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Utility of Range of Motion Measurements on Classification of Athletes

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Abstract**—**In this study, a comparison of Range Of Motion (ROM) of middle and long-distance runners and swimmers has been made. The mobility of the various joints is essential for the quick movement of any sportsman. Knowledge of a ROM helps in preventing injuries, in repeating the movement, and in generating speed and power. ROM varies among individuals, and it is influenced by factors such as gender, age, and whether the motion is performed actively or passively. ROM for running and swimming, both performed with due consideration on speed, plays an important role. The time of generation of speed and mobility of the particular joints are very important for both kinds of athletes. The difficulties that happen during running and swimming in the direction of motion is changed. In this study, data were collected for a total of 102 subjects divided into three groups: control group (22), middle and long-distance runners (40), and swimmers (40), and their ages are between 12 to 18 years. The swimmers have higher ROM in shoulder joint flexion, extension, abduction, and adduction movement. Middle and long-distance runners have significantly greater ROM from Control Group in the left shoulder joint flexion with a 5.82 mean difference. Swimmers have significantly higher ROM from the Control Group in the left shoulder joint flexion with 24.84 mean difference and swimmers have significantly higher ROM from the Middle and Long distance runners in left shoulder flexion with 19.02 mean difference. The picture will be clear after a more detailed investigation.

Key words**—**Range of motion, runners, swimmers, significance.

I. Introduction

EVERY sportsperson or athlete performs certain activities which involve motion of their segmental body parts. However, it is well known that in freestyle, butterfly or backstroke type of swimming, swimmers with large ROM of their upper limbs get additional advantage while in sprinting or in other kinds of running, athletes with larger ROM of their lower extremities get additional advantage over their counterparts in the same trade. ROM is the angle of motion in degrees between the beginning and the end of a motion with a specific plane. The angle of motion may occur either at a single joint or at a number of joints. ROM is an essential tool for the description of movements and has a vital role for every person. ROM has different values for the different joint movements needed in activities for any sports. Also it has different values observed in the daily life activity of sedentary persons or in performances of all sports persons. ROM is the available amount of movement of a joint. ROM measurement is done in various ways like video analysis, goniometric measurement etc. We have followed the goniometric measurement. Low ROM of a joint reduces the performance of any person whether normal or athlete. Because of low ROM different types of injury, lack of mobility within the joint, stiffness of the muscles, swelling of tissue around the joint etc. may happen. Normal ROM refers to activity aimed at improving performance of a specific joint. This motion is influenced by several structural configurations of bone surfaces within the joint, ligaments, tendons, joint capsule and muscles acting on the joint.

Comparison of the ROM of dominant side and non-dominant side of upper and lower extremity was found in [1]. They measured active and passive ROM of ankle joints, hip joints, knee joints, shoulder joints, elbow joints and wrist joints of 90 healthy women. The ages of the subjects were between 18-59 years. Result of this study showed a statistical significant difference between dominant and non-dominant sides for 34 out of 60 ROM measurements done. In [2], one gets a comparison of the ROM and muscle length between different types of foot posture in lower limb joints. They have found out the correlation of ROM and muscle length with balance performance. An interesting study [3] compared the ROM testing in supine and sitting position for shoulder joints. Result of this study showed no significant difference for flexion in sitting and supine position but showed significantly higher measurement of abduction in supine position. On the basis of linear and nonlinear method with 17 volunteers on a motorized treadmill, [4] characterized walking and running pattern of healthy persons. Variables selected for this study are: ankle joints - plantar and dorsiflexion, knee joints flexion and extension, knee joints abduction and adduction, hip joints flexion and extension, and hip joints abduction and adduction ROM. This study showed that the knee flexion/extension and ankle dorsiflexion/planter flexion were greater during running but other variables do not have significant difference between running and swimming. The study on comparison between 15 throwing athletes and 15 non-athlete person in the shoulder rotational strength, ROM and proprioception was done by [5]. Measurement of ROM of shoulder internal and external rotation motion of the subjects was measured by standard goniometer. In this study they have found that the results of internal rotation difference are not significant between throwing athletes and non-athletes but in case of external rotation, it is significantly more for the throwing athletes. In a study of evaluation of rotatory ROM in hip joint [6], 120 subjects participated where 71 were women and 49 were men and their age was in the range of 20-60 years. Their internal

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and external ROM of hip joint was measured with photographic technique in three different postures - supine, pronation and sitting. Result of this study showed no significant difference of ROM among three postures.

II. Materials and Methods

In this study, we have collected data for a total of 102 subjects who were divided into three groups: (i) control group, (ii) middle and long distance runners group and (iii) swimmers group. There were 22 subjects in the control group, 40 subjects in the middle and long distance runners group and 40 subjects in the swimmers group. Criterion of selection of the control group was no performance in any competitive sports event. On the other hand, runners and swimmers have participated in district level or state level competitions. Their age level was 12 to 18 years.

