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Dynamics of Changes in Standing Broad Jump among Girls and Boys Aged 8 to 18, as well as Women and Men aged 32-34 and 50- 52 (Based on Longitudinal Studies)

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ABSTRACT

Aim: The aim of the study was to analyse the dynamics of changes in standing broad jump (SBJ) length as a measure of physical fitness among girls and boys in their developmental years (childhood and adolescence), and in women and men aged 32-34 and 50-52, based on the Kraków Longitudinal Growth Study (KLGS). The study was aimed at examining motor development, sex-related differences and correlations between SBJ and somatic characteristics (body height and mass), taking ageing and physical fitness results into account.

Material and methods: The study was based on longitudinal data from the KLGS (1976–2022), including 18 women and 32 men, selected on the basis of continuity of SBJ measurements. Measurements of somatic characteristics (body height and mass) and lower limb explosive strength (SBJ) were taken in standard conditions, in accordance with the ethical protocol. Descriptive statistics, Pearson's correlation coefficients and the Student's t-test (α=0.05) were used to verify hypotheses concerning changes in SBJ and dependence on somatic characteristics.

Results: The standing broad jump distance increased during childhood and adolescence, with marked sex-related differences after the age of 12, reflecting motor development. At ages 32-34, performance declined, and at ages 50-52, further regression was observed, indicating the impact of ageing on physical fitness. Correlations between SBJ and height were significant in males during adolescence and early adulthood, and negative for body mass in 8-year-old girls and 50-52-year-old males.

Conclusions: It was found, among others, that the standing broad jump reflects dynamic motor development during developmental years (childhood, adolescence), with a marked decline in adulthood, which is greater in women due to the ageing of physical fitness.

Keywords: Standing Broad Jump; Body Height; Body Mass; Childhood; Adolescence; Females; Males; Longitudinal Studies; Kraków; Poland.

1. Introduction

Human physical fitness is a dynamic trait that changes depending on age, gender, genetic predisposition and lifestyle. It is the result of interactions between morphological, physiological, motor and psychological characteristics. Human physical development occurs in stages, each characterised by distinct biological and functional processes.

Performing the Standing Broad Jump (SBJ) is simple, quick and effective way to test the explosive strength of the lower limb muscles.

This test is frequently used in population studies, physical education, sports medicine, and for selection to sports schools. It is included in sets such as Eurofit, FitnessGram, ALPHA-FIT, and the International Physical Fitness Test. Its popularity stems from its low cost, ease of administration, high validity and reliability, and the ability to compare its results across populations [1].

The standing broad jump is an indicator of explosive power not only in sports (e.g. track and field, volleyball), but also in everyday activities such as climbing stairs, rising from a seated position and maintaining balance. The test results correlate positively with other movement tests, i.e. the vertical jump, 30-metre sprint and the Wingate anaerobic power test [2].

The standing broad jump test results obtained for children and adolescents are presented in numerous studies found in literature on the subject. These data reveal significant differences between age groups and gender. In a study by Raczek and Mynarski [3], it was shown that standing broad jump test results in boys increase, on average, from approximately 120 cm at age 8 to 200 cm at age 18. The progress for girls is somewhat less dynamic – from approximately 110 cm to approximately 165-175 cm over the same period. These differences are related to testosterone levels, muscle mass and physical activity.

In an international study, Tomkinson and Olds [4] analysed data from 30 countries and noted that children's performance in movement tests, including the standing broad jump, has declined over the last 20 years, which is associated with decreased physical activity, weight gain and lifestyle changes.

It is worth noting that a gradual loss of the ability to generate explosive force is observed in adults (above the age of 30).

In women and men aged 32-34, the standing broad jump test results are similar to those achieved in late adolescence, but after the age of 50, a significant decline in jump length is observed. In the studies by Tieland et al. [5], and Cruz-Jentoft et al. [6], it is indicated that the average decline in muscle strength after the age of 50 is approximately 1-2% per year, which directly translates into standing broad jump test results.

SBJ test results are influenced not only by age and gender, but also:

- body mass and composition – individuals with more muscles have a greater ability to generate force;
- neuromuscular coordination – jumping requires synchronised movement of the arms, trunk and legs;
- level of physical activity – individuals who exercise regularly achieve higher results;
- environment of upbringing – family support, physical education, access to sports activities;
- genetic predisposition – body type, biomechanical determinants.

