# The impact of adaptation to hypokinesia during growth

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# Adaptation

Process of modification which an organism undergoes in order to adapt itself to novel environmental conditions, *opposed to the influence of heredity* (Butterworths Medical Dictionary)

Factors -

light, temperature, altitude, nutrition – *energy balance*

**physical activity** – increased or **reduced**, etc

# Adaptation to different degree of physical activity depends on

- *Age of the start* of intervention, education in the family, kindergarten etc.
- Character of physical activity
- *Duration*
- Intensity
- Frequency

Adaptation stimulates a cascade of hormonal, metabolical, biochemical, functional etc. reactions
changes energy intake and expenditure, energy balance and turnover
result finally in morphological modifications : body weight and composition - *degree of muscular and skeletal development* (osteogenic changes, bone structure , density etc.
joint modification
fat percentage and distribution
etc

# Long-term developmental changes of children and adolescents

Increase of percentage of body fat, obesity – apparent, or **latent** without the increase of BMI

**Start of adiposity rebound – AR at earlier age**

**Decrease of cardiorespiratory fitness - aerobic power ( by O.5 % per year during last decades), endurance, skill, motor abilities, muscle force etc.**

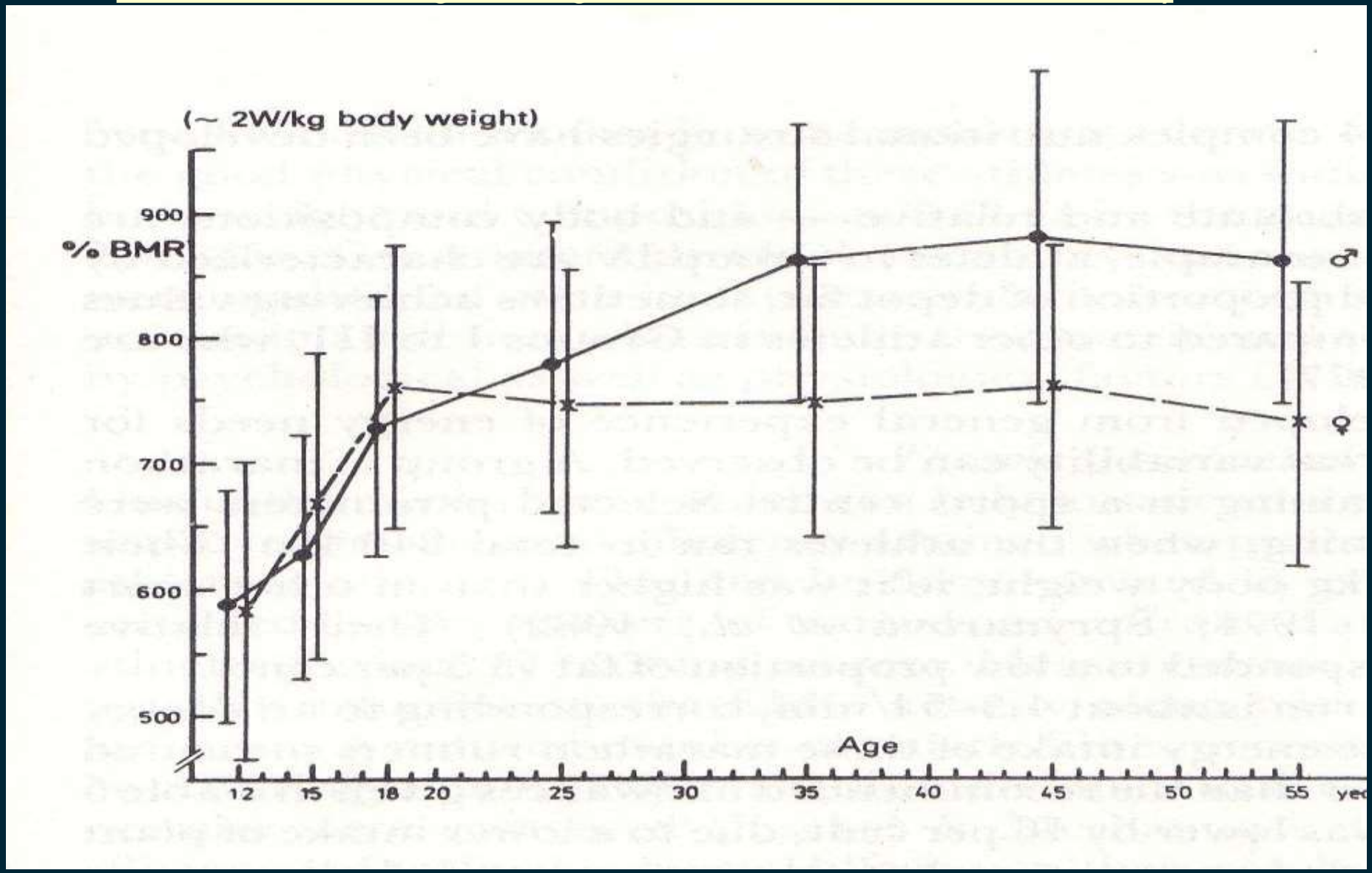
**Increase of the prevalence of early cardiovascular, metabolic diseases (hypertension, diabetes etc.)**

**Deteriorated body posture along with musculoskeletal problems including pains, accidents and bone fractures –** ***accompanying the reduction of physical activity and kinesiophobia***

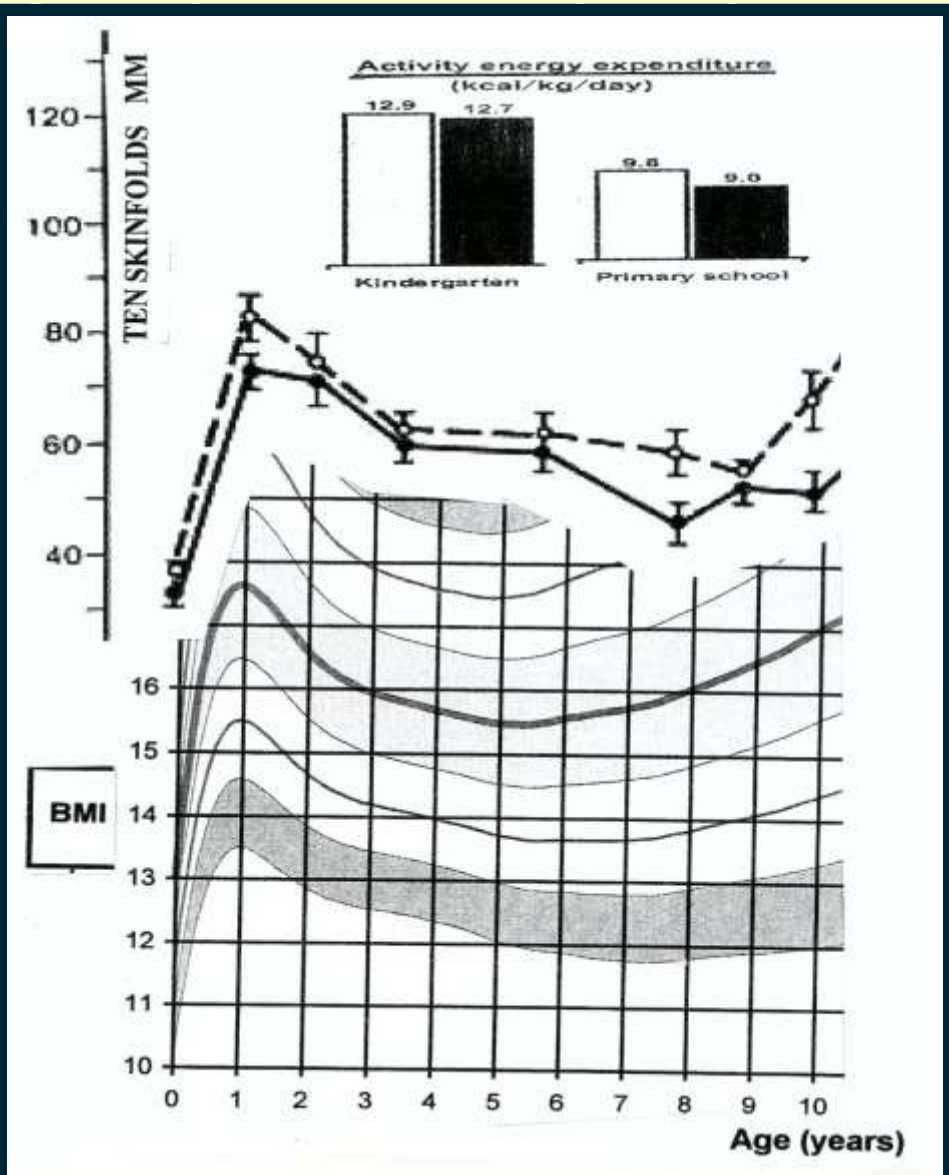
# Musculoskeletal problems of hypokinesia

- **Disbalanced – increased activity of selected muscles , EMG disbalance of activities**
- **Deterioration of body posture, biomechanical problems (during gait etc.)**
- **Reduced endurance, muscle flabbiness, increased fatiguability**
- **Reduced coordination of movements, reduced skill**
- **Joint hypermobility syndrome**
- **Pain of muscles, joints – knees, hips, back, shoulders, neck etc.**
- **Deterioration of the structure and mineralization of bones, of the quantity and composition of fat marrow tissue - marker of bone health**
- **Degenerative processes of intercalar disks**
- ***Increased prevalence of accidents and fractures* - reduced stability of lower extremities**
- **Tibia vara, Tibia valga, Idiopathic *scoliosis,* Flat feet – one - or bothsided**

