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FACULTY OF BIOLOGY

Bioelectric impedance assessment of body composition in 7-18-year-olds children and adolescents from Sofia (Bulgaria)

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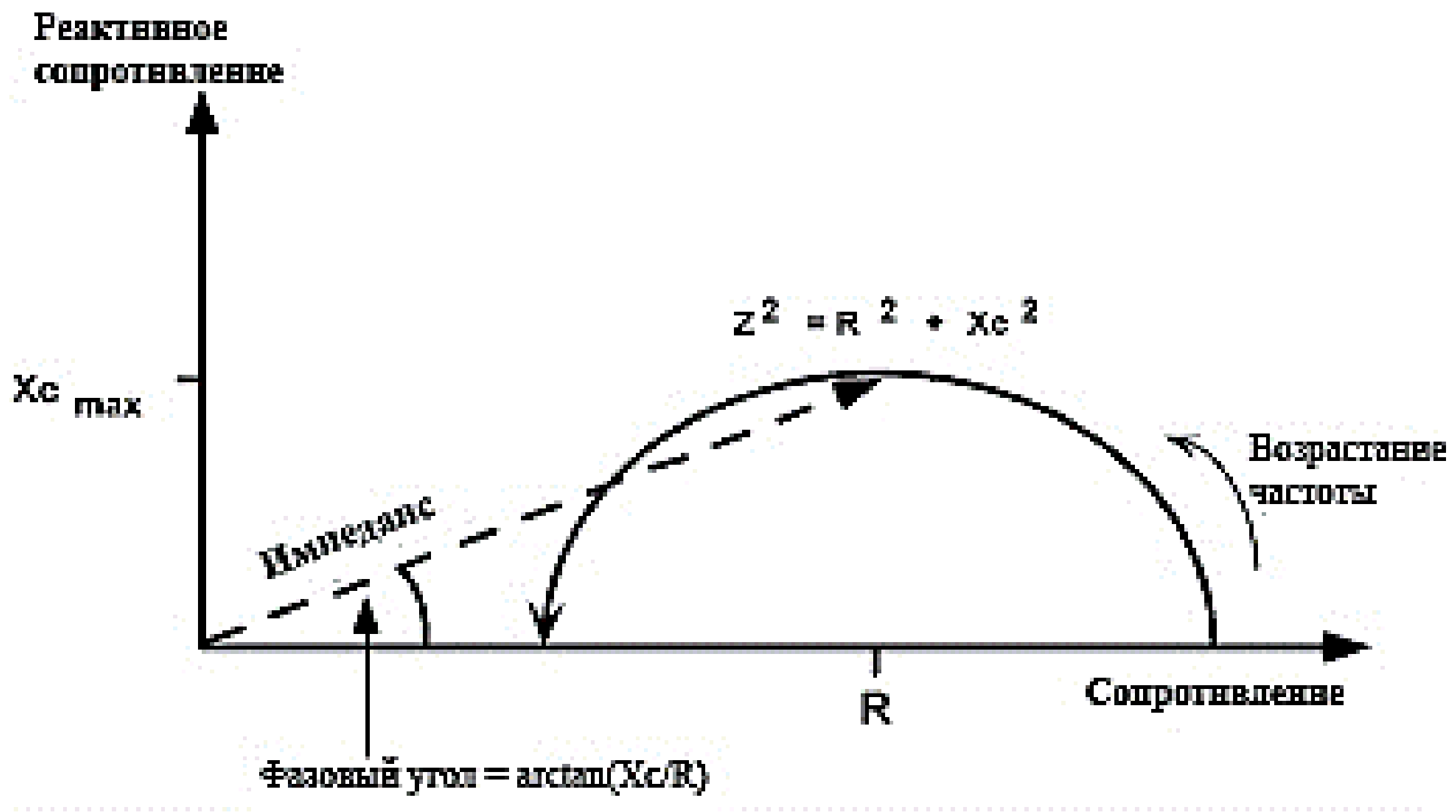
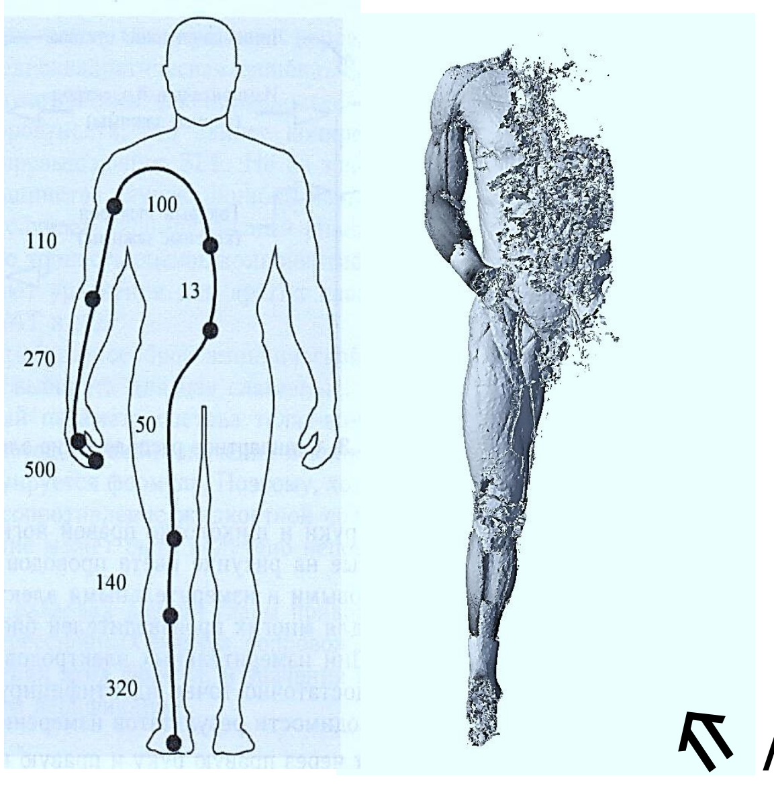
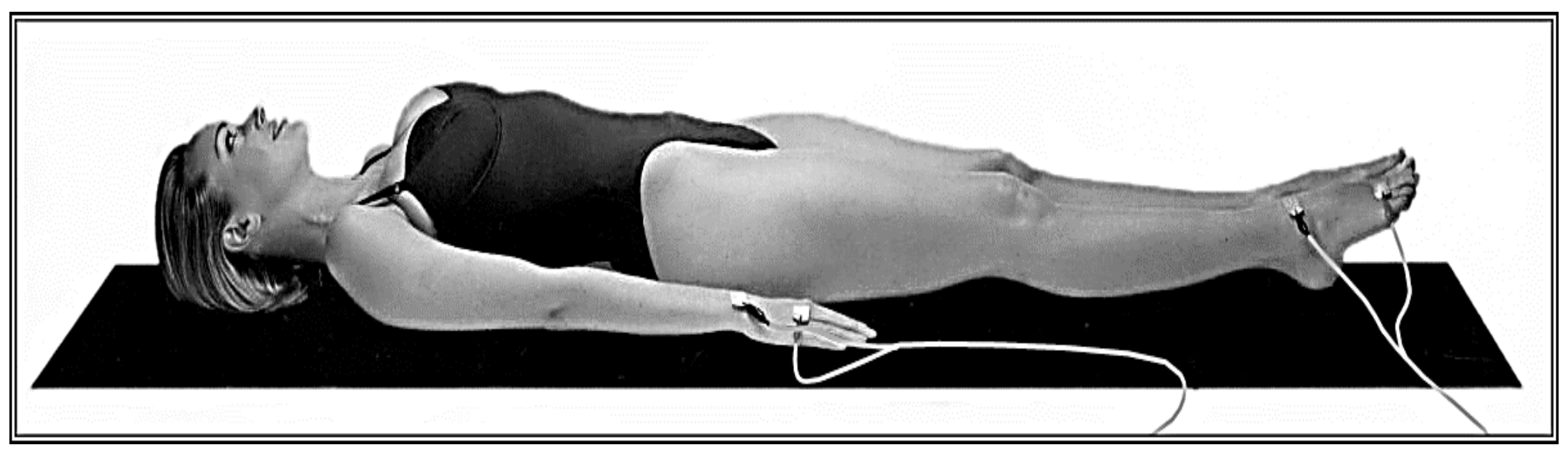
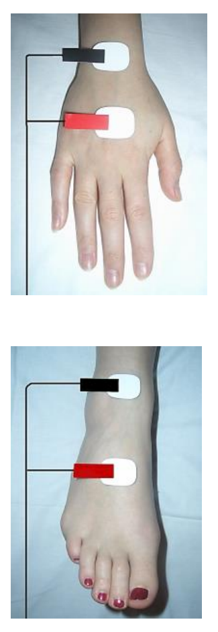
Introduction: One of the contemporary methods of morphological and functional diagnosis of human body composition is bioimpedance analysis (BIA) of its components. The bioimpedance analysis of body composition is achieved by measuring the electrical resistance in different tissues of the biological object. Components of electrical impedance (Z) are the active (R) and reactive resistance (Xc), as given in the relationship $Z^2 = R^2 + Xc^2$, as well as the phase angle (φ, arctg φ = Xc/R; at 5 and 50 kHz, and 800 μA).