It is worth noting that even in older adults, properly tailored resistance and plyometric training can significantly improve SBJ performance, as highlighted in the research conducted by Van Roie et al. [7].

The differentiation in results of standing broad jump performance according to gender is well documented. Boys have an advantage resulting from greater muscle mass, higher testosterone levels and more frequent participation in activities requiring strength and power [8],[3]. Girls reach their peak physical fitness earlier than boys, but their performance is typically lower.

In the research conducted by Przewęda and Dobosz [9], it was shown that after the age of 14, gender-related differences start to become statistically significant.

Among women in adulthood and during menopause, the fitness decline may be more dramatic than in men, which is associated with, among others, lower oestrogen levels and osteopenia.

It is not just age and gender that influence the results of the standing broad jump test – environmental factors such as physical activity level, eating habits, sleep quality and health status also play a significant role. Physically active

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children participating in sports and extracurricular activities achieve significantly better results than their inactive peers.

In adults, activity level is even more important – regularly undertaking physical activity can slow down the ageing processes of the muscular and nervous systems.

Additionally, it is worth mentioning the study by Faigenbaum et al. [10], who analysed the effect of plyometric and resistance training on standing broad jump performance in children and adolescents. Their results showed significant improvements in SBJ execution after just a few weeks of training intervention, confirming the high adaptive potential of young organisms and the practical value of the test as a measure of training progress. Similarly, in the article by Castro-Piñero et al. [11], analysing the relationship between SBJ performance and the general health of children and adolescents, the authors provided important information for functional assessment. They indicated that low motor skills are associated with an increased risk of metabolic and cardiovascular diseases, confirming the usefulness of the SBJ test as a preventive tool in public health.

1.1. Study objectives

- body characteristics of growth changes in women and men aged 8 to 50,
- characteristics of growth changes in women and men aged 8 to 50,
- changes in body weight in women and men aged 8 to 50,
- dynamics of changes in standing broad jump during this period,
- determination of the correlation between standing broad jump results and height and body weight separately for women and men in particular age groups.

2. Material and methods

The SBJ involves performing a maximum forward jump without a run-up from a standing position, using the swing of the arms and a standing push-off with both feet. The measurement is taken from the starting line to the nearest point of contact with the ground (usually the heels or buttocks).

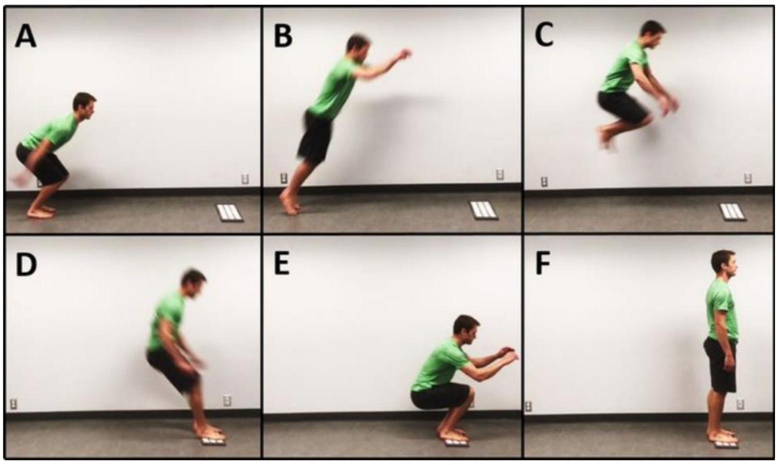

Photo 1. Phases of standing broad jump: A) beginning of take-off phase, (B) take-off, (C) flight, (D) ground contact upon landing, (E) landing, and (F) completion. SOURCE: Westermann et al. [12].

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The standing broad jump trial was conducted on a mat marked with a centimetre scale, maintaining uniform environmental conditions (temperature 20-22°C, non-slip surface). The participant performed a maximal jump from a standing position (feet hip-width apart, half-squat with arms swinging backward, and a double-leg take-off using full explosive power), landing on both feet without falling backwards or taking corrective steps. The measurement was taken from the starting line to the closest point of contact (usually the heel or buttocks), considering the better result of the two trials, which minimises measurement error and increases test reliability [1], [2]. The procedure included a short warm-up (dynamic exercises such as skipping or jumping) and verbal instruction as well as quality control.

