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Secular changes of the age at menarche and physical performance

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ABSTRACT

As for menarche age, recent results of the "Körmend Growth Study" series are in accordance with those of regional studies (Budapest, Kaposvár, Jászság, Székesfehérvár, Érd, and Makó) in Hungary. The age at menarche was estimated based on data acquisition with "status quo" method and probit analysis, respectively. The median of the estimated values show a positive secular trend in the 20th Century. In the 21st century, this trend became less expressed. Our recent Körmend research in 2018, however, revealed a significant decrease in the age of the first period (M=12.43 year). The reason is probably the robust and significant increase of body mass or even more, that of body fat.

Proper knowledge concerning the sexual maturation process is inevitable for physical instructors, coaches and other sports experts, inasmuch as physical performance of children greatly differs in distinct stages of sexual maturation. The seven item conditional motor capacities test series confirms this as well.

Keywords: growth study, secular trend, menarche, conditional motor capacities

INTRODUCTION

Growth and maturation of children is close-knit to their physical performance (Peltenburg 1984). Thus, it is inevitable to know the transgenerational changes in biological development. In the past few decades, the number of studies concerning the physical maturity, body composition, stature, maturation and physical fitness of children tend to grow by leaps and grounds. Similarly, the impact of environmental factors affecting the aforementioned and the interconnection between these environmental factors are extensively researched. Analysis of the connection between sexual maturation and physical performance came to the front, as well. Results prove to be useful in respect of both average children and young sportsmen. Based on the knowledge experts may size up the potential and limits of the improvement of children's facilities, thus, gym classes and training can be planned more effectively.

The biological development, growth characteristics and changes in girls' maturation had been followed up by Ottó Eiben (Eiben 1988, 1994, 2001, Eiben and Tóth 2000, 2022) for 40 years in Körmend (Western Hungary, Europe) population.

The first cross-sectional study performed in 1958 was succeeded by follow-up investigations in every tenth year thereafter. Carrying on Eiben's research, the 2008 and 2018 follow-ups of the growth study were led by Gábor Tóth (Suskovics and Tóth 2009, 2011, Tóth and Suskovics 2020, Tóth et al. 2011, 2012, 2014, 2015, 2016, 2017). Based on the series of seven consecutive researches, 60 year's changes can be traced. The aim of the present paper is to determine the secular trend of 60-year changes in sexual maturation. The link between sexual maturation and physical performance is discussed, too.

MATERIAL AND METHODS

Data acquisition regarding the age at menarche of Körmend girls (1958-1968-1978-1988-1998-2008-2018) was performed by means of "status quo" method, estimation was based on probit analysis.

The cleaned sample of the cross-sectional research in 2018 was N= 1195, containing the data of 3-18-year-old children and young ones, respectively (involving 77.2 % of the age matched total population). The number of girls within the sample is 559.

Conditional motor capacities were tested by means of hand grip strength, medicine ball push, standing long jump, sit-up test, Burpee test, 60 m dash and Cooper test (Eiben et al. 1991).

RESULTS AND DISCUSSION

Eiben's results have been mirroring the changes of the age at menarche during the past almost half a century. After a spectacular positive trend, the acceleration of sexual maturation came to a standstill, confirmed by the 2008 medians. However, our 2018 research shows significant alteration, namely a decrease in the age at menarche again. Median of the age at menarche was M=12.43 year (Figure 1, Table 1). The question arises: what could be the cause this unexpected, surprising decline? Compared to our 2008 data, the body mass, and, what is being more important with a view to the age of the first period, the body fat of girls have increased to a critical extent (Tóth and Suskovics 2020). Thus, the background of such a great decline in the age at menarche could probably be the strongly significant increase of body mass, or, even more, that of the body fat.

