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AUTHOR Covington, N. Kay
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ABSTRACT

This study investigated the effects of selected physiological variables on preadolescent male and female long distance runners. The trained group was comprised of 20 children between the ages of 8 and 10 who had been running a minimum of 20 miles per week for two months or longer. The control group was made up of 20 children of the same ages who were not participating in an organized recreational sport. The physiological parameters compared were maximum oxygen consumption, bone density width, cortical score, and bone mineral content. The findings suggested that participating in long distance running was advantageous for the runners. A bibliography is included. (JD)

# THE EFFECTS OF LONG DISTANCE RUNNING ON PREADOLESCENT CHILDREN

N. Kay Covington

Paper presented at the National Convention of the American Alliance for Health, Physical Education, Recreation and Dance. Las Vegas, Nevada, April, 1987

# INTRODUCTION

Children are participating in organized sports at earlier ages and in greater numbers. New and popular sports are attracting our youth (Brueck, 1979). More than 6 million youth are involved in a wide variety of high school sports today. Twenty million youth between the ages of 8 and 16 are in non-school, community-sponsored athletic programs (Zito, 1983). One of the new sports activities in which children are involved is long distance running. Long distance running has become a very popular activity for children.

Opinions concerning children participating in long distance running are varied. Kenney (1981) states that running is a natural activity for the child. Brueck (1979) questions the value of children running a marathon. Long distance running places a severe strain on the articular cartilage, which could lead to adverse growth effects, particularly epiphyseal injury and subsequent disturbed growth in the affected limb. Physicians, educators, and scientists are less opinionated in view of the lack of scientific evidence (Caine & Lindner, 1984). Medical documentation of injury to children running long distances is very limited.

The purpose of this study was to investigate the effects of selected physiological variables on preadolescent male and female long distance runners. The investigation entailed an assessment of selected physiological characteristics of trained preadolescent children involved in long distance running and a control group of untrained children. The trained group was comprised of 8-, 9-, and 10-year-old males and females who had been running a minimum of 20 miles per week for 2 months or longer. The mean age was 9.5 years; the mean weight was 32.85 kg (72.42 lbs.); and the mean height was 140.91 cm (55.4 in.). A second group of 8-, 9-, and 10-year-old males and females who had not undertaken a regular schedule of exercise and/or were not participating in an organized

recreational sport served as the untrained group. The mean age was 9.05 years; the mean weight was 33.35 kg (73.54 lbs.); and the mean height was 134.6 cm (52.99 in.). The physiological parameters compared were maximum oxygen consumption, bone density width, cortical score, and bone mineral content. Bone density width - the thickness of the bone. Bone mineral content - the percentage of chemical constituents contained within bone. Calcium phosphate, calcium carbonate, with lesser quantities of sodium, magnesium, and fluoride. Cortical Score - The total width of the bone compared to cortical bone.

## METHODS AND PROCEDURES

Each subject's voluntary maximum oxygen consumption was measured during work on a Quinton treadmill, using the Bruce protocol. The Tissot Chain-Compensated Gasometer was used to collect all gases. The S-3A Oxygen Analyzer and the Beckman Medical Gas Analyzer were used to analyze the oxygen and carbon dioxide content of the collected gases. Bone density width was determined by x-ray densitometry of the radius. A radiograph was taken of the subject's left radius using a 60 kv peak Picker mobile x-ray unit. The exposed film was processed according to standardized technique. Bone denisty width was evaluated at the radius and phalanx 5.2.

The exposed film was evaluated for cortical score by measuring the thickness of the walls and the total width of the bone of the metacarpal II-4, using a magnifying glass. The 2 scores were added together and divided by the total width of the bone. The cortical score of the metacarpal III-4 was determined in a similar method.

Bone mineral content was determined by utilizing a Norland-Cameron Bone Mineral Analyzer. Depending upon subject movement, 4 or 5 scans were taken. A digital numerical readout for bone mineral content appeared on the screen after the completion of each scan. The mean of the 4 or 5 scans were calculated. Twenty-four (24) subjects completed a 3-day dietary recall.