2.1. Sample size and representativeness

The study included data from 18 girls (women) and 32 boys (men) who had individual developmental trajectories in the standing broad jump. This was the primary criterion for selecting 50 participants from a total of over 200. The proportion of women (36%) and men (64%) reflects the typical gender imbalance observed in continuous studies, potentially related to the higher retention of men in long-term projects (for example, 60-70% in European groups, where women are more likely to withdraw from participation for family, health or migration reasons) [13]. This numerical imbalance may affect the generalisability of the results, especially within the context of gender-related differences in performance regression.

The initial sample of the first series began in 1976 and included over 900 children (485 boys and 455 girls), and the second series, conducted from 1980, included over 800 (460 boys and 360 girls). However, by the age of 18, the number had dropped threefold, to 180 boys and 143 girls in the first series, and 178 boys and 108 girls in the second series, illustrating a significant decline in the group size over the years [14]. From these two combined series, data were collected for 103 women and 122 men in 2004, and 47 women and 67 men in 2022. These were individuals born in 1970 (series I) and 1978 (series II). In 2004, the individuals were aged 32-34, and in 2022, they were aged 50-52 years.

Table 1. Comparative characteristics of height and body weight and standing braod jump results at different stages of ontogenesis (KLGS 1976-2022) in groups of varying sizes.

	Girls N = 83; Boys N = 92			**Women N = 35; Men N = 49**	
	8 yrs.	**13 yrs.**	**17 yrs.**	**32-24 yrs.**	**50-52 yrs.**
	Mean; SD	**Mean; SD**	**Mean; SD**	**Mean; SD**	**Mean; SD**
		Body height [cm]			
Women	127.0; 5.6	156.0; 7.2	163.7; 6.0	164.4; 5.9	164.2; 5.9
Men	127.4; 5.3	155.8; 8.4	175.0; 6.5	178.3; 5.8	178.0; 5.9
		Body mass [kg]			
Women	25.3; 4.3	44.2; 7.7	55.1; 6.4	58.5; 7.2	66.4; 10.9
Men	26.1; 3.8	44.7; 8.7	64.7; 7.8*	79.6; 10.7	88.1; 16.0
		Standing broad jump [cm]			
Women	121.3; 17.4	161.8; 17.1	173.3; 17.3	163.9; 19.3	140.8; 19.8
Men	125.9; 17.3	177.5; 20.9	218.4; 19.6	212.2; 24.4	182.1; 19.5

	Women N = 18	**Men N = 32**			
	8 yrs.	**13 yrs.**	**17 yrs.**	**32-24 yrs.**	**50-52 yrs.**
	Mean; SD	**Mean; SD**	**Mean; SD**	**Mean; SD**	**Mean; SD**
		Body height [cm]			
Women	130.1; 4.4	158.0; 5.0	163.5; 5.7	164.6; 5.7	164.4; 5.6
Men	129.7; 5.9	158.8; 8.5	175.5; 5.6	177.6; 5.5	177.1; 5.6
		Body mass [kg]			
Women	26.5; 3.2	46.7; 5.3	53.8; 3.8	58.2; 5.6	65.5; 8.7
Men	26.0; 3.8	45.1; 7.9	64.5; 7.4	79.3; 10.8	88.2; 17.9
		Standing broad jump [cm]			
Women	125.2; 15.4	168.6; 10.8	176.1; 12.3	164.7; 20.3	135.9; 18.2
Men	128.9; 15.9	182.9; 21.6	225.0; 14.7	218.8; 15.4	184.2; 18.4

Although the sample size is small, no clear selection was observed in either somatic characteristics or broad standing jump results, as illustrated in Table 1, which compares these variables for selected age categories. The table summarizes data for larger sample sizes - before puberty, during puberty, after puberty, especially in girls and in adulthood and mature age, on the threshold of aging.