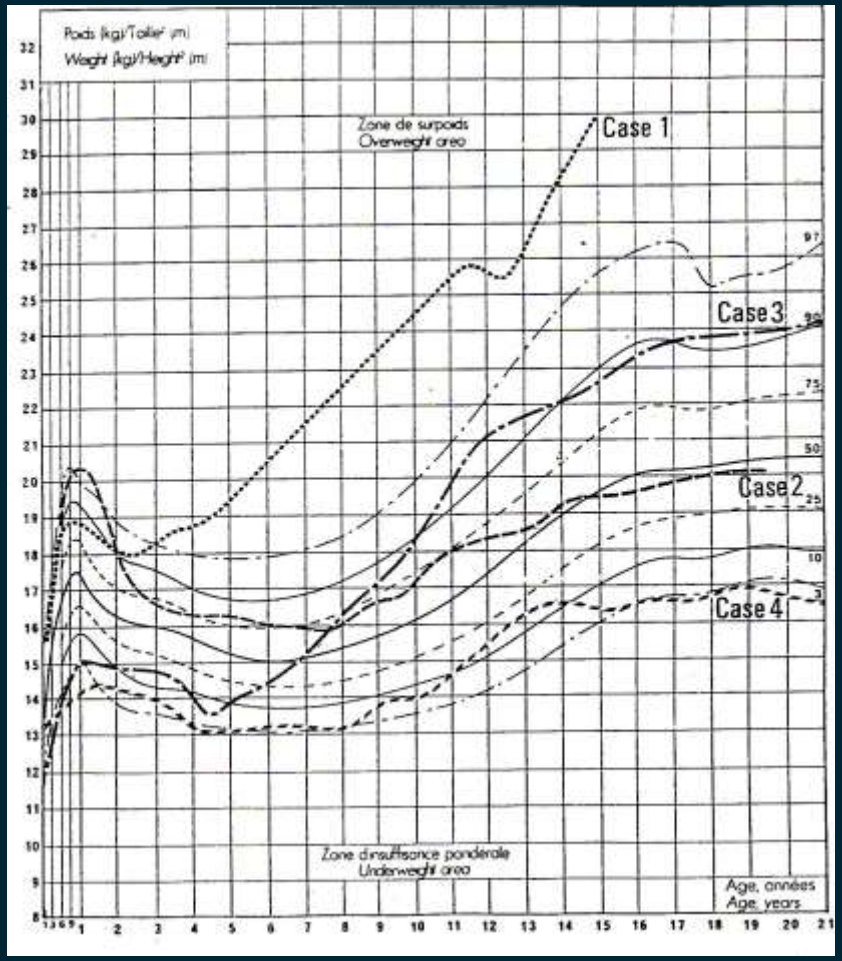
# Increase of the percentage of BMR – MET during the same work load at different age (based on *Interational Biological Programme* - IBP data; Pařízková 1985)



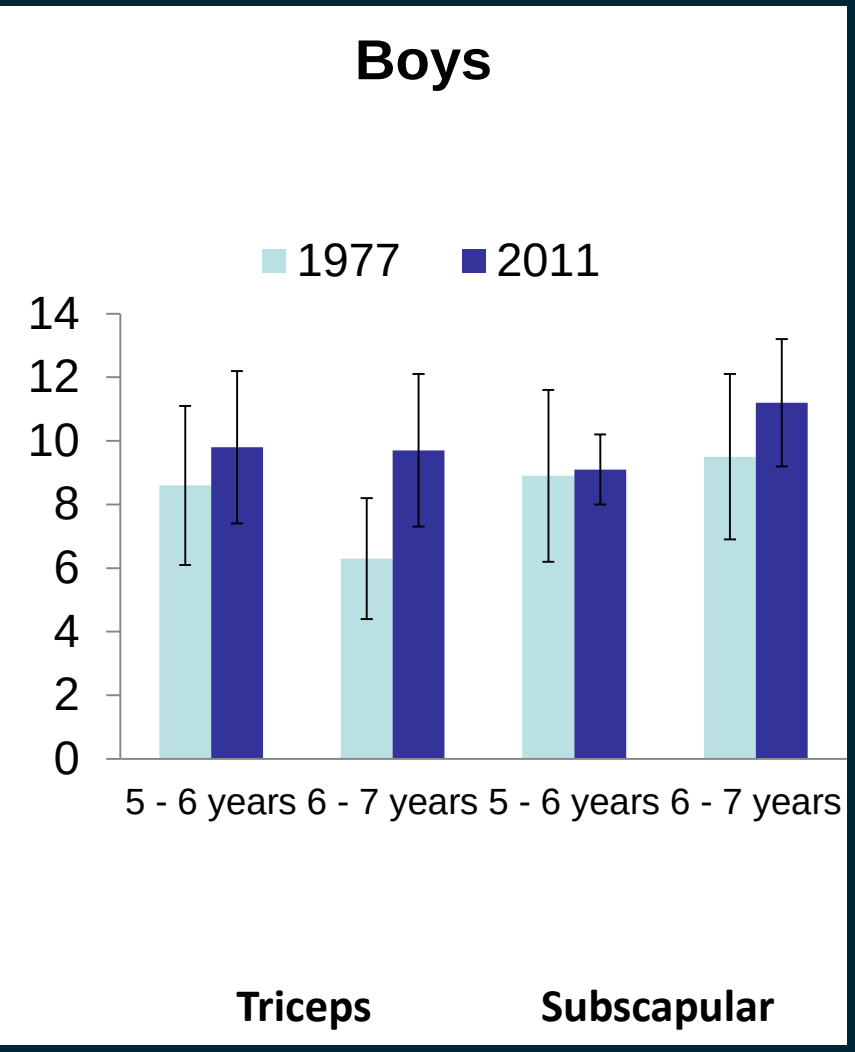
# Changes of body mass index (BMI), body fat (sum of ten skinfolds) and spontaneous physical activity during the period of adiposity rebound (AR)

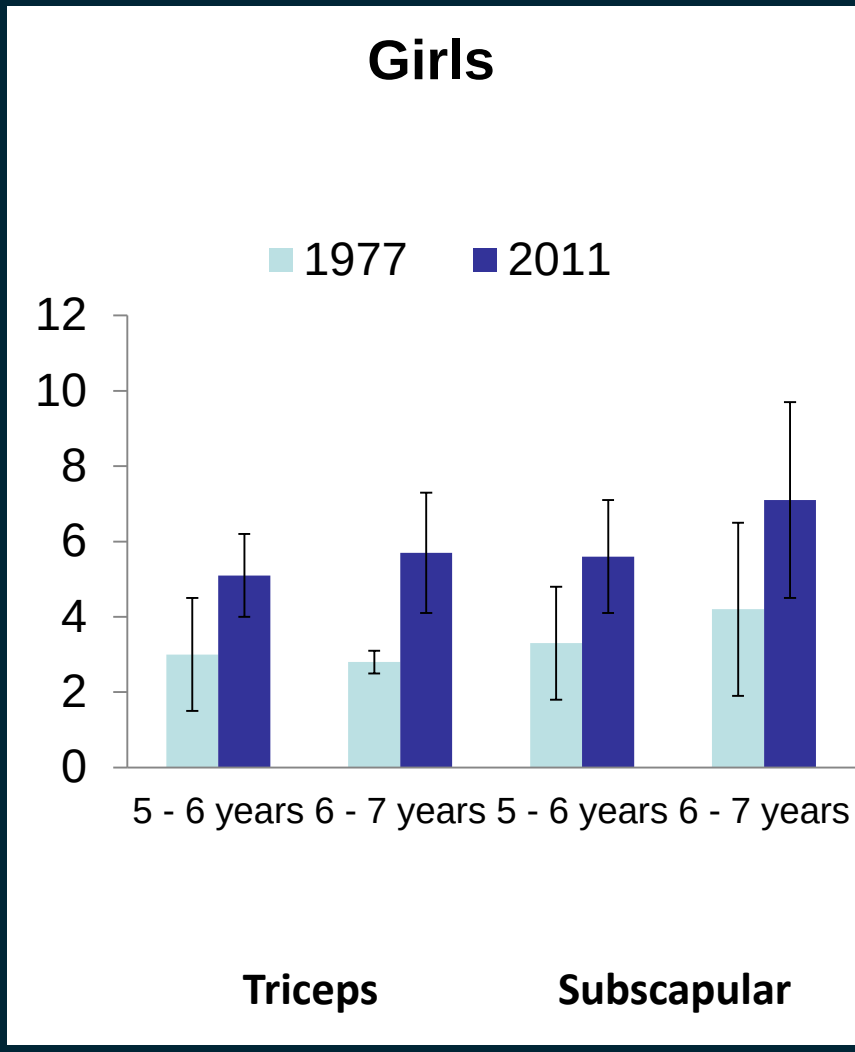


# Changes of BMI development due to different start of AR



# Triceps and subscapular skinfold thickness in 1977 and 2011



# Secular changes of tricipital skinfold in children and adolescents (0-18 years, 1950 – 2000 ; Olds et al .2011)

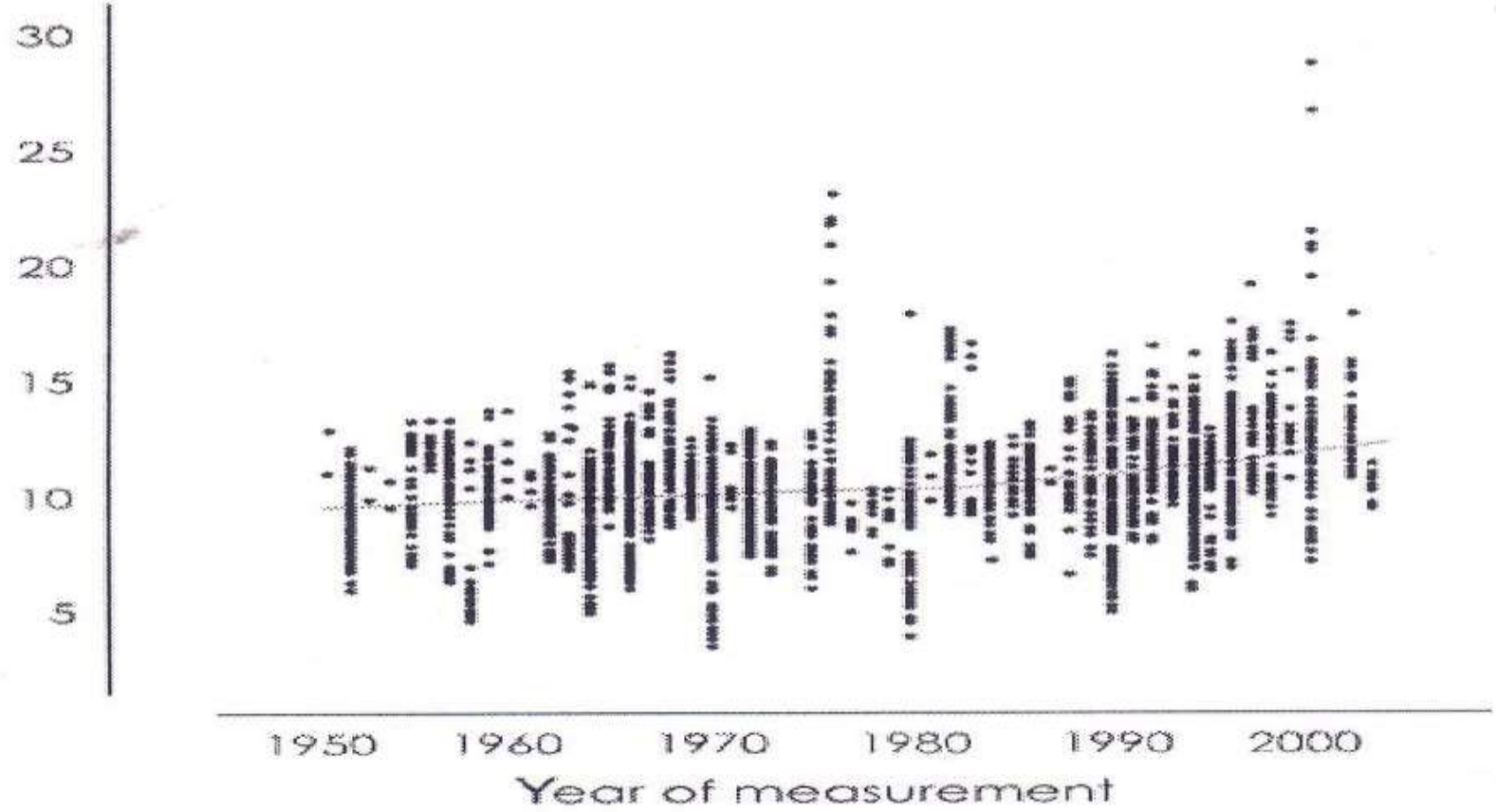



**Figure 2** Secular trends in the thickness of the triceps skinfold in children aged 0–18 years. The curve shown is a Lowess model (tension = 66).

