

Determining the relation level of the general and specific motricity indices to develop strategies for improving performance in luge events

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Abstract:

Background and Study Aim. In luge sport, the performance of athletes is influenced by a complex combination of general and specific motor skills, which are essential for achieving competitive results on ice tracks. The aim of this study is to analyze the relationship between general motricity indices and specific motricity indices to develop effective strategies for improving performance in luge events. **Material and Methods.** The study involved 10 performance athletes practicing luge, selected from the Muscel Sports Club. To assess general motricity, six fitness tests were used: the 4 kg weight throw, 30m sprint, fixed bar pull-ups (10 seconds), barbell bench press, barbell hang clean and 5 consecutive standing long jumps. For specific motricity, the tests included: the luge start on rollers and a ranking system based on the points difference from the best recorded time. According to the relations identified between general and specific indices, strategies for performance improvement were proposed. Data analysis was conducted using parametric statistical tests, specifically Pearson correlation coefficient. **Results.** The results of the correlation analysis between general motricity indices and luge specific performance indices highlight that, although general motor skills significantly impact on specific performance, explaining 50% of their variability, there are other factors that also have an important contribution. While 66.7% of the correlations are either strongly negative or positive, suggesting a considerable influence, 33.3% of the correlations are weak, indicating that improvements in general motricity do not automatically guarantee better specific performance. **Conclusions.** The results of the correlation analysis show that although general motor skills have major influence on performance in luge events, a substantial part of their variability remains unexplained. This fact highlights the need for developing a personalized training program that integrates both general motor skills and the specific technique and strategy of the event in order to maximize competitive performance.

Key Words: assessment, training programs, performance, correlation analysis

Introduction

Sliding sports, such as luge, require a unique combination of physical and technical skills to achieve top performance. Skeleton, luge and bobsleigh are distinct ice sliding sports that involve high-speed races on icy tracks. These sports share advanced technology in sled design, racing suits and refrigeration infrastructure. Tracks are often used for multiple sports disciplines and are subject to strict rules regarding equipment and materials to ensure fair competition (Barton, 2020). Performance in these sports is influenced by general and specific motricity, both of which significantly contributing to the success of athletes. General motricity includes attributes such as strength, speed, coordination and endurance, while specific motricity refers to the specialized abilities required for luge performance, such as starting technique, sled control and adaptability to different track conditions (Brüggemann, Morlock & Zatsiorsky, 1997; Zanoletti et al., 2006).

Understanding the relation between these motricity indices is essential for the development of successful strategies meant to improve performance. Previous research has highlighted the importance of both general physical training and specific training for success in competitions. However there are few studies that explore in detail the interaction between these factors in the context of luge events (Leonardi et al., 1985; Morlock & Zatsiorsky, 1989).

The aim of this study is to investigate the level of the relation between general and specific motricity in luge athletes for identifying the factors that contribute the most to their performance. By evaluating various aspects of the physical and technical training of the athletes, it is intended to correlate these data and formulate concrete recommendations for optimizing training and competitive strategies (Sands et al., 2005).

Statistical and mathematical methods are used in the research to analyze the collected data and determine the relations between different indices of motricity. The methodology includes correlation analysis and regression for

examining the influence of motricity variables on performance (Abdi, 2007). The results obtained are fundamental for the development of personalized training programs that address the specific needs of athletes and increase their performance potential in luge competitions.

Research was conducted to contribute to the improvement of knowledge in the field of sports training and provide practitioners with useful tools to optimize their approaches and methods to train the athletes, ensuring a competitive advantage in the international arena (Brown, 2020; Preuss & Plambeck, 2021).

The aim of the study is to evaluate the level of the relation between general and specific motricity indices in luge sport in order to develop effective strategies for improving performance in luge events.

Material & methods

Participants

The study involved 10 luge performance female athletes selected from the Muscel Sports Club of Argeș County. All participants had a minimum experience of 3 years in luge competitions. Informed consent was obtained from all participants and approved by the Ethics Committee of the Doctoral School of Sport Science and Physical Education at the University of Pitești, part of the National University of Science and Technology “Politehnica” Bucharest.

