

Variability (Co-Variance) of Selected Length Dimensions of Female Students in a Longitudinal Physical Conditioning Programme of 18-Weeks

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Article Info

Abstract

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Conditioning is usually referred to the circumstance of state of being. Physical conditioning enables an individual/ athlete to be prepared to take strenuous loads. It leads to various radical and mechanical changes in the body. Not many studies have investigated on the training effect of a systematic training or conditioning programme for female students in the University of Delhi. Hence, the present study is aimed at studying the variability of covariance of selected length dimensions of female students (youth) in a longitudinal physical conditioning programme of 18-weeks duration. The sample size for the study was 78 (N) having three groups of female students i.e. progressive load (PLT, n1=26), constant load (CLT, n2=26), and no load group (NL, n3=26); 26 samples in each group (mean age = 19.76±1.69 years). The variables included sitting height, leg length, arm length, foot length and foot breadth. The design of the study was a multi-group repeated measure design. The testing was conducted four times, i.e. pre-test and three post-tests at an interval of Six weeks on completion of each of the three meso-cycles. The variables were measured while using standard landmarks and protocols. The study concluded that the progressive load of physical training positively affected foot breadth, leg length, arm length and foot length, whereas the constant load of the physical training group demonstrated changes in the foot breadth of female students (youth).

Introduction

Conditioning is usually referred to the circumstance of state of being. It refers to getting the individual exposed to certain activities, predominantly physical in nature (Bilik, 1956). The conditioning programme includes running, hopping, jumping and stretching exercises of calisthenics type. It also refers to the process by

which one attempts to improve a given physiological function, which may or may not be for the purpose of improving a skilled performance (Johnson, 1971).

Physical conditioning enables an individual/ athlete to be prepared for the strenuous load (Shaw, 2021). It leads to various functional and

mechanical changes in the body (Shephard, 1983), (Harris, et al, 1989), (McHenery, 1990), (Blomquist, 1983), (Monahan, 1987) & (Shaw, 2006). Different researchers have suggested different training programmes for the improvement of physical fitness of different populations [10-13], but there is no specific training/conditioning programme for any specific population in India.

Many researchers have included different lengths and breadths as variables in their studies, which reflects its importance. However, most of the studies have studied them to study the morphology for a particular sport or its use in general (Arnheim, 1985), (Novich, 1983), (Kaushik, 2014) & (Welk, 2000). It is also observed that the effect of training of length and breadth dimensions are not properly addressed, particularly the college level students. Hence, the investigators were motivated to conduct a study on the variability of covariance of selected length dimensions of female students (youth) in a longitudinal physical conditioning programme of 18-weeks duration.

Methods

Sample: The study was conducted on seventy eight (N=78, Mean age = 19.76 ± 1.69 years) female students of Delhi University classified equally in three groups viz. (a) Progressive load of training or conditioning group coded as Progressive Load of Training (PLT) (n1=26, Mean Age= 19.31 ± 1.54 years); (b) Constant load of training or non-conditioning group coded as Constant Load of Training referred as "CLT" (n2=26, Mean Age= 20.42 ± 1.77 years); and (c) No load or control or sedentary group coded as NL (n3=26, Mean Age= $20.19.54 \pm 1.79$ years). The samples were randomly selected which matched similar fitness groups and maximum consideration was given to their homogeneity.

Variables: The following variables were selected: sitting height, leg length, arm length, foot length and foot breadth.

Experimental and Testing Protocol: The design of the study was a multi-group repeated measure test. Testing was done at the end of each meso

cycle, four times at a interval of six weeks. The emphasized components during 18-weeks of training included flexibility and cardio-respiratory endurance during first Meso-cycle of 0-6 weeks; muscular endurance and strength during second Meso-cycle of 6-12 weeks; and speed and power/explosive strength during third Meso-cycle of 12-18 weeks. The principle of training of *progressive* overload was implemented throughout *the experiment*.