# RESULTS

Data collected from the 20 trained and 20 untrained subjects were analyzed to determine if there was a difference between the groups for each physiological characteristic measured, using the multivariate analysis of variance.

1. There was a significant difference between the maximum oxygen consumption of the runners and the untrained. The maximum oxygen consumption of the runners (45.08 ml/kg/min) was higher than the untrained (33.05 ml/kg/min).

2. There was a significant difference between the runners and the untrained for bone mineral content. The bone mineral content of the runners was greater than that of the untrained.

3. When the bone density width-radius of the runners was compared with the untrained, there was not a significant difference.

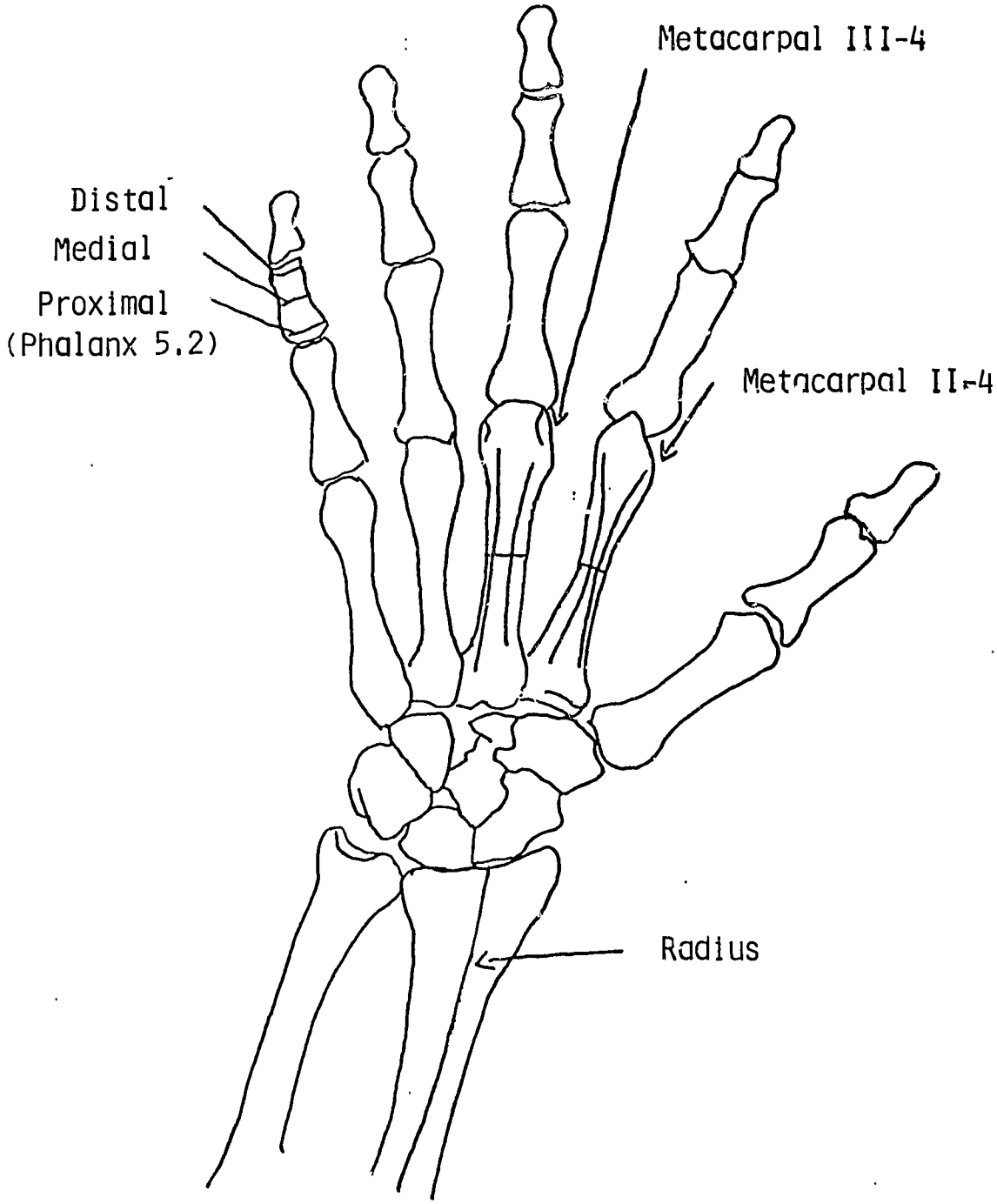
4. There was a significant difference between the runners and the untrained group for bone density width-phalanx 5.2. The F-ratio was 5.15. The bone density width-phalanx 5.2 was greater than that of the untrained.