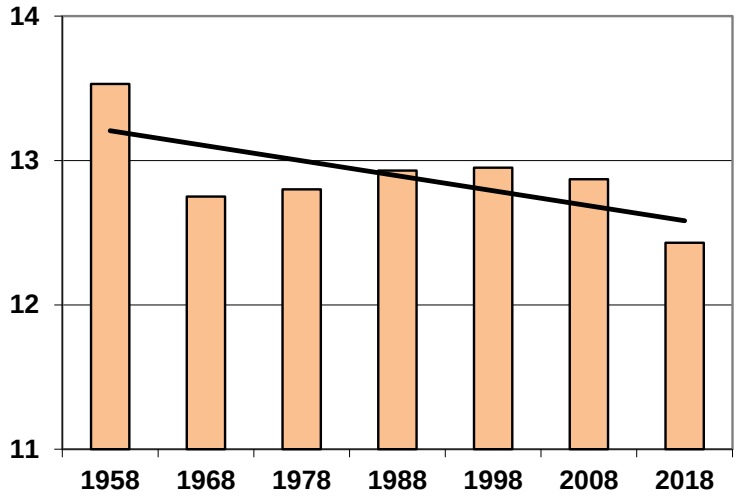

Figure 1: Changes in the median values of the age at menarche of Körmend girls

Table 1: *Changes in the median values of the age at menarche of Körmend girls*

Year of research	Age of menarche — median (years)	Researcher performing the study
1958	13.53	Eiben
1968	12.75	Eiben
1978	12.80	Eiben
1988	12.93	Eiben
1998	12.95	Eiben & Tóth
2008	12.89	Tóth & Suskovics
2018	12.43	Tóth & Suskovics

The secular trend of the sexual maturation among Körmend girls is in accordance with the results of regional studies in Hungary (Table 2). The very first of the latter ones is the median of the age at menarche in Kaposvár, published by Véli in 1947 (Véli 1968). Its result (M=13.9

year) is one of the earliest estimated value worldwide, gained by methods (status quo method, probit analysis) still used in our days. Between 1947 and 2012, a positive secular trend could be observed in Kaposvár, however, with a gradually flattening curve (Bodzsár and Véli 1980, Környei et al. 1983, Suskovics and Eiben 2002, Suskovics and Tóth 2009, Véli 1968). The same tendency can be observed in other regions (Budapest, Jászság, Székesfehérvár, Érd, Makó), too. The results are in accordance with experiences of others (Bodzsár 2001, 2002, Eiben et al. 1992, Farkas and Horváth 2003, Gyenis and Szerényiné Pásztor 1984, Gyenis et al. 2001, Hidegh 1995, Pápai et al. 2007, Thoma 1960), stating that the decline in the age at menarche has stopped, in some cases turning into an increase towards a higher age. It is to be noted at this point that even the most recent data from these growth studies, even that from the ongoing ones, date back to the turn of the millennium or even earlier ages. Thus, most recent researches would probably reveal as surprising changes as we have found in Körmend study.

Table 2: Changes in the median values of the age at menarche of Hungarian girls

Research site	Year of research	Age of menarche – median (years)	Researcher performing the study
Budapest	1959	12.75	Thoma
	1960	12.94	Dezső
	1970 - 1988	12.40	Eiben et al.
Kaposvár	1947	13.90	Véli
	1962	12.98	Véli
	1975	12.72	Bodzsár & Véli
	1981	12.69	Környei et al.
	1997	12.61	Suskovics & Eiben
	2012	12.58	Suskovics & Tóth
Érd	1979	12.85	Gyenis & Sz. Pásztor
	1989	12.60	Hidegh
	1999	12.56	Gyenis et al.
Jászság	1983-1984	12.75	Pápai et al.
	2004	12.68	Pápai et al.
Makó	1983	12.66	Farkas & Horváth
	2002	12.72	Farkas & Horváth
Székesfehérvár	1972	12.61	Bodzsár
	1982	12.65	Bodzsár
	1991	12.54	Bodzsár

The biological age of children is not identical with their chronological age. Apparently, children's physical performance may significantly differ even within distinct age brackets. Results are highly influenced by body mass, body composition and other human biometric parameters as well (D'Hondt et al. 2009, Etchison et al. 2011, Heyward and Gibson 2018, Kruschitz et al. 2013, Malina 1980, Suskovics 2000). Children being at different levels of sexual maturation show varying performance, too (Malina 1980, Pápai et al. 1991, 1992, Suskovics 2005). It turned out that, within the groups arranged by different sexual maturity levels, the trend of boys' performance is distinct from those of girls (Suskovics 2006, Suskovics and Rendes 2009).

Based on our Kaposvár studies (Suskovics 2005), girls being at a higher stage of sexual maturation (thus, girls menstruating already) show better capacity on tests where body mass plays a critical role. In other motor tests, however, their performance is equal or even lower (Figure 2-8).