The first group was classified as progressive load referred to as 'PLT' or a conditioning group referred to as 'CLT'. The PLT group was subjected to treatment-1 i.e. step-progression loading based conditioning programme of 18-weeks duration (45 minutes per day, 5-days a week) in addition to the load given to the second group, since it was a part of their common curriculum. The second group i.e. constant load or non-conditioning group (CLT) was subjected to treatment-2 which aimed at improving the general fitness to meet the professional preparation and curricular requirement of the students. The third group i.e. no load or control or sedentary group (NL) included those students of University of Delhi who did not participate in any sports or vigorous activity. They were also requested not to participate in any sports or to undergo training in yoga or meditation during the time of experimentation.

Collection of Data: The data was collected at the Biomechanics Laboratory, Department of Natural/ Medical Sciences, IGIPSS, University of Delhi. Standard landmarks and measurement protocols were used to measure selected variables as described by various authors Koley, 2005), (Singh, 1989) & (Kansal, 1996).

Statistical Procedure: Descriptive statistics (Mean & SD) was applied to compute a description of selected length and breadth dimensions measurements; while ANCOVA and post-hoc analysis was used to assess the change as the effects of conditioning programme to three selected groups (progressive load, constant load or no load group) during different stages of training and testing on the selected variables.

Table-1
Descriptive statistics of selected length and breadth dimensions of female students (youth)

Variable	Group Code	N	Test-1		Test-2		Test-3		Test-4	
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Sitting Height (cm.)	PLT	26	75.43	2.16	75.50	2.17	75.61	2.16	75.67	2.17
	CLT	26	75.53	2.77	75.57	2.75	75.64	2.74	75.68	2.75
	NL	26	76.49	2.05	76.51	2.07	76.57	2.06	76.62	2.04
Leg Length (cm.)	PLT	26	81.97	2.41	82.05	2.42	82.11	2.43	82.20	2.41
	CLT	26	81.36	2.57	81.40	2.56	81.45	2.57	81.48	2.59
	NL	26	80.69	2.00	80.76	1.98	80.78	1.97	80.82	1.98
Length of Arm (cm.)	PLT	26	70.27	2.35	70.34	2.36	70.43	2.35	70.53	2.37
	CLT	26	69.47	2.29	69.55	2.29	69.61	2.30	69.67	2.29
	NL	26	69.13	2.71	69.23	2.71	69.29	2.73	69.35	2.73
Length of Foot (cm.)	PLT	26	23.00	0.98	23.05	0.98	23.14	0.97	23.19	0.97
	CLT	26	22.83	0.84	22.89	0.84	22.93	0.83	22.95	0.84
	NL	26	22.76	0.72	22.81	0.70	22.88	0.68	22.90	0.68
Foot Breadth (cm.)	PLT	26	8.39	0.23	8.45	0.21	8.53	0.20	8.62	0.21
	CLT	26	8.24	0.35	8.27	0.34	8.31	0.34	8.33	0.35
	NL	26	8.42	0.35	8.45	0.34	8.55	0.34	8.58	0.34

