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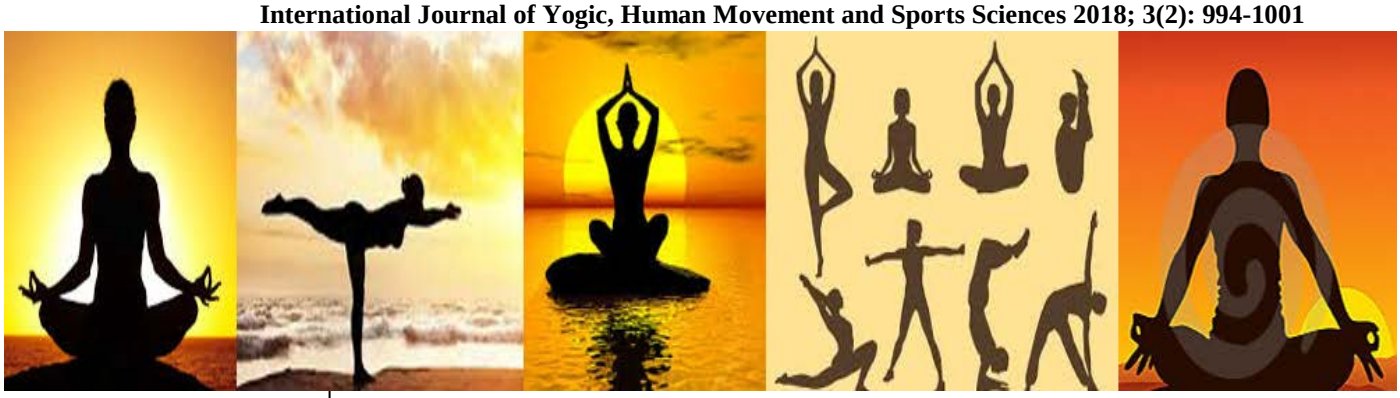

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Relationship between selected kinematical variables and snatch lift performance of women senior national weightlifters

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Abstract
For this research data was obtained from "70th Men and 33rd women senior national weightlifting championship held at Mangalore, Karnataka 21st to 25 January 2018. Men and women weightlifters competed in various weight categories, acted as the subjects. The age of the subjects ranged from 18- 35 years. The total subjects were selected Eighty (N=80) forty (40) men elite first eight (8) each weight category and forty (40) women elite first eight (8) each weight category subject were selected. from the five weight categories for men (69 kg, 77 kg, 94 kg, 105 kg and +105 kg.) and female weight five-category (63 kg, 69 kg 75 kg 90 kg and +90 kg). The sum of the best one lift for (snatch) of individual events was considered as the accounts of the lifters. The analysis of data was using Statistical Package for the (SPSS) version 21 relationship Multiple correlation was to find out the relationship. It is conclusion that there was significant relationship between the "70th MEN & 33rd Men and Women" weightlifters of kinematical variables like Initial position Angle of knee and first pull Angle of Elbow, transition phase Angle of Ankle, The Catch Phase Distance between both feet and no relationship from Second pull and turn over under the barbell Snatch lift position for the different weight category and deferent position of snatch lift performance (1.initial position, 2. First pull, 3.trantition phase, 4 Second pull, 5. Turnover under the barbell, 6. The catchphrase). It was to find out the relationship of selected kinematical variables with the performance of snatch for the initial position of elite woman weightlifters. To find out the relationship of selected kinematical variables with the performance of snatch for the first pull of elite woman weightlifters.

Keywords: Senior National, Mangalore, Karnataka weight categories, kinematics, Men, Women, weightlifting

Introduction
The sport or activity of lifting barbells or other heavyweights. There are two standard lifts in modern weightlifting: the single-movement lift from floor to extended position (the *snatch*), and the two-movement lift from floor to shoulder position, and from shoulders to extended position (the clean and jerk)

Kinematics
In classical mechanics, we are ultimately interested with understanding the motion of objects. However, before we can even begin to discuss the causes of such motion (i.e. before we study the dynamics of physical systems) we must first find a way of describing the motion of objects. In other words, we want to develop a mathematical formalism that allows us to represent the position, velocity, and acceleration of moving objects, and to express how these quantities are related to each other in time.