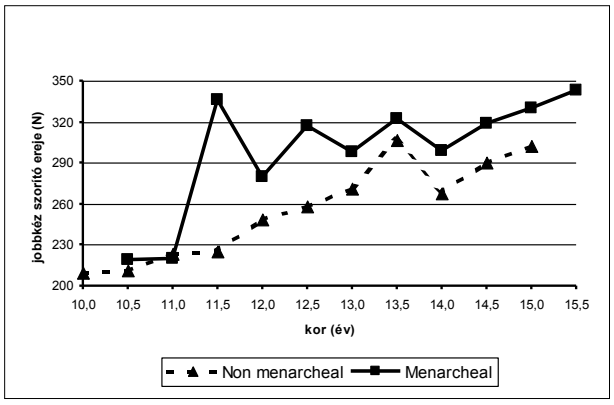

Figure 2: Right hand grip strength of menstruating and non-menstruating girls

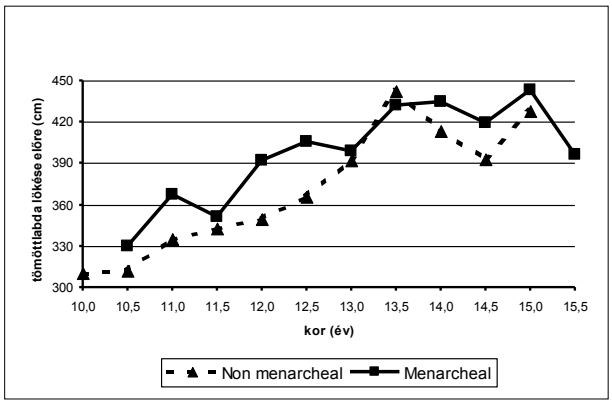

Figure 3: Medicine ball push forwards – menstruating and non-menstruating girls

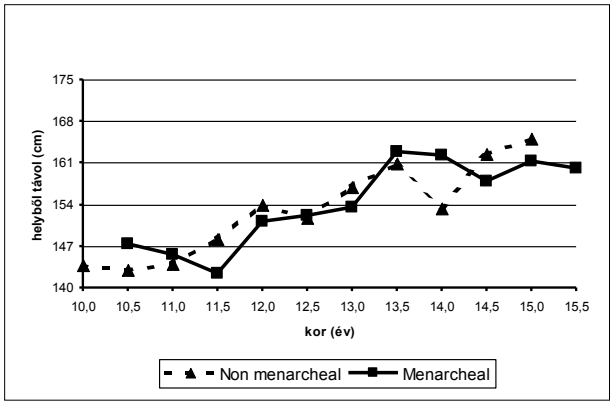

Figure 4: Standing long jump – menstruating and non-menstruating girls

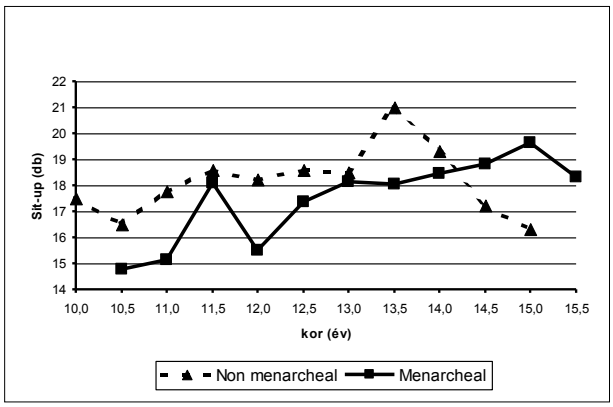

Figure 5: Sit-up test – menstruating and non-menstruating girls

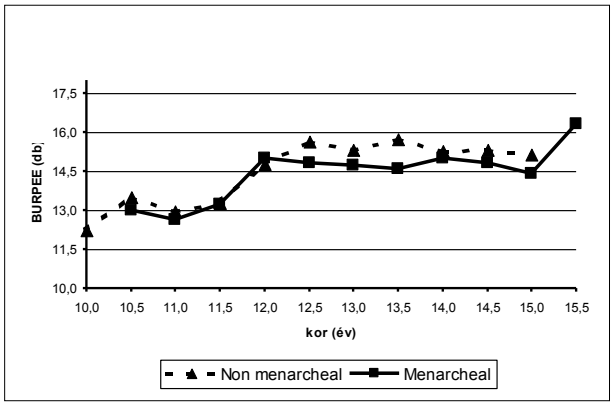

Figure 6: Burpee-test – menstruating and non-menstruating girls

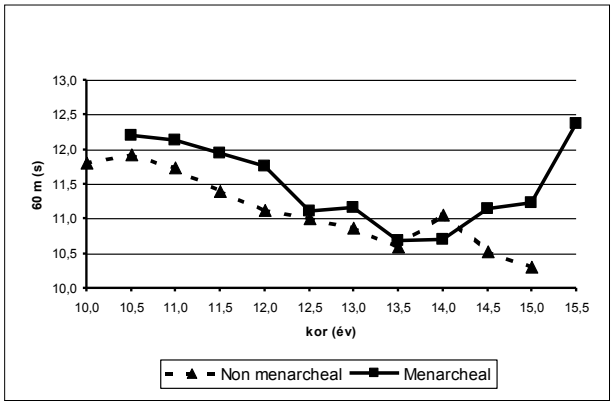

Figure 7: 60 m dash – menstruating and non-menstruating girls

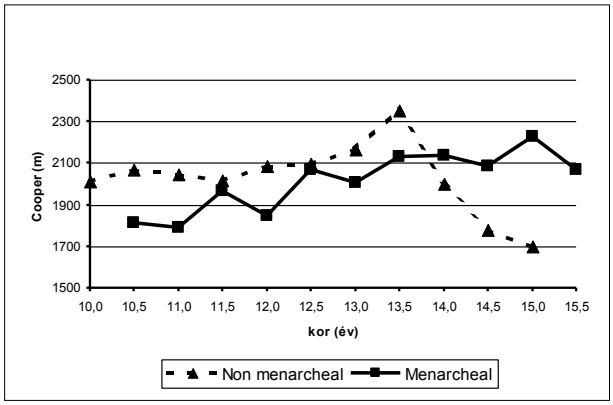

Figure 8: Cooper-test – menstruating and non-menstruating girls

According to the above, greater body mass is an important factor of capacity in tests (hand grip strength and medicine ball push) where absolute strength plays a crucial role. Post-menarcheal girls are heavier and taller than their biologically less maturated peers are. Moving this greater inert mass requires greater muscle strength. Better results in tests requiring static exertion is, in all likelihood, a consequence of increased muscle strength. This theory is supported also by Malina's (Malina 1980) conclusion stating that increased static strength is related to body mass gain. In other motor tasks, however relative strength dominates over the absolute one. Thus, the capacity of premenarcheal girls is fairly equal to or better than that of their peers in those tests where moving the own body mass is required. The background of the difference seen in children with similar capability but different body mass is the fact that, as body mass increases, absolute strength increases too, while relative strength decreases. Body mass is in direct proportion to body volume, whiles strength is in direct proportion to the transverse section of the muscle. That explains the above statements. Parallel with the child's biological development, its muscle strength (absolute strength) increases, too. The