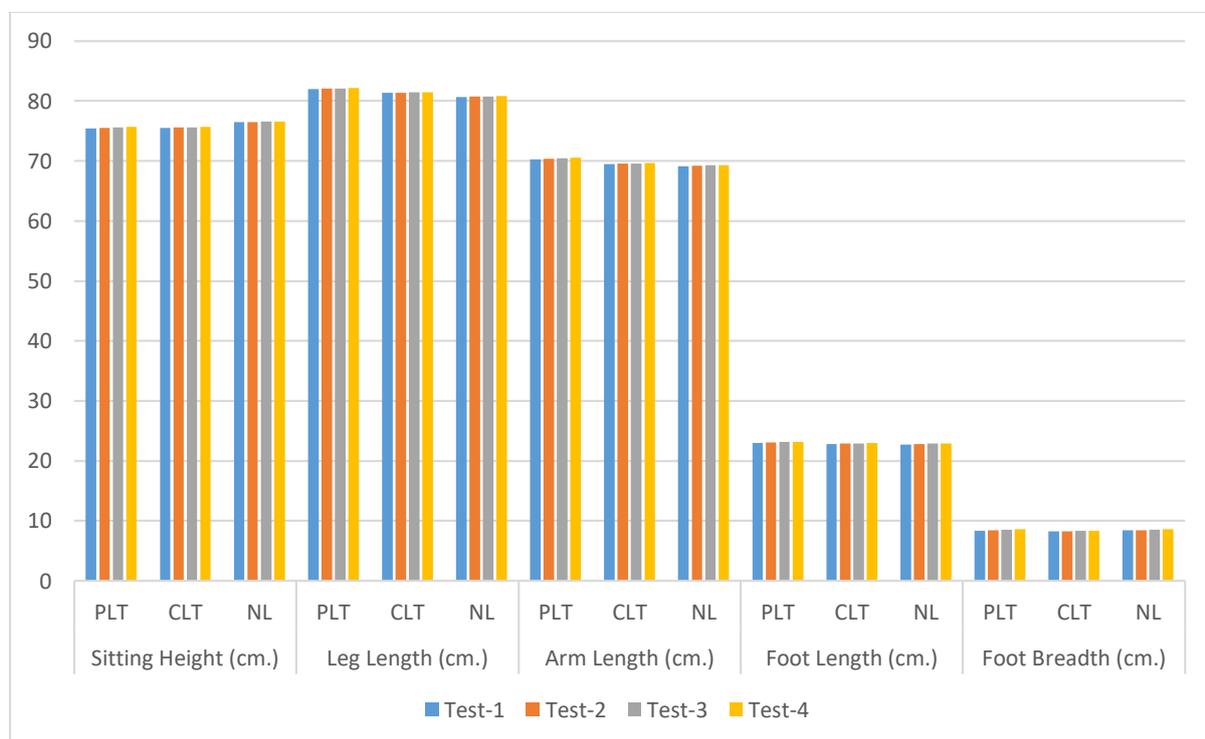


Fig.-1: Comparison of selected lengths of female students of university of Delhi

The analysis of data in table-1, illustrated vide Fig.-1 with respect to the descriptive statistics of selected lengths and breadths of female students of Delhi University reveal that:

1. All the selected variables namely sitting height, leg length, arm length, foot length and foot breadth observed similar trends.
2. The mean value observed with an increasing trend among all the selected groups i.e. the progressive training load or conditioning group (PLT), constant training load or non-conditioning group (CLT); as well as for the no-load or sedentary group (NL), reflecting

that the training might have influenced the selected variables.

3. Based on combining all four values (one pre-test and three post-tests) divided by the number of tests describes that the mean values of selected variables of female students of University of Delhi are as follows:
 - a. Sitting Height (75.90 cm.)
 - Progressive Load Training Group-75.55 cm.
 - Constant Load Training Group-75.61 cm.
 - No Load Group-76.55 cm.
 - b. Leg Length (81.42 cm.)
 - Progressive Load Training Group-82.08 cm.
 - Constant Load Training Group-81.42 cm.
 - c. Arm Length (69.74 cm.)
 - No Load Group-80.76 cm.
 - Progressive Load Training Group-70.39 cm.
 - Constant Load Training Group-69.58 cm.
 - No Load Group-69.25 cm.
 - d. Foot Length (22.94 cm.)
 - Progressive Load Training Group-23.10 cm.
 - Constant Load Training Group-22.90 cm.
 - No Load Group-22.84 cm.
 - e. Foot Breadth (8.43 cm.)
 - Progressive Load Training Group-8.50 cm.
 - Constant Load Training Group-8.29 cm.
 - No Load Group-8.50 cm.

Table – 2
Analysis of Covariance of Selected Length and Breadth Dimensions of Female Students (Youth)

Variable	F-Ratio					
	Stage- 1 (0-6 weeks)	Stage- 2 (0-12 weeks)	Stage- 3 (0-18 weeks)	Stage- 4 (6-12 weeks)	Stage- 5 (6-18 weeks)	Stage- 6 (12-18 weeks)
Sitting Height	2.94 (NS)	6.39*	7.76*	2.76 (NS)	3.76*	0.82 (NS)
Leg Length	1.28 (NS)	2.24 (NS)	7.09*	2.14 (NS)	6.45*	5.28*
Arm Length	0.73 (NS)	0.33 (NS)	3.20*	2.43 (NS)	6.82*	2.74 (NS)
Foot Length	0.20 (NS)	1.51 (NS)	5.74*	3.50*	10.22*	3.28*
Foot Breadth	4.25*	15.01*	38.36*	9.30*	26.59*	10.57*