5. There was not a significant difference found for the cortical score-metacarpal II-4 and metecarpal III-4.

6. There was not a significant difference between the runners and the untrained group for the nutritional intake of calcium, phosphorus, vitamin A, vitamin D, protein, or kilocalories.

# CONCLUSION

The findings of this investigation suggest that participating in long distance running was advantageous for the runners. It was concluded that long distance running may have affected the bone density width, bone mineral content, and maximum oxygen consumption in a positive way.




Sites investigated

Table 1

Description of the Subjects

| Group Variables | Range | M | SD | SEM |
|---|---|---|---|---|
| Runners | | | | |
| Age | 2.00<br>8.00 - 10.00 | 9.50 | .76 | .17 |
| Weight (kg) | 22.91<br>22.00 - 44.91 | 32.85 | 7.26 | 1.62 |
| Height (cm) | 42.16<br>122.34 - 165.10 | 140.91 | 10.21 | 2.28 |
| Maximum Oxygen Consumption (ml/kg·min) | 23.30<br>35.30 - 58.60 | 45.08 | 7.06 | 1.86 |
| Maximum Oxygen Consumption (l/min) | 1.25<br>.95 - 2.20 | 1.48 | .46 | .10 |
| Ventilation (ml/min) | 3474.3<br>2600.5 - 6074.8 | 4297.9 | 890.98 | 199.23 |
| Cortical Score (mg/cm) | .33 | | | |
| Metacarpal II-4 | .32 - .64 | .49 | .07 | .02 |
| Metacarpal III-4 | .36<br>.28 - .64 | .46 | .90 | .02 |
| Bone Density Width (mg/cm) | .16 | | | |
| Phalanx 5-2 | .16 - .32 | .20 | .04 | .00 |

table continues

| Group<br>Variables | Range | M | SD | SEM |
|---|---|---|---|---|
| Runners | | | | |
| Radius | .19<br>.20 - .39 | .31 | .04 | .00 |
| Bone Mineral Content ($g/cm^2$) | .30<br>.42 - .72 | .52 | .06 | .01 |
| Untrained | | | | |
| Age | 2.00<br>8.00 - 10.00 | 9.05 | .83 | .18 |
| Weight (kg) | 27.67<br>20.41 - 48.08 | 33.35 | 16.49 | 3.69 |
| Height (cm) | 32.02<br>115.57 - 148.59 | 134.60 | 9.30 | 1.97 |
| Maximum Oxygen Consumption (ml/kg'min) | 25.40<br>20.50 - 45.90 | 33.05 | .30 | .85 |
| Maximum Oxygen Consumption (l/min) | 1.02<br>.73 - 1.75 | 1.10 | .32 | .07 |
| Ventilation (ml/min) | 3570.1<br>2054.57 - 5624.67 | 3419.31 | 990.32 | 221.44 |
| Cortical Score (mg/cm) | | | | |
| Metacarpal II-4 | .23<br>.32 - .55 | .45 | .06 | .01 |

table continues

| Group<br>Variables | Range | M | SD | SEM |
|---|---|---|---|---|
| Untrained | | | | |
| Metacarpal III-4 | .30 - .25 .55 | .42 | .07 | .02 |
| Bone Density Width (mg/cm) | | | | |
| Phalanx 5-2 | .13 - .11 .24 | .18 | .03 | .00 |
| Radius | .22 - .13 .35 | .30 | .03 | .00 |
| Bone Mineral Content ($g/cm^2$) | .44 - .10 .55 | .17 | .03 | .05 |