# Secular changes of aerobic and anaerobic power, and speed in childen and adolescents (Tomkinson and Olds 2007)

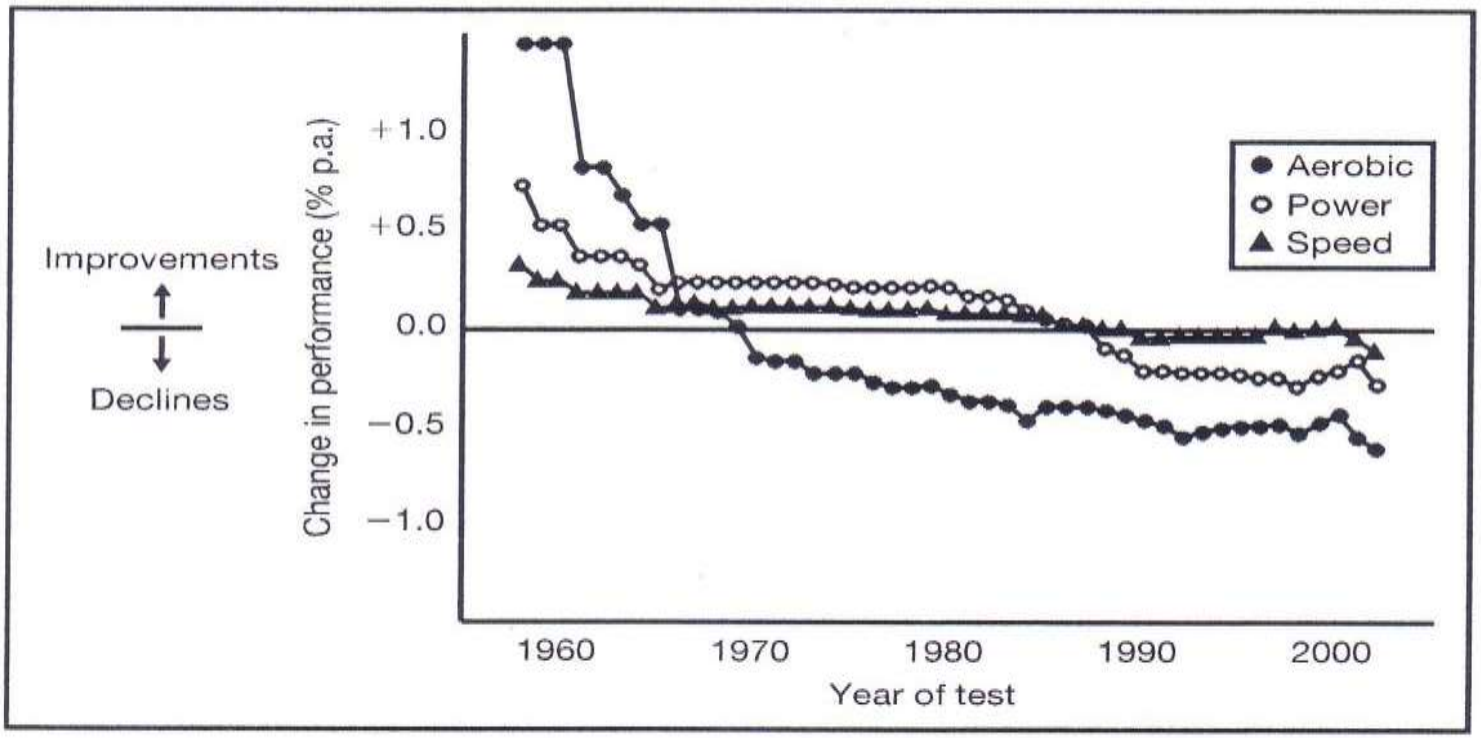
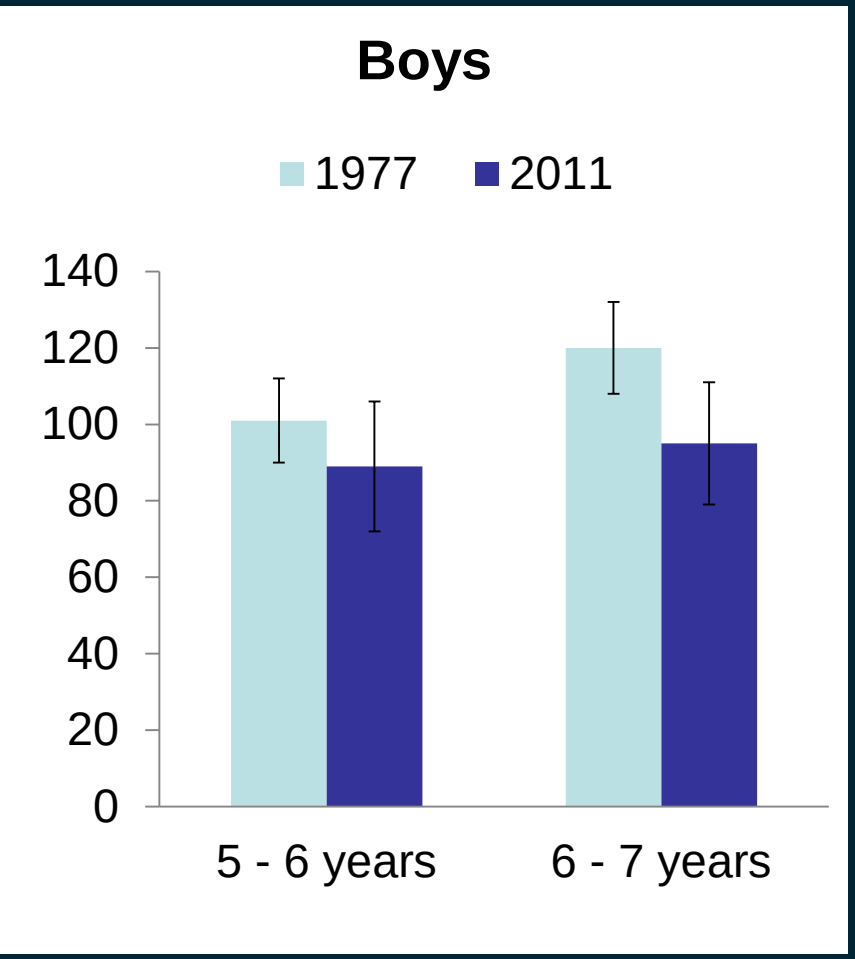
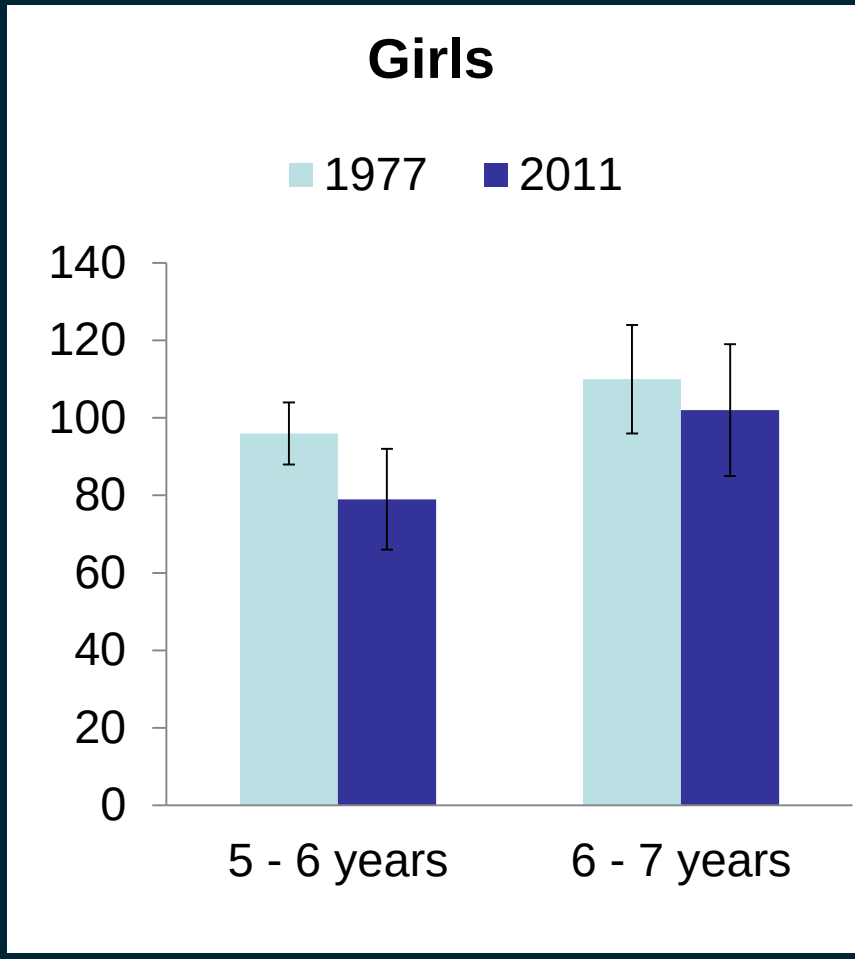