"ABC-01 MEDAS"









⇖ *Modeled zones when measured with integral BIA programs.*

The body composition was characterized by both the absolute and relative value of its components, i.e. **Active resistance (R)** → Total body water (TBW = Intracellular + Extracellular BW), Fat free mass (FFM), Fat mass (kg) normalized by height (FM), % Fat mass (%FM), Skeletal muscle mass (kg, %); **Reactive resistance (Xc)** → Active cell mass (ACM, kg), % Active cell mass, Basic metabolic rate (BMR, kcal/day), specific BMR (kcal/sqm per day).

The **aim** of the present study is to identify trends of changes in the components of body composition during childhood and adolescence in boys and girls from Sofia (Bulgaria).

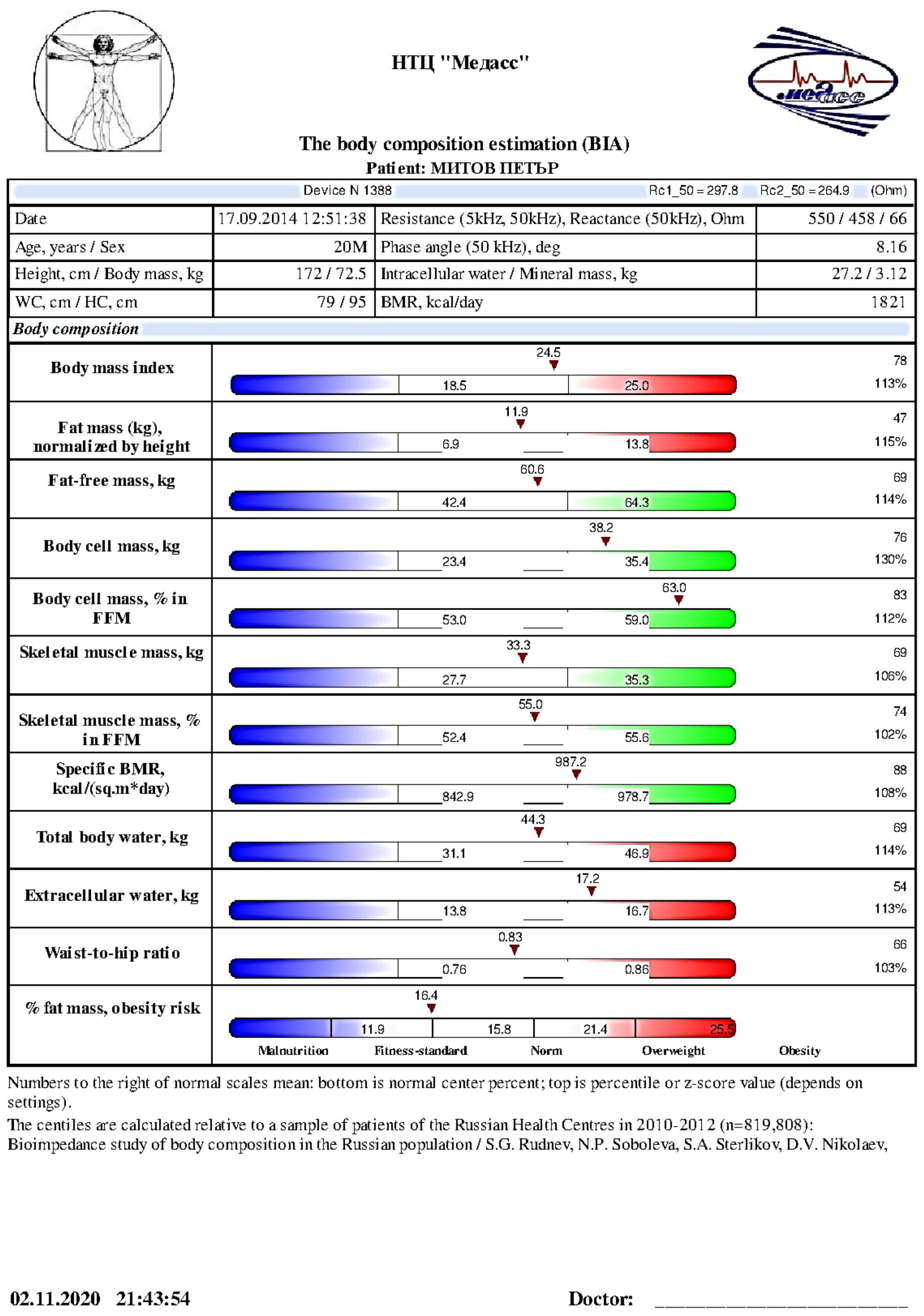
Material and methods

The data was obtained during a complex cross-sectional anthropological study including 1568 schoolchildren (723 boys and 845 girls) aged 7-18 years, from twenty-two schools in Sofia city. The study was carried out between the years 2014 and 2019. Both the boys' and girls' groups were separated in twelve age groups with mean ages of 7.5, 8.5…, up to 18.5 years.

Using standard anthropometric methods data on height (m), body weight (kg), waist and hip circumference (cm) was obtained to be used as a basis for the bioelectric impedance analysis of the body composition with the medical device ABC-01 "MEDASS" (developed by the Moscow Scientific Research Centre "MEDASS").