Table 2

Summary of Multivariate Analysis of Variance

| Source | df | ss | MS | F | p |
|---|---|---|---|---|---|
| A: Fitness Level | | | | | |
| Age | 1 | 2.02500 | 2.025 | 3.16 | .0841 |
| Metacarpal II-4 | 1 | .00992 | .00992 | 2.08 | .1579 |
| Metacarpal III-4 | 1 | .01640 | .01640 | 2.92 | .0959 |
| Phalanx 5.2 | 1 | .00625 | .00625 | 5.15* | .0294* |
| Radius | 1 | .00169 | .00169 | 1.17 | .2865 |
| Mineral | 1 | 1.17306 | 1.17306 | 37.45* | .0000* |
| $VO_2$ Max | 1 | 1449.50000 | 1449.50000 | 24.31* | .0000* |
| B: Sex | | | | | |
| Age | 1 | .62500 | .62500 | 0.97 | .3303 |
| Metacarpal II-4 | 1 | .00004 | .00004 | 0.01 | .9239 |
| Metacarpal III-4 | 1 | .03540 | .03540 | 6.31* | .0166* |
| Phalanx 5.2 | 1 | .00004 | .00004 | 0.03 | .8570 |
| Radius | 1 | .00064 | .00064 | 0.44 | .5098 |
| Mineral | 1 | .05402 | .05402 | 1.72 | .1974 |
| $VO_2$ Max | 1 | 33.14220 | 33.14220 | 0.56 | .4608 |

table continues

| Source | df | ss | MS | F | p |
|---|---|---|---|---|---|
| AB:Interaction | | | | | |
| Age | 1 | .22500 | .22500 | 0.35 | .5574 |
| Metacarpal II-4 | 1 | .00246 | .00246 | 0.52 | .4769 |
| Metacarpal III-4 | 1 | .01190 | .01190 | 2.12 | .1539 |
| Phalanx 5.2 | 1 | .00025 | .00025 | 0.21 | .6527 |
| Radius | 1 | .00000 | .00000 | 0.00 | 1.0000 |
| Mineral | 1 | .03782 | .03782 | 1.21 | .2291 |
| $VO_2$ Max | 1 | 73.46800 | 73.46800 | 1.23 | .2743 |
| Error | | | | | |
| Age | 36 | 23.10000 | .06416 | | |
| Metacarpal II-4 | 36 | .17176 | .00477 | | |
| Metacarpal III-4 | 36 | .20197 | .00561 | | |
| Phalanx 5.2 | 36 | .04369 | .00121 | | |
| Radius | 36 | .05197 | .00144 | | |
| Mineral | 36 | 1.12766 | .03132 | | |
| $VO_2$ Max | 36 | 2146.52410 | 59.62566 | | |