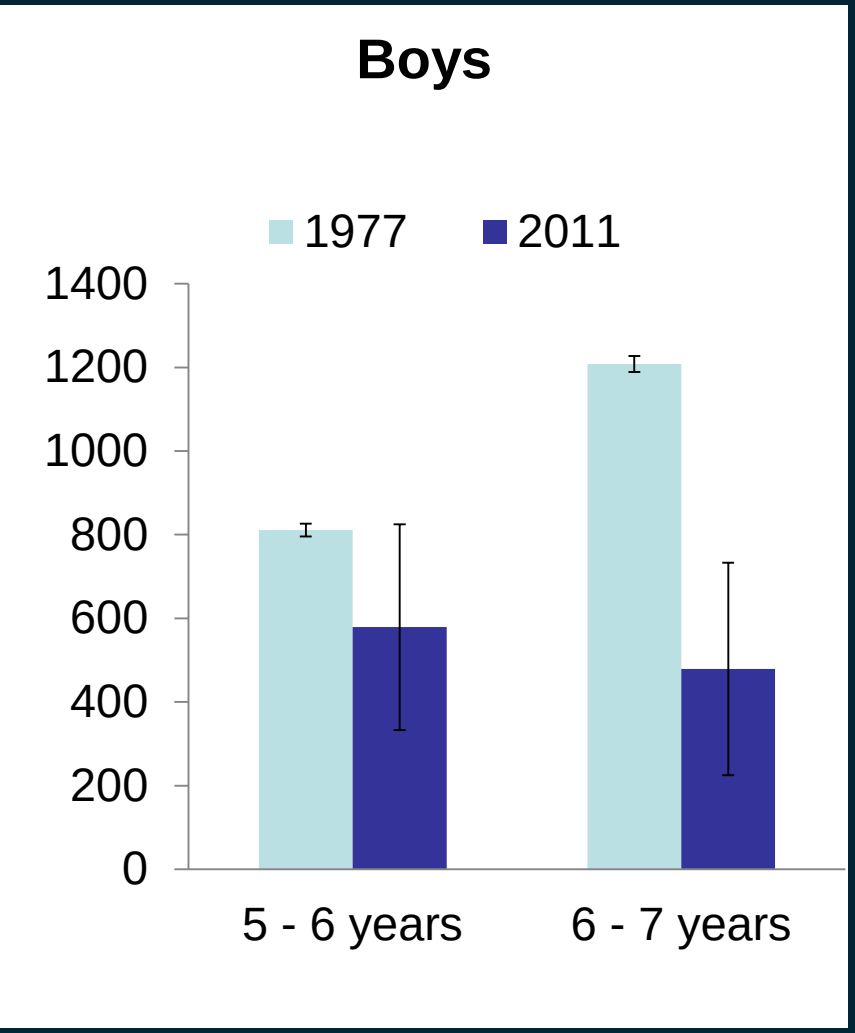

*Fig. 5.* Global time-related patterns of change for aerobic fitness tests (closed circles) and anaerobic fitness tests of power (open circles) and speed (closed triangles) for the period 1958–2002. The power and speed test data are from Tomkinson [53]. Higher values (i.e. those greater than zero) indicate improvements in performance.

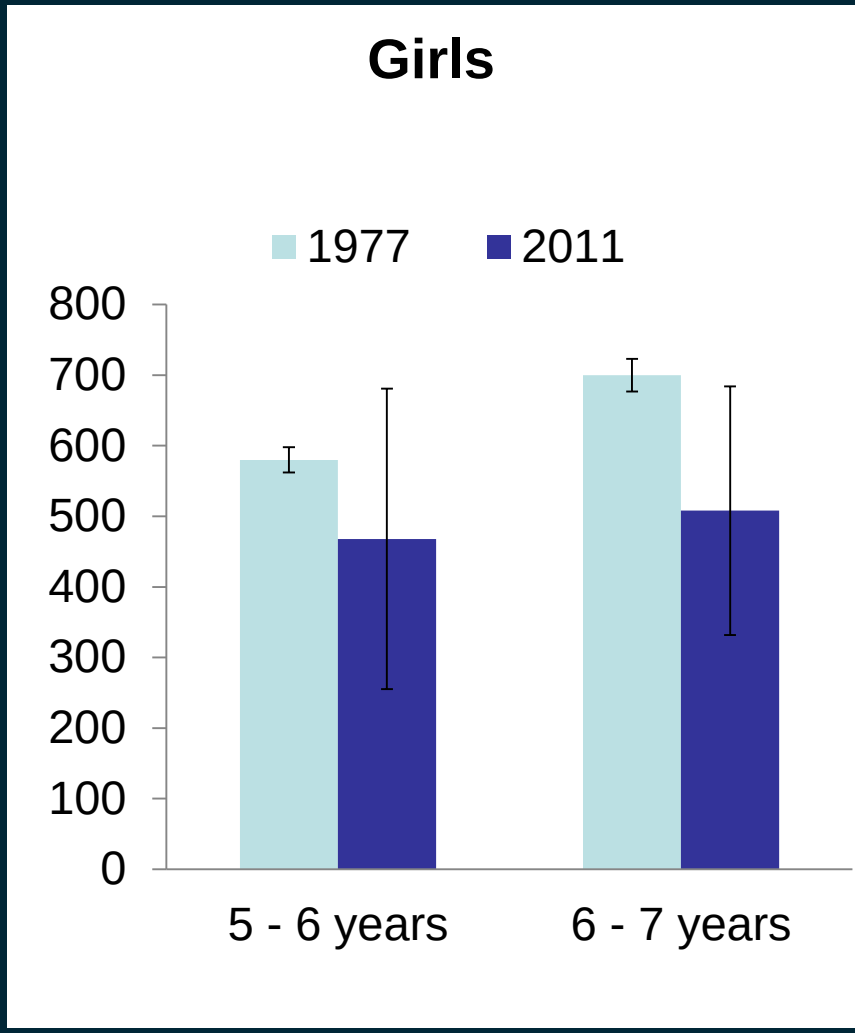
# Performance in broad jump in preschool children in 1977 and 2011