Table-2 With respect of the analysis of Covariance of selected length and breadth dimensions of female students of Delhi University demonstrated F-ratios for the adjusted post-test means for comparison among different groups namely progressive load group 'PLT', constant load group 'CLT' and no-load group 'NL' for various stages of conditioning programme viz. stage-1 (difference between zero to 6-weeks), stage-2 (difference between zero to 12-weeks), stage-3 (difference between zero to 18-weeks), stage-4 (difference between 6 to 12 weeks), stage-5 (difference between 6 to 18 weeks) and stage-6 (difference between 12 to 18 weeks). The calculated 'F-ratios' significant at .05 level are marked with * symbol, and F-ratios not significant at .05 level are marked with NS. The results and findings suggested that the F-ratios were statistically significant for sitting height during stages 2, 3 & 5 and not significant during stages 1, 4 & 6. In case of leg length, the

F-ratio was statistically significant during stages 3, 5 & 6 of conditioning and non-significant during stages 1, 2 & 4. In case of arm length, the F-ratios were observed to be significant at stages 3 & 5, but not significant during stages 1, 2, 4 & 6. In case of the foot length, there were statistically significant F-ratios during stages 3, 4, 5 & 6 and not significant F-ratios during stages 1 & 2. The F-ratios were found to be significant in case of foot breadth during all the stages of experimentation. Along with the progression of time, there is a significant change in the selected length and breadth dimensions. The data also reflect that most of the changes are observed at the end of 18-weeks of training. In order to find out which of the group significantly differed in the adjusted post means, the post-hoc t-test for paired mean comparison was applied, where F-ratio was found statistically significant, and results of the same are presented in table-3.

Table 3

Post-hoc comparison of adjusted Post Mean of Selected Length and Breadth Dimensions of Female Students (Youth)

Variable	Mean Difference between PLT and CLT (3.1)					
	Stage- 1 (0-6weeks)	Stage- 2 (0-12weeks)	Stage- 3 (0-18weeks)	Stage- 4 (6-12weeks)	Stage- 5 (6-18weeks)	Stage- 6 (12-18weeks)
Sitting Height	0.023 (NS)	0.061 (NS)	0.077 (NS)	0.038 (NS)	0.054 (NS)	0.015 (NS)
Leg Length	0.033 (NS)	0.047 (NS)	0.104*	0.014 (NS)	0.071 (NS)	0.057*
Arm Length	0.017 (NS)	0.017 (NS)	0.061 (NS)	0.034 (NS)	0.079*	0.045 (NS)
Foot Length	0.002 (NS)	0.042 (NS)	0.077*	0.044 (NS)	0.080*	0.036 (NS)
Foot Breadth	0.036 (NS)	0.077*	0.139*	0.042*	0.103*	0.063*
Variable	Mean Difference between PLT and NL (3.2)					
	Stage- 1 (0-6 weeks)	Stage- 2 (0-12 weeks)	Stage- 3 (0-18 weeks)	Stage- 4 (6-12 weeks)	Stage- 5 (6-18 weeks)	Stage- 6 (12-18 weeks)
Sitting Height	0.049 (NS)	0.082*	0.102*	0.033 (NS)	0.053 (NS)	0.020 (NS)
Leg Length	0.016 (NS)	0.058 (NS)	0.097*	0.042 (NS)	0.082*	0.039 (NS)
Arm Length	0.025 (NS)	0.005 (NS)	0.041 (NS)	0.030 (NS)	0.066 (NS)	0.036 (NS)
Foot Length	0.010 (NS)	0.028 (NS)	0.056 (NS)	0.019 (NS)	0.046 (NS)	0.028 (NS)
Foot Breadth	0.027 (NS)	0.013 (NS)	0.065*	0.014 (NS)	0.038 (NS)	0.052*
Variable	Mean Difference between CLT and NL (3.3)					
	Stage-1 (0-6 weeks)	Stage- 2 (0-12 weeks)	Stage- 3 (0-18 weeks)	Stage- 4 (6-12 weeks)	Stage- 5 (6-18 weeks)	Stage- 6 (12-18 weeks)
Sitting Height	0.026 (NS)	0.021 (NS)	0.026 (NS)	0.005 (NS)	0.000 (NS)	0.004 (NS)
Leg Length	0.017 (NS)	0.011 (NS)	0.007 (NS)	0.028 (NS)	0.010 (NS)	0.018 (NS)
Arm Length	0.008 (NS)	0.012 (NS)	0.021 (NS)	0.004 (NS)	0.012 (NS)	0.008 (NS)
Foot Length	0.012 (NS)	0.014 (NS)	0.021 (NS)	0.026 (NS)	0.033 (NS)	0.007 (NS)
Foot Breadth	0.010 (NS)	0.064*	0.074*	0.056 (NS)	0.065*	0.011 (NS)

