

Relationship Between Motor Abilities and Success in Alpine Skiing

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Abstract: *Alpine skiing is a complex sports activity in which various motor abilities of athletes play a significant role. The aim of this study was to determine, through a review of relevant scientific literature, the relationship between motor abilities and success in mastering skiing technique. The study applied a descriptive method and theoretical analysis of previously published research. Six scientific studies dealing with the relationship between motor abilities and performance in alpine skiing were analyzed. The results of the analyzed studies indicate that motor abilities have a significant impact on the process of learning and performing skiing techniques. Balance, coordination, and agility are particularly highlighted as abilities that play an important role in the initial stages of learning to ski. In addition, some studies point to the importance of lower limb strength and functional abilities in achieving better results in alpine skiing. Based on the obtained results, it can be concluded that an optimal level of developed motor abilities represents an important prerequisite for successful mastery of skiing technique and achieving better sports results.*

Keywords— motor abilities; alpine skiing; skiing technique; balance; coordination

1. INTRODUCTION

Alpine skiing is a complex sports discipline in which the success of technique execution depends on the interaction of morphological, functional, and motor characteristics of the athlete. Due to the specific conditions of movement execution—changing terrain configuration, high speeds, and constant balance adjustments—skiers must possess a high level of development of various motor abilities (Gilgien, Spörri, Chardonens, Kröll, & Müller, 2015). Therefore, contemporary research places particular emphasis on identifying those motor abilities that contribute most to successful mastery of skiing technique.

Motor abilities represent a set of biologically determined characteristics that enable efficient execution of various motor tasks. In kinesiology literature, abilities such as strength, speed, coordination, balance, flexibility, and agility are most commonly distinguished (Bompa & Buzzichelli, 2019). Their development has a significant influence on the process of learning sports techniques as well as on the level of sports performance across different disciplines.

In alpine skiing, special emphasis is placed on balance and coordination, as athletes must continuously maintain body stability at high speeds and during changes of direction. Research shows that the ability to maintain balance has a direct impact on the quality of skiing performance, especially among beginners who are in the process of acquiring basic skiing techniques (Cigrovski, Matković, & Prlenda, 2009). In addition to balance, explosive strength and agility also play an important role, enabling rapid changes in body position and efficient execution of turns while skiing downhill (Turnbull, Kilding, & Keogh, 2009).

Modern research in sports science indicates that a high level of specific physical fitness is necessary for success in alpine skiing, particularly lower limb strength and neuromuscular control abilities. These abilities enable skiers to effectively overcome mechanical forces that occur during skiing, especially during the phases of entering and exiting turns (Spörri, Kröll, Amesberger, Blake, & Müller, 2012). Furthermore, well-developed motor abilities also play an important role in injury prevention, which is relatively common in alpine skiing due to the high loads to which athletes are exposed (Burtscher, Nachbauer, Schröcksnadel, & Wilber, 2008).

In the context of learning skiing technique, some studies indicate that different motor abilities contribute differently depending on the skier's level of expertise. While balance and coordination are more important in the initial stages of learning, explosive strength and agility become more relevant in advanced skiers and competitors (Hydren, Volek, Maresh, Comstock, & Kraemer, 2013). Therefore, understanding the relationship between motor abilities and skiing technique is of particular importance for planning and programming the training process.

Considering the above, it can be concluded that motor abilities represent one of the key factors of success in alpine skiing. The analysis of previous research provides a better understanding of their role in the process of learning and refining skiing technique, as well as the identification of those abilities that contribute most to sports performance.

2. METHOD

This study applied a systematic review of the scientific literature in accordance with the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), which represent a standard for transparent reporting of the processes of identification, screening, and analysis of scientific papers (Page et al., 2021). The aim of the review was to identify studies that analyze the relationship between motor abilities and success in alpine skiing.

The literature search was conducted in the electronic databases Google Scholar, PubMed, and Scopus. The search was performed using combinations of English keywords: motor abilities, motor skills, balance, physical fitness, alpine skiing, and skiing performance, as well as regional language terms such as motor abilities, skiing, and alpine skiing. The search included studies published between 2000 and 2024.