* $F_{.95}(1.36) > 4.10$

Table 3

Description of the Nutrients

| Group Variables | Range | M | SD | SEM |
|---|---|---|---|---|
| **Runners** | | | | |
| Calcium (mg) | 1588.0<br>370.0 - 1958.0 | 952.5 | 403.8 | 116.6 |
| Phosphorus (mg) | 1388.8<br>567.2 - 1956.0 | 1126.0 | 413.0 | 119.2 |
| Vitamin A (RE) | 292.0<br>251.0 - 543.0 | 776.4 | 495.4 | 143.0 |
| Vitamin D (µg) | .4<br>.4 - .8 | .6 | .1 | .4 |
| Protein (g) | 80.5<br>28.2 - 108.8 | 63.8 | 22.8 | 6.6 |
| Kilocalories | 1912.1<br>953.9 - 2866.0 | 1818.0 | 559.1 | 161.4 |
| **Untrained** | | | | |
| Calcium (mg) | 2866.5<br>173.5 - 3040.0 | 983.9 | 784.6 | 226.5 |
| Phosphorus (mg) | 2799.0<br>163.0 - 2942.0 | 1130.0 | 731.7 | 211.2 |
| Vitamin A (RE) | 445.9<br>145.7 - 591.6 | 710.8 | 553.2 | 159.6 |
| Vitamin D (g) | .1<br>.0 - .1 | .1 | .1 | .1 |

table continues

| Group Variables | Range | M | SD | SEM |
|---|---|---|---|---|
| Protein (g) | 42.0<br>105.0 - 147.0 | 60.9 | 36.9 | 10.7 |
| Kilocalories | 3083.7<br>475.3 - 3559.0 | 1759.0 | 831.4 | 240.0 |

Table 4

Dietary Recall

| Source | df | ss | MS | F | p |
|---|---|---|---|---|---|
| Fitness Level | | | | | |
| Calcium | 1 | 5899.44 | 5899.44 | 0.02 | .9031 |
| Phosphorus | 1 | 141.81 | 141.81 | 0.00 | .9842 |
| Vitamin A | 1 | 684238.00 | 684238.00 | 0.10 | .7556 |
| Vitamin D | 1 | 19971.70 | 19971.70 | 2.81 | .1076 |
| Protein | 1 | 51.07 | 51.07 | 0.05 | .8180 |
| Kilocalories | 1 | 20995.30 | 20995.30 | 0.04 | .8398 |
| Error | | | | | |
| Calcium | 22 | 8564195.40 | 389281.61 | | |
| Phosphorus | 22 | 7764998.10 | 352954.46 | | |
| Vitamin A | 22 | 15157482.00 | 6889764.70 | | |
| Vitamin D | 22 | 156102.96 | 7095.58 | | |
| Protein | 22 | 20709.81 | 941.35 | | |
| Kilocalories | 22 | 11041253.00 | 501875.14 | | |

*$F_{.95}$ (1.22) > 4.30

# BIBLIOGRAPHY

Adams, J. B. (1968). Bone injuries in very young athletes. Clinical Orthopaedics and Related Research, 58, 129-140.

Allman, F. L. (1966). Competitive sports for boys under fifteen, beneficial or harmful? Journal of Medical Association-Georgia, 55, 464-468.

American College of Sports Medicine. (1978). Physician statement on the recommended quantity and quality of exercise for developing and maintaining fitness in healthy adults. Indianapolis, Indiana: ACSM.

Anderson, S. D. & Godfrey, S. (1971). Cardiorespiratory response to treadmill exercise in normal children. Clinical Science, 40, 433-442.

Andrew, G. M., Becklake, M. R., Guleria, J. S., & Bates, D. V. (1972). Heart and lung functions in swimmers and nonathletes during growth. Journal of Applied Physiology, 32, 245-251.

Astrand, P. O. & Rodahl, K., (1977). Textbook of work physiology: Physiological bases of exercise. New York: McGraw-Hill.

Bailey, O. A. (1978). Sport and the child: physiological considerations. In R. A. Magill, M. J. Ash, & F. L. Small (ed). Children in sport: A contemporary anthology. Champaign, Illinois: Human Kinetics.

Bar-Or, O., Shephard, R. J., & Allen, C. L. (1971). Cardiac output of 10 to 13 year old boys and girls during submaximal exercise. Journal of Applied Physiology, 30, 219-223.

Bengtsson, E. (1956). The working capacity in normal children, evaluated by submaximal exercise on the bicycle ergometer and compared with adults. Acta Medica Scandanavia, 154, 91-109.