The individual values of active (R) and reactive resistance (Xc), as well as the phase angle have were obtained.

These measurements have been taken as the basis for the assessment of body composition, and are presented herein.



НТЦ "Медасс"

The body composition estimation (BIA)
Patient: МИТОВ ПЕТЪР

Device N 1388 Rc1_50 = 297.8 Rc2_50 = 264.9 (Ohm)

Date	17.09.2014 12:51:38	Resistance (5kHz, 50kHz), Reactance (50kHz), Ohm	550 / 458 / 66
Age, years / Sex	20M	Phase angle (50 kHz), deg	8.16
Height, cm / Body mass, kg	172 / 72.5	Intracellular water / Mineral mass, kg	27.2 / 3.12
WC, cm / HC, cm	79 / 95	BMR, kcal/day	1821

Body composition

Body mass index	24.5	18.5	25.0	78	113%
Fat mass (kg), normalized by height	11.9	6.9	13.8	47	115%
Fat-free mass, kg	60.6	42.4	64.3	69	114%
Body cell mass, kg	38.2	23.4	35.4	76	130%
Body cell mass, % in FFM	63.0	53.0	59.0	83	112%
Skeletal muscle mass, kg	33.3	27.7	35.3	69	106%
Skeletal muscle mass, % in FFM	55.0	52.4	55.6	74	102%
Specific BMR, kcal/(sq.m*day)	987.2	842.9	978.7	88	108%
Total body water, kg	44.3	31.1	46.9	69	114%
Extracellular water, kg	17.2	13.8	16.7	54	113%
Waist-to-hip ratio	0.83	0.76	0.86	66	103%

% fat mass, obesity risk	16.4	11.9	15.8	21.4	25.5
	Malnutrition	Fitness-standard	Norm	Overweight	Obesity

Numbers to the right of normal scales mean: bottom is normal center percent; top is percentile or z-score value (depends on settings).
The centiles are calculated relative to a sample of patients of the Russian Health Centres in 2010-2012 (n=819,808): Bioimpedance study of body composition in the Russian population / S.G. Rudnev, N.P. Soboleva, S.A. Sterlikov, D.V. Nikolaev,

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Results

The age-gender growth-curves of body composition components have been structured to assess the deviations from the norms for physical development, and to assess the current physiological status of the schoolchildren from Sofia (Figs. 1÷10). Statistically significant gender differences (at $p<0.05$) in the separate body components are marked as a superscript on the respective ages"*" on the graphs.

For comparison, on Figure 1 we have provided growth curves for BMI, where significant differences between boys and girls may be detected from age of 16 years onward when the growth processes and the transformation of the body structure decelerate and show characteristics similar to adults men and women.

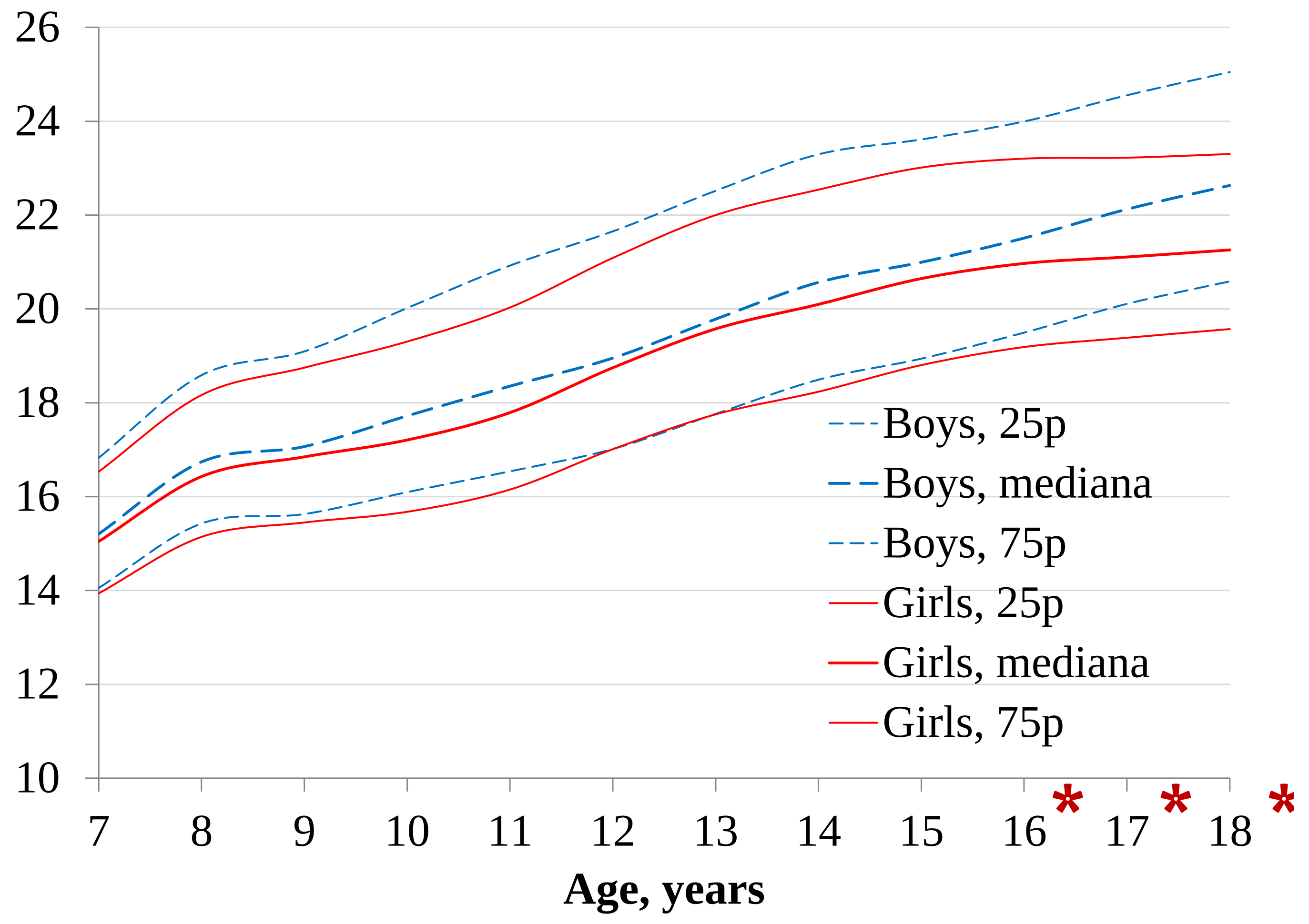

Fig. 1. Body Mass Index, kg/sq.m.