2.1 Study selection

The study selection process was carried out in several phases in accordance with the PRISMA procedure. In the initial identification phase, 115 potentially relevant papers were found in the selected databases. After screening titles and abstracts, a preliminary selection was made of studies thematically related to the research topic. In the next phase, a more detailed review of the full-text availability and content was conducted, which further narrowed the number of studies that could potentially be included in the analysis.

2.2 Study exclusion criteria

Studies were excluded if they were not directly related to the research topic, i.e., if they did not analyze the relationship between motor abilities and skiing technique or performance. Review papers, theoretical articles without empirical results, studies without available full text, and duplicates identified across multiple databases were also excluded. Based on title and abstract screening, 98 studies were excluded, while an additional 11 studies were removed in the next phase due to not meeting the defined criteria.

2.3 Study inclusion criteria

Studies The final analysis included studies that met the following criteria:

- original scientific articles,
- studies examining the relationship between motor abilities and success in alpine skiing,
- studies conducted on skiers or participants involved in the skiing learning process,
- studies available in full text.

After the selection process was completed, 6 studies met the criteria for final inclusion and were subsequently analyzed in detail and presented in a tabular summary of results.

3. RESULTS AND DISCUSSION

The process of study identification and selection is presented in a PRISMA flow diagram. The initial search of electronic databases identified a total of 115 potentially relevant papers. After screening titles and abstracts, 98 papers that did not match the research topic were excluded. In the next phase, a full-text review of 17 studies was conducted, during which an additional 11 studies were excluded due to not meeting the defined inclusion criteria. After the selection process, 6 studies met all criteria and were included in the final analysis.

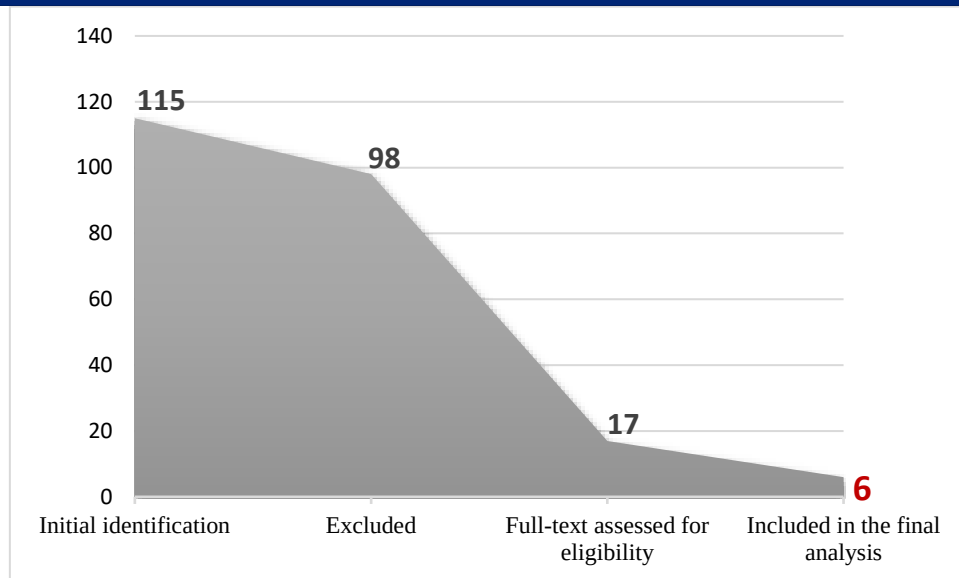


Fig. 1. Flow diagram of study selection process for the research

In order to systematize the collected studies, Table 1 presents an overview of the relevant research analyzed within this review study. The table contains basic information about authors, sample characteristics, applied methods, and the most important research findings. This provides a clearer insight into existing knowledge on the relationship between motor abilities and success in skiing.