Biomechanical analysis
Biomechanical Knowledge is a "Must" for Coaching. All movements of men and animals are defined by the laws of mechanics. It is the first responsibility of science (but only the first) to understand the movements of athletes. Teachers and coaches of human movement, safety equipment designers, rehabilitation specialists, and students performing advanced research in the area of human biomechanics will appreciate the scientific and mathematical focus in the

text. This focus allows readers to gain an understanding of human biomechanics that will enhance their ability to determine or calculate loads applied to the body as a whole or induced in individual structures.

Biomechanical Study of Fundamental Human Movements starts with a discussion of the principles of biomechanics and then advances into more forward study involving the mechanical and mathematical bases for a range of fundamental human activities and their variations, including balance, slipping, falling, landing, walking, running, object manipulation, throwing, striking, catching, climbing, swinging, jumping, and airborne man oeuvres. Each activity is analyzed using a specific seven-point format that helps readers identify the biomechanical theories that explain how the movements are made and how they can be modified to correct problems. The seven points for analysis are aim, mechanics, biomechanics, variations, enhancement, safety, and practical examples that move from the simple to the more complex. More than 140 figures represent the points of analysis during the text, providing readers with a clear depiction of both the mechanics and mathematics involved in human movements. Biomechanical Analysis of Fundamental Human Movements provides a comprehensive understanding of this branch of human biomechanics using mechanical, mathematical, and biological definitions and concepts. Its focus on fundamental human exercises to develops advanced analytical skills and provides a unique and valuable approach that facilitates mastery of a body of information and a method of analysis applicable to further study and research in human movement.

Objective of the study

- The Relationship of kinematical analysis for the snatch lift technique of women in Elite Indian weightlifters

Methodology

Participants

For the purpose of this study data was collected from "70th Men and 33rd women senior national weightlifting championship held at Mangalore, Karnataka 21st to 25 January 2018. Men and women weightlifters participated in various weight categories, acted as the subjects. The age of the subjects ranged from the 18- 35 years. The total subjects were selected Eighty (N=80) forty (40) men elite first eight (8) each weight category and forty (40) women elite first eight (8) each weight category subject were selected. from the five weight categories for men (69 kg, 77 kg, 94 kg, 105 kg and +105 kg.) and female weight five category (63 kg, 69 kg 75 kg 90 kg and +90 kg).

Collection of data

To measure the kinematic analysis for snatch lift concerning elite Indian weightlifters of different weight category men & women, the data obtained from the results for the 70th Men and 33rd women senior national weightlifter" for the 21st to 25 January 2018 held at Mangalore, Karnataka, India. The sum of the best 3 lifts for each weight category of respective events was regarded as the scores of the lifters.

Filming Protocol

Silicon coach 7 and Kinovea software's were used for Kinematical analysis of snatch technique in weightlifting. High speed camera Casio Exilim.EX-F1which was position at 7.70m from the subject at a front of the subjects and second camera was position at 6.50m from right side of the subject on an extension of restricted area line. 300 Frames per second were obtained. The subject was got 3 trails. The kinematical variables of the body were calculated at the different phases of snatch skill which is listed below.

Analysis of film

a) The 300 frames per second as obtained by the use of high speed video grapey was analyzed (the best trail) by Silicon coach Pro-7 and Kinovea software's. Only one selected frame obtained and investigator developed the stick figures from which various kinematical measurements were taken. The stick figures were developing by using joint point method in which the body projections at the joints facing the camera was considered.
b) The videos of technique of subjects were captured at National Weightlifters from "70th Men and 33rd women senior national weightlifting championship held at Mangalore, Karnataka 21st to 25 January 2018. The videos were captured under controlled conditions.