Anthropometric measurements regarding a number of somatic characteristics were taken, along with physical fitness tests. Data on body height and mass were included in this study. All examinations were conducted with the written, informed consent of the participants. The approval of the Bioethics Committee at the Regional Medical Chamber in Kraków was also obtained for the examination in 2022 (Approval No. 65/KBL/OIL of April 11, 2022). All procedures contributing to the study complied with the ethical standards of the relevant national and institutional committees on human experimentation and the 1975 Helsinki of Declaration, as revised in 2008.

2.2. Statistical methods

Descriptive statistics (mean measures and measures of variability) were used in this study, and Pearson's correlation coefficients (r) were calculated to assess linear relationships between standing broad jump test results and somatic characteristics. Correlation analysis was also performed for men and women in selected age groups (8, 13, 17, 32-34, 50-52 years), calculating Pearson's coefficients between standing broad jump and body height as well as mass to assess changes in these relationships over the participants' lifespan, taking possible gender-related differences in the dynamics of these correlations into account [8], as well as regression analysis.

The Student's *t*-test was used to verify the hypotheses, where the null hypothesis assumes no relationship ($\rho=0$) and the alternative hypothesis indicates the existence of a linear relationship ($\rho\neq0$).

The test statistic was calculated based on the correlation coefficient and sample size. It was then compared to the critical value of the corresponding *t*-distribution at a specified significance level ($\alpha=0.05$ was assumed in the present study). If the calculated value exceeds the critical threshold or the corresponding probability (*p*-value) is less than 0.05, the correlation is considered statistically significant.

The *t*-test statistic for correlation:

$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$ (1)

where:

r – Pearson's correlation coefficient;

n – sample size.

The statistic has a Student's *t*-distribution with n−2 degrees of freedom.

The comparison is made with the critical value of the *t*-distribution:

$[t] = t_{\frac{\alpha}{2},n-2}$ (2)

or equivalently, the *p*-value is checked.

The minimum correlation value considered significant:

$r_{min} = \frac{t_{crit}}{\sqrt{t_{crit}^2+(n-2)}}$ (3)

For the group of women n = 18 → needed |r| ≥ 0.47;

For the group of men n = 32 → needed |r|≥0.32.

The Cohen's d effect size was calculated for dependent samples:

$d = t/\sqrt{n}$ (4)

3. Results

In the analysis of the results, the variability of body height and mass with age is presented for selected age categories – 8 years (before puberty), 13 years (during puberty) and 17 years (after its completion), as well as at the ages of 32-34 and 50-52.

Table 2. Changes in body height among study group with age based on the Kraków Longitudinal Growth Study (KLGS) – data in cm

Women N=18				Age (years)	Men N=32			
$\bar{x}$	SD	MIN	MAX		$\bar{x}$	SD	MIN	MAX
130.13	4.36	121	138	8	129.71	5.87	120	142
135.49	4.82	125	143	9	135.01	6.07	125	147
141.61	5.76	129	154	10	140.09	6.17	129	152
147.22	5.89	135	160	11	144.80	6.79	133	157
153.48	5.51	141	164	12	150.15	7.57	135	165
158.04	5.00	147	168	13	158.85	8.47	142	176
160.69	4.99	149	171	14	165.88	8.25	145	180
162.26	5.47	150	172	15	171.25	7.40	150	185
163.27	5.76	151	173	16	174.13	6.40	158	187
163.49	5.68	151	173	17	175.46	5.60	165	187
163.86	5.86	151	175	18	175.89	5.37	165	187
164.61	5.73	152	176	32-34	177.61	5.49	167	190
164.43	5.58	152	177	50-52	177.13	5.58	167	189

In the age period of 8-17 years, body height increases non-linearly, with an acceleration occurring during puberty (Table 2). At age 18, body height stabilises (approximately 165 cm in women), and in men, it is close to completion of growth – approximately 176 cm. After the age of 18, it increases by approximately 1 cm [15], and between the ages of 50 and 52, it shows minimal decline. These values are similar to national data from the OLAF project [16] – 165 cm in women, and 178.5 cm in men.