Table 1: Detailed analysis of studies included in the research

Research, author and year	Respondent sample			Experimental program			
	N	Age	Gender	Number of groups	Objective and measures taken into account	Types of tests	Results
Cigrovski, Matković, Krističević (2006)	29	13 ($\pm 1,15$)	M	1E	To determine the relationship between morphological characteristics and motor abilities.	-11 morphological measures -1 test for functional capacity assessment- -4 tests for explosive strength	After excluding a number of variables, it was determined that aerobic capacity is a key factor for success in alpine skiing at this age, and therefore important for the identification of young talents entering alpine skiing as well as for selection of athletes when transitioning to higher categories or national teams.
Cigrovski, Matković, Prlenda (2009)	119	22.8 (± 1.33)	M	1E	To determine the relationship between results obtained on three laboratory balance tests and success in acquiring alpine skiing skills	- Horizontal and vertical balance position in a wide stance on a platform - Balance position in a wide stance on a dual-support platform - Skiing tasks: diagonal descent, wedge turn, basic	Results showed a correlation between all three static balance tests and the level of skiing skill. Participants who maintained balance for a longer time on the platform demonstrated better predisposition for

Research, author and year	Respondent sample			Experimental program			
	N	Age	Gender	Number of groups	Objective and measures taken into account	Types of tests	Results
					among beginner skiers.	turn, snowplough turn, skiing in a straight line, and slalom-like skiing	acquiring skiing technique.
Kuna, Franjko, Maleš (2009)	43	31	M	1E	To determine the influence of basic motor abilities and specific skiing motor skills on giant slalom performance in skiing demonstrators of different competitive efficiency.	- Rhythmic tapping with hands and feet - Balance on a bench with both feet in a transverse position - Isometric half-squat hold - Snowplough turn - Mogul skiing - Professional skiing technique	It can be concluded that performance in competitive giant slalom primarily depends on the level of specific motor skills in alpine skiing. Different mechanisms underlie the performance of demonstrators of different competitive levels when achieving results in giant slalom.
Cigrovski, Božić, Prlenda (2012)	86	22,76 ($\pm 1,15$)	M	1E	-the influence of motor skills on the learning process -Balance -Agility -Explosive strength -Static strength -Frequency of movements -Flexibility -Evaluation of morphology of 39 IBP measures	- For the purposes of this research, seventeen tests were selected to assess the motor abilities of the subjects. +IBP 39	Seventeen motor ability tests were used for the assessment of participants. Agility showed the greatest influence on the acquisition of skiing skills in beginners. Static leg strength also influenced the learning process, while balance had a significant role at the very beginning of learning, particularly in mastering basic skiing elements.
Bilić, Cigrovski, Prlenda, Martinčević (2010)	96	23,3 ($\pm 1,66$)	M	1E	- the aim of this research was to determine the relationship between explosive leg strength and the acquired level of skiing knowledge. -explosive strength	-Vertical jump from a squat -Vertical jump with preparation -Long jump from a standing position Established level of knowledge: -Slope descent -Turn towards a hill -Basic turn -Wiring -Parallel turn from a hill	-The analyzed results of this research show that explosive leg strength is not an important link for beginner skiers when acquiring the basics of this sport.
Krsmanović (2010)	60	Students	M/W	1E	-The aim of the research was to determine the	-Sledge skiing technique -Parallel technique -Parallel stepping	A statistically significant relationship

Research, author and year	Respondent sample			Experimental program			
	N	Age	Gender	Number of groups	Objective and measures taken into account	Types of tests	Results
					connection between skiing techniques and motor skills -Explosive strength -Flexibility -Balance -Coordination	-Carving	was found for the plough skiing technique. In the parallel turn, coordination, flexibility, and explosive strength showed significant influence ($p = 0.05$). Parallel stepping did not show significant results, while carving showed no statistically significant multiple correlation.

4. DISCUSSION

The results of the presented studies indicate a significant relationship between motor abilities and success in learning and performing skiing techniques. Most of the analyzed studies confirm that different motor abilities contribute differently to the process of learning and performing skiing elements, with balance, coordination, agility, and lower limb strength being particularly emphasized.

