

Original Research Article

Gender Related Differences in Back Strength among Indian State and National Level Gymnasts

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ABSTRACT

Background: High intensity training presents gender related changes in athletes. Gymnasts, throughout their sports career required a hard, prolonged and constant physical training. Numerous motor variables such as flexibility, strength, coordination, rhythm, balance, agility and endurance determine the potential talent for competitive success. However strength is labeled as a basic motor ability that will estimate the performance efficiency in gymnastics.

Materials and methods: 306 (134 males and 172 females) state and national level gymnasts aged 15-25 years was purposively selected from Amritsar, Patiala, Jalandhar, and Gurdaspur districts of Punjab, India. The subjects were assessed for back strength using back leg chest dynamometer.

Results: It was observed that a male gymnast possesses higher mean differences in back strength. Also, when compared between genders and the level of game national level gymnasts showed highly significant results. However interaction between these two factors is absent. Further means were compared using Tukey post Hoc test, which showed significant results between genders and the level of game. The interactions post hoc tests compared six pairs of combinations. This shows that the only significant differences are for the national level male & females ($p < 0.0001$) and state level female and national level male gymnasts ($p < 0.0001$) and state level male and national level female gymnasts ($p = 0.0025$).

Conclusion: Back strength is an important indicator which would lay emphasis on flexibility, and endurance, hence reduces the risks of injuries.

Keywords: Back strength, performance, training, gymnasts.

INTRODUCTION

Gymnasts demonstrate their strength by being able to move their bodies through a myriad of positions. [1] It is one of the redeeming characteristics of gymnastics. [2] The demand of developing back strength is probably most significant and unique in gymnastics than any other elite sports. [3] Back strength in conjunction with flexibility is considered as an effective aid to the reduction of spinal and extremities injuries. [4-8]

Strength is one of the accurate predictor determining the physical fitness of a person. [9] Strength training is based on the underlying 'Overload' principle. [10] A number of studies reveal that muscle strength is critical to health and well-being. [11-12] Muscle strength in general varies among untrained and trained athletes. [13] Back strength is one of the important characteristics to keep the individuals at bay from back pain. Strength can be defined as the maximum force which can be exerted against an immovable object (static or

isometric strength), the heaviest weight which can be lifted or lowered (dynamic strength), or the maximal torque which can be developed against a pre-set rate-limiting device (isokinetic strength).^[14-15] Muscular strength, endurance and flexibility are important components of healthy back functions.^[16] Several external factors, viz. altitude,^[17] position of exerting strength,^[18] diet^[19] and internal factors, viz. age, sex,^[20] height, weight^[21] etc. influence the maximum force that can be exerted by a muscle.^[22]

Gymnastics is a sport that is generally characterized by high levels of strength and power relative to body weight, as well as high flexibility.^[23] Gymnasts are progressively trained with heavy resistance exercises with an aim to perform well in competitive events.^[10] This will direct them to adopt both functional and structural alterations in their neuromuscular system.^[24-27] Strength training affects the quality as well as quantity of nervous activation by three ways. Firstly it will enhance the co-contraction of the agonists, secondly by switching on the synergists to aid prime-movers and thirdly by reducing the activation of antagonists. These processes when combined will help in recruiting the numbers and improving the intensity of the firing rate of motor units.^[26]

Strength is considered as a basic motor capacity determining the performance efficiency in gymnastics.^[9] Back strength is the prerequisite in most of the movements and elements performed by the gymnasts.^[28] A gymnast with adequate strength is highly capable to execute the technical skilled movements correctly with appropriate range and intensity.^[29] Numerous strategies work for increasing the strength of an untrained athlete. The most accepted intervention is by increasing the training loads adequately enough to that of the normal day activities of an individual muscle.^[10] However, utmost concern at this stage should be focused on the mechanisms responsible for training induced increases in strength and/or power. When these aspects

are grossly examined by Komi in 1986 it was noted that the interaction of various mechanical, neuromotoric, and hypertrophic factors ruled the training process.^[25]

Recent studies revealed that to execute jumps explosive strength of lower limbs is required and for a big throw of apparatus upper limb strength is demanded^[30] but for repetitive dual tasks resistance strength training is mandatory.^[16] It should be accomplished through regular training per day often 3 to 4 hours. Several studies had done so far to rule out explosive strength through vertical jumps and power kicks^[31-33] or vertical and horizontal jumps.^[34]

Gymnastics is a complex sport with many dramatic and delicate movements. The act of performing varying movements with the aid of certain apparatuses makes it more challenging. The intensity of training varies and affects the strength which ultimately uplifts the performance scores. However training adaptations varies among different levels of sports and so forth their impact of resistive strength on the success will vary. So the present study was designed to evaluate sex differences in back strength and to determine the variation of back strength in two levels of sports i.e. state and national level among Indian male and female gymnasts. The results of which will assist the gymnasts coach, trainer, sports specialist to frame the training and desired requirements to increase the back strength and hence to keep back pain at a bay.