Table 3. Body mass in study group based on KLGS – data in kg

Women N=18				**Age (years)**	**Men N=32**			
$\bar{x}$	**SD**	**MIN**	**MAX**		$\bar{x}$	**SD**	**MIN**	**MAX**
26.46	3.18	21	33	8	25.97	4.10	21	41
29.14	3.64	24	37	9	28.82	4.74	22	47
32.71	4.60	25	42	10	31.67	5.18	24	50
36.43	6.05	28	52	11	34.69	5.63	25	53
41.61	5,98	32	56	12	39.43	6.80	27	61
46.71	5.33	38	61	13	45.11	7.87	29	71
50.36	4.74	42	61	14	51.89	8.32	32	78
51.83	4.37	42	63	15	57.89	8.57	34	84
53.82	3.97	44	64	16	62.67	8.28	40	87
53.82	3.84	45	64	17	64.53	7.41	49	88
54.03	3.78	47	61	18	65.55	7.40	53	88
58.19	5.61	44	67	32-34	79.31	10.79	55	106
65.48	8.70	51	79	50-52	88.18	17.87	54	147

Weight changes in the study group based on the KGLS demonstrate a non-linear increase in body mass over the 8-18 year period. Boys increase from 26 kg at age 8 to 66 kg at age 18, and girls also increase from 26 kg to 54 kg. Sex-related differences at the time of the developmental age become more pronounced after age 14.

Between ages 32 and 34, body mass increases by approximately 4 kg in women and nearly 14 kg in men compared to age 18, and by ages 50-52, a further increase of 7 kg in women and almost 8 kg in men is observed.

Table 4. Standing broad jump length in study group based on KLGS – data in cm

Women N=18				**Age (years)**	**Men N=32**			
$\bar{x}$	**SD**	**MIN**	**MAX**		$\bar{x}$	**SD**	**MIN**	**MAX**
125.2	15.4	90	152	8	128.9	15.9	99	160
139.5	15.7	110	170	9	143.9	17.4	109	176
145.1	18.6	120	186	10	152.3	18.9	112	192
.157.5	12.5	133	174	11	158.5	18.0	118	193
164.0	11.1	140	183	12	165.4	20.0	126	228
168.6	10.8	151	190	13	182.9	21.6	142	234
170.9	12.6	146	190	14	191.5	21.2	150	245
179.5	13.9	152	199	15	204.6	22.9	168	264
176.0	14.0	148	199	16	215.6	18.7	176	260
176.1	12.3	158	201	17	225.0	14.7	202	253
175.3	12.6	150	199	18	229.7	15.5	205	264
164.7	20.3	130	205	32-34	216.8	15.4	180	248
135.9	18.2	100	175	50-52	184.2	18.4	145	224

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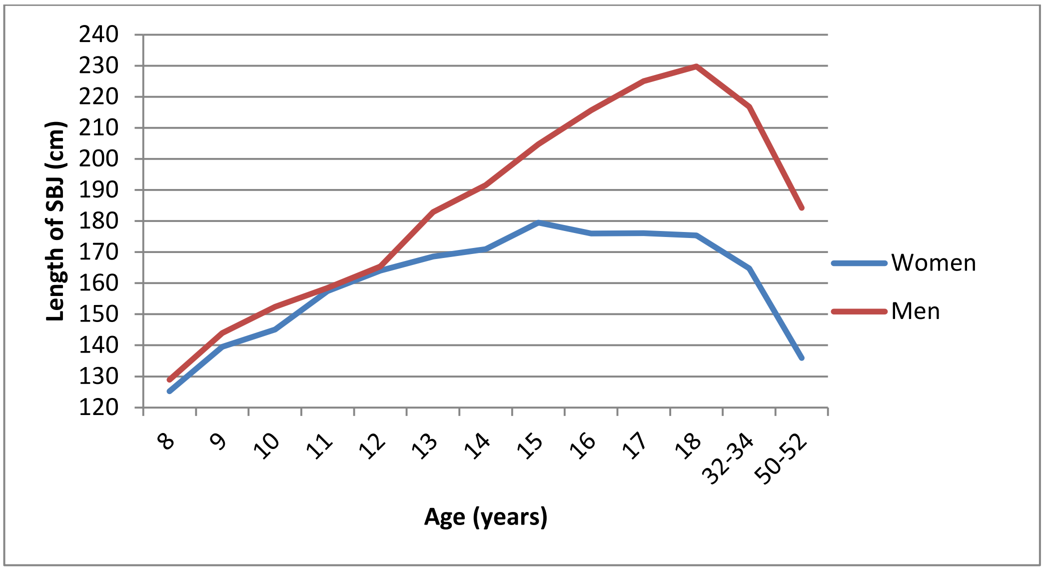

Figure 1. Changes in standing broad jump length with age in study group based on KLGS

Changes in the standing broad jump (SBJ) with age based on the KLGS are presented in Table 4 and Figure 1. SBJ increases from 125 cm (women) and 129 cm (men) at age 8 to 175 cm and 230 cm at age 18. Gender-related differences become more evident after the age of 12 (boys jump 30-50 cm further).