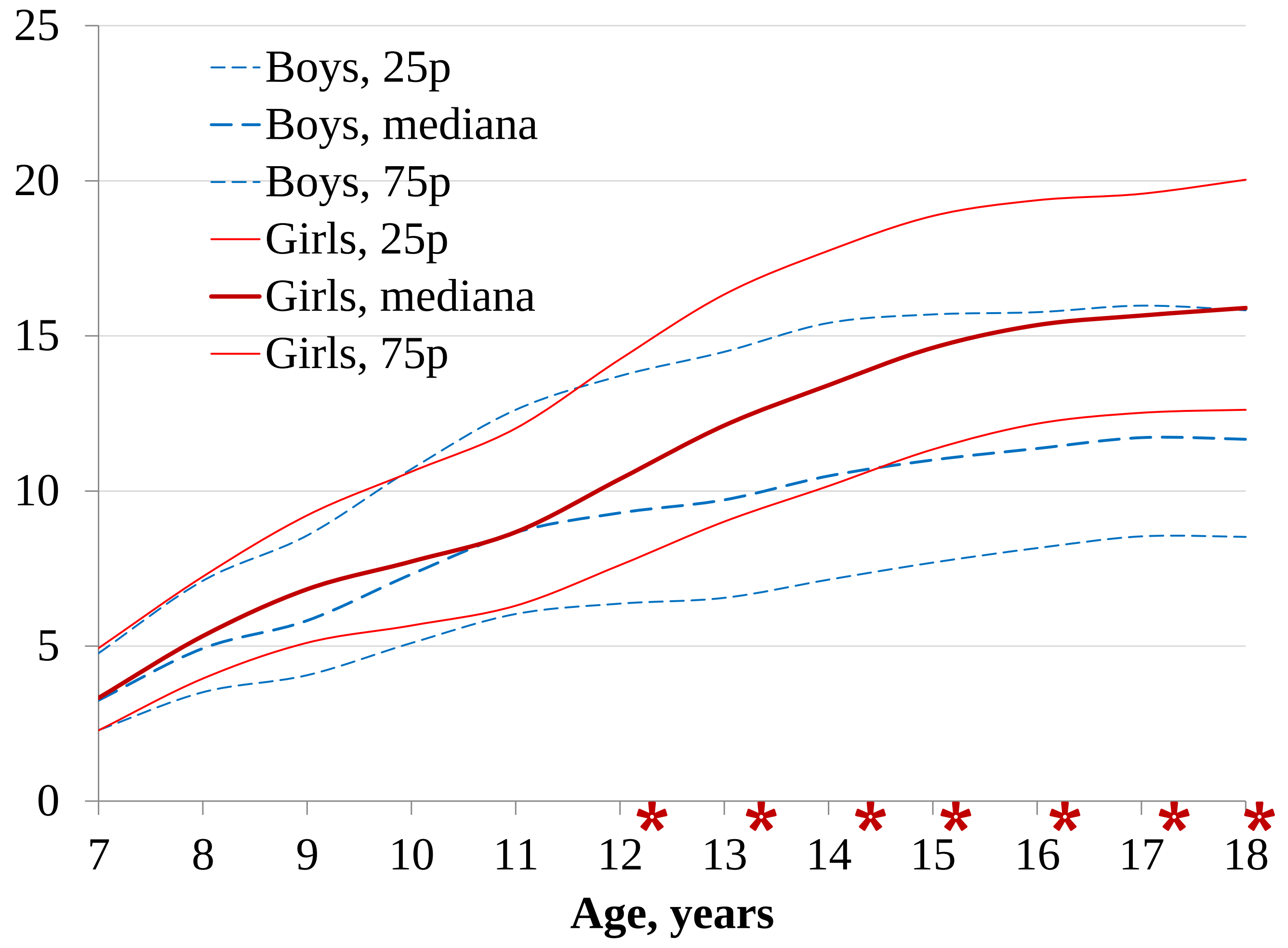

Fig. 2. Fat mass, kg

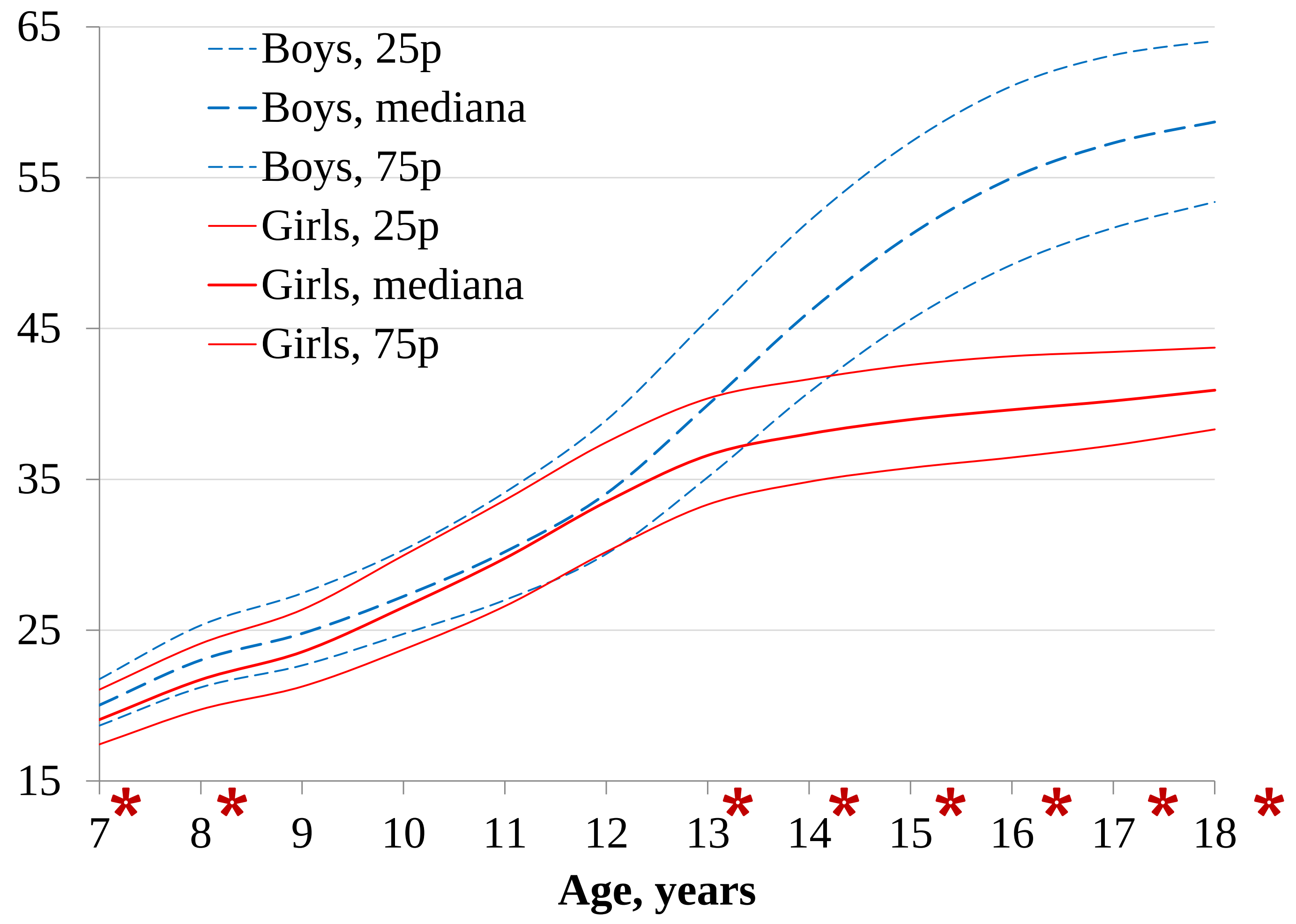

Fig. 3. Fat-free mass, kg

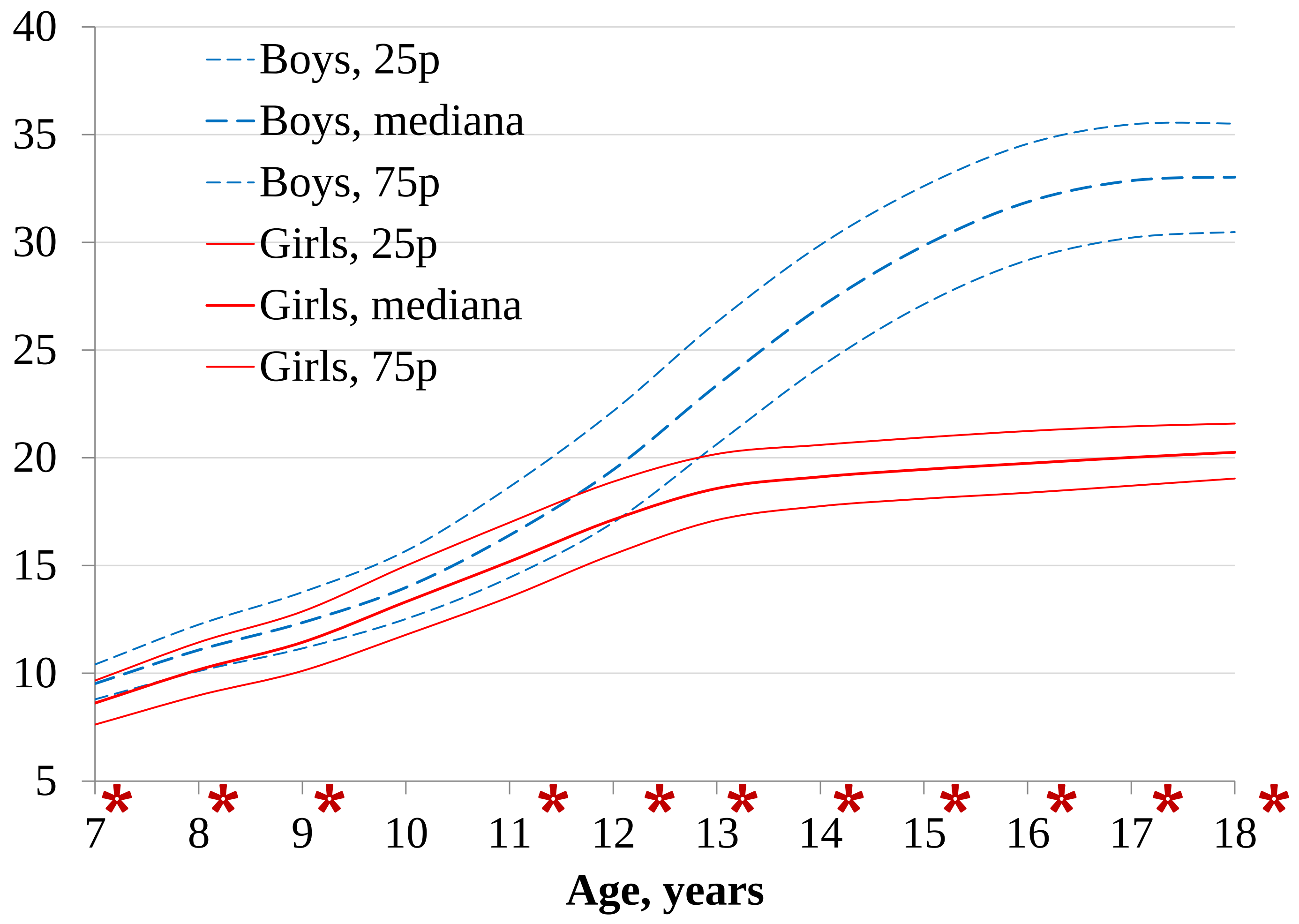

Fig. 4. Skeletal muscle mass, kg

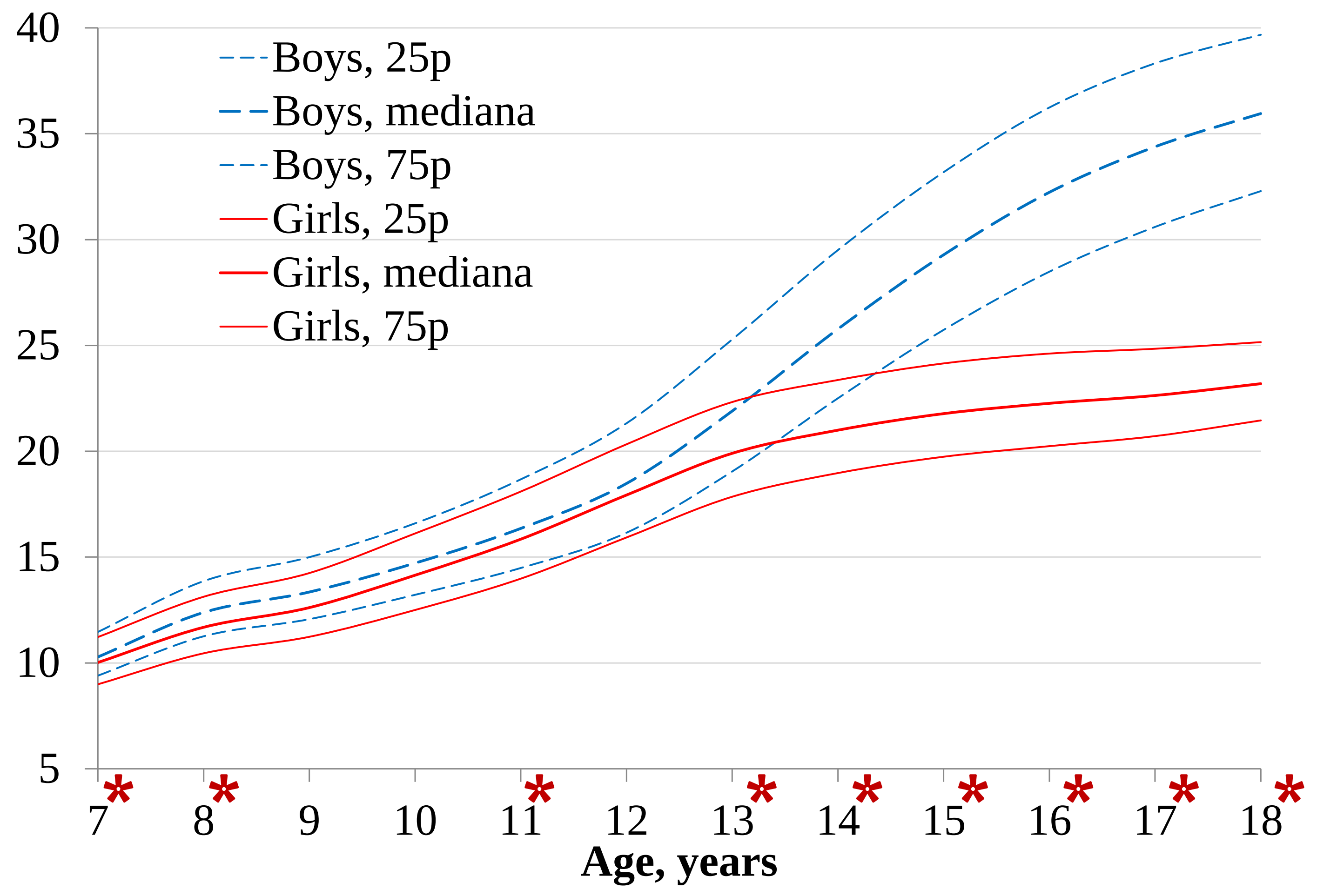

Fig. 5. Active cell mass, kg

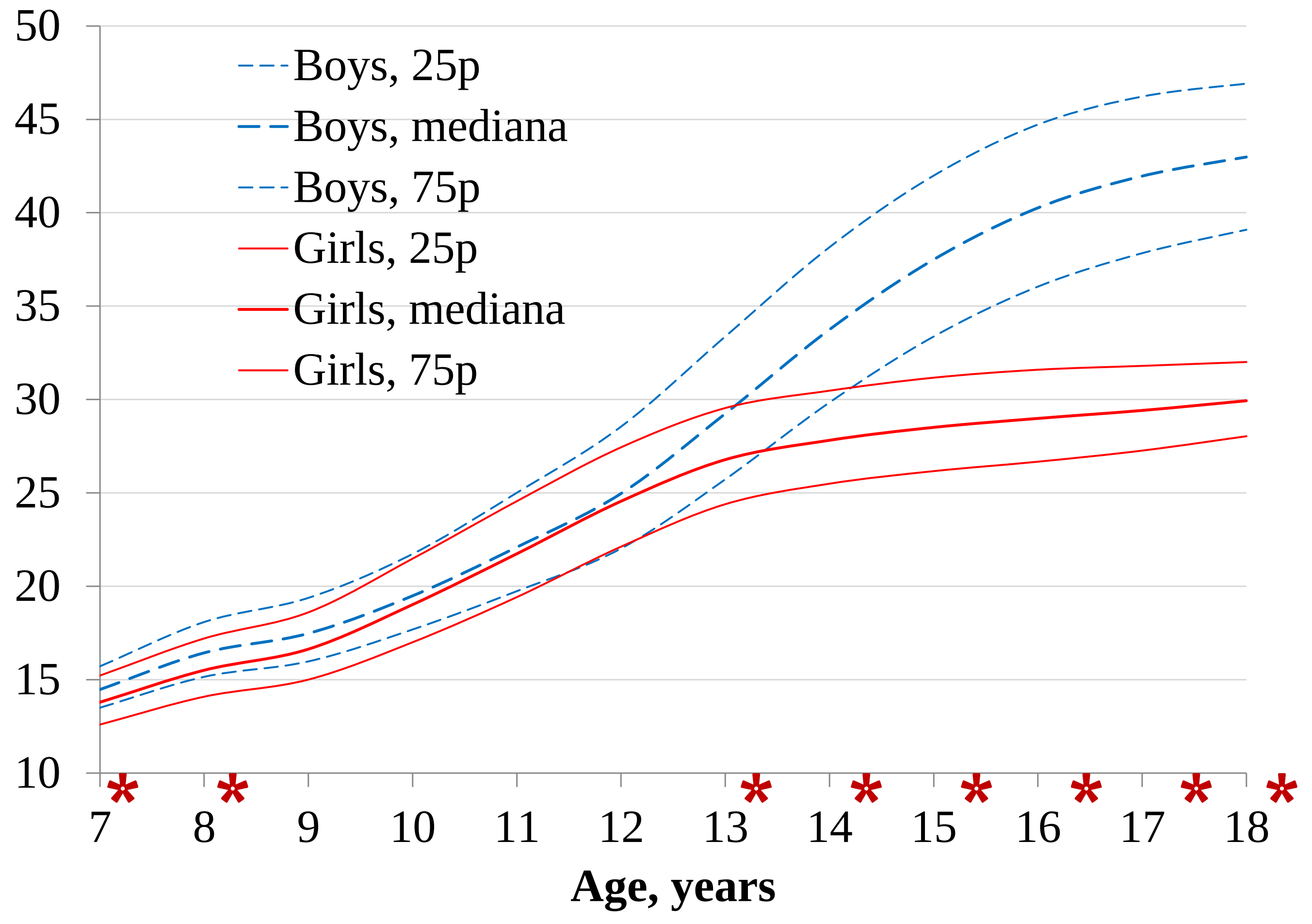

Fig. 6. Total body water, kg

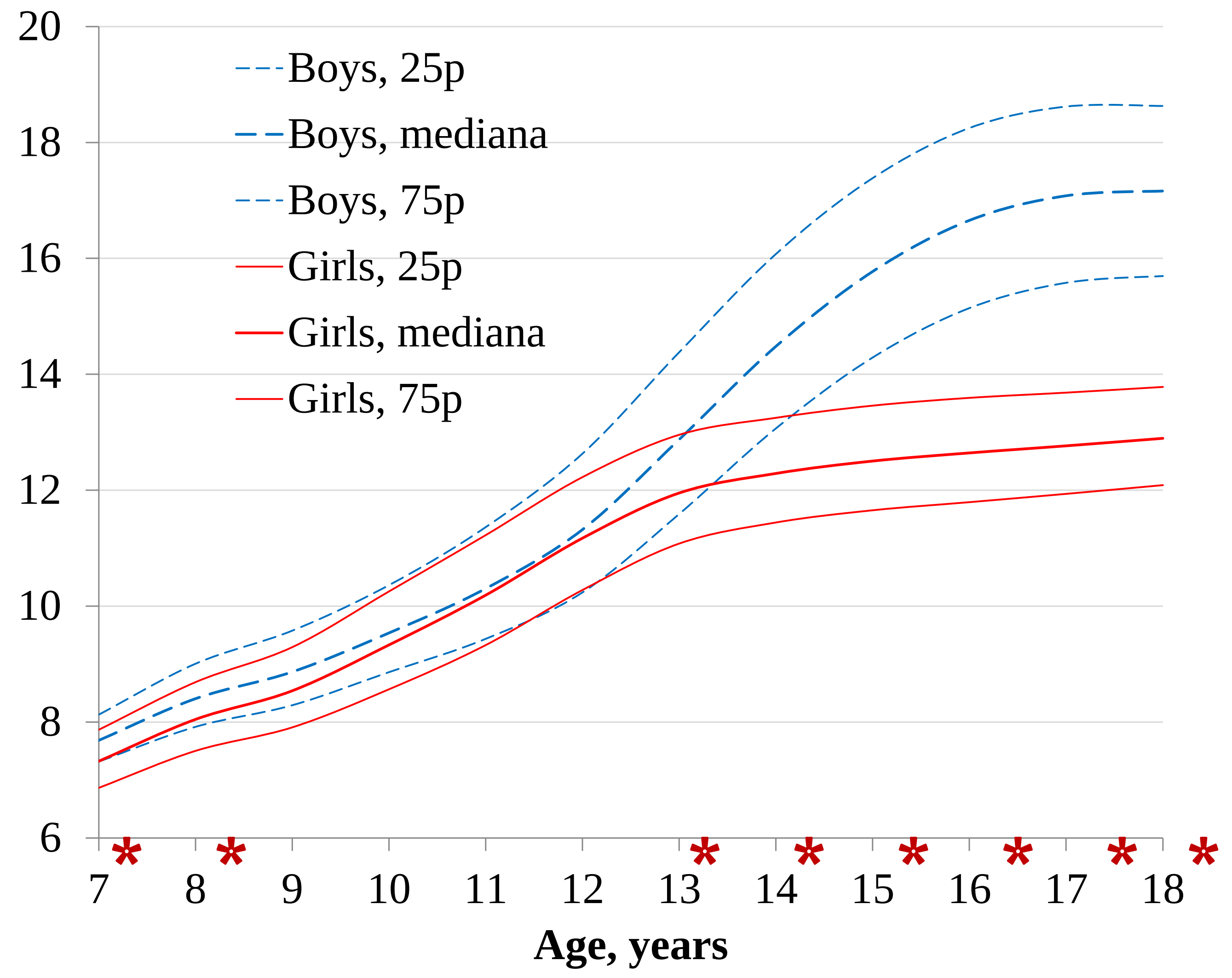