Procedure & Fitness tests

The following tests were used for evaluating *general motricity* indices:

1. *Weight throw test*: In women’s category, it consists of using a 4 kg ball to be thrown as far as possible from a standing position with the back to the sector and feet placed on the edge of the throwing circle. Two attempts are made and the final result is the longest throw.
2. *30m sprint test*: It is carried out on a running track, with standing start. An electronic timing system is used to measure the time in seconds and hundredths of a second from the activation of the starting photocell until crossing the finish line.
3. *Pull-ups test*: Involves lifting the upper body by bending the arms until the chin or chest reaches the level of the fixed bar. The number of repetitions is recorded over a duration of 10 seconds.
4. *Barbell bench press test*: Performed lying on a horizontal bench, with controlled and explosive movements to develop upper body strength. The final result is the maximum weight pressed after 4-6 progressively heavier attempts.
5. *Barbell hang clean test*: It consists of lifting and holding a barbell on the shoulders by extending the hips and knees, with 4-6 progressively heavier attempts. The final result is the maximum weight lifted.
6. *Consecutive standing long jumps test*: It involves performing five jumps from a squat position, beginning from the start line and landing in a sand pit. The total length is measured from the start line to the first mark in the pit; each athlete is allowed to perform two consecutive attempts

For *specific motricity* evaluation there were used:

Indicator of aptitude no. 1: assessed with the rollers luge start test, which involves positioning the luge in the center of the sliding surface with short forward-backward movements from a sitting position, with a preparation time of 20 seconds from the green visual signal.

Indicator of aptitude no. 2: Hierarchy based on the recorded times of the participants. It uses a calculation formula that allocates points according to the difference from the best recorded time, in order to make a ranking.

The research was conducted at the sports facilities of the Muscel Sports Club in Argeș County, which includes one of the most technical roller luge start tracks. The study was designed as cross-sectional research, where participants were evaluated only once. Data on general and specific motricity were collected using a series of standardized tests.

Strategies for Improving Performance in Luge Events

To develop effective strategies for better performance in luge events, it is highly important to take into account the relation between general and specific motricity indices. Based on this relation, the following strategies can be proposed:

1. Improving explosive strength by implementing a training program that includes plyometric exercises (box jumps and weighted jumps, for example). Use of the training with weights to develop lower body strength (for instance, squats and deadlifts).
2. Enhancing sprint speed by using sprint training sessions that include acceleration and maximum speed exercises. Specific drills for improving start technique should be also used, such as repeating starts on a luge track. Exercises include: starts from various positions followed by sprints over distances of 5 m / 10 m / 15 m; starts from different positions followed by forward tuck rolls and sprinting with changes of direction through four longitudinally placed obstacles.
3. Development of aerobic capacity by means of endurance training, such as medium-duration runs (30-45 minutes) at moderate intensity. High-intensity interval training (HIIT) will be used to improve VO₂ max and recovery capacity.
4. Optimizing luge handling technique: training sessions dedicated to handling technique exclusively, including simulations on specially designed tracks. Video analysis of runs will be used to identify and

correct technical errors. Exercises will include: luge start, while maintaining the starting position, followed by additional pushes on the ice on the start track braking surface, meant to achieve maximum sliding distance of the luge.

5. Adaption to environmental conditions: training sessions will be carried out on various tracks to acclimate athletes to different competition conditions. Detailed analysis of track profiles will be done. Race strategy will be adapted on the basis of critical sections identified through strong correlations between time intervals.
6. Improvement of equipment by collaborating with aerodynamics experts and engineers to develop and test new equipment. Testing of various luge configurations and selection of those that provide the best performance on the specific competition track.
7. Recovery and Nutrition Program: A recovery program that includes stretching, sports massage and active recovery techniques will be implemented. Personalized diet will be planned to ensure optimal nutrient intake for training and competition.

Statistical analysis

The data were analyzed using parametric statistical tests, specifically Pearson correlation coefficient, for determining the relation between general and specific motricity indices. Statistical analysis was conducted using SPSS IBM software, version 21 (Abdi, 2007). Linear regression analysis was employed to identify predictive factors for performance in luge events. The number of observations and the statistical results were presented in detail where applicable, to ensure the transparency and replicability of the study.

Results

To evaluate the level of the relation between general and specific motor indices in luge sports and to develop effective strategies for improving performance in luge events, a Pearson linear correlation analysis was conducted. The results of the relations between the analyzed indices are presented in Table 1 and Figures 1 and 2.