In Figure 1, illustrated is the linear increase with an acceleration in adolescence and a plateau between ages 16-18 in girls. Between the age of 32 and 34, the SBJ decreases to 165 cm in women and 217 cm in men, and between 50-52, SBJ decreases by a further 19 cm in women and 33 cm in men compared to the values recorded for ages 32-34.

Table 5. Pearson's correlation coefficients between standing broad jump results and body height as well as mass for selected age groups of women and men (KLGS)

Women		Age group	Men	
Body height	Body mass		Body height	Body mass
-0.15	-0.54*	8	-0.12	-0.10
-0.12	-0.43	13	0.33*	0.23
0	0,22	17	0.38*	0.26
0.07	-0.20	32-34	0.42*	-0.15
-0.29	0	50-52	0.07	-0.44*

** statistically significant values*

In Table 5, a comparison is given of Pearson's correlation coefficients between the standing broad jump results and selected somatic characteristics for selected age groups in women and men (KLGS). For women, the values indicate a low correlation for body height as well as for body mass. However, for girls aged 8, the correlation was statistically significant; the higher the body mass at that age, the shorter the standing broad jump results.

For men, significant positive correlations occurred at ages 13 and 17, and between the ages of 32 and 34, indicating that the higher the body height, the longer the jump. However, for body mass, a significant correlation coefficient was only observed in the oldest age group, indicating that the higher the body mass, the shorter the jumps.

Summarising the results of the correlation analysis based on Pearson's coefficients (Table 5), it can be concluded that for basic morphological characteristics, such as height and body mass, strong linear relationships were not demonstrated with standing broad jump distance in the studied age groups in both women and men (KLGS). The correlation coefficient values were low to moderate, suggesting that these somatic parameters explain only a limited part of the variability in motor test results.

For women, Pearson's correlation coefficients indicated a low correlation between body height and standing broad jump distance across all of the analysed age groups. No statistically significant differences were noted, suggesting a lack of a clear effect of body height on the effectiveness of this motor movement in the female population. A slightly stronger, but still small, negative correlation was observed for body mass. A particularly statistically significant effect occurred in the group of 8-year-old girls, where higher body mass correlated with shorter jump distance (Table 5). This relationship can be interpreted in the context of motor development, where excess body mass in the early ontogenetic period can burden the musculoskeletal system, limiting explosive movement. In older age groups (above 8 years), these correlations did not reach significance, suggesting potential compensatory adaptive mechanisms, such as improved technique or muscle strength.

In the male group, the results revealed a more diverse pattern of correlations. Statistically significant positive correlations were found for body height in selected age groups: 13 years, 17 years, and in the group of adults aged 32-34. This suggests that a higher value of this somatic parameter was associated with a longer standing broad jump distance. The lack of such a relationship in other age groups (e.g. below the age of 13) may be due to the incomplete development of the neuromuscular system in the prepubertal period.

For body mass in men, a statistically significant negative correlation occurred, but only in the oldest age group (32-34 years), where higher body mass correlated with shorter jump performance (Table 5). This observation indicates that in adulthood, excess body mass may act as a hindering factor, potentially through increased joint loading and reduced relative muscle strength. In younger groups, the lack of significant correlations specifies a smaller effect of body mass on motor performance, which may be modified by higher developmental plasticity. For both women and men, all of these significant correlation coefficients had a weak effect, well below 2 units.