latter is, however, out of proportion to the more intense biological development. Thus, as body volume increases, body mass gain follows this advancement faster than strengthening of muscles does. As a conclusion, greater body mass is an important factor of efficiency in movements where absolute strength plays a significant role. This is the account for the fact that menstruating girls with greater body mass perform better not only in hand grip strength test but in medicine ball push, requiring dynamic strength, too. During these tests the child's own body is not put in motion, the latter would definitely require more energy. Other tasks, however, go hand in hand with either locomotion or relocation of such an extent that implies the transposition of the centre of gravity. Relative strength plays a decisive role in movements where the outcome highly depends on the effort resulting in relocation of the body. Relative strength refers to the strength benchmarked against body mass.

If body mass increases, relative strength generally decreases. This is supported by the results gained from those tests where the subject had to move its own body mass. While performing these types of tests, there is either no difference between the performances of the two groups arranged by their different biological maturity levels, or, even more characteristically, post-menarcheal girls achieve worse results. Thus, the rise in the capacity of girls halts after the peak of the growth spurt in adolescence. Although girls being at a higher level of biological maturity are brawnier, their physical fitness is not better than their age matched peers. It follows from this, that the body mass excess of adolescent girls is primarily less related to the increase of muscle mass than to that of body fat mass. The latter, however, hinders efficiency.

REFERENCES

Bodzsár, É. B. (2001): Maturation, body composition and mental performance. Acta Med. Auxol. 33(2); 89–95.

Bodzsár, É. B. (2002): Sexual maturation and body composition in puberty. Humanbiol. Budapest. 27; 27–38.