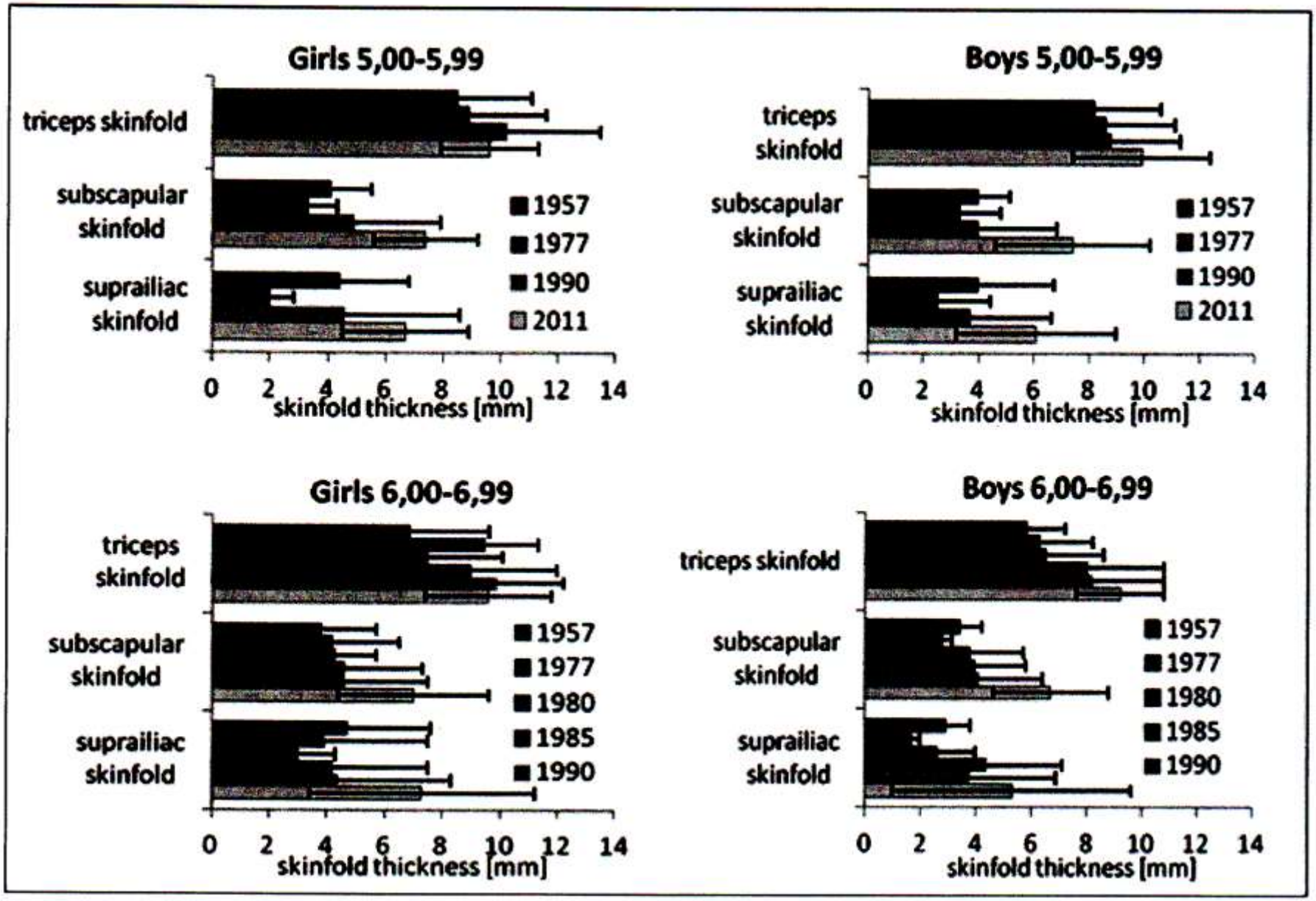



# Performance in ball throw in preschool children in 1977 and 2011

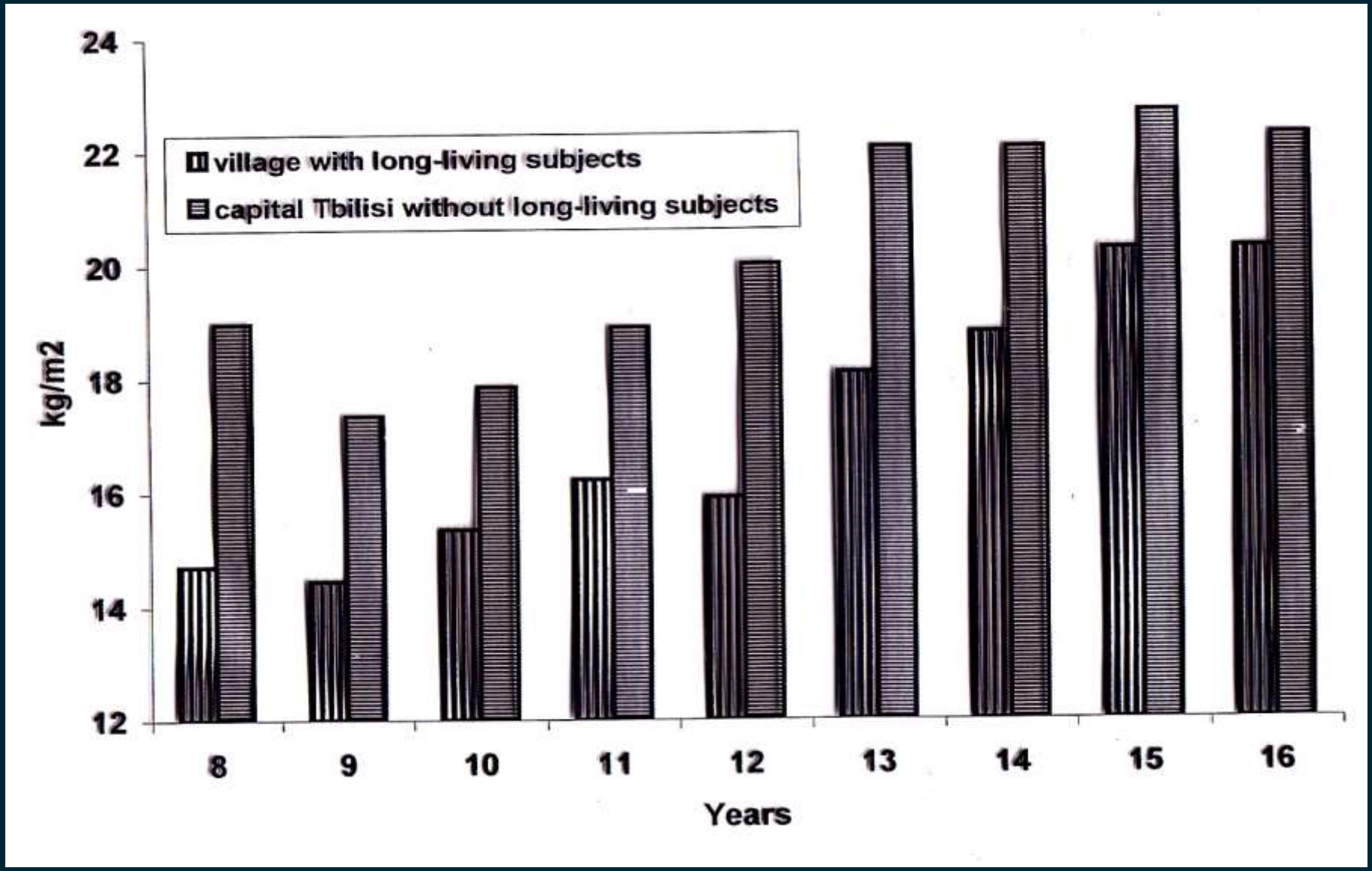


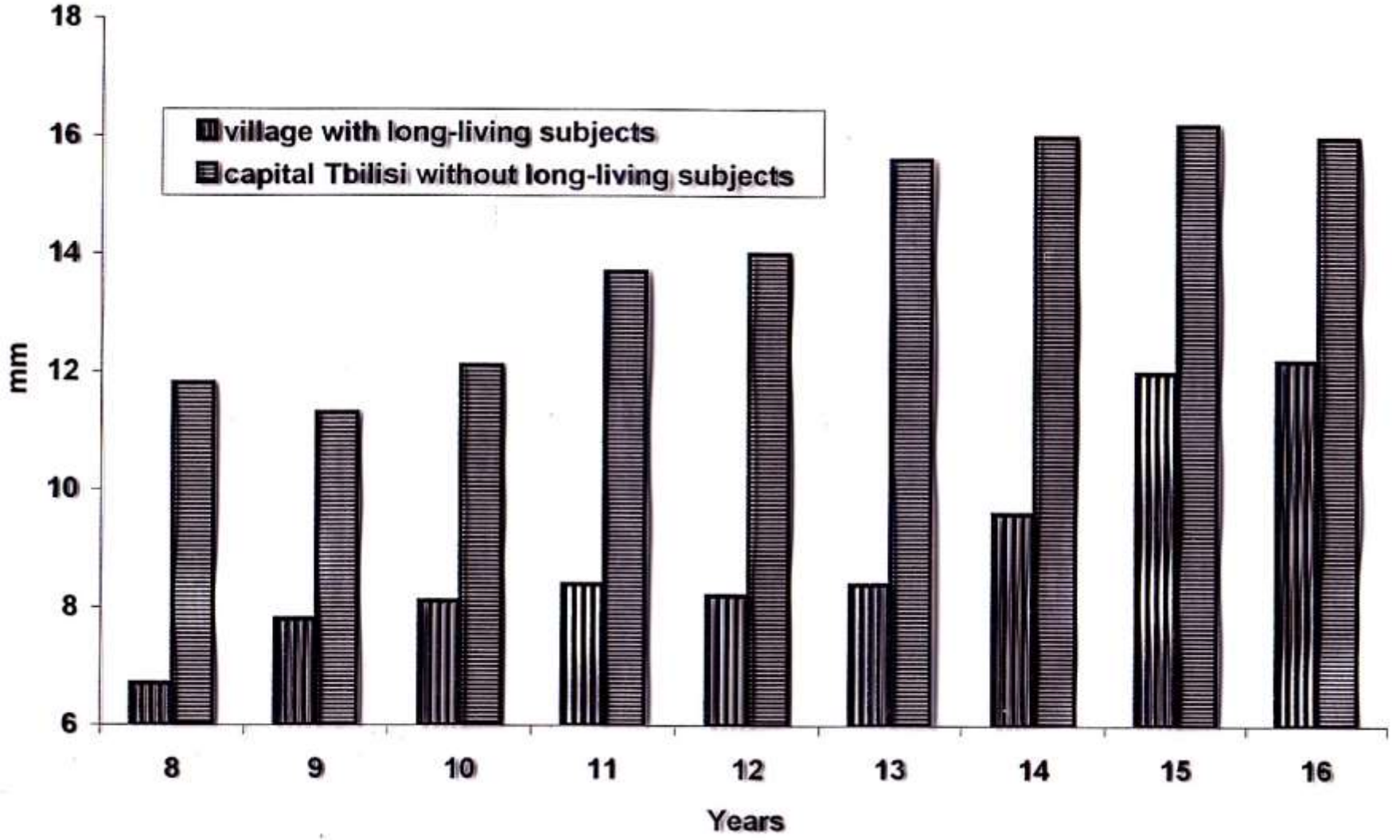
# Secular changes of subcutaneous fat in preschool children (Sedlak, Pařízková, Vignerová et al. 2014)



# BMI in girls from two Abkhasian communities (Kozlov; Miklashevskaya 1987)



# Subscapular skinfold in girls from two Abkhasian communities (Kozlov; Miklashevskaya 1987)



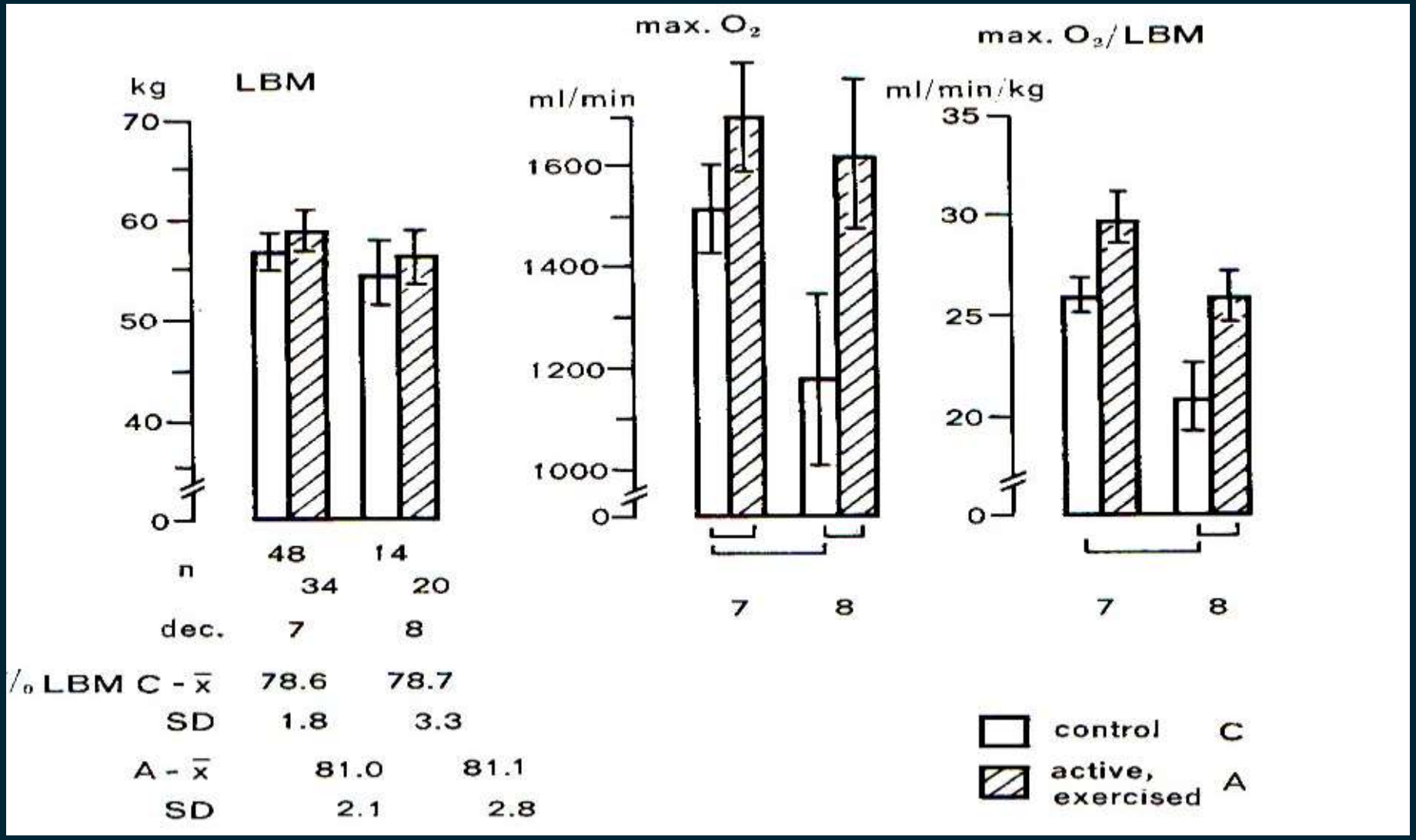
| Girls | % Fat | Index Waist/Height | Index Subscapular/Triceps | Index 5 Trunk/ 5 Extremities. Skinfolds |
|---|---|---|---|---|
| Average | **17.7** | **39.2** | **0.78** | **0.92** |
| SD | 2.01 | 2.2 | 0.16 | 0.11 |
| Average | **24.3** | **41.2** | **0.74** | **0.95** |
| SD | 3.7 | 2.4 | 0.15 | 0.17 |
| Average | **30.5** | **47.0** | **1.03** | **1.28** |
| SD | 1,7 | 3.7 | 0.29 | 0.23 |
| Average | **33.2** | **53.0** | **1.10** | **1.32** |
| SD | 1.9 | 6.3 | 0.21 | 0.14 |