We have measured height, weight and the ROM of all the candidates taken for test. In Table I we present the classes of data taken.

TABLE I
ROM of Four Joint Movements

Name of the joint	Measuring movement of the joints
Shoulder	Flexion
	Extension
	Abduction
	Adduction
Hip	Flexion
	Extension
	Abduction
	Adduction
Knee	Flexion
	Extension
Ankle	Dorsiflexion
	Plantar flexion

Before administering the test, consent forms duly filled up and signed by the respective candidates were taken. The dates of birth of all the candidates were collected from their birth certificates. The weights of the candidates were measured by a spring balance which has an uncertainty about ± 0.1 kg using the method of measuring the weight of clothes to be worn during measurement and measuring the weight of the person wearing those clothes and then taking the difference of these two weights in kg. The heights of the candidates were measured by straight stature method using a standard stadiometer. The ROM for both right and left shoulder joints (flexion, extension, abduction, adduction) were measured using a universal goniometer after each subject was in supine/ pronation position and palm was facing toward the trunk and elbow was fully extended. Approximate bony landmarks were placed on (a) Lateral aspect of acromion process, (b) Lateral midline of thorax, (c) Lateral humeral epicondyle. Later ROM was measured for hip joint movements and also for knee joints.

III. Statistical Procedure for Data Analysis

The collected data distribution pattern was checked with alpha 0.05 by Anderson-Darling Test of all variables. The descriptive statistics like Mean and Standard Deviation of the variables was done. The data of the selected variables were analyzed through statistical procedures by using single way analysis of variance (ANOVA). Then we have done Tukey's HSD Post Hoc test for the significant difference of each groups. The level of significance was set at 0.05 and 0.01. If Q-value obtained is > 2.80 it is taken as of significant difference in 0.05 (*) and if Q-value is > 3.70, it is taken as of significant difference in 0.01(**).

TABLE II
Mean and SD of Age, Weight and Height of Participants

Variables	Groups	Mean	SD
Age in year	Control	15	0.78
	Runner	16	1.07
	Swimmer	15	1.68
Weight in kg	Control	40.05	5.42
	Runner	47.73	7.55
	Swimmer	49.74	10.94
Height in cm	Control	156.38	5.03
	Runner	161.18	5.06
	Swimmer	158.67	10.67

It appears that the Swimmers group has a better weight to height ratio (0.31) compared to Runners (0.29).

In Table II we present the mean, SD, of ROM of left shoulder joint for four kinds of postures of three groups under study with corresponding F-values and P-values arising out of the analysis. It is evident from the table that for flexion, extension, abduction and adduction the swimmers with the corresponding values of 178,0, 92.0, 184.0, 33.0 are far ahead of runners with the corresponding values of 159.0, 60.0, 154.0, 23.0 in all these categories giving a clear signal of advantages they enjoy. The smallness of P-values (7.5041 E-16, 15.2 E-17, 8.6577 E-20, 3.5077 E-13) suggests rejection of the null hypothesis.

The mean values of ROM for flexion, extension, abduction and adduction of runners and swimmers are greater than those of control group. It indicates the excess use of the left shoulder of athletes in general.

The graphical presentation of our data also indicates the advantageous position of the swimmers over runners and the control group in ROM.

TABLE III
Analysis of ROM of Left Shoulder Joint Movements

Variables	Groups	Mean	SD	F	P-value
Flexion	Control	153	5.47	50.54	7.504
	Runner	159	10.95		E-16
	Swimmer	178	12.2		
Extension	Control	52	13.0	58.73	15.2
	Runner	60	17.95		E-17
	Swimmer	92	15.4		
Abduction	Control	148	5.89	70.65	8.658
	Runner	154	10.4		E-20
	Swimmer	184	18.17		
Adduction	Control	19	4.69	38.85	3.508
	Runner	23	5.42		E - 19
	Swimmer	33	8.25		

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The analysis of ROM of left shoulder of all the candidates is presented in Fig. 1.

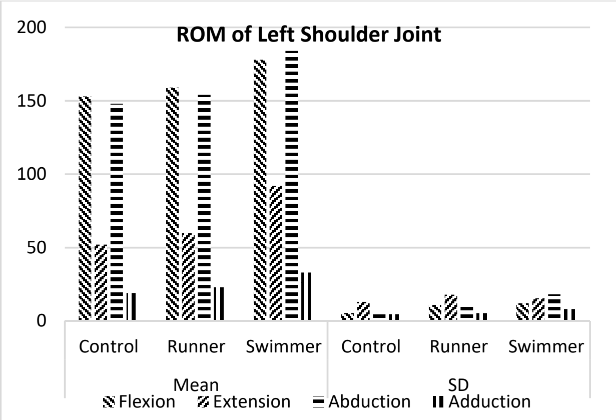

Fig. 1 Analysis of ROM of left shoulder joints of all candidates

In Table IV, we present the analysis of our data for right shoulder movements of all the candidates along with mean, SD, F-values and P-values and in Fig. 2 the graphical representation of the data has been presented.