MATERIALS AND METHODS

Participants

The gymnasts involved in the study were from Amritsar, Patiala, Jalandhar, Gurdaspur districts of Punjab, India after taking approval from institutional ethical committee. The study was purposely conducted on 306 young state and national level male and female gymnasts, out of which 172 were females and 134 were males aged 15-25 years. The study procedure was described thoroughly to the participants and signed informed consent

was taken from the subjects. The subject's age was confirmed from their date of birth registered in their respective records submitted to the authorities. The data was collected under natural environmental conditions in morning (between 8:00 am to 12:00 noon) and in evenings (between 5:00 pm to 7:00 pm). Participants who had recent injury or systemic illness were excluded from the study.

Back Strength Measurement

The back strength was measured using back leg chest dynamometer. The subject was positioned with body erect and knees bent so that grasped hand rests at proper height. Spine is inclined forward projecting at a 60 degrees angle. Pulling force was then applied on the handle by straightening the knees and drawing the chain of the dynamometer. The strength of the back musculature was recorded on the dial of the dynamometer at the best of three trials in kilograms. All subjects were tested after 3 minutes of independent warm-up. Thirty seconds time interval was maintained between each back strength testing. [35]

Statistical Analysis

Standard descriptive statistics (mean \pm standard deviation) were determined for back strength among male and female gymnasts. To determine the interaction of independent variables i.e. Gender (male and

female gymnasts) and the level of game (state and national level gymnasts) on dependent variable i.e. back strength two way ANOVA analysis was done. Further Tukey multiple comparison of means was done. The data was analyzed using SPSS Statistical Package for Social Science) version 17.0. A 5% level of probability was used to indicate statistical significance.

RESULTS

Table 1 showed the mean differences of the state and national level male and female gymnasts. Two way ANOVA analysis (table 2) showed highly significant differences ($p < 0.0001$) in back strength when genders are compared and also similar results ($p < 0.0003$) are seen when compared with the level of game (male & female gymnasts). However interaction between these two factors is absent. Further means were compared using Tukey post Hoc test, which showed significant results between genders and the level of game. The interactions post hoc tests compared six pairs of combinations. This shows that the only significant differences are for the national level male & females ($p < 0.0001$) and state level female and national level male gymnasts ($p < 0.0001$) and state level male and national level female gymnasts ($p = 0.0025$).

Table 1: Descriptive statistics of back strength among state and national level male and female gymnasts.

Variable	NLFG (n=105)		SLFG (n=67)		NLMG (n=72)		SLMG (n=62)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Back Strength (kg)	59.00	16.68	53.07	16.63	74.62	31.43	61.42	19.27

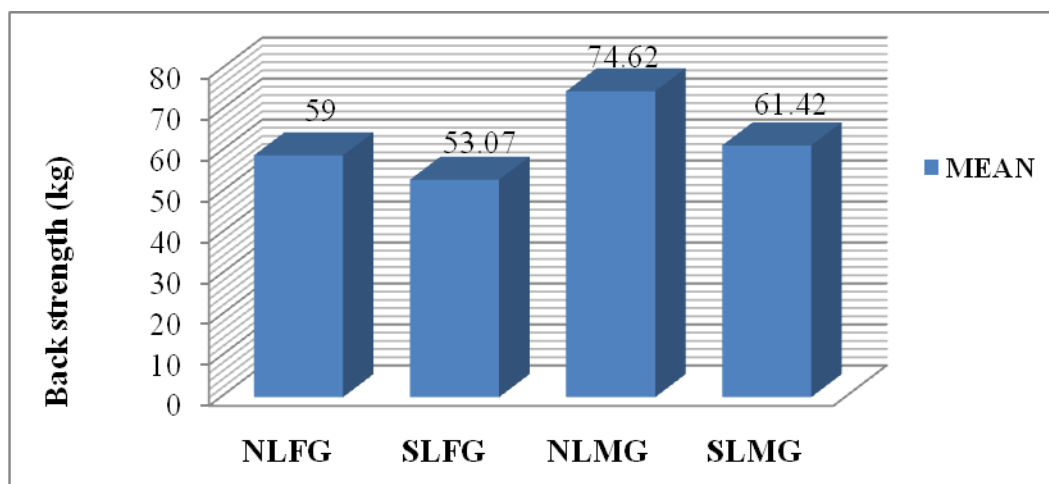
NLFG= national level female gymnasts, SLFG= state level female gymnasts, NLMG= national level male gymnasts, SLMG=state level male gymnasts

Table2: Two-way analysis of variance of back strength between genders (male and female gymnasts)

Variable	Male gymnasts (n=134)		Female Gymnasts (n= 172)		F- value	p- value
	Mean	SD	Mean	SD		
Back strength (kg)	68.51	27.22	59.69	16.86	22.710*	$p < 0.0001$

Table3: Two-way analysis of variance of back strength between the level of game (state and national level) male and female gymnasts.