Data analysis

The data thus collected were statistically treated by using Statistical Package for the (SPSS) version 21 relationship Multiple correlation was to find out the relationship between "70th Men and 33rd women senior national weightlifter of the kinematical variables like Angle of Ankle, angle of Knees, Angle of Hips, Angle of Shoulders, Angle of Elbow, Angle of Wrists, Trunk Inclination, Head Inclination, Distance Between both feet's, Central of gravity (C.G) for the different weight category and deferent position of snatch lift performance (1. Mnitial position, 2. First pull, 3. Transition phase, 4. Second pull, 5. Turnover under the barbell, 6. The catch phase) for the different weight category. The results have been presented in the following table:

Results and findings

Relationship of Selected kinematic variables with the snatch Performance in Elite Women Indian weightlifters.

Initial position

The scores of each of the selected variables of kinematic variables were correlated with snatch performance, in order to find out the relationship.

Relationship of selected kinematic variables in snatch performance

From the correlation results, we found that coefficient between snatch performance (Dependent variables) and Angle of the ankle, Angle of the Knee, Hip, Shoulder, Elbow, Wrist, Trunk Inclination, Head Inclination, Distance between both feet's and centre of gravity. All (Independent variables) is no significant correlation of initial position significant at 0.05 level.

Initial position

Table 1: Relationship of Selected kinematic variables with the snatch Performance in Elite Women Indian weightlifters

SN	Kinematic Variables	Snatch Performance
1	Performance	1
2	Angle of ankle	0.17224
3	Angle of knee	-.380*
4	Angle of hip	0.19622
5	Angle of shoulder	-0.2375
6	Angle of elbow	-0.1002

7	Angle of wrist	0.08883
8	Angle of head inclination	0.0643
9	Angle of trunk inclination	0.14047
10	Distance between both feed's	-0.2472
11	Centre of gravity	-0.2842

From the correlation results, we found that coefficient between snatch performance (Dependent variables) and Knee -.380* (Independent variables) and p-value for two-tailed significance set at 0.05 level. Thus, we can conclude that there is significant correlation. Moreover, we found that snatch performance has no significant correlation with Angle of ankle, elbow, Hip, Shoulder, wrist, Head, trunk inclination, and distance between both feeds and Centre of gravity.

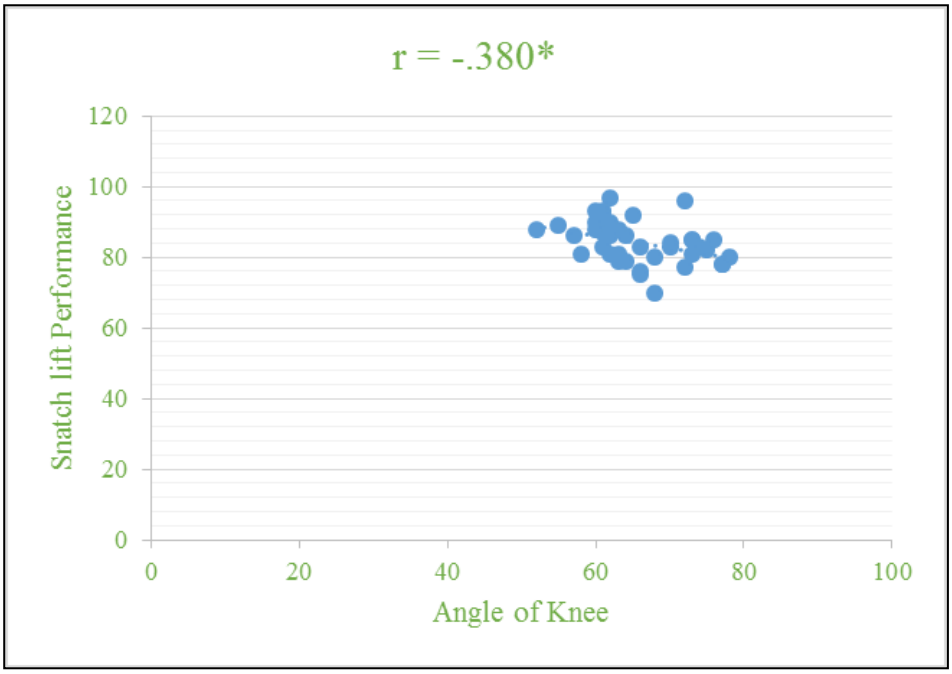

Fig 1: Relationship between Snatch Lift Performance and Angle of Wrist

First pull

The scores of each of the selected variables of kinematic variables were correlated with snatch performance, in order to find out the relationship.