Bodzsár, É. B., Véli, Gy. (1980): The changing of height and weight of body during half a century in Hungary. Glass. Antr. Dr. Jug. 17; 69–75.

D'Hondt, E., Deforche, B., De Bourdeaudhuij, I., Lenoir, M. (2009): Relationship between motor skill and body mass index in 5- to 10-year-old children. Adapt. Phys. Act. Q. 26; 21–37.

Eiben, O. G. (1988): Szekuláris növekedésváltozások Magyarországon. Humanbiol. Budapest. Suppl. 6.

Eiben, O. G. (1994): The Körmend Growth Study: Data to secular growth changes in Hungary. In: Eiben, O. G. (ed.): Auxology '94. Children and youth at the end of the 20th Century. Humanbiol. Budapest. 25; 205–219.

Eiben, O. G. (2001): Changes of age at menarche over a half century in Körmend Growth Study. Anthropological Notebooks 7(1); 33–44.

Eiben, O. G., Tóth, G. (2000): Secular changes of sexual differences in height during puberty. In: Bodzsár, É. B., Susanne, C., Prokopec, M. (eds.): Puberty: Variability of changes and complexity of factors. Eötvös Univ. Press, Budapest. 177–183.

Eiben, O. G., Tóth, G. A. (2022): A classical secular trend research from Central Europe: The Körmend Growth Study (KGS). Human Biology Review 11(1); 1–19.

Eiben, O. G., Barabás, A., Pantó, E. (1991): The Hungarian National Growth Study I. Humanbiol. Budapest. 21.

Eiben, O. G., Farkas, M., Körmendy, I., Paksy, A., Varga Teghze-Gerber, Zs., Vargha, P. (1992): A Budapesti Longitudinális Növekedésvizsgálat 1970-1988. Humanbiol. Budapest. 23.

Etchison, W. C., Bloodgood, E. A., Minton, C. P., Thompson, N. J., Collins, M. A., Hunter, S. C., Dai, H. (2011): Body mass index and percentage of body fat as indicators for obesity in an adolescent athletic population. Sports Health 3; 249–252.

Farkas, Gy. L., Horváth, K. (2003): Makói fiatalok testi fejlettsége és obesitása. Anthrop. Közl. 44; 63–87.

Gyenis, Gy., Szerényiné Pásztor, Zs. (1984): „Érd ’79”. Az érdi iskolásgyermekek testi fejlettsége. Humanbiol. Budapest. Suppl. 2.

Gyenis, Gy., Szerényiné Pásztor, Zs., Horváthné Hidegh, A. (2001): „Érd ’99” növekedésvizsgálat (Előzetes eredmények). Anthrop. Közl. 42; 105–109.

H. Hidegh, A. (1995): Az érdi iskoláskorú gyermekek testi fejlettsége 1989-ben. PhD thesis. ELTE, Budapest.

Heyward, V. H., Gibson, A. L. (2018): Assessing body composition. In advanced fitness assessment and exercise prescription. Human Kinetics, Champaign. 219–266.

Környei, V., Gyódi, Gy., Gelencsér, E., Kercsó, K., Szokola, Á. (1983): Kaposvári leányok menarchekora 1981-ben. Anthrop. Közl. 27; 39–44.

Kruschitz, R., Wallner-Liebmann, S. J., Hamlin, M. J., Moser, M., Ludvik, B., Schnedl, W. J., Tafeit, E. (2013): Detecting body fat. A weighty problem BMI versus subcutaneous fat patterns in athletes and non-athletes. PLoS ONE, 8, e72002.

Malina, R. M. (1980): Growth, strength and physical performance. In: Stull, G. A., Cureton, T. K. (eds.): Encyclopedia of physical fitness and sports. Training, environment, nutrition and fitness. Salt Lake City, Brighton. 443–470.

Malina, R. M., Bouchard, C., Bar-Or, O. (2004): Growth, maturation, and physical activity. Human Kinetics.

Pápai, J., Bodzsár, É. B., Szmodis, I. (1991): Relationship between indices of sexual maturation and physical performance. Anthrop. Közl. 28; 125–130.

Pápai, J., Szabó, T., Tróznai, Zs., Szabó, A. (2007): Secular trend in maturation, body composition and physical performance. Humanbiol. Budapest. Suppl. 31; 123–131.

Pápai, J., Szmodis, I., Bodzsár, É. (1992): Growth, maturation and performance. Anthrop. Közl. 34; 75–82.

