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Dominant physical, physiological and anthropometric variables associated with the success of alpine skiers

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Abstract
Snow skiing is a game which requires almost all physical, physiological, anthropometric, biome Chanical and psychological parameters for improving performance of athletes. This study is related to those parameters which are of prominent importance for an athlete to improve his performance in snow skiing, especially in alpine skiing. In this study we are discussing only about physical, physiological and anthropometric variables helpful for skiers. Based on various studies we have chosen those variables which play a dominant role in improving performance or at least show ones peak performance. These variables are aerobic capacity, strength, flexibility, power, and body composition. On-hill snow training and dryland training programs should focus on the elevation of these fitness components.

Keywords: Dominant physical, Anthropometric, game

Introduction
Competitiveski racing (alpine skiing) is an aerobic sport requiring, prolonged dynamic submaximal muscular contractions that generally use only a small percentage of maximal muscle power. According to history of ski racing physiology, more attention has been given to central circulation and gross energy output. However, due to new inventions, different techniques and different skiing styles, attention has been given to peripheral muscle physiology, energy output of muscles as well as delivery of oxygen and fuel expenditure. There has been a controversy over knowing which energy system is important for alpine skiing and this controversy resulted in conducting more physical tests and training programs. The most significant tests which were used to test the performance showed that an elite skier cannot be predicted only by physiological parameters **(**Veicsteinas, 1984; Andersen, 1988; Andersen, 1990; White, 1991; White, 1993; Bosco, 1994; Tesch, 1995; Neumayr, 2003) [2, 3, 8,16, 17, 3].

Alpine skiing
Alpine skiing is a racing event which requires high capability of physical, physiological and technical qualities to cope with the numerous hurdles during the race.In relation to that we need to concentrate more on the physical, physiological, anthropometric, biomechanical, and psychological characters so as to improve the quality and performance of the skiers. It would be better to know the muscle contractions and energy systems which are helpful for skiers to enhance their performance in snow skiing. Not only for athletes but for coaches also it is necessary to have a deep knowledge of these characteristics so that they will avoid chances of alpine skiing injuries to a great extent. Now a days a big challenge for coaches is to identify talented skiers and provide some specific training for them. This thing is only possible if they are well versed with those attributes which are helpful for skiers. Alpine Skiing is comprised of two racing events, one is based on speed and the other is based on technique. Both these events are distinguished on the basis of placement of gates, speed of skies, length of the course and elevation of slope.In Speed events, the speed is too high nearly 130km/h because the skies run in the fall line of the slope. But the technical events are slower than speed events because in these events only technique is being evaluated. The speed of the skier is hardly 20 – 40km/h.The Giant Slalom (GS) typically lasts 60 – 90 seconds, while the Slalom (SL) lasts 45 – 60 seconds and includes very narrow, short turns(White 1993; Szmedra 2001) [4, 5].
(According to Bacharach and Duvullard, 1995) “No singular feature can be used to judge the potential for success of an Alpine Ski Racer”. When we consider training and identification of talent in skiing there has been different suggestions regarding different aspects of the sport. In that case there are different requirements and demands for professional skiing. As compared to other sports, there are very less documents related to the professional alpine skiing. Limited and specific information is available. A thorough knowledge of some physical and physiological characteristics is essential, and how these characteristics influence during training, competition as well as recovery processes(Neumayr, 2003; Hartmann, 2005) [9, 19].

Physical parameters
A study consisted of anthropometric as well as physical attributes of Swiss skiers in relation to age. Swiss Skier Power test was used to assess physical characters like coordination, speed, strength, anaerobic capacity and endurance. After analysis the results showed that there was an increase in anthropometric variables in relation to increase in age. Males were leading in all results than females. There was a significant improvement in physical characters with an increase in

age(Gorski, 2014).Another study is based on three groups of skiers (national, divisional and club skiers). In this study physical and physiological characteristics were assessed. It was realized that club skiers were weaker than divisional skiers and consistently divisional skiers were weaker than national skiers. There was no difference in skinfolds, flexibility and kinetic strength (Brown, 1983) [25].

Knee extension strength

The study aims to examine the effect of knee extension strength on performance of alpine skiers. It involves 29 subjects above the age of 15 years. Anthropometric variables such as height and weight were also tested. It was found that there was no correlation between isometric knee extension strength and racing performance. But the skier's height was important for racing performance (Benjamin, 2007).Successful skiers are having strong legs as measured by isometric and isokinetic contractions through knee extension. It can be due to long durations of crouched positions and hence there is a significant correlation between performance and leg strength among downhill skiers and giant slalom skiers (Anderson, 1988) [16].

Muscular Strength

According to(Berg, 1995) [20] skiers have significant leg strength. Previously it was studied that strength is the essential for performance of US ski team(Tesch, 1978; Haymes, 1980) [13, 17]. In relation to the previous studies the current studies show that no correlation has been found between strength and World Cup ranking(Andersen, 1988; Neumayr, 2003). The real studies stated that downhill skiers have more strength than other discipline skiers. Moreover no research shows that there is a difference among Technical, Speed or Combined skiers on the basis of strength(Berg and O., 1999; Neumayr, 2003) [20, 14]. However, it has been also studied that skiers have to withstand high forces and loads during skiing. So, in that case insufficient strength is not good for skier to overcome injuries and forces(Hintermeister, 1995; Berg and O., 1999) [12, 20].Alpine skiing is an intensive activity which lasts between 90 to 120 seconds and hence high contraction forces like isometric and eccentric forces are needed. These contractions depend on the blood flow to the muscles that are working. But later on these muscle fibers are not able to sustain the intensity. It may be because of reduction of oxygen delivery to the working muscles. Due to this, fatigue occurs in the muscles and deficiency of motor control may decrease performance (Ferguson, 2010).