Fig. 7. Extracellular body water, kg

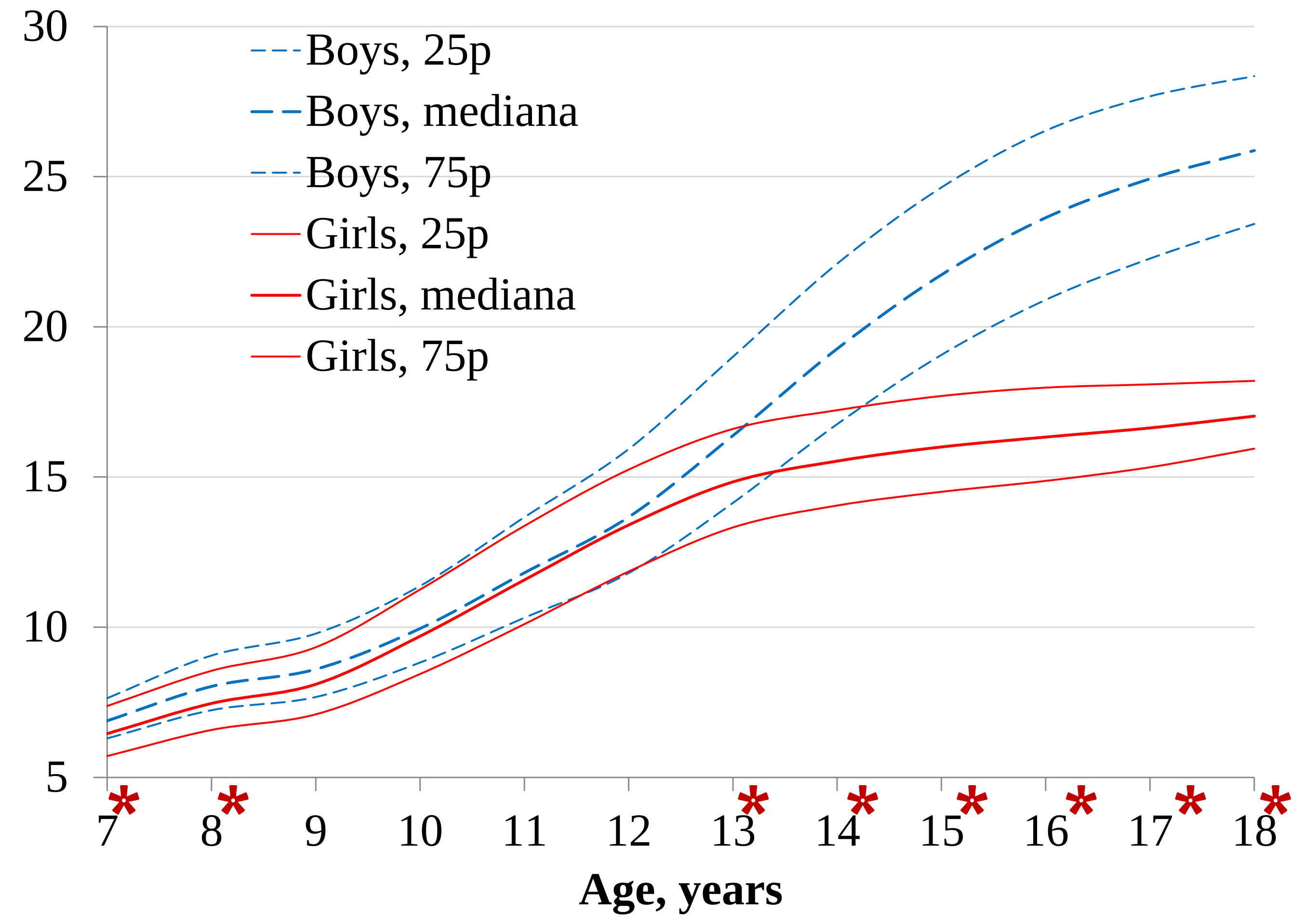

Fig. 8. Intracellular body water, kg

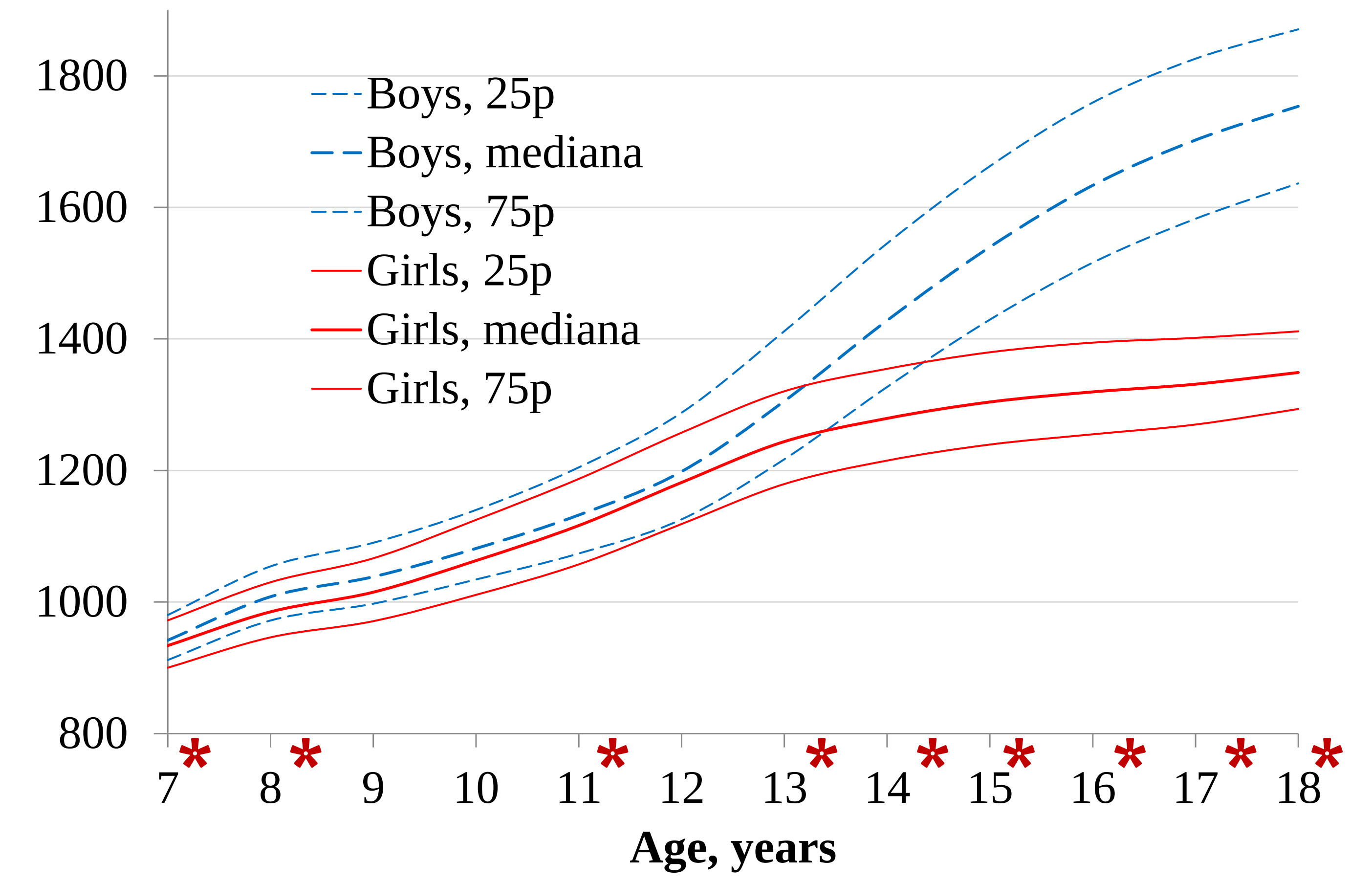

Fig. 9. Basic metabolic rate, kcal/day

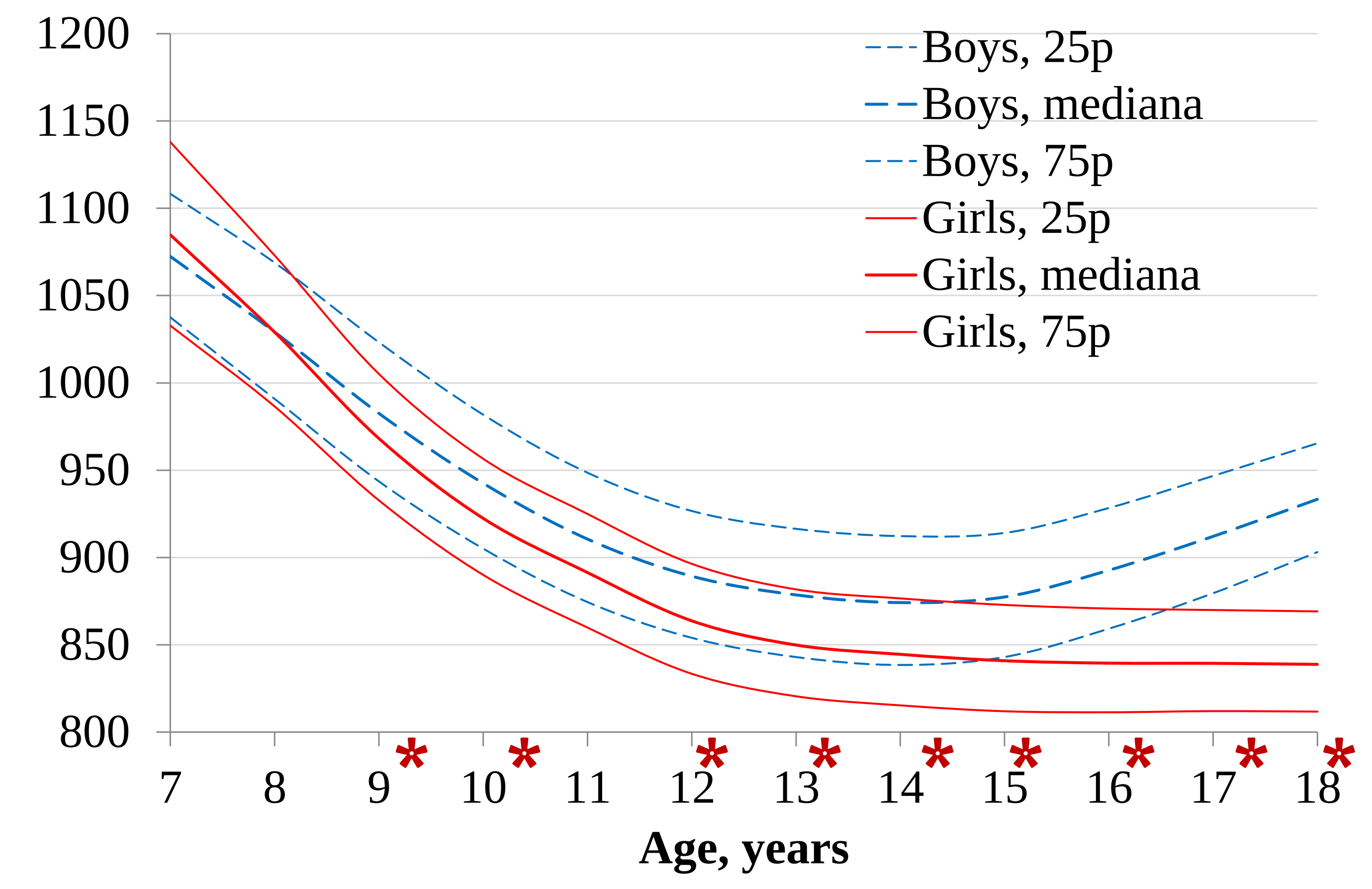

Fig. 10. Specific basic metabolic rate, kcal/sq.m. per day

Conclusion:

All analyzed body composition components corresponded to age and gender physical norms. Basic trends of changes in body composition components during childhood and adolescence in boys and girls from Sofia according to BIA data (as obtained by the "ABC-01 MEDAS" device) were observed and can be summarized as follows:

1) For indicators of general physical development as a measure for the adaptive reserves of the organism, the boys show a constant priority over that of girls.
2) Significant gender differences are found as early as during the child's bodybuilding (i.e., at an age of 7 and 8 years) in FFM, SMM, ACM, TBW, IBW, EBW, and BMR.
3) During and after the pubertal growth phase the differences between the sexes in these body-components tend to become more and more pronounced, being associated with the formation of the typical features of the male bodybuilding.
4) The gender-difference priority in favor of the girls is detected only in the body-fat component.
5) The fat-accumulation is particularly pronounced during the early pubertal development phase in girls, and is accompanied by the topical redistribution of fat mass in the body during the formation of the female bodybuilding.