR were expressed as Z-scores, percentile rates and evaluated. The percentile rates of the BMI and the WHR are depicted gender specifically in Table 3 and Table 4.

In girls 68.2% were in a normal weight range, 14.7% were underweight, 9.8% were overweight and 7.3% were obese. In boys 72.8% were in a normal weight range, 13.6% were underweight, 9.1% were overweight and 4.5% were obese. In

Table 1. Age-specific subject distribution and descriptive statistics of anthropometric variables among boys

Age (years)	**5**	**6**	**7**
Number (n)	7	24	13
Body weight (kg)	20.54 ± 1.67	21.68 ± 4.54	24.40 ± 3.85
Body height (cm)	113.5 ± 3.20	117.20 ± 6.70	123.70 ± 5.90
Waist circumference (cm)	53.23 ± 2.60	53.14 ± 4.59	54.16 ± 6.29
Hip circumference (cm)	63.30 ± 2.46	62.26 ± 5.88	64.07 ± 4.36
BMI (kg/m^2)	15. 93 ± 0.66	15.64 ± 1.61	15.88 ± 1.55
WHR	0.84 ± 0.03	0.85 ± 0.04	0.84 ± 0.04
The sum of three skinfolds (mm)	20.17 ± 3.71	20.18 ± 10.27	22.02 ± 8.71
The percentage of BF	13.51 ± 2.65	13.17 ± 5.29	14.12 ± 4.30

Table 2. Age-specific subject distribution and descriptive statistics of anthropometric variables among girls

Age (years)	5	6	7
Number (n)	16	11	14
Body weight (kg)	18.86 ± 2.07	21.93 ± 2.00	22.81 ± 4.32
Body height (cm)	112.70 ± 3.50	119.60 ± 5.30	119.60 ± 5.30
Waist circumference (cm)	51.30 ± 2.62	52.33 ± 2.86	53.83 ± 6.10
Hip circumference (cm)	59.93 ± 4.08	62.37 ± 3.91	66.30 ± 5.61
BMI (kg/m^2)	14.83 ± 1.36	15.32 ± 0.78	15.88 ± 2.30
WHR	0.86 ± 0.04	0.84 ± 0.03	0.81 ± 0.04
The sum of three skinfolds (mm)	22.94 ± 6.31	23.31 ± 5.06	25.73 ± 10.01
The percentage of BF	15.41 ± 3.97	15.20 ± 3.07	16.33 ± 4.47

Table 3. The BMI and the WHR percentiles in boys

Percentile	BMI	WHR
0 to 5.0	2 (4.5%)	2 (4.5%)
5.1 to 15.0	4 (9.1%)	4 (9.1%)
15.1 to 85.0	32 (72.8%)	33 (75.1%)
85.1 to 95.0	4 (9.1%)	3 (6.8%)
95.1 to 100	2 (4.5%)	2 (4.5%)

Table 4. The BMI and the WHR percentiles in girls

Percentile	BMI	WHR
0 to 5.0	2 (4.9%)	2 (4.9%)
5.1 to 15.0	4 (9.8%)	4 (9.8%)
15.1 to 85.0	28 (68.2%)	30 (75.5%)
85.1 to 95.0	4 (9.8%)	2 (4.9%)
95.1 to 100	3 (7.3%)	2 (4.9%)

girls 68.2% were in between the 15th and 85th percentile of the WHR; in boys it was 75.5%. Under the 15th percentile there were 14.7% of girls and 13.6% of boys, but 14.7% of girls and 11.3% of boys were over the 85th percentile. The present study analysed the correlations between the WHR and other calculable measurements that determine the body composition in children. There was no correlation found in either boys or girls between the WHR and the BMI; the WHR and the sum of three skinfolds; the WHR and the percentage of BF. There was also no correlation between the Z-scores of the BMI and Z-scores of the WHR, therefore a higher BMI cannot be associated with a higher WHR.

DISCUSSION

The WC and the hip circumference increased with age in both boys and girls, consistent with previous data [6]. The WC is the simplest clinical measure of childhood central obesity and has been proved a strong predictor of cardiovascular and metabolic disease risk in children because it provides a better estimate of visceral adipose tissue than the BMI and is more efficient than the BMI in predicting insulin resistance, blood pressure, and serum cholesterol and triglyceride levels [18]. A study by Kolpa et al. (2016) showed that the schoolchildren, aged 10–12 years, with hypertensionm had also a larger hip circumference [10]. The present study did not determine blood pressure in preschool children; therefore it is unknown whether a larger hip circumference can be associated with higher blood pressure in preschool children in the Latvian population.

