
**The Steadier – the Better the Course Time – an