Variable	State level gymnasts (n= 129)		National level gymnasts (n= 177)		F- value	p- value
	Mean	SD	Mean	SD		
Back strength (kg)	57.09	18.36	65.36	24.94	13.541*	0.0003



Graph 1: graph displaying the means of back strength in state and national level male and female gymnasts.

Table 4: Interaction between genders (male & female gymnasts) and the level of game (state & national level gymnasts) with regard to back strength.

Variable	F- value	p- value
Back strength (kg)	2.098	0.1485

Table 5: Tukey's multiple comparisons of means.

Variable	Factor	Diff	Lower	Upper	P value (95% confidence interval)
Back strength (kg)	Gender (Males & females gymnasts)	11.820	6.939	16.701	<0.0001*
	Level of game (National & state level)	-9.145	-14.049	-4.241	0.0003*

Groups being compared	Differences in means	Lower confidence interval	Upper confidence interval	95% confidence interval
				Adjusted p-value
NLMG:NLFG	15.62	7.11	24.13	<0.0001*
SLFG:NLFG	-5.92	-14.62	2.76	0.2940
SLMG:NLFG	2.41	-6.49	11.32	0.8967
SLFG:NLMG	-21.55	-30.99	-12.11	<0.0001*
SLMG:NLMG	-13.20	-22.84	-3.57	0.0025*
SLMG:SLFG	8.34	-1.45	18.14	0.125

DISCUSSION

Gymnastics is differentiated from other sports due to the implementation of certain positions and elements on several apparatuses underlying the extreme range of motion. As ground reaction forces should be cleared while executing vaulting [36] and tumbling [37] events it stresses the body to nearly two- four times the body weight. [38] Back strength is highly desired during stick landings succeeding certain skills and dismounts so as to avoid huge scores deductions and hence to optimize the performance. [39]

Many physical and physiological assumptions were considered to support the results of the present study. Athletes, both male and female, differ significantly in their physical and biological make up. Sex differences in the rates of muscular growth

are obvious following the beginning of puberty, males displaying accelerated gains in strength than the females. [40] Where male players were taller and heavier, also more muscular due to presence of testosterone hormone in them. Strong back muscles help to lift the body in jumping as well as proper landing. More musculature generates more force in their back region to perform the skills effectively. [40]

In the present study gender related changes in gymnasts also existed. Male's gymnast possesses higher means of back strength than the female counterparts. Many factors seemed to be responsible for such variation. Male's gymnasts outperformed the females because of the indulgence of several physical and biological physiognomies. Adult males tend to be taller with longer limbs. The breadth of their

shoulders allows for more muscle on a larger shoulder girdle, contributing in upper-body strength. [41] Adult males have more overall muscle mass and less body fat than females. Male athlete's average 4% to 12% body fat compared to 12% to 23% in female athletes. Males develop larger skeletal muscles, as well as larger hearts and lungs and a greater number of red blood cells which absorb oxygen for an aerobic advantage. [40]

Men have higher levels of testosterone, which gives them a performance advantage in other ways. [42] Male athletes have a higher ratio of muscle mass to body weight, which allows for greater speed and acceleration. Females possess more body fat than males because of high estrogen levels. In addition, women's bodies are less muscular, but their joints are more flexible, which gives them greater range of motion. The wider female pelvis also affects the alignment and movement of the extremities. [43]

Differences in mode of training programs in gymnastics of these two sexes might be the reason for the differences in state and national level performance. Volkov and Filin supported the fact that the genetic inheritance and the strict selection procedure are pointed as the reasons for overall performance in sportive events. [44] The body size and maturation of male and female athletes follow a different scrutiny. [45] The short stature and later maturation observed in female artistic gymnasts have often been credited to the effects of intensive gymnastics training from a young age. [46-47] This possibly reflects the earlier achievement of advanced levels of training and competition among females, specifically during the interval of the adolescent growth spurt, whereas the more rigorous training for male gymnasts occurs later in the growth spurt when significant gains in muscle mass and muscular strength occur. [48]

Training is routinely described in the scientific literature as hours per week. Average time training reported by gymnasts

at major championships was 30 hours per week, but variation was considerable. [45,49-50] Overall, reported weekly time in training overlaps in females and males, and increases with age and level of competition. A study postulated by Ziemilska et al in 1973 suggested practice protocols of Polish youth gymnasts for 19 and 22 weeks where females worked for more sessions and repetitions per week than males, while males trained more hours per week and at a somewhat greater estimated intensity than females. This trend is somehow followed with the increasing level of the game too thereby enhancing the competitive success of male athletes. [51]

CONCLUSION

The conclusions drawn from the study could be stated as there were higher mean differences in the values of back strength among males gymnasts. Also, when compared between genders and the level of game results are highly significant. The possible reasons predicted are supreme physical and biological physique of males as compared to females and implementing greater intensity training strategies among national level gymnasts than their state counterparts. Greater time spent in activities however varies among age as well as with the level of game.

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