Peltenburg, A. L. (1984): Growth and biological development of female athletes. Drukkerij Elinkwijk BV, Utrecht.

Suskovics, Cs. (2000): Differences in body dimensions and maturity status of the girls. In: Bodzsár, É. B., Susanne, C., Prokopec, M. (eds): Puberty: Variability of changes and complexity of factors. Eötvös Univ. Press, Budapest. 95–104.

Suskovics, Cs. (2005): A leányok nemi érése és fizikai teljesítménye. Folia Anthrop. 3; 9–20.

Suskovics, Cs. (2005): Relationship between sexual maturity of the girls and their physical performance. Kalokagathia 43(3); 35–46.

Suskovics, Cs. (2006): Sexual maturation and sport abilities. New Horizons – Fitness Research 23; 199–209.

Suskovics, Cs., Eiben, O. G. (2002): Secular changes in growth and maturation in Kaposvár (South-West of Hungary) over the last Century. In: Eiben O. G., Bodzsár É. B. (eds): Children and youth at the begining of the 21st Century. Humanbiol. Budapest. 27; 185–196.

Suskovics, Cs., Rendes, K. (2009): Trends in girls' and boys' performance on different levels of sexual maturity. In: Hughes M., Dancs H., Nagyváradi, K. (eds): Research in sport science. Data2Win, Cardiff. 183–194.

Suskovics, Cs., Tóth, G. (2009): The maturation of Hungarian girls during the past 60 years. Papers on Anthrop. 18; 353–360.

Suskovics, Cs., Tóth, G. (2011): Secular trend in changes of the subcutaneous fat in the Transdanubian Region among 3-18-year-old children – unfavourable changes. In: Hughes, M., Dancs, H., Nagyváradi, K., Polgár, T., James, N., Sporis, G., Vuckovic, G., Jovanovic, M. (eds): Research methods and performance analysis. Univ. of West Hung., Szombathely. 136–145.

Thoma, A. (1960): Age at menarche, acceleration and heritability. Acta Biol. Acad. Sci. Hung. 11; 241–254.

Tóth, G., Suskovics, Cs. (2020): Körmendi Növekedésvizsgálat 2018. Folia Anthrop. 16; 71–81.

Tóth, G., Buda, B., Suskovics, Cs. (2015): A classical secular trend research from Central Europe: The Körmend Growth Study. In: Sikdar, M. (ed): Human growth – The mirror of the society. B. R. Publ. Corp., Delhi. 169–199.

Tóth, G., Buda, B., Suskovics, Cs., Cornélissen, G. (2016): Half a century of the Körmend Growth Study: BMI and skinfold values. Int. Journ. of Anthrop. 31(1–2); 51–60.

Tóth, G., Molnár, P., Suskovics, Cs. (2012): Gender differences and secular trends in height, pattern of growth and maturation during puberty. Human Biol. Rev. 1(1); 16–21.

Tóth, G., Molnár, P., Suskovics, Cs. (2014): Trends in body mass index in school-age children in Central-Europe (Transdanubia, Hungary). Human Biol. Rev. 3(2); 167–174.

Tóth, G., Németh, J., Molnár, P., Suskovics, Cs. (2014): The Körmend Growth Study 1968 and 2008: Somatotypes of the boys. Papers on Anthrop. 23(2); 117–121.

Tóth, G. A., Suskovics, Cs., Buda, B., L (2011): The values of body surface in Hungarian children based on the Körmend Growth Study. Health, Demography, Ecology of Finno-Ugric Peoples 4; 39–42.

Tóth, G., Suskovics, Cs., Buda, B. L., Cornélissen, G. (2015): Analysis of body mass index (BMI) of 3 to 18-year-old boys in 6 cohorts. Journ. of Human Sport and Exerc. 10(1); 462–470.

Tóth, G., Suskovics, Cs., Buda, B., Cornélissen, G. (2017): Boys' BMI from early preschool to late adolescence: Evaluation of six decades' data. Papers on Anthrop. 26(1); 88–96.

Tóth, G. A., Suskovics, Cs., Molnár, P., Dancs, H., Sporis, G., Milanovic, Z. (2012): The Körmend Growth Study: Historical background and secular trends among children aged 3-18 years. Acta Kinesiol. 6; 82–86.

Véli, Gy. (1968): A testi fejlődés és a menarche. Anthrop. Közl. 12; 161–171.