Table 1. Results of the relation between general and specific motricity indices in luge events

General motricity tests	Specific motricity tests			
	Aptitude indicator no. 1		Aptitude indicator no. 2	
	R ²	R	R ²	R
Test 1	0.357	-0.597	0.309	0.556
Test 2	0.030	0.173	0.022	-0.149
Test 3	0.021	-0.147	0.035	0.186
Test 4	0.336	-0.579	0.301	0.549
Test 5	0.341	-0.584	0.306	0.553
Test 6	0.268	-0.518	0.215	0.464

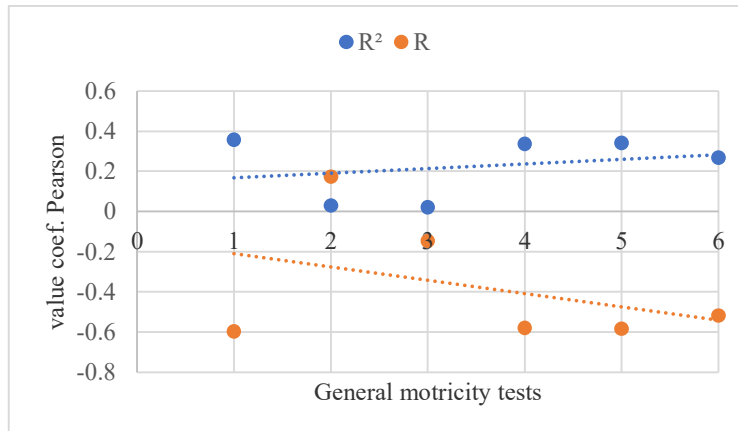


Fig. 1. Relation of the general motricity indices and the specific indicator 1

The results of the correlation analysis between general motricity indices and specific aptitude indicator 1, shown in figure 1, highlight 5 negative correlations and 1 positive correlation. In the context of the relation between the analyzed indices, 50% of the coefficient of determination (R²) suggests that general motricity explain only a small part of the variability in specific motricity. The remaining 50% indicates a significant influence on specific motricity, but there are also other important factors that contribute. Regarding the degree of connection between general and specific motor indices, the Pearson correlation coefficient (R) reveals 66.7% strong

correlations, with R values ranging from -0.518 to -0.597. This shows that the improvement of general motor skills has an important and positive impact on specific performance. However, 33.3% of the correlations are weak ($R = 0.173$ and -0.147). This fact indicates that, in these cases, improving general motor skills does not automatically guarantee a notable improvement in specific performance.

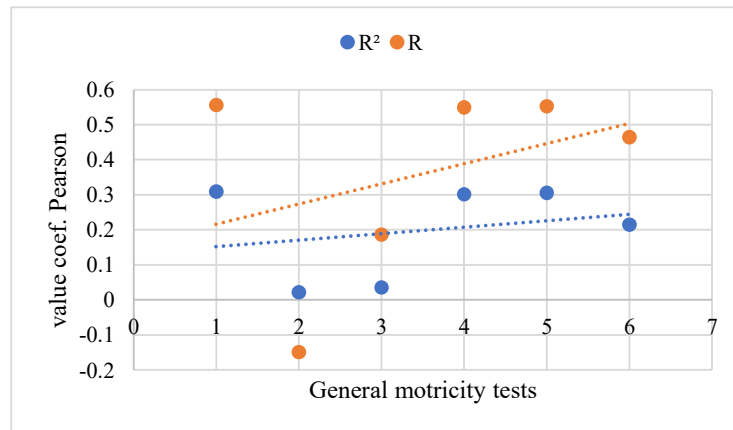


Fig. 2. Relation of the general motricity indices and the specific indicator 2

The results of the correlation analysis between the general motricity indices and the specific aptitude indicator 2 are presented in Figure 2. There are highlighted 5 positive correlations and 1 negative correlation. Within the relation between the analyzed indices, the coefficient of determination (R^2), at 50%, shows only a small part of the variability of specific motricity, while the other 50% indicates a significant influence, but other important factors have also their contribution. Regarding the degree of connection between general and specific motor indices, the correlation coefficient (R) reveals 50% strong correlations with values ranging from 0.549 to 0.556, indicating a notable and positive impact on specific performance. Additionally, 16.7% show moderate correlation ($R = 0.464$), and 33.3% demonstrate weak correlations with opposite values in terms of specific performance. Therefore, in these cases, the improvement of general motor skills does not guarantee a significant improvement in specific performance.

Discussion

The study focuses on highlighting the relations between the general and specific motricity indices. The purpose is to establish effective training strategies meant to improve performance in luge events, emphasizing that a deep understanding of these correlations can lead to better oriented and personalized training programs.