Benton, J. W. (1982). Epiphyseal fracture in sports. The Physician and Sportsmedicine, 10, 63-71.

Brooks, G. A. & Fahey, T. D. (1984). Exercise physiology: human bioenergetics and its applications. New York: John Wiley & Sons.

Brown, C. H., Harrower, J. J., & Deeter, M. F. (1972). The effects of cross-country running on pre-adolescent girls. Medicine and Science in Sports, 4, 1-5.

Bruce, R. A., Kusumi, F., & Hosmer, D. (1973). Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. American Heart Journal, 85, 546-562.

Brueck, C. (1979). Caution: children at play. Do little kids belong in marathons? Runner, 1, 60-67.

Burkhart, S. S., & Peterson, H. A. (1979). Fractures of the proximal tibial epiphysis. Journal of Bone Joint Surgery, 61, 996-1002.

Caine, D. J., & Lindner, K. J. (1984). Growth-plate injury: a threat to young distance runners? The Physician and Sportsmedicine, 12, 118-124.

Cameron, J. R. & Sorenson, J. (1963). Measurement of bone mineral in vivo: an improved method. Science, 142. 230-232.

Chausow, S. A., Finer, W. F., & Boileau, R. A. (1984). Metabolic and cardiovascular responses of children during prolonged physical activity. Research Quarterly, 55, 1-7.

Corbin, C. B., Dowell, L. J., Lindsey, R., & Tolson, H. (1981). Concepts in physical education. Dubuque, Iowa: William C. Brown.

Cunningham, D. A., Paterson, D. H., & Blimkie, C. J. R. (1984). The development of the cardiorespiratory system with growth and physical activity. In: Advances in pediatric sport sciences I. biological issues, R. A. Boileau (ed). Champaign, Illinois: Human Kinetics Publishers, Inc.

Food & Nutrition Board (1980). Recommended dietary allowances, 9th ed. Washington: National Academy of Sciences, National Research Council.

Freedson, P. S., Gilliam, T. B., Sady, S. P., & Katch, V. L. (1981). Transient $VO_2$ characteristics of children at the onset of steady-rate exercise. Research Quarterly For Exercise and Sport, 52, 167-173.

Gibbins, J. A., Cunningham, D. A., Shaw, D. B., & Bynon, R. B. (1972). The effect of swimming training on selected aspects of the pulmonary function of young girls - a preliminary report. In Taylor, A. W. (ed). Training: scientific basis and application, Springfield: Charles C. Thomas.

Goldsmith, N. F., Johnston, M. D., Ury, H., Vose, G., & Colbert, C. (1971). Bone-mineral estimation in normal and osteoporotic women. The Journal of Bone and Joint Surgery, 53-A, 83-100.

Guthrie, H. A. (1983). Introductory nutrition. St. Louis: C. V. Mosby Company.

Hamill, P. V. V., Drizd, T. A., Johnson, C. L., Reed, R. B., Roche, A. F., Moore, W. M. (1979). Physical growth: National Center for Health Statistics percentiles. American Journal of Clinical Nutrition, 32, 607-629.

Harrison, R. A. (1978). Composition of bone. The Journal of Bone and Joint Surgery, 78, 44-50.

Heyward, V. H. (1984). Designs for fitness: A guide to physical fitness appraisal and exercise prescription. Minnesota: Burgess.

Iliev, I. B. (1978). Maximal aerobic power in girls and boys aged 9 to 16 years who participate regularly in sport. In R. J. Shephard & H. Lavellee (eds), Physical fitness assessment. Springfield: Charles C. Thomas.

Ivanitsky, M. F. (1962). Effects on diameter of bones. Medical Tribune, 3, 22-34.

Kaluger, G. & Kaluger, M. F. (1984). Human development: the span of life. St. Louis: Times Mirror/Mosby.

Kenney, M. (1981). Kids are natural runners. Running Times, 50, 22-28.