Table 2: Relationship of Selected kinematic variables in snatch performance

SN	Kinematic Variables	Snatch Performance
1	Performance	1
2	Angle of ankle	-0.2893
3	Angle of knee	0.01406
4	Angle of hip	-0.0269
5	Angle of shoulder	-0.0944
6	Angle of elbow	-.335*
7	Angle of wrist	0.24255
8	Angle of head inclination	0.15932
9	Angle of trunk inclination	-0.212
10	Distance between both feed's	159
11	Centre of gravity	212

From the correlation results, we found that coefficient between snatch performance (Dependent variables) and Elbow -.393* (Independent variables) and p-value for two-tailed significance set at 0.05 level. Thus, we can conclude that there is significant correlation. Moreover, we found that snatch performance has no significant correlation with Angle of ankle, knee, Hip, Shoulder, wrist, Head, trunk inclination, and distance between both feeds and center of gravity.

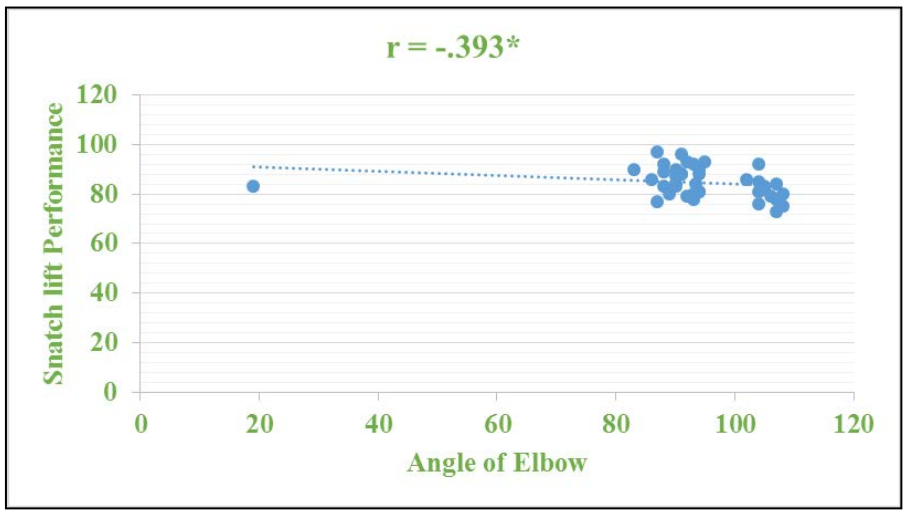

Fig 2: Relationship between Snatch Lift Performance and Angle of Wrist

Relationship of selected kinematic variables with the snatch performance in elite women Indian weightlifters Transition phase

The scores of each of the selected variables of kinematic variables were correlated with snatch performance, in order to find out the relationship.

Table 3: Relationship of Selected kinematic variables in snatch performance

SN	Kinematic Variables	Snatch Performance
1	Performance	1
2	Angle of ankle	-.546**
3	Angle of knee	0.2746748
4	Angle of hip	0.1838758
5	Angle of shoulder	0.1766927
6	Angle of elbow	0.0376373
7	Angle of wrist	-0.278243
8	Angle of head inclination	-0.185594
9	Angle of trunk inclination	0.2508489
10	Distance between both feed's	0.1206351
11	Centre of gravity	0.1379099

From the correlation results, we found that coefficient between snatch performance (Dependent variables) and Angle of ankle -.546** (Independent variables) and p-value for two-tailed test of significance set at 0.05. Thus, we can conclude that this correlation is significant at 0.05 level. Moreover, we found that snatch performance has no significant correlation with Angle of Knee, Hip, Elbow, Shoulder, Wrist, Trunk Inclination, Head Inclination, and distance between both feed's and Centre of gravity.