The analysis of data in table-3.1 displays both the progressive load & constant load of training which bring changes in various lengths and breadths of female students of Delhi University. The changes are as follow-

- Table 3.1 reveals that the longitudinal physical conditioning programme 18-weeks training duration had the following effects (comparison in PLT and CLT) :
 - There was no significant difference between progressive load of training (PLT) and constant load of training (CLT) with regard to sitting height.
 - Significant difference between PLT and CLT in regard to leg length in stage 3 & 6 of training, which was not significant during stages 1, 2, 3, 4 & 5.
 - Significant difference between PLT and CLT in regard to arm length at stage-5 i.e. 6-18 weeks, which was not significant during stages 1, 2, 3, 4 & 6 of conditioning.
 - Significant difference between PLT and CLT in regard to foot length at stages 3 & 5, which was not significant during stages 1, 2, 4 & 6 of conditioning.
 - Significant difference between PLT and CLT in regard to foot breadth during all the stages except stage-1 i.e. 0-6 weeks of conditioning.
 - There was no significant difference between PLT and CLT with regard to all the selected length and breadth dimensions at the end of 6-weeks of conditioning.
 - There was significant difference with regard to foot breadth and non-significant difference with regard to all other variables i.e. sitting height, lengths of leg, arm, and foot length of the female students at the end of 12-weeks of conditioning.
 - There was significant difference with regard to leg length, foot length and foot breadth and non-significant difference with regard to sitting height and arm length of the female students at the end of 18-weeks of conditioning.
 - The periodic testing shows that the Stage- 4 i.e. 6 -12 weeks of conditioning had significant differences only in foot breadth of the female students and it was not sufficient to bring changes in the rest