Krause, M. V. & Mahon, L. K. (1984). Food, nutrition and diet therapy. Philadelphia: W. B. Saunders.

Larson, R. L. (1973). Physical activity and the growth and development of bone and joint structures. In Rarick, G. L. (ed). Physical activity: human growth and development. New York: Academic Press.

Larson, [illegible] L. & McMahan, R. O. (1966). The epiphyses and [illegible]ldhood athlete. Journal of American Medical [illegible]ation, 196, 99-104.

Lopez, R. & Pruett, D. M. (1982). The child runner. Journal of Physical Education, Recreation, and Dance, 4, 78-81.

Mack, P. B., Brown, W. N., Trapp, H. D. (1949). The quantitative evaluation of bone density. The American Journal of Roentgenology and Radium Therapy, 61, 808-825.

Mazess, R. B. & Cameron, J. R. (1972). Growth of bone in school children: comparison of radiographic morphometry and photon absorptiometry. Growth, 36, 77-92.

Maroteaux, P. (1979). Bone diseases of children. Philadelpia: J. B. Lippincott Co.

Oeser, H. & Krokowski, E. (1963). Quantitative analysis of inorganic substances in the body: A method using x-rays of different qualities. American Journal of Roentgenology and Radium Therapy, 36, 274-279.

Peterson, C. A. & Peterson, H. A. (1972). Analysis of the incidence of injuries to the epiphyseal growth plate. Journal of Trauma, 12, 275-281.

Rarick, G. L. (1974). Exercise and growth. In B. Johnson (ed), Science and sports. New York: Harper & Row.

Rowland, T. W. (1985). Aerobic response to endurance training in prepubescent children: A critical analysis. Medicine and Sciences in Sports and Exercise, 17, 493-497.

Salter, R. B. & Harris, W. R. (1963). Epiphyseal-plate injuries. Journal of Bone Joint Surgery, 45, 587-621.

Shaffer, T. E. (1982). Risks in long-distance running for children. The Physician and Sportsmedicine, 10, 82-83.

Shephard, R. J., Allen, C., Bar-Or, O., Davies, C. T. M., Degre, S., Hedman, R., Ishii, K., Kaneko, M., LaCour, J. R., diPrampero, P. E., & Selinger, V. (1969). The working capacity of Toronto schoolchildren, part I. Canadian Medical Association Journal, 100, 560-566.

Siegal, J. A. & Manfredi, T. G. (1984). Effects of a ten-month fitness program on children. The Physician and Sportsmedicine, 12, 91-97.

Smithgall, E. B., Johnston, F. E., Malina, R. M., & Galbreath, M. (1966). Developmental changes in compact bone relationships in the second metacarpal. Human Biology, 38, 141-151.

Spencer, H. & Kramer, L. B. (1985). Nutritional and other factors influencing skeletal status. In A. F. Roche (ed.), Report of the Sixth Conference on Medical Research, body compostion assessments in growth in youth and adults (pp. 33-37). Columbus, Ohio: Ross Laboratories.

Tanner, J. M. (1955). Growth at adolescence. Oxford: Blackwell.

Vaughn, J. M. (1975). The physiology of bone. Oxford: Clarendon Press.

Whitney, E. N. & Cataldo, C. B. (1983). Understanding normal and clinical nutrition. St. Paul: West Publishing Co.

Wilmore, J. H. & Sigerseth, P. O. (1967). Physical work capacity of young girls, 7-13 years of age. Journal of Applied Physiology, 22, 923-928.

Zaricznyj, B., Shattuck, L. J. M., Mast, T. A., Robertson, R. V., & D'Elia, G. (1980). Sports-related injuries in school aged children. The Journal of Sports Medicine, 8, 318-323.

Zito, M. (1983). The adolescent athlete: a musculoskeletal update. The Journal of Orthopaedic and Sports Physical Therapy, 5, 20-25.