Fig 3: Relationship between Snatch Lift Performance and Angle of Ankle

Second pull

The scores of each of the selected variables of kinematic variables were correlated with snatch performance, in order to find out the relationship.

Table 4: Relationship of Selected kinematic variables with the snatch Performance in Elite Women Indian weightlifters

SN	Kinematic variables	Snatch performance
1	Performance	1
2	Angle of ankle	-0.022399468
3	Angle of knee	0.092474965
4	Angle of hip	0.06951747
5	Angle of shoulder	-0.207021479
6	Angle of elbow	0.004708897
7	Angle of wrist	0.245904126
8	Angle of head inclination	-0.428
9	Angle of trunk inclination	-0.234717479
10	Distance between both feed's	0.215374468
11	Centre of gravity	0.288147409

From the correlation results, we found that coefficient between snatch performance (Dependent variables) and Angle of ankle, Angle of knee, Hip, Shoulder, Elbow, Wrist, Trunk Inclination, Head Inclination, Distance between both feed's and center of gravity. All (Independent variables) is no significant correlation of second pull significant at 0.05 level.

Relationship of selected kinematic variables with the snatch performance in elite women Indian weightlifters

The scores of each of the selected variables of kinematic variables were correlated with snatch performance, in order to find out the relationship.

Table 5: Relationship of Selected kinematic variables in snatch performance, Turnover under the barbell

SN	Kinematic variables	Snatch performance
1	Performance	1
2	Angle of ankle	-0.022399468
3	Angle of knee	0.092474965
4	Angle of hip	0.06951747
5	Angle of shoulder	-0.207021479
6	Angle of elbow	0.004708897
7	Angle of wrist	0.245904126
8	Angle of head inclination	-0.428
9	Angle of trunk inclination	-0.234717479
10	Distance between both feed's	0.215374468
11	Centre of gravity	0.288147409

From the correlation results, we found that coefficient between snatch performance (Dependent variables) and Angle of ankle, Angle of knee, Hip, Shoulder, Elbow, Wrist, Trunk Inclination, Head Inclination, Distance between both feed's and center of gravity. All (Independent variables) is no

significant correlation of second pull significant at 0.05 level.

Relationship of Selected kinematic variables with the snatch Performance in Elite Women Indian weightlifters

Catch Phase

The scores of each of the selected variables of kinematic variables were correlated with snatch performance, in order to find out the relationship

Table 6: Relationship of Selected kinematic variables in snatch performance

S.N	Kinematic Variables	Snatch Performance
1	Performance	1
2	Angle of ankle	-0.392
3	Angle of knee	-0.364
4	Angle of hip	0.285
5	Angle of shoulder	-0.109
6	Angle of elbow	0.072
7	Angle of wrist	0.286
8	Angle of head inclination	-0.428
9	Angle of trunk inclination	-0.153
10	Distance between both feed's	.880*
11	Centre of gravity	-0.091

From the correlation results, we found that coefficient between snatch performance (Dependent variables) and Distance between both feed's (Independent variables) is 880* and p-value for two-tailed test of significant set at 0.05. Thus, we can conclude that this correlation is significant at 0.05. Moreover, we found that snatch performance has no significant correlation with Angle of Ankle, Knee, Hip, Shoulder, Elbow, Wrist, Trunk Inclination, Head Inclination, and, Centre of gravity.