Muscle property

One of the studies is based on assessing the physiological demands and characters of elite skiers. The elite skiers have a high maximum aerobic power. Anaerobic capacity also provides more than half energy. Knee extension strength is also important for better performance in skiing (Tesch, 1995).

Power

Alpine skiing includes uploading and unloading, mostly at the time of jumping. Moreover,when the duration of the events is between 50 seconds to 2.50 minutes in that case endurance and power are essential. A study was conducted on 27 elite skiers. The power variables were analyzed and it was realized that performance improvement is needed, peak power should be measured. As power is an important aspect in alpine skiing. In order to avoid the effect of bumps or sudden untoward, power should be created quickly. But there is no need of peak power (Patterson *et al*., 2009) [23].

Flexibility

Flexibility is essential for injury prevention and stability in range of motion and there was a least difference among National, Divisional and club male skiers (Brown and Wilkinson 1983; Andersen and Montgomery, 1988) [23, 16].

Aerobic Power

The objective of the study was to find out physical and physiological attributes of world cup skiers. The study includes 20 female and 28 male skiers who were tested during 1997 to 2000. Many physical variables including age, height, body mass, body mass index, percent body fat and circumference of thigh were examined while as, the physiological parameters included aerobic power and lower limb strength. Performance was judged on the basis of ranking in world cup. The study results show that there is strong correlation between aerobic power and performance. Moreover, muscle strength is also important for alpine skiers (Neumayr *et al*., 2003) [25]. During skiing alpine skiers aerobic demands reach upto 90 to 95 percent of maximal aerobic power. Heart rate reaches upto its optimal limit at the later part of the race. It was studied that elite skiers are having high VO_{2max} (Anderson, 1988) [16].A number of authors have tested the effect of aerobic power on ski racing, and there has been a disagreement among them whether it is important or not (Bacharach, 1995) [3]. According to (Tesh, 1995) [8], maximum aerobic power is least important for successful alpine skiing (White and Johnson,1993) also stated that aerobic power is somehow important but it does not affect the performance of skiers. Comparing the above mentioned studies, a recent study was conducted on world dominating Austrian National Team, and it showed that aerobic power is highly correlated with the performance of alpine skiers (Neumayr, 2003) [28]. It has been evaluatedwhether physiological power test ishelpful to categorize elite alpine skiers. Total 61 subjects were grouped into three categories such as regional, national and international on the basis of competition results. Many tests were used to evaluate body composition, aerobic and anaerobic power. It showed that average work from repeated jumps, absolute power for vertical jump, Wingate endurance were important for men and for women average work from repeated jump, absolute and vertical relative jump power, Wingate power were important. Fat free mass is essential for both sexes(White, 1991) [18].

Anthropometric attributes

The study aimed to compare the anthropometric attributes of three elite alpine skier groups. The study was conducted on the Italian national World Cup team, in 3years (1982, 1999 and 2005). Total 89 males were analyzed on the basis of age, height and body mass index, percent body fat and lean body mass. There was a difference in results in the year 1982 and 1999. In 1999 skiers were older, heavier and of raised body mass index. Body fat was lower and lean body mass was higher. There was no significant difference in height. The same results were seen

in the year 1982 and 2005(Osgnach, 2006) [26]. Highly ranked skiers have an average height and body mass. Nowadays best performing skiers are taller than ancient time skiers. Moreover, slalom skiers are more-lean than other alpine skiers like in giant slalom and super giant slalom. Downhill skiers are heaviest of all (Anderson, 1988) [4].

Age Effect

The current study focuses to find out the effect of aging on skiing performance. In this study 6996 participants were tested for 8 years. The Swiss Ski Power test was used which includes anthropometric variables and physical variable such as coordination and speed, endurance and strength. The results show that there was a relative age affect in all male and female skiers. Male skiing performance was not affected but female performance was affected. Physical tests were also influenced by relative age effect except upper body limb strength (Gorski, 2014) [19].

Morphology

The study is based on correlation analysis among morphology and ranking in alpine skiing based on gender. Total 58 skiers were selected for the study and were grouped into technical and speed events in relation to their ranking at international competition. Based on gender and age, Body Mass Index, skinfolds and somatotype were tested and then analyzed using bivariate Pearson correlation. Female speed skiers were having more fat mass than the female technical specialists. There was a slight relation between speed ranking and their body weight. High ranked female speed skiers were associated with high fat mass. High ranked male skiers were low ectomorph (Benjamin Vermeulen, 2017) [2].

Conclusion

Inconclusion we can say thatpeak performance of skiers is not related to a single variable. But it depends on several physical, physiological and anthropometric variables. Almost all the physical, physiological and anthropometric variables are essential for peak performance but the most important parameters are aerobic power, muscular strength, power, flexibility, lean mass and height of the athlete. Regarding strength we can say that strength is not only important for performance improvement but also essential for prevention of injuries in alpine skiing. There is great relationship between muscle force of lower limbs and alpine skiing performance. Flexibility is also important for prevention of injuries and improvement in strength and stability. While as aerobic capacity is important to meet the energy demands, to attain quick and enough recovery and to bear stress caused by long duration events.

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