In the present study the sum of three skinfolds and the percentage of BF showed no statistically significant increase or decrease with age. The sum of three skinfolds contributes negatively to the lean body mass, according to a study by Slaughter et al. (1978) [20]. Therefore it is a useful indicator of nutrition in preschool children. The percentage of BF is a useful metabolic indicator in children [16], and the SF-derived Slaughter formula is highly correlated with the percentage of body fat from dual energy X-ray absorptiometry, which is the most precise method of determining the the percentage of BF [7]. The data of the present study are representative of the sum of three skinfolds and the percentage of BF in preschool children population in Latvia, and can be further used in determining future risks. Calculating the percentage of BF from SF measurements is useful in practice, because the standard BMI is a weak predictor of the percentage of BF [23]. The SF measurements and the Slaughter formula are not suitable for primary practices due to complicity, however, it may be used in advanced examination or further scientific research in the Latvian population.

In different previous studies, the WHR showed a continuous decrease with advancing age [1, 13]. The present study shows the same tendency in girls, however, there is no statistically significant decrease in the WHR with age in boys. In a study by Mustaq et al. (2011), the WHR showed a plateau pattern among the boys aged 5–13 years; in girls, the study showed a decrease in the WHR from 9 years of age [14]. Therefore, the present data is credible in showing changes in the WHR in the Latvian preschool children.

Previously published literature suggests the use of pre-specified cut-off points for defining central obesity of WHR >0.90 in adult men and >0.85 in adult women [5]. In the present study the cut-off of WHR >0.90 corresponded at the 88^{th} WHR percentile for boys; the cut-off of >0.85 corresponded at the 73rd percentile in girls. These WHR cut-offs used in adults are not suitable to be used as a threshold for obesity in children, consistent to a previous study [1].

The present study found no correlation between the BMI and the WHR in either boys or girls. This contradicts to the results of a study by Zhang et al. (2017) that showed a significantly higher waist-hip ratio in obese children [26]. This can be explained by the fact that the present study only included only a small number of obese children of both genders, therefore a comparison analysis was not performed.

The WHR is used to describe body fat distribution in adults; however, it is influenced by other body factors in children, therefore it is an inconsistent measure of body fat distribution and the risk of obesity related diseases in children [12, 13]. A study by Guzman de la Garza et al., 2017, found that the WHR is not significantly correlated with body frame size measures [8]. The present study also found no correlation between the WHR and the sum of three skinfolds, and the WHR and the percentage of BF. Therefore, consistent with previous literature data, the body fat distribution and percentage in preschool children should be determined with other anthropometric methods.

According to a study by Vasqez et al. (2017), anthropometric adiposity indicators become associated to cardiometabolic markers only from the age of 7 years, with associations being slightly higher at 10 years [24]. At all ages the BMI to age, the WC and the waist-to-height ratio correlate with cardiometabolic markers, therefore they are more sensitive in determining cardiometabolic risks, while the WHR is a slightly weaker marker [24]. A study by Qi et al. (2017) in 8 to 16-year-olds found that in boys, the BMI, the WC and the percentage of BF showed the strongest association with insulin resistance, and was significantly stronger compared with the fat mass index than the WHR; in girls, the percentage of BF showed a significantly stronger association with insulin resistance compared with the BMI, the WC, the WHR [16]. A study by Zhu et al. (2016) found that the BMI correctly identified 77% of the total dyslipidemic disorders in obese children, aged 7–17, while the WHR identified 70.8% [27]. This adds to the present study that the WHR should not be used in determining future cardiovascular and metabolic risks in preschool children; it is dubious whether other anthropometric adiposity markers are sensitive in the age of 5–6 years. In preschool children, the WHR is a questionable marker in determining the body composition; however, its use in adolescents and adults is helpful.

The present study had several strengths, for example, the fact that similar studies have not been previously performed in Latvian preschool children; also, the anthropometric measurements were collected by trained health professionals. The data is representative of the modern preschool children's population in Latvia. The disadvantages include low participation and the limited age group.

CONCLUSIONS

WHR is a questionable body composition marker in preschool children in the Latvian population and must be evaluated separately from other body composition markers.

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