- of the variables including sitting height, leg length, arm length and foot length. Stage-5 i.e. 6-18 weeks of conditioning observed significant differences in arm length, foot length and foot breadth; and no significant difference in sitting height, foot length and foot breadth of the female students. Stage-6 i.e. 12-18 weeks of conditioning showed significant difference for leg length and foot breadth; which was not significant for sitting height, arm length & foot length of the female students.
- Hence, it may be summarized that the progressive load of training (PLT) dominates the constant load of training (CLT) with regard to the selected length and breadth dimensions of female students (youth). It also indicates that there should be at least 12 weeks of training to observe significant changes in foot breadth, and at least 18 weeks training to observe changes in the leg length and foot length.
 - Table 3.2 indicates that the combination of progressive load PLT (conditioning programme of 18-weeks) and constant training load of(CLT) (continuous and regular physical education programme at Indira Gandhi Institute of Physical Education and Sports Science) showed the following effects (difference between PLT and NL) :
 - Significant difference between PLT and NL in respect to sitting height in stages 2 & 3 and insignificant changes in stages 1, 4, 5 & 6 of training.
 - Significant difference between CLT and NL with respect to leg length during stages 3 & 5, which was not significant during stages 1, 2, 4 & 6 of training.
 - Not significant changes with respect to arm length and foot length throughout the stages of training and testing.
 - Significant changes in foot breadth during stages 3 & 6, which was not significant during stages 1, 2, 4 & 5 of training.
 - There was no significant difference at the end of 6-weeks of conditioning in all the selected variables.
 - There was a significant difference in the sitting height; which was not significant with regard to leg length, arm length, foot length and foot breadth at the end of 12-weeks of conditioning.
 - There was a significant difference with regard to sitting height, leg length, & foot breadth, which was not significant changes for arm length and foot breadth at the end of 18-weeks of conditioning.
 - The periodic testing showed the Stage- 4 example. 6-12 weeks of conditioning observed remarkable significant differences for all the selected variables; Stage-5 i.e. 6-18 weeks of conditioning observed significant differences for leg length only and not significant changes in respect to sitting height, arm length, foot length and foot breadth. Stage- 6 (12-18 weeks) of conditioning observed significant differences only for foot breadth which was not significant for the rest of the variables i.e. sitting height, and lengths of leg, arm and foot length.
 - Hence, it may be summarized that the progressive load of training (PLT) demonstrated significant differences with the control group (NL) with regard to the selected length and breadth dimensions of female students (youth). It is also evident that there needs to be at least 12 weeks training to observe significant changes in sitting height, and at least 18 week training to observe changes in the leg length and foot breadth of female Students.
 - The analysis of table 3.3 demonstrates that the constant training load (regular physical education programme at IGIPSS) had the following effects (difference between CLT and NL):
 - No Significant difference between CLT and NL with regard to sitting height and lengths of leg, arm and foot during all the stages of experimentation.
 - Significant difference between CLT and NL with regard to foot breadth during stages 2, 3 & 5; which was not significant during stages 1, 4 & 6 of the experimentation.
 - There was no significant difference between CLT and NL for all the selected variables at the end of 6-weeks of experimentation.
 - There was a significant difference between CLT and NL in foot breadth;

which was not significant for the variables sitting height, leg length, arm length and foot length at the end of 12-weeks as well as 18-weeks of experimentation.

- The periodic testing also revealed that the stage- 4 i.e. 6-12 weeks and stage-6 i.e. 12-18 weeks of conditioning observed no significant difference with regard to all the selected variables; while Stage-5 i.e. 6-18 weeks of conditioning observed significant difference with regard to foot breadth only, which was not significant for the variables sitting height, leg length, arm length and foot length.
- Hence, it may be summarized that the constant load of training (CLT) demonstrated significant difference with control group (NL) in foot breadth only and insignificant difference in sitting height, leg length, arm length and foot length of female students (youth). It also indicates that the progressive training possibly contributes to the improvement in the foot breadth along with the progression of time.

All the above findings are strongly supported by the illustrations and documentations by various scholars.

Conclusion

1. The progressive load of training was found to be superior to that of constant load of training in regard to changes in the foot breadth, foot length, leg length and arm length of female students (youth) along with the progression of time of training with progressive load.
2. The progressive load of training is significantly different from the control group in terms of observing significant changes in the sitting height, leg length and foot breadth along with the progression of time.
3. The constant load of training is significantly different from the no load or control group in terms of observing significant changes in foot breadth only, reflecting that some form of physical training is better than following a sedentary lifestyle.