| Boys | % Fat | Index Waist/Height | Index Subscapular/Triceps | Index 5 Trunk/5 Extrem ities. Skinfolds |
|---|---|---|---|---|
| Average | **17.6** | **40.2** | **0.76** | **0.85** |
| SD | 2.6 | 2.4 | 0.14 | 0.31 |
| Average | **22.1** | **45.1** | **0.72** | **0.96** |
| SD | 3.8 | 3.3 | 0.20 | 0.25 |
| Average | **28.2** | **48.8** | **0.65** | **1.15** |
| SD | 3.9 | 4.2 | 0.18 | 0.19 |
| Average | **34.0** | **59.0** | **1.10** | **1.51** |
| SD | 2.4 | 7.0 | 0.25 | 0.17 |

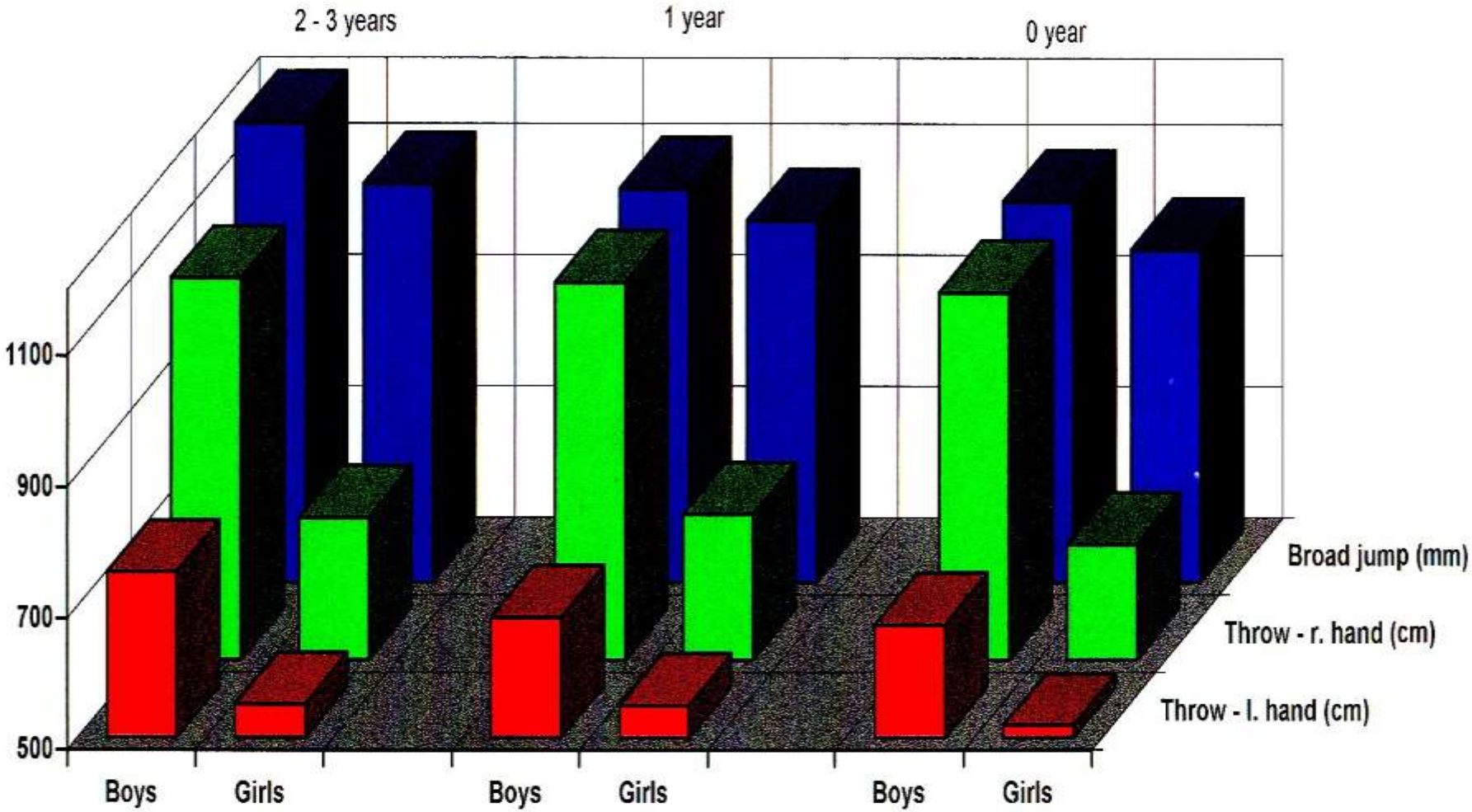
# Morphological and functional characteristics of boys adapted to different physical activity (International Biological Programme IBP)

| | Control inactive | SD | Athletes | SD |
|---|---|---|---|---|
| 12 years Fat % | 18.5 | 5.1 | 14.9 | 3.8 |
| $VO_2$ max (ml/kg/min) | 44.5 | 7.8 | 45.5 | 7.6 |
| 15 years Fat % | 13.3 | 4.2 | 12.1 | 3.6 |
| $VO_2$ max " | 43.2 | 7.7 | 53.0 | 5.5 |
| 18 years Fat % | 12.9 | 4.4 | 9.9 | 2.7 |
| $VO_2$ max " | 45.3 | 9.5 | 55.4 | 4.6 |

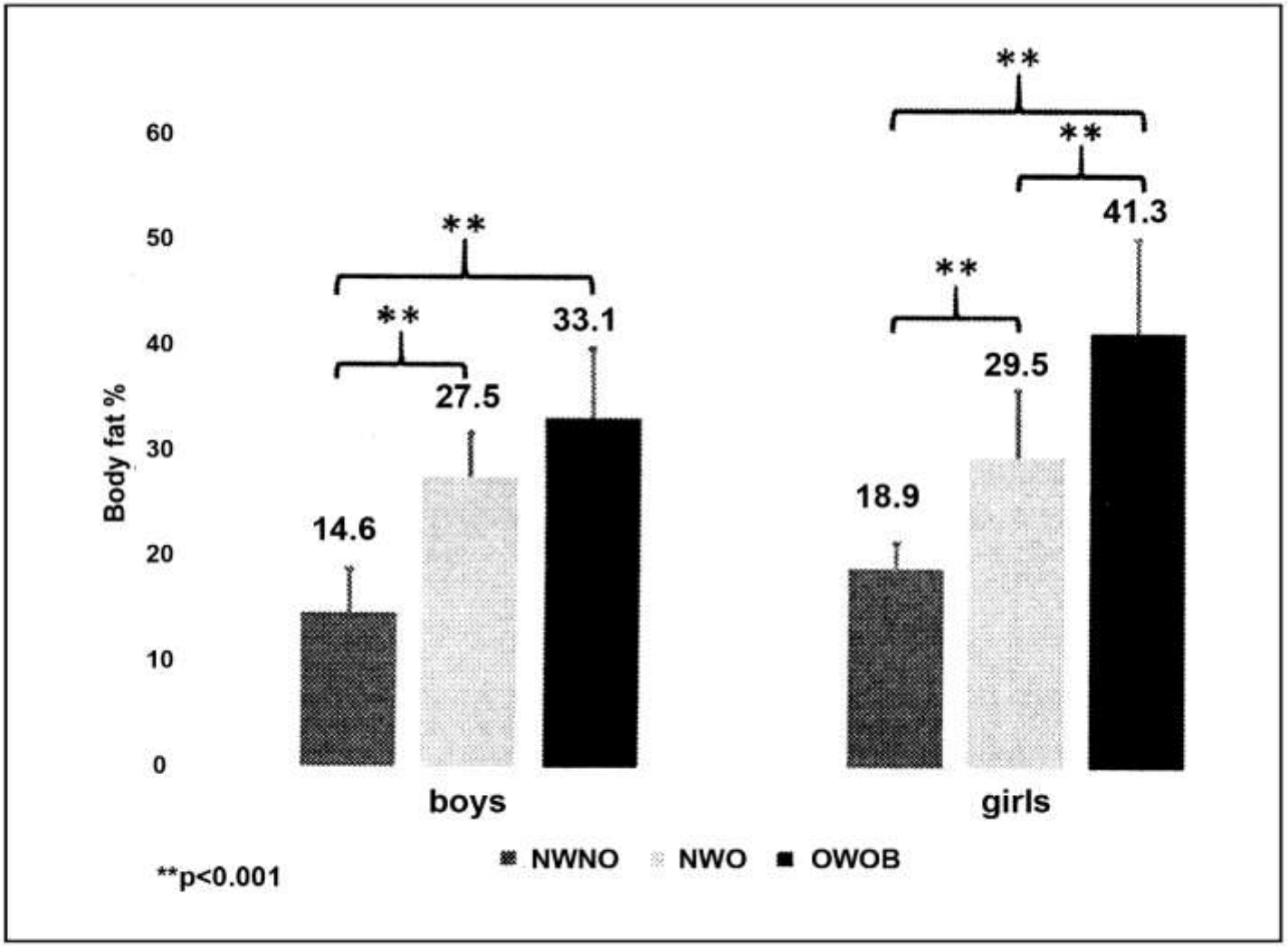
# Comparison of lean body mass and maximal oxygen uptake in exercised and control men (7th and 8th decade) (Pařízková 1977)



# Physical performance in preschool children with different physical education (Pařízková 2010)



# Differences in % body fat in normal weight/non obese, normal weight/obese and overweight/obese children (Musálek, Pařízková,Godina et al. 2018)



# Evaluation of hypokinesia in human subjects

- Mostly followed by indirect methods (forms, interviews-personal, by mobiles etc.)