TABLE IV
ANALYSIS OF ROM OF RIGHT SHOULDER JOINT MOVEMENTS

Variables	Groups	Mean	SD	F	P-value
Flexion	Control	155	5.89	36.44	1.379
	Runner	158	10.7		E-12
	Swimmer	178	16.1		
Extension	Control	52	11.4	62.17	3.233
	Runner	60	20.9		E-18
	Swimmer	92	10.9		
Abduction	Control	148	6.12	86.34	1.987
	Runner	155	11		E-22
	Swimmer	185	16.1		
Adduction	Control	20	4.47	68.09	2.511
	Runner	23	5.03		E - 19
	Swimmer	36	7.44		

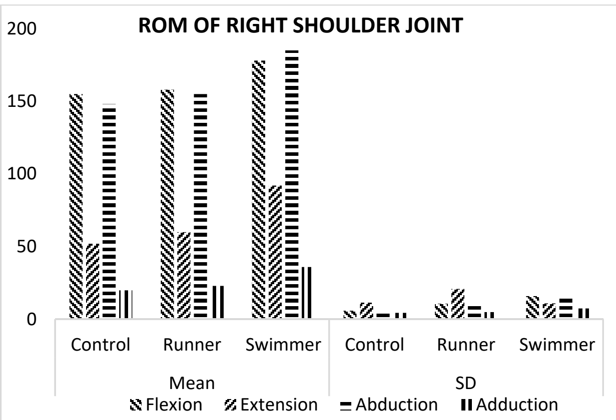

Fig. 2 Analysis of ROM of right shoulder joints of all candidates

It can be seen from Table IV that in the case of all types of right shoulder movements the group of swimmers have a clear edge over the group of runners who have performed better compared to the control group. This is visible from the graphical presentation of the data in Fig. 2.

In Table V we present our data of ROM for movements of the left hip joint of all the cases studied under this project.

TABLE V
ANALYSIS OF ROM OF LEFT HIP JOINT MOVEMENTS

Variables	Groups	Mean	SD	F	P-value
Flexion	Control	128	10.59	16.03	9.31
	Runner	140	6.54		E-07
	Swimmer	137	8.9		
Extension	Control	40	6.11	7.03	0.001
	Runner	48	6.04		
	Swimmer	45	11.61		
Abduction	Control	40	4.34	18.79	1.209
	Runner	48	5.81		E-07
	Swimmer	52	9,38		
Adduction	Control	17	2.39	0.138	0.871
	Runner	18	4.77		
	Swimmer	18	4.16		

The data shown in Table V shows an interesting point that in the case of left hip movements the ROM of the swimmer group is equivalent to that of runner group. The reason for this observation can be explained if we look at the biomechanical movements of the limb under consideration. The motion performed by this limb in case of the runners on the ground is almost similar to that of the swimmers in the water. For this reason the ROM for left hip movement has similar values for both the groups. This analysis is further fortified by the observation of ROM of the right hip movements of all the candidates as presented in Table V. It shows that biomechanical movement of the right hip of the athletes doing either running on the ground surface or swimming inside water surface behave more or less in identical fashion. Therefore, one should not expect much deviation in values of the ROM in the lower extremities of these two groups and the differences in mean or SD of these movements is not significant.

TABLE V
ANALYSIS OF ROM OF RIGHT HIP JOINT MOVEMENTS

Variables	Groups	Mean	SD	F	P-value
Flexion	Control	128	7,6	8.07	5.65
	Runner	137	5		E-04
	Swimmer	135	12		
Extension	Control	40	5.8	5.84	0.004
	Runner	46	5.3		
	Swimmer	44	8.9		
Abduction	Control	40	2.8	22.9	6.77
	Runner	45	5.1		E-09
	Swimmer	49	8,39		
Adduction	Control	18	2	0.45	0.639
	Runner	18	4.3		
	Swimmer	18	2.7		

The ROM analysis of the knee joints and ankle joints of both feet of all the candidates also corroborate our conjecture about the equivalence of movements of both athletic groups under consideration. However, we must point out that smallness of P-values in the cases of flexion (9.31 E-07) and abduction (1.209 E-07) suggests rejection of the null hypothesis.

Another important thing to be observed is that for hip movements there is not much difference between athletes and non-athletes. So, this observation is not sufficient for categorization of basic level sportspersons into swimmers and runners.

In conclusion we can say that ROM is very good tool to segregate would-be athletes in groups of swimmers and athletes and it will help the coaches to nurture the future sportsmen to become elite athletes in specific sports activities.

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