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BLADDER CAPACITY. NEW MODELS FOR CHILDREN'S NORMAL MAXIMUM VOIDED VOLUMES.

<u>Hypothesis / aims of study</u>

There is an agreement to use simple formulae (expected bladder capacity and other age based linear formulae) as children bladder capacity benchmark. But real normal child's bladder capacity is unknown. The aims of our study were:

a) To measure the normal maximum voided volumes [MVVs] (maximum [MVV], nocturnal [NMVV] and daytime [DMVV] maximum voided volume) on healthy children between 5-14 years old and based on three-day frequency voiding charts.

b) To construct a model of normal MVVs (MVV, NMVV and DMVV).

c) To compare these new models and assess the reliability of the current linear formulae: Koff's [1], EBC [2] and Rittig's [3] one.

<u>Study design, materials and methods</u>

Epidemiological, observational, transversal, multicentre study. A consecutive sample of healthy children aged 5-14 years, attending 20 Primary Care centres with no urologic abnormality were selected.

Participants filled-in a 3 days frequency-volume chart. Variables were MVVs: (MVV, NMVV and DMVV).

-Statistitcs

A sample size of at least 500 children, stratified by age so that there were approximately 50 per year of age, was estimated to be enough to adequately represent the 5th and 95th extreme percentiles

The MVVs distributions by age, gender, body-measure data (weight, height, and Body Mass Index) and diuresis (average daily output) and its fractions, daytime and nighttime urine output were also evaluated analysing the variance. The level of statistical significance was set at $\alpha = 0.05$.

The consecutive steps method was used in a multivariate regression model with an in-criterion of $p \leq 0.05$ and removed with an out-criterion of $p > 0.1$. Linear, quadratic, cubic, logarithmic, inverse and exponential models were tried, along with their combination with the various variables and its transformations.

<u>Results</u>

From November/2005 to July/2006, informed consents from 891 children 5-14 years old were obtained. Only 531 (67.05%) completed the second visit. 17 children (3.2 %) were excluded. 514 cases were analysed (Tables I and II).

TABLE I. MVV, NMVV and DMVV explanatory models.							
Model	**Factors**		**Not standardized coefficients**		**Standardized coefficients**	**t**	**p**
(R2 adjusted)	**R2 adjusted contribution**		**B**	**Typ. Error**	**Beta**		
MVV f(diur24, height) (63.9)		(Constant)	-0.39786	0.25171		-1.581	.115
	62.0	Log(Diur24)	0.96233	0.10304	0.95413	9.339	.000
	1.5	Log(Height-90)	0.14024	0.03107	0.14549	4.513	.000
	0,4	Diur24	-0.00013	0.00005	-0.25701	-2.570	.010
	Dependent variable: log(MVV)						
Model: Log(MVV) = -0.39786 + 0.96233 Log (Diur24) + 0.14024 Log (Height-90) -0.00013 Diur24							
MVV f(diur24, age) (63.4)		(Constant)	-0.32825	0.25648		-1.280	.201
	62.0	Log(Diur24)	1.01159	0.10291	1.00165	9.830	.000
	0.7	Age-5	0.00558	0.00187	0.09489	2.991	.003
	0.7	Diur24	-0.00014	0.00005	-0.27339	-2.713	.007
	Dependent variable: log(MVV)						
Model: Log(MVV) = -0.32825 + 1.01159 Log (Diur24) + 0.00558 (Age-5) -0.00014 Diur24							
NMVV f(diur24) (56.3)		(Constant)	-0.53829	0.29638		-1.816	.070
	55.0	Log(Diur24)	0.96498	0.11874	0.91681	8.127	.000
	0.5	Log(Height-90)	0.23041	0.06727	0.22744	3.425	.001
	0.5	Age-5	-0.01033	0.00399	-0.16778	-2.588	.010
	0.3	Diur24	-0.00012	0.00006	-0.22135	-2.000	.046
	Dependent variable: log(NMVV)						
Model: Log(NMVV) = -0.53829 + 0.96498 Log(Diur24) +0.23041Log(Height-90) -0.01033 (Age-5) -0.00012 Diur24							
DMVV f(diur24,		(Constant)	-0.17934	0.09711		-1.847	.065
	57.1	Log(Diur24)	0.75346	0.04015	0.63486	18.768	.000

height, gender) (61.5)	3.3	Height	0.00249	0.00038	0.22411	6.643	.000
	1.1	Gender*	0.04327	0.01091	0.10939	3.966	.000
	Dependent Variable: log(DMVV)						
Model: Log(DMVV) = -0.17934+0.75346 Log(Diur24)+ 0.00249 (Height) + 0.04327 Gender*							
DMVV f(diur24, age, gender) (61.2)		(Constant)	0.03819	0.10827		.353	.724
	57.2	Log(Diur24)	0.77497	0.03881	0.65313	19.967	.000
	3.1	Age-5	0.01431	0.00225	0.20712	6.349	.000
	0.9	Gender*	0.03913	0.01092	0.09908	3.581	.000
	Dependent Variable: log(DMVV)						
Model: Log(DMVV) = 0.03819 + 0.77497 Log(Diur24)+ 0.01431 (Age-5) + 0.03913 Gender*							
* Values 0 for male and 1 for female allowed for the direct calculation of one gender (0 value) and the possibility to easily add or multiply a correction factor for the other.							

TABLE II. Bland and Altman agreement analysis of the prediction models

Bias from actual values	**MVV average±2SD**	**NMVV average±2SD**	**DMVV average±2SD**
Koff	-5±238	10±255	88±203
Hjälmas	-40±238	-20±255	58±203
Kaefer	-30±240	-15±249	62±204
Treves	-21±239	-6±249	71±206
Rittig			48±201
Our model	-9±164	-11±185	-10±149
MVV: Maximum Voided Volume. NMVV: Nocturnal Maximum Voided Volume.		DMVV: Daytime Maximum Voided Volume. 2SD: 2 Standard Deviation.	

Interpretation of results

There was poor agreement between MVVs and usual formulae. When diuresis (24h urine output) was added as an explanatory variable to other classical variables (age, gender, and body-measure data), it was observed that diuresis was the most significant factor. With it, the model reached figures of explained variance (R2) of 64, 55 and 62% (for MVV, NMVV and DMVV respectively), versus just 31, 24 and 34% without the diuresis. Diuresis fitted better in an exponential equation.

Concluding message

•Diuresis (not age) was the main factor in every MVVs' prediction model.
•Nocturnal bladder reservoir function differs from daytime's. Nocturnal and daytime maximum voided volumes should be used with different meanings in clinical setting.
•Current formulae are not suitable for clinical use.
•These models are complex, and difficult to be used in clinical settings, therefore practical implementations (like nomograms or computer programs) are needed. In a future paper, they will be offered.

References

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