The study by Cigrovski et al. (2006) showed that functional abilities, especially aerobic capacity, have a significant influence on success in alpine skiing in younger age categories. These findings highlight the importance of athletes' functional fitness in the selection and development of young skiers. Similar findings regarding the importance of specific motor abilities are reported in the study by Cigrovski et al. (2009), where a statistically significant relationship was found between balance test results and success in acquiring basic skiing techniques among beginners. These results indicate that balance represents one of the key abilities in the initial phases of skiing acquisition.

Further studies also confirm the importance of motor abilities in performing more complex skiing tasks. Kuna et al. (2009) demonstrated that skiing demonstrators with better giant slalom performance possess higher levels of basic motor abilities and specific skiing skills compared to less successful performers. These findings suggest the importance of combining general motor abilities and specific technical skills for achieving better performance in alpine skiing.

The study by Cigrovski et al. (2012) further confirms the importance of motor abilities in the skiing learning process, showing that agility has the greatest influence on the acquisition of skiing skills among beginners. In addition to agility, static leg strength and balance also significantly contribute, especially in the early stages of learning basic skiing elements.

On the other hand, the results of Bilić et al. (2010) indicate that explosive leg strength does not play a significant role in the process of learning skiing techniques among beginners. These findings suggest that certain motor abilities have different levels of importance depending on the athletes' skill level and experience. While balance and coordination are more important for beginners, strength and explosiveness may become more relevant for advanced skiers.

The results of Krsmanović (2010) also confirm the relationship between motor abilities and success in performing specific skiing techniques. This study found that coordination, flexibility, and explosive strength significantly influence the performance of parallel skiing techniques, while a significant relationship was also observed in the ploughing technique. However, for more complex techniques such as parallel stepping and carving, no statistically significant relationship was found, which may indicate the need for longer learning processes and greater experience in mastering these skills.

Additionally, the presented findings can be compared with those of other authors who have also investigated the role of motor abilities in alpine skiing. Malliou et al. (2004) showed that balance is one of the most important motor abilities influencing stability and movement control during skiing turns. Similar findings are reported by Neumayr et al. (2003), who emphasize that neuromuscular control and balance significantly affect skiing technical efficiency. Gilgien et al. (2014) also highlight that motor control and coordination play a key role in maintaining stability at high speeds in alpine skiing.

Furthermore, several authors emphasize the importance of lower limb strength in achieving better performance in this sport. Gross et al. (2010) state that well-developed leg strength enables more efficient management of forces acting on the body during skiing and turning. Turnbull et al. (2009) highlight that a combination of strength, balance, and coordination forms the foundation for optimal skiing technique execution. Similarly, Hébert-Losier et al. (2012) emphasize the importance of explosive lower limb strength in competitive skiers, particularly in disciplines requiring rapid changes of direction.

In this context, previous research confirms that success in alpine skiing depends on the interaction of multiple motor abilities. According to Spörri et al. (2012), an optimal combination of strength, balance, and coordination is necessary for efficient skiing performance and injury prevention. These findings further support the conclusion that motor abilities represent one of the key factors of success in alpine skiing.

5. CONCLUSION

Based on the analysis of available studies, it can be concluded that motor abilities play a significant role in the acquisition and execution of skiing techniques. The results of the presented studies indicate that balance, coordination, and agility are among the most important abilities influencing success in the skiing learning process. The importance of balance is particularly emphasized in the initial phases of learning basic skiing techniques.

In addition, certain studies also highlight the importance of functional abilities and lower limb strength in achieving better performance in alpine skiing. However, the influence of individual motor abilities may vary depending on the skier's level of skill and experience. In beginners, basic motor abilities play a greater role, while in advanced skiers the importance of specific motor and functional abilities increases.

Overall, it can be concluded that the optimal development of motor abilities represents an important prerequisite for successful acquisition and execution of skiing techniques.

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