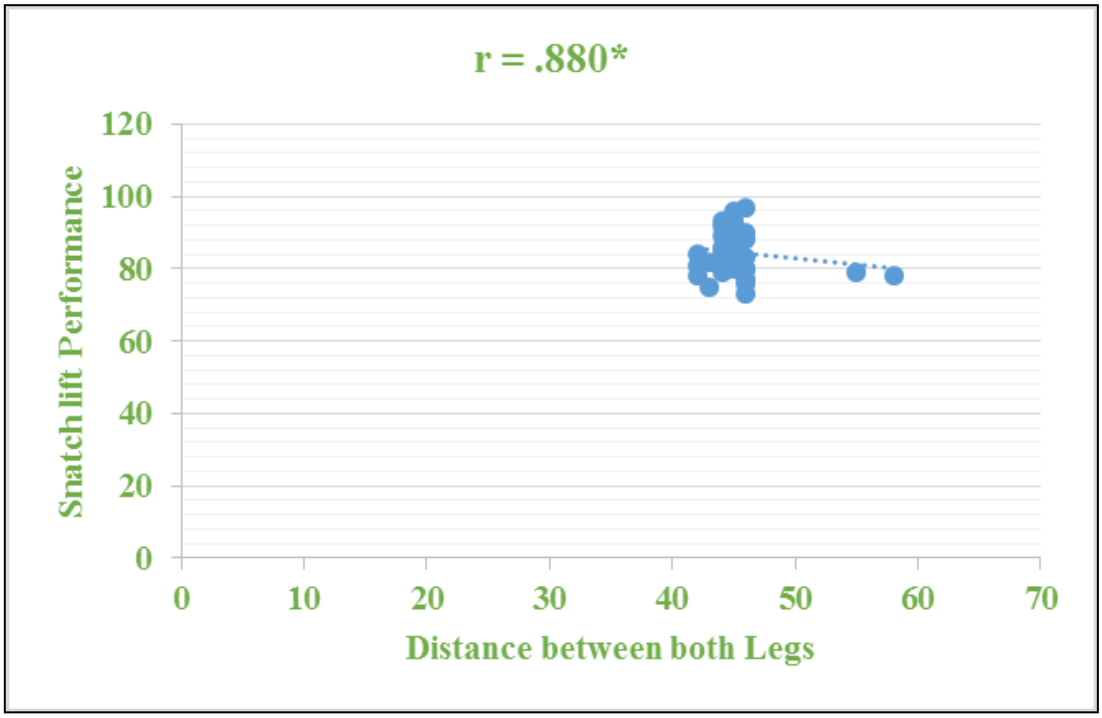

Fig 6: Relationship between Snatch Lift Performance and Angle of Ankle

Discussion of findings

Initial position

Further, it was found that snatch performance has a relationship with the angle of the knee, Angle of Hip, Shoulder, Elbow, Wrist, head inclination, Trunk Inclination, and centre of gravity and distance between both feet, whereas no association was seen between snatch performance and Angle of Ankle during the initial position of Snatch performance. In the initial position of Snatch, a lifter flex knees, hips, and ankles. The toes are to be signified slightly outwards, the body is relaxed at the arms and a lord tic back position is maintained. This is the starting position of the snatch lift, the butt is down and the head is up, ready to explode through the movement. The initial position plays a very important role in optimum snatch performance because proper starting position puts the body in a position that will aid optimal force production. Poor starting positions will result in minimal force production. This will have a negative effect performance and may result in returns possibly leading to injury. Appropriate Angle of the ankle, Angle of the knee, Angle of the wrist, Angle of head inclination during the initial position of snatch helps the athletes to overcome the inertia with minimum application of force and greatly favours the successful development of every movement that follows as well as the rational use of the physical capabilities of an athlete. Barbell path, degree of effort, work achieved, Speed, the amplitude of the barbell movement, stability and performance of athletes depends upon starting position. The increase of performances in weightlifting, a phenomenon that we are continuously witnessing, is based on the improvement of technique and training methods. That the speed of the bar is governed by how fast the lifter can accelerate the bar and still maintain the correct body position.