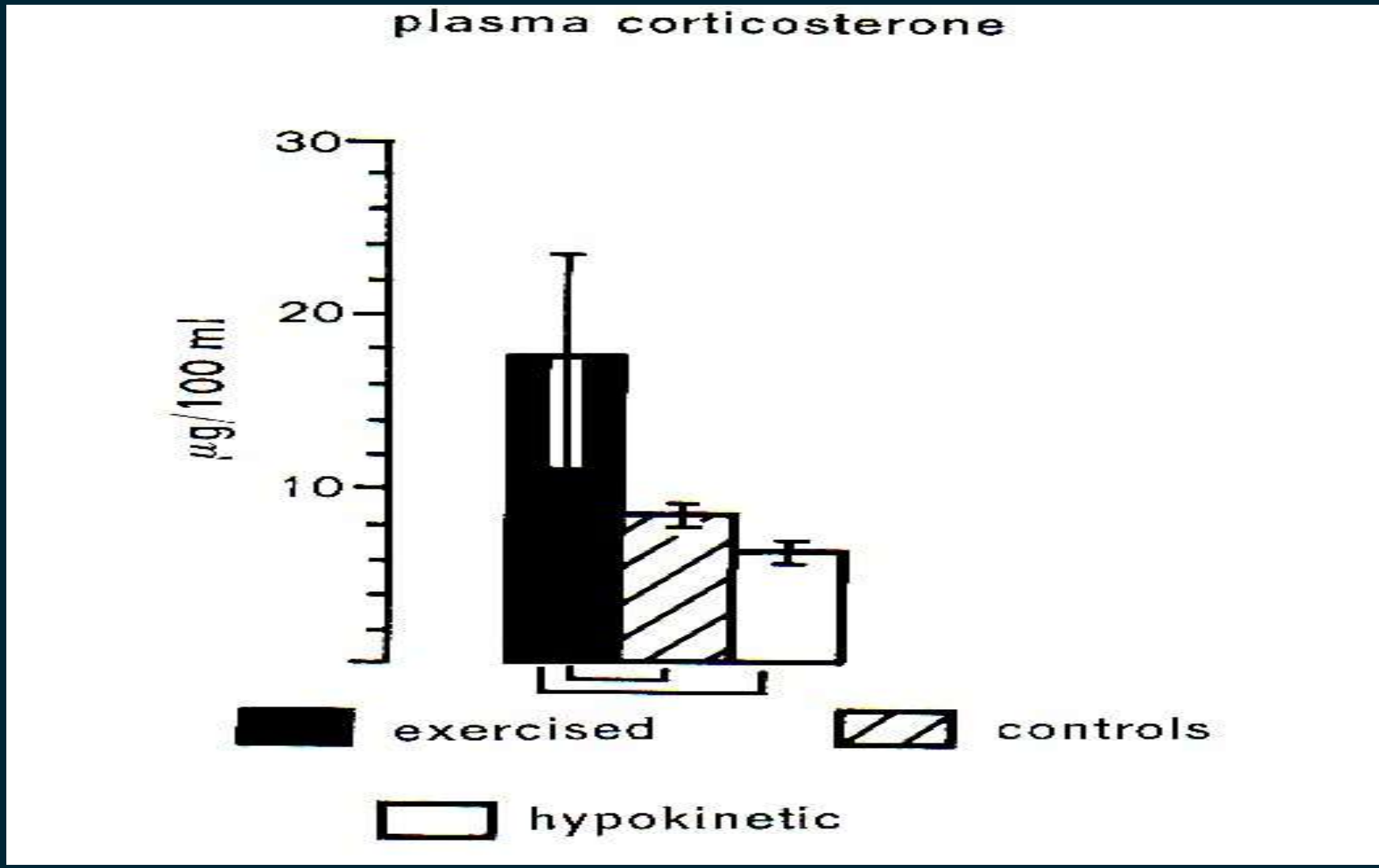
- Rare use of akcelerometry, metabolic, heart rate, oxygen consumption etc. measurements

- Followed without evaluation of genetic, epigenetic, nutritional, psychological and other additional factors

- Considered e.g. in the obese, or sick, injured etc. children – not under exactly defined conditions of reduced physical activity in normal healthy subjects

Specially studied during preparation of cosmonauts

# Plasma corticosteron levels in rats with different physical activity (Kvetňanský, Pařízková et al.1975)



# Activities of catecholamine synthetizing enzymes in the adrenals of rats adapted to different physical activity level (Kvetňanský, Pařízková et al. 1975)

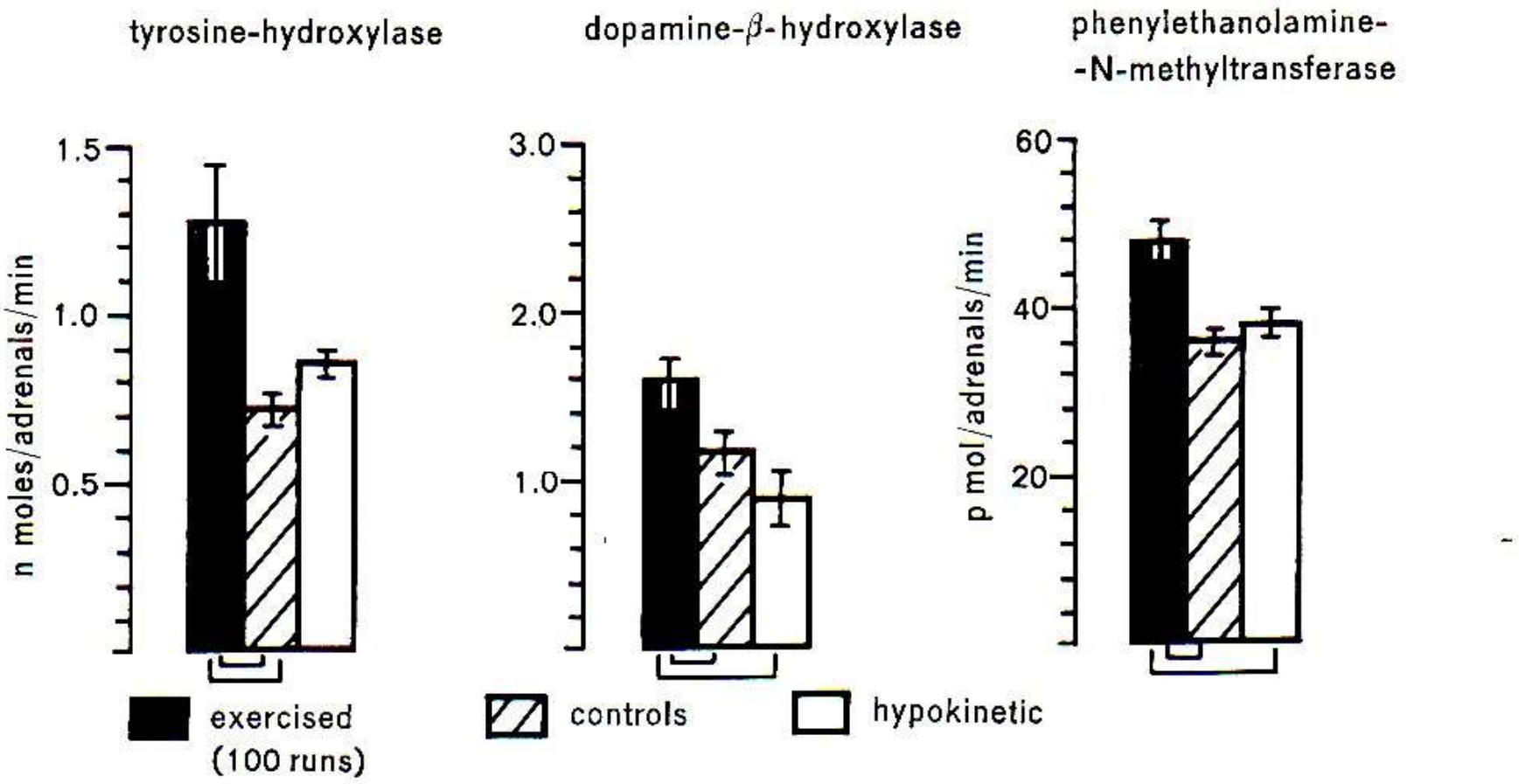
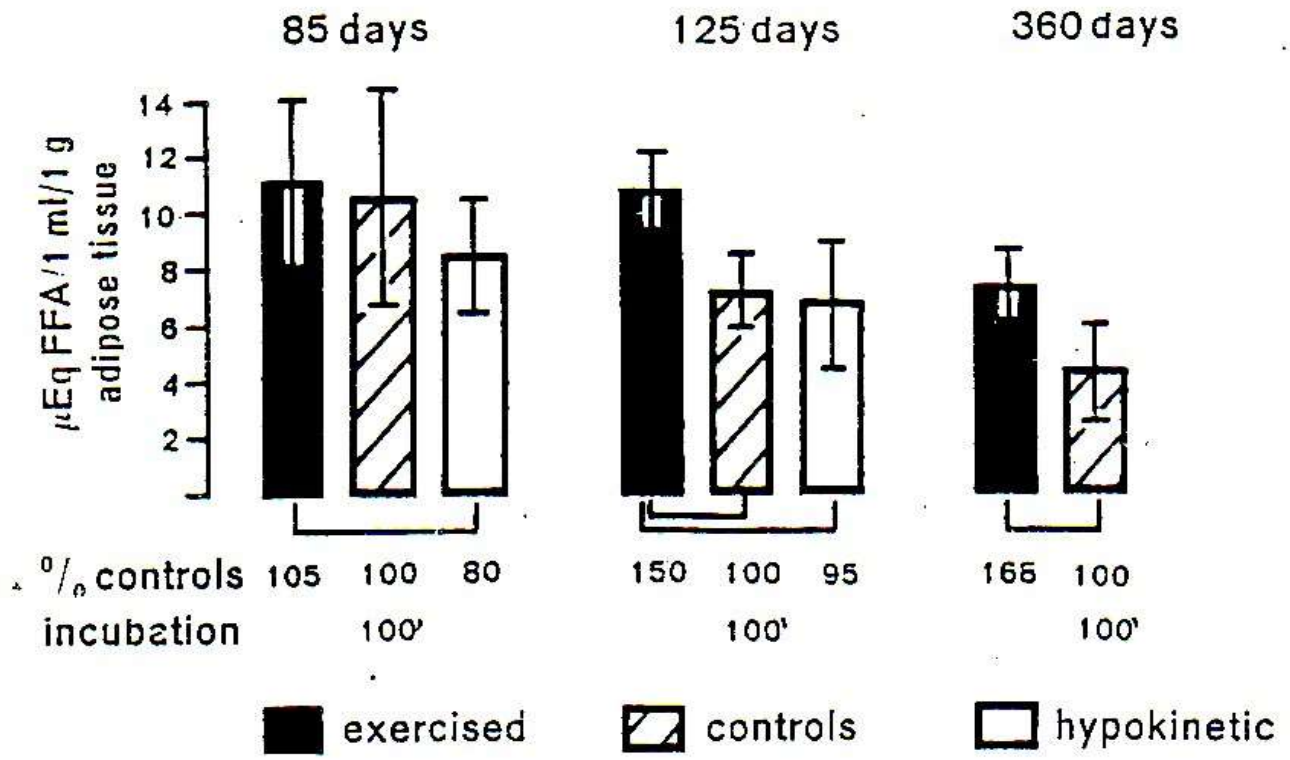
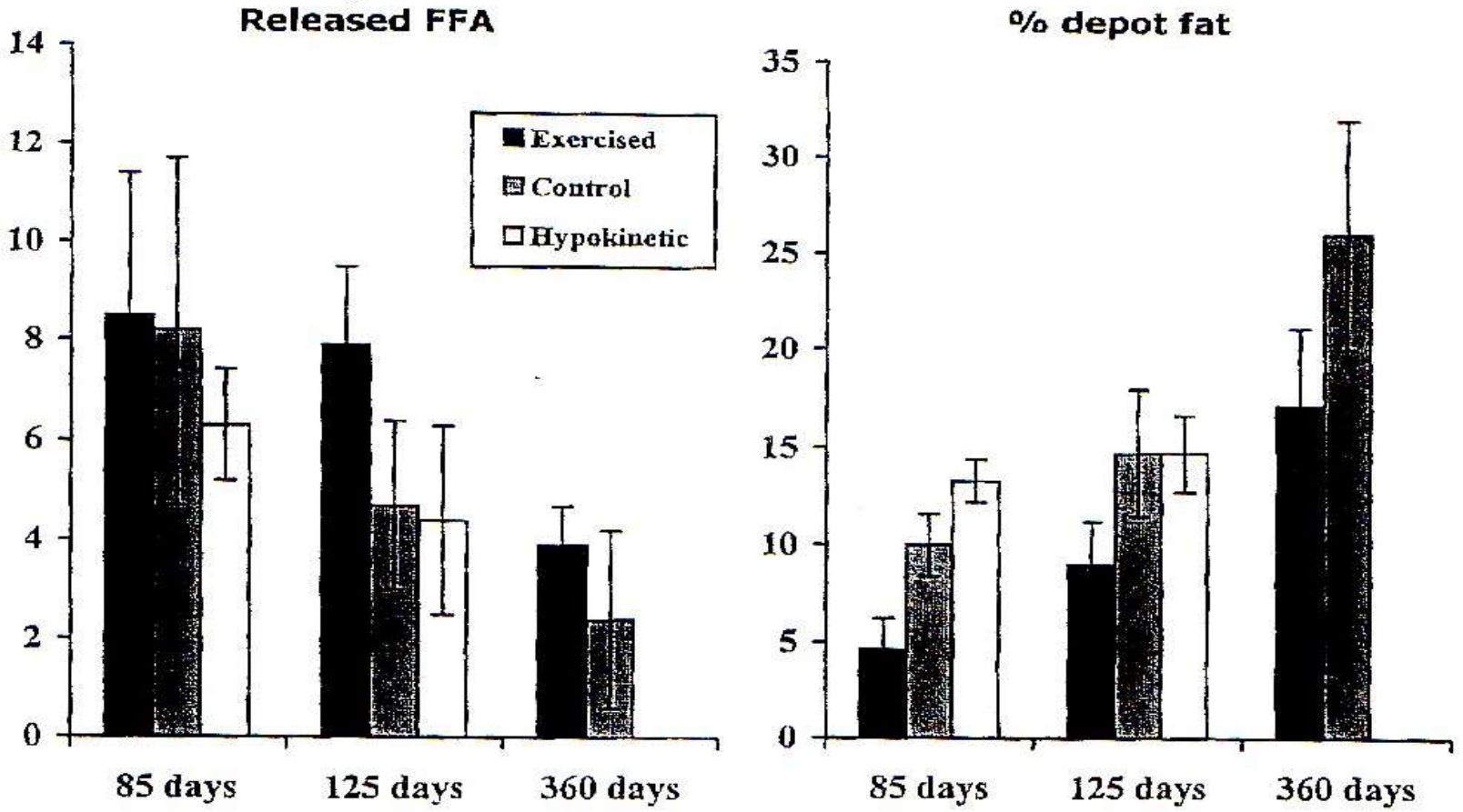