To assess the relation between general and specific motricity indices in luge sport and develop effective strategies for performance enhancement, a linear correlation analysis was carried out using Pearson's coefficient. The analysis of the relation between general and specific motricity indices (aptitude indicator no. 1, Fig. 1) shows strong negative correlations (66.7%) between general and specific motor indices in luge events. This indicates that, in most cases, there is a significant inverse correlation between these indices. It suggests that as general motor abilities (such as strength, speed and overall coordination) increase, specific performance in luge events (such as the start with a roller luge) may decrease, meaning that a lower time is associated with better performance. On the other hand, the weak correlations (33.3%), both negative and positive, indicate that for some athletes, improving general motor abilities does not have a clear impact on specific performance in luge events. This fact highlights the importance of personalizing training programs.

Analyzing the relations between general and specific motricity indices (aptitude indicator no. 2, fig. 2) points out 50% strong positive correlations, 16.7% moderate positive correlations, and 33.3% weak positive and negative correlations. This proves that, in half of the cases, there is a significant positive correlation between general motricity and specific performance, emphasizing the importance of developing general motor skills to enhance performance in specific events. However, in approximately one-third of the cases, the correlations are weak or may even be negative, indicating that other factors or specific aspects of training and luge technique may influence performance. Thus, more personalized training approaches and improvement strategies are required.

Training programs for athletes participating in luge events should include exercises that develop general strength, speed and coordination, as these general skills are directly correlated with success in specific luge events. For example, strength training for legs and torso, sprint exercises and training sessions for coordination and balance will significantly contribute to performance. Training should also be more specialized, focusing on the specific skills required for luge events. This can include specific exercises for luge starts, technique training for handling the luge at high speeds and exercises for improving reflexes and balance specific to luge. It is also

important to pay attention to training on simulated or real tracks to develop the technical and tactical skills needed.

Specialized literature highlights several research trends related to innovations in timing systems, leading to results in milliseconds and rare cases of ties between competitors in sports such as athletics, swimming, equestrianism, skiing, biathlon and sliding sports. Also research on changes in the materials of the sports grounds has led to performance considered impossible before (Bucur, Macovei & Istrate, 2016). Some specialists analyzed the facilities for winter sports (bobsleigh, luge, skeleton) which are perceived as “white elephants” due to limited use and negative heritage (Preuss & Plambeck, 2021; Campbell-Pegg, Preuss & Weitzmann, 2024). Studies have shown that a good start is important for competition success but does not necessarily guarantee a top ranking. Correlations between start times and final times have varied by sport and gender (Zanoletti et al., 2006; Leonardi et al., 1985; Morlock & Zatsiorsky, 1989; Brüggemann, Morlock & Zatsiorsky, 1997; Fedotova, 2010). Other studies have identified variable correlations between start times and final times in luge and skeleton, with different coefficients for various rankings and specific sports (Oguchi & Schwameder, 2024; Oguchi et al., 2019; Zanoletti et al., 2006; Brüggemann et al., 1997). Body mass has a notable influence on performance in Skeleton and Luge competitions. Therefore, it is necessary to adjust sports regulations to ensure fair conditions for athletes with different body masses (Fuss, 2023). Experiments on bobsleigh and luge tracks have shown that adjusting the runner rigidity can significantly improve performance (Irbe et al., 2019). The innovative technologies and design of bobsleigh, luge and skeleton tracks have been carefully studied, with a focus on the Sochi bobsleigh track used in the 2014 Winter Olympics. The off-season use of tracks has been also analyzed (Komarova, 2018). Head injuries and concussions are a concern in sledding sports, requiring further research for managing the condition known as “sled head” (McCraden & Cusimano, 2018). Research has examined the impact of start characteristics on performance in skeleton, indicating that international-level athletes achieve shorter start times through higher step speed and bigger step length (Oguchi & Schwameder, 2024; Oguchi et al., 2019). These studies point out the importance of technical innovations, performance factors and management of injuries in sliding sports.

Conclusions

The results of the correlation analysis indicate that, while improvements in general motor abilities have an important impact on specific performance in luge events, as explained by a determination coefficient of 50%, there is anyway a significant variability in specific performance that is not covered by general motricity. The strong correlations observed (66.7% for aptitude indicator no. 1 and 50% for aptitude indicator no. 2) suggest that general motor abilities positively influence luge performance. However, the weak correlations (33.3%) highlight that not all athletes benefit equally from these improvements. This fact reveals the need for developing a personalized training program to integrate both general motor aspects and technical and strategic components specific to luge events for optimizing performance in competitions.

Implementing these strategies, based on the identified relations between general and specific motricity indices, can lead to notable improvements in the performance of athletes in luge events. A comprehensive approach, including physical, technical and mental training, as well as adaptation to specific competition conditions, is essential for long-term success.

Conflicts of interest - The authors have not any conflicts of interest to declare.

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