Novel references for ultrasound estimated testicular volumes and pubic hair in 6 to 16-year-old Norwegian boys

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BACKGROUND

Studies on secular trends in male pubertal development report equivocal results. Lack of reliable pubertal markers makes pubertal assessment in boys challenging, but testicular growth is considered to be the best indicator of pubertal onset.

OBJECTIVES

To present novel references for ultrasound (US) estimated testicular volume (TV) and Tanner stages of pubic hair (PH) in 6 to16-year-old healthy Norwegian boys.

METHODS

TV was measured using US in a cross-sectional study of 514 healthy boys (range: 6.1-16.4 years). A continuous TV for age reference curve was estimated with the LMS-method (Figure 1). Tanner stages for PH were clinically assessed in 452 boys (range: 6.1-16.3 years). Age references for pubertal milestones were estimated for selected TVs (Table 1) and each of the PH stages (Table 2) with probit regression. An empirical equation to predict Prader orchidometer volume from US volume was derived as $Vol_{OM} = 1.96 \times Vol_{US}^{0.71}$(1).

RESULTS

Puberty onset, defined by an US testicular volume of 2.7 ml, corresponding to a Prader orchidometer volume of 4 ml, occured on average at a mean (SD) age of 11.7 (1.1) years. The mean age (SD) of reaching Tanner PH stage 2 was 11.8 (1.2) years.

RESULTS

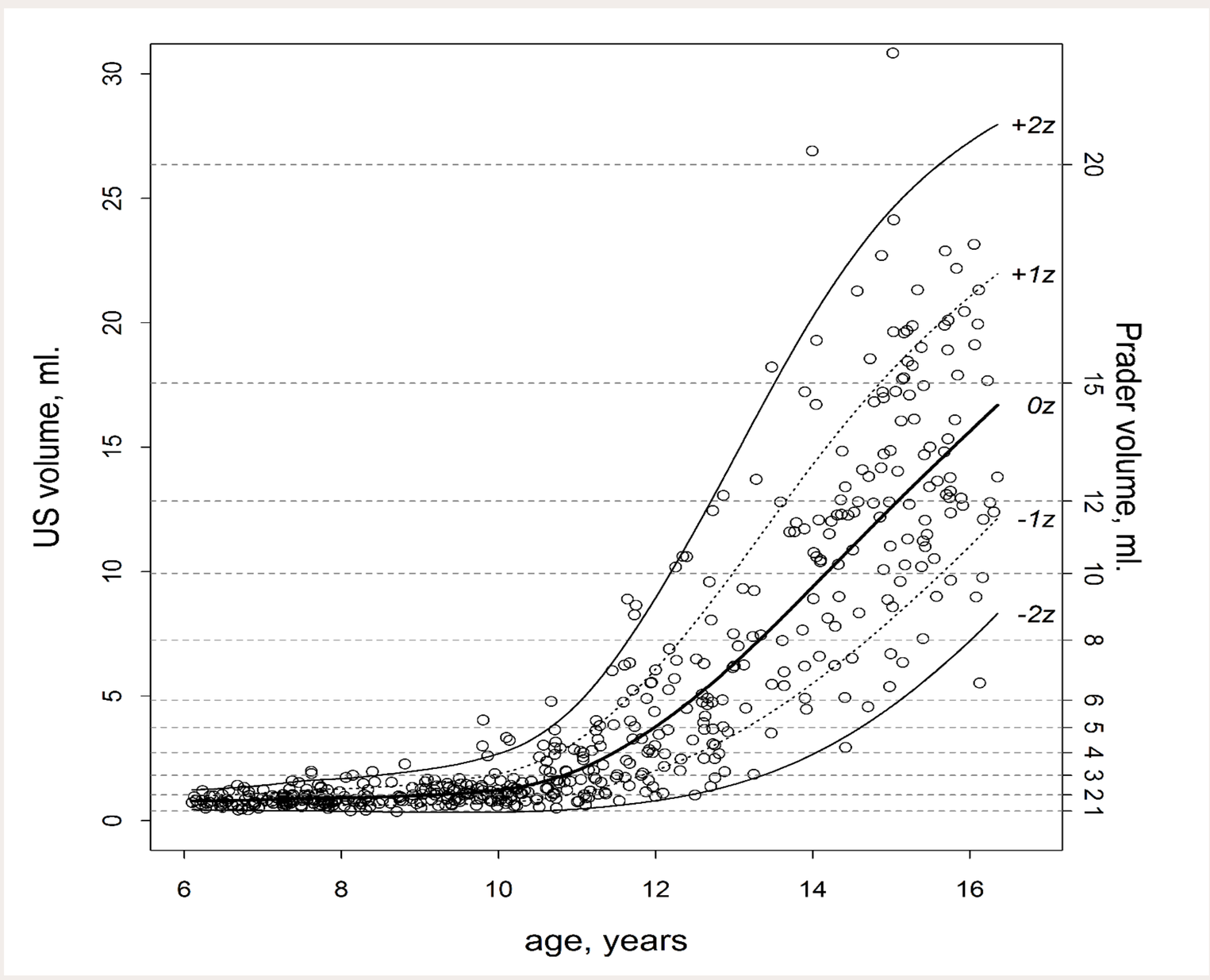

Figure 1 LMS-smoothed reference chart of US measured testicular volumes in 514 healthy Norwegian boys, aged 6-16 years.

Corresponding equivalent Prader orchidometer volumes are shown on the right axis

RESULTS

Table 1 Age percentiles (P) for attaining equivalent Prader orchidometer volume, estimated with probit regression, based on a sample of 514 healthy Norwegian boys aged 6-16 years

Prader	USV	P3	P25	P50	P75	P97
2	1.0	5.2	7.6	8.9	10.3	12.7
3	1.8	8.7	10.2	11.1	11.9	13.4
4	2.7	9.7	10.9	11.7	12.4	13.7
5	3.7	10.4	11.6	12.2	12.9	14.1
6	4.8	10.8	12.0	12.7	13.3	14.5
8	7.2	11.4	12.7	13.5	14.2	15.6
10	9.9	11.8	13.3	14.1	14.9	16.3
12	12.8	12.6	14.2	15.1	16.0	17.6
15	17.6	13.4	15.2	16.3	17.3	19.2

Abbreviations: Prader = equivalent Prader orchidometer volumes (ml); USV = Ultrasound volume (ml)

Table 2 Age percentiles (P) for Tanner pubic hair stages (PH) 2 – 5, estimated with probit regression, based on a sample of 452 healthy Norwegian boys aged 6-16 years

Tanner PH	P3	P25	P50	P75	P97
2	9.5	11.0	11.8	12.6	14.1
3	10.6	11.9	12.7	13.4	14.8
4	11.8	12.9	13.5	14.0	15.1
5	12.7	13.8	14.4	15.0	16.1

Abbreviation: PH= Tanner pubic hair stage

CONCLUSION

New references were estimated for TV measured using US and equivalent Prader orchidometer volumes, and for Tanner PH. US provides continuous measure of TV that allows for calculation of z-scores and to detect smaller changes in the testicular volume, and to detect testicular pathology. No secular trend in pubertal onset was observed when compared to previous studies. The clinical definition of normal pubertal onset in boys remains between 9 to 14 years.

Disclosure statement
There are no conflicts of interest

REFERENCES
[1] Oehme NHB, Roelants M, Bruserud IS, et al. Ultrasound-based measurements of testicular volume in 6- to 16-year-old boys - intra- and interobserver agreement and comparison with Prader orchidometry. Pediatric radiology 2018;48:1771-1778.