Fig. 32. Mean values ($\bar{x} \pm SD$) of activities of catecholamine synthetizing hormones in male rats with different physical activity regimes (Kvetňanský, Pařízková et al. 1975).

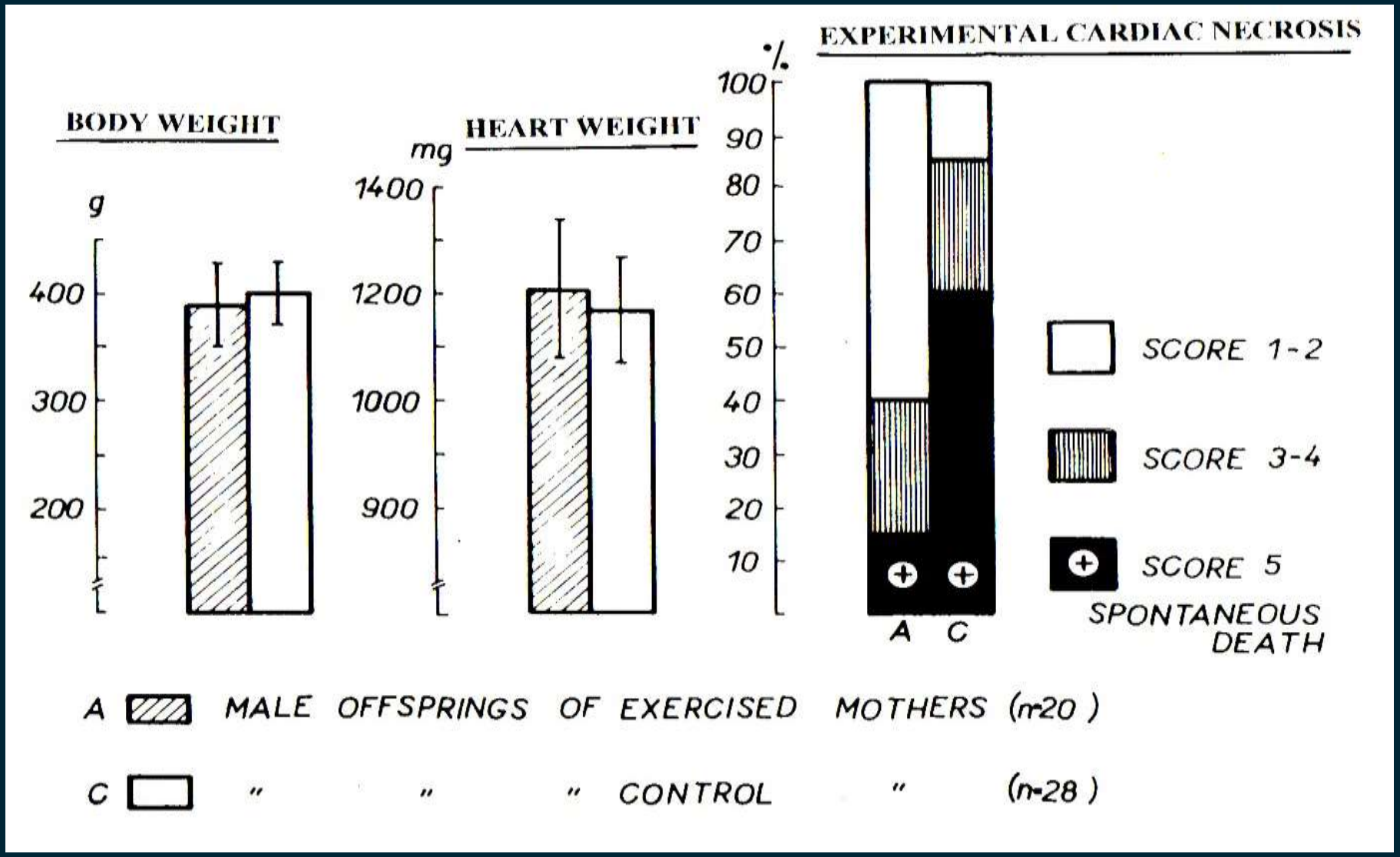
# RELEASE OF FREE FATTY ACIDS FROM EPIDIDYMAL ADIPOSE TISSUE OF MALE RATS ADAPTED TO DIFFERENT LEVELS OF PHYSICAL ACTIVITY AFTER ADRENALINE (Pařízková 1977)



Release of free fatty acids after adrenaline in vitro and the percentage of body fat in male rats of different age adapted to different physical activity



# Body and heart weight, and cardiac necrosis after isoprenaline in the offspring of exercised and control mothers (Pařízková 1978, 2010)



Hypokinesia becomes a health risk when **adaptation** along with undesirable resulting consequences develops since **early growth**, and when these changes can be evaluated by the measurements of anthropometric parameters, ***before*** they become more serious health problems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EDITED WITH AN INTRODUCTION AND NOTES

BY

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BOSTON NEW YORK CHICAGO

**. . . The more child is employed in something, runs about, is occupied in doing something, the sweeter is its sleep, the more easily it digests, the more richly it grows, becomes vigorous and flourishing in body and mind; solely, as long as one sees that it is protected from injury. For this purpose a safe place where children may run about and exercise themselves should be meant for them and found for them, and a harmless way of such exercise should be shown to them …**

**J.A.Comenius, Informatorium of the School of Infancy - Schola Infantiae 1632, Mss, Edited in Latin, Amsterdam 1657**

Second Edition

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Jana Pařízková