4. Discussion

Analysis of data collected within the KGLS allows us to identify three distinct phases in the development of lower limb explosive strength throughout the life cycle of the studied cohort measured using the standing broad jump. Phase I represents a dynamic progression during ontogeny (ages 8-18), with an intense, non-linear increase in SBJ scores observed during childhood and adolescence. This dynamic development is consistent with general patterns described in the literature [8],[17], which indicate a close relationship between motor development and growth processes, neuromuscular maturation and the hormonal changes of puberty. The key moment is the period after the age of 12, when the developmental paths of the two sexes begin to differ significantly. In girls, the rate of performance gain slows down, reaching a plateau around the age of 16-18. In boys, however, the greatest acceleration occurs during the same period, leading to significant between-gender differences, reaching 20-30% in favour of men at the age of 18. The reasons for this phenomenon should be sought in a different hormonal profile –

the strong anabolic effect of testosterone in boys stimulates a significant increase in muscle mass and strength, which directly translates into the ability to generate power [18],[19].

In the third decade of life, a slow decline in SBJ scores is observed; there is a small but noticeable difference in the scores measured in the study group. This period represents a phase of biological maturity in which motor skills reach their maximum or remain at a high level, provided that adequate levels of physical activity are maintained [20]. This regression observed in the KLGS may reflect the influence of environmental factors, such as entering the workforce and a shift towards a more sedentary lifestyle, which is typical of urban populations [21].

Around the age of 50, the average jump length decreased to 136 cm in women and 184 cm in men. This decline was more pronounced in women. Compared to the peak results at age 18, the decline in women was approximately 22.5%, while in men, it totalled 19.8%. The main biological cause of this phenomenon is sarcopenia, the progressive loss of muscle mass and strength with age, estimated at 1-2% per year after the age of 50 [22]. In women, this process is further accelerated by hormonal changes associated with menopause, which intensify the loss of muscle and bone tissue [23]. The slower decline observed in men confirms the information given in literature reports indicating their greater potential to maintain muscle mass at an older age [24],[25].

The relationship between body height and standing broad jump distance was weak in women throughout the analysed period, while in men: a statistically significant positive correlation occurred during puberty (age 13: r = 0.33; age 17: r = 0.38) and early adulthood (r = 0.42), reflecting the harmonious development of strength and skeletal structure [17]. However, the strength of this relationship weakens in later adulthood.

The relationship between body mass and the SBJ was statistically significant for 8-year-old girls and 50-52-year-old men. In these age groups, excess body mass, primarily in the form of fat tissue, constituted a "ballast" that had to be overcome during take-off, negatively impacting performance. These observations highlight the limitations of analysis based solely on total body mass and emphasise the need to include body composition indices in future research [20].

5. Conclusions

Based on the collected data from the Kraków Longitudinal Growth Study (KLGS) and analysis of the results, the following conclusions can be drawn:

1. The standing broad jump length increases during childhood and adolescence (ages 8-18), with significant sex-related differences. By age 18, these differences reach 20-30% in favour of boys, reflecting the influence of puberty on the development of muscle strength and motor skills.

2. In adulthood (32-34 years of age), the standing broad jump results decrease, while between the ages of 50 and 52, a more pronounced regression is observed, which is greater in women than in men.

3. Correlations between the standing broad jump results and somatic characteristics vary depending on age and gender. The relationship between body height and standing broad jump distance in women was weak throughout the analysed period, while in men, a statistically significant positive correlation occurred during puberty and early

adulthood, and the negative relationship between body mass and SBJ was statistically significant only for 8-year-old girls and 50-52-year-old men.

The results indicate the need for preventive interventions: plyometric training for youth and resistance training for adults to delay regression. Monitoring the SBJ as a health marker is recommended in physical education, with focus on postmenopausal women.

6. Suggestions for Future Studies

1. It is worth trying to interpolate some results in continuous studies, especially between short time intervals,

2. Therefore, the goal should be to increase the sample size,

3. Take into account body composition measurements (fat mass, lean mass),

4. Indicate the relationship between body composition and physical fitness test results,

5. Take into account more measurements of physical fitness tests, as well as other tests assessing explosive strength in the lower limbs.

Declarations

Source of Funding

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Competing Interests Statement

The authors declare no competing financial, professional, or personal interests.

Consent for publication

The authors declare that they consented to the publication of this study.

Authors' contributions

Both the authors took part in literature review, analysis and manuscript writing equally.

Availability of data and materials

Supplementary information is available from the authors upon reasonable request.

Ethical Approval

Not applicable for this study.

Informed Consent

Informed consent was obtained from all participants before the commencement of the study.

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