First pull

Though, it was found that in First pull snatch performance is more associated with Angle of Ankle, Knee, Hip, Angle of Shoulder, Head Inclination, Trunk Inclination, Distance between both feet, and centre of gravity Wrist whereas no significant association was observed between Snatch Performance Angle of elbow during the first pull of snatch performance. In First Pull How fast should the first pull of the snatcher clean be as fast as possible without negotiating position balance or tension the first pull is the section of the

lift in which the knees and hips are at their most mechanically disadvantaged due to the smaller joint angles this means that no matter how energetically you try to accelerate the first pull will never be as fast at the second during which the joints are open to larger angles the bar speed a given lifter can produce in the first pull and how it compares to the second will vary based on proportions and how the lifter is trained but all lifters will be faster in the second pull than the first essentially the more bar speed established from the first pull the more speed you can produce in the second just like it's easier to take a car from 60 to 80 miles an hour than from 30 to 80 however if you create too much speed before the second pull you'll be unable to maintain enough tension against the bar to maximally accelerate it additionally it's nearly impossible to establish a proper second pull entry position with excessive speed the bar will tend to blow right past the knees and stay away from the body however this is really only an issue with lightweights you won't get truly heavyweights moving too fast no matter how hard you try this simply means that with lighter warm-up weights and all lifts for new lifters who aren't able to move big weights yet because of technical limitations you'll need to intentionally control the speed of the first pull to ensure correct positions and continuous tension against the bar this doesn't mean we're trying to move slowly think of it more as mimicking the speed at which you'd be capable of lifting a maximal weight.

Transition phase

However, it was found that in Transition Phase snatch performance is more associated with Angle of Knee, Hip, Elbow, Angle of Shoulder, Head Inclination, Trunk Inclination, Distance between both feet, and centre of gravity Wrist whereas no significant association was observed between snatch performance and Angle of Ankle, during First Pull of Snatch performance. The transition phase serves to realign the lift are relative to the barbell in preparation for the second pull it is also known as the double knee bend because after reaching their first maximum extension the knees go through a period of flexion as the body is pulled towards the barbell and the hip continues to extend this knee flexion uses the muscles stretch-shortening cycle to produce elastic energy in the knee extensor muscles similar to that seen in a counter movement jump the stored elastic energy is used for explosive muscular power which is necessary during the second pool, therefore, the transition phase is one biomechanical variable of the movement tasks that can easily be modified by a coach to improve efficiency and performance of the snatch by having the lifter executed quickly with small knee flexion to fully take advantage of this stretch-shortening cycle.

Second pull

Despite, it was found that in Second Pull snatch performance is more associated with Angle of Ankle, Knee, Hip, Elbow, Wrist whereas no association was observed between snatch performance and Angle of Shoulder, Head Inclination, Trunk Inclination, Distance between both feet, and centre of gravity during Second Pull of Snatch performance. (Khaled Ebada, Ibrahim Abdel Hady, and Mohammed El-Rouby) 2015 [6], Morphological and dynamical Rates as a function to predict results of snatch lift for women's Olympic weightlifting. (Timothy J. Suchomel, Paul Comfort, Michael H. Stone, 2015 [7] Weightlifting Pulling Derivatives: Rationale for Implementation and Application, Review Article 3. **(**Haug, William B1, 2, 3, Drinkwater, Eric J.4, Chapman, Dale W.) 2015 Learning the Hang Power Clean: Kinetic, Kinematic, and technical changes in four weightlifting naive athletes.

Turn over under the barbell

However, it was observed that in Turn over under the Barbell snatch performance is more associated with Angle of Hip, Elbow, Wrist, Head Inclination whereas no significant association was observed between snatch performance and Angle of Ankle, Knee, Shoulder, Trunk Inclination, Distance between both feet, and center of gravity during Turnover under the Barbell of Snatch performance. (Erbil Harbiliand Ahmet Alptekin, 2014 [9] Comparative Kinematic Analysis of the Snatch Lifts in Elite Male Adolescent Weightlifters. (Ho, Lester KW Lorenzen, Christian, Wilson, Cameron J Saunders, John E, Williams, Morgan D, 2014 [10] Reviewing current knowledge in snatch performance and technique the need for future directions in applied research.