References

- Arnheim, D.D., & Sinclair, W.A. (1985). *Physical Education for Special Populations*. Prentice Hall, Englewood Cliffs, N.J. 15.
- Bilik, S.E. (1956), *The Trainers Bible 9th ed.* TJ Reed & Co., New York.
- Bilsborough, J. C., Greenway, K. G., Opar, D. A., Livingstone, S. G., Cordy, J. T., Bird, S. R., & Coutts, A. J. (2015). Comparison of Anthropometry, Upper-body Strength, and Lower-Body Power Characteristics in Different Levels of Australian Football Players. *Journal of Strength and Conditioning Research*, 29(3), 826–834.
- Blomquist, C.G. (1983), Adaptation to Physical Training. *Annual Review of Physiology*. 45,169.
- Bourgois, J.; and Claessens. A.L. et.al. (2002). Anthropometric Characteristics of Elite Male Junior Rowers. *British Journal of Sports Medicine*. 34(3), 213–217
- Cooper, Kenneth H.; and Blair, Steven N. (2019). Exercise Physical Fitness. *Encyclopedia Britannica* retrieved from <https://www.britannica.com>.
- Edmond J. Burke; and Florence C. Bush (May, 1975). Physiological and Anthropometric Assessment of Successful Teenage Female Distance Runners. *Research Quarterly*. 50, 180.
- Harris, S.S.; Caspersen, C.J.; Defriese, G.H.; and Estes, E.H. (1989), Physical Activity Counselling for Healthy Adults as a Primary Preventive Intervention in the Clinical Setting. *JAMA*: 261, 3590-98.
- Johnson, P.; and Strolberg, D. (1971). *Conditioning*. Prentice Hall, Englewood Cliffs, N.J.), p.8.
- Kalayci, Metin Can; Guleroglu, Ferhat; and Eroglu, Huseyin (2016). Relationship between Anthropometric Parameters and Speed Performance: A Kinanthropometry Research. *Turkish Journal of Sport and Exercise*. 18 (2), 90-96.
- Kansal, D.K. (1996). *Test and Measurement in Sports and Physical Education*. D.V.S. Publications, Delhi.
- Kaushik, S. (2014), Effect of Intensive and Moderate Physical Training on Selected Health Indicating Variables of Male Students of University of Delhi. One India-Fit India: Proceedings of the National Seminar on Fitness & Wellness at LNIPE, ISBN:978-81-7879-801-1, 289-293.

- Kęska, A., Lutosławska, G., Mazurek, K., Czajkowska, A., Tkaczyk, J., & Iwańska, D. (2018). Changes in anthropometry and selected metabolic parameters in young men during their first year of study at a university of Physical Education. *American journal of men's health*, 12(2), 463–471.
- Koley, S.; and Sandhu, J.S. (2005), *An Introduction to Kinanthropometry*. Friends Publications, Delhi, India, pp. 40-79.
- McHenery, P.L.et.al. (1990), Statement of Exercise. *Special Report Circulation*. 51,1.
- Mohamed, H.; Vaeyens, R.; Matthys, S.; Multael, M.; Lefevre, J.; Lenoir, M.; and Philippaerts, R. (2009). Anthropometric and Performance Measures for the Development of a Talent Detection and Identification Model in Youth Handball. *Journal of Sports Sciences*. 27(3), 257-266
- Monahan, T. (1987). Is Activity As Good as Exercise. *The Physicians and Sports Medicine*: 15: 10, 181.
- Muñoz, C.S.; Muros, J.J.; Belmonte, Ó.L.; Zabala, M. (2020). Anthropometric Characteristics, Body Composition and Somatotype of Elite Male Young Runners. *Int. J. Environ. Res. Public Health*. 17, 674.
- Novich, M.M.; & Taylor, Baddy. (1983). *Conditioning of Athletes* 2nd ed., Lea and Febiger, Philadelphia, 58.
- Shaw, D. (2006), Indian Trends in Percentage Height of Centre of Gravity – A Cross-Sectional Study from 3 to 78 years of Age of Male and Female. *Journal of Biomechanics*. 39 (Suppl.1), S545.
- Shaw, D. (2021). *Sports Training (General Theory and Methods of Sports Training and Exercise)*, Sports Publications, Delhi.
- Shephord, J.E. (1983). Employee Health and Fitness-State of the Art. *Preventive Medicine*. 12, 644-653.
- Singh, S.P.; and Malhotra, P. (1989). *Kinanthropometry – Human Size, Shape, Proportion, Composition, Maturation and Gross Function*. Lunar Publications, Patiala, India, 9-19.
- Welk, J.G.; and Blair, S.N. (2000). Physical Activity Protects Against the Health Risks of Obesity. *PCPFS Research Digest*. 3 (12).
- Zhao, K.; Hohmann, A.; Chang, Y.; Zhang, B.; Pion, J.; Gao, B. (2019). Physiological, Anthropometric, and Motor Characteristics of Elite Chinese Youth Athletes from Six Different Sports. *Front. Physiol*. 10, 1–12.