The catch phase

However, it was found that in Catch phase snatch performance is more associated with Angle of Shoulder, Elbow, Wrist, Angle of Ankle, Knee, Hip, Trunk Inclination, Head Inclination, Distance between both feet, and centre of gravity whereas no association was observed between snatch performance and during the Catch phase of Snatch performance. In The Catch Phase the lifter rapidly pulls themselves under the bar holding it in an overhead squat with arms fully extended knees and hips flexed and ankle dorsiflexed the quadriceps eccentric Lee contract to control the right of the body's deceleration to the bottom of the squat where the rhomboids traps core quadriceps includes all isometrically contract to catch the bar in this optimal position being directly over the lifters center of mass the vertical drop of the barbell from its maximum height achieved to the bottom of the catch position should be minimized so the muscles do not have to catch a weight with downward momentum which would negatively affect the efficient the lift the recovery of the snatch simply involves the lifter concentric Li contracting the knee extensors such as the quadriceps while maintaining the barbell locked out overhead in order to stand to full knee and hip extension signifying the end of the lift the trajectory of the barbell is a direct result of the forces applied to it by the lifter during the snatch the extension of the lifters joints induce a great amount of the barbells vertical displacement however a small horizontal displacement is also apparent and executes a characteristic toward away toward pattern during the first pull. 1. (Musser, Leslie J Garhammer, John, Rozenek, Ralph, Crussemeyer, Jill A Vargas, Emmy M) 2014 [11] Anthropometry and Barbell Trajectory in the Snatch Lift for Elite Women Weightlifters. (Whitehead, Paul N. Schilling, Brian K. Stone, Michael H. Kilgore, J Lon Chiu, Loren Z.F) 2014 [12] Snatch Technique of United States National Level Weightlifters. (Kristof Kipp & Chad Harris) 2014 [13] Patterns of barbell acceleration during the snatch in the weightlifting competition.

After applying the multiple correlations, it was found to have a significant difference between men and women men groups mean score was more than the women groups mean score for the deferent snatch lift technique position like initial position, first pull, Transition, second pull, turn over under the barbell and the catch phase in their kinematical variables. Significance was set at 0.05 level. This is probably due to the perfect angle of the joint and follow to exact technique and maybe more effect of muscular strength because make a good snatch position so must be the perfect angle of joints than more perfect work through muscles groups. Hence

kinematical variables good effective for the men weightlifters because good muscular strength provides good power of groups of muscles so that best performance of snatch lift technique that's why the score of mean value and results of men weightlifters. And other aspects of effects snatch lift technique for the selected position vise kinematical variables may be the centre of gravity different nature of the training components and pre-requisite for lifters. These results may be due to muscular strength according to individual differences male and female and other factors such as different types of body, differences in body composition, and maybe psychological, and physiological variable etc.

Conclusion

- To find out the relationship of selected kinematical variables with the performance of snatch for the initial position of elite woman weightlifters.
- To find out the relationship of selected kinematical variables with the performance of snatch for the first pull of elite woman weightlifters.
- To find out the relationship of selected kinematical variables with the performance of snatch for the transition phase of elite woman weightlifters.
- To find out the relationship of selected kinematical variables with the performance of snatch for the second pull of elite woman weightlifters.
- To find out the relationship of selected kinematical variables with the performance of snatch for the turnover under the barbell of elite woman weightlifters.
- To find out the relationship of selected kinematical variables with the performance of snatch for the catch phase of elite woman weightlifters.

Significance of the study

The result of the study may provide an authentic understanding of role of selected kinematic variables of snatch in weight lifting even though there are numerous factors which will be responsible for the performance of the weight lifters including Biomechanics of human activity and the physique (size and shape). The present study will be contributed to the physical educator, coaches and trainees in following ways:

1. The results of this study were indicate the variables which may considered as factors affecting the performance of snatch in weight lifting.
2. The result was provided a model for the teaching of different phases in snatch in weightlifting.
3. The result of the study was helpful in preparation of training schedules for weight lifters more efficiently.
4. Finding of the study was used to identify the talented weight lifters.
5. Finding of the study was used to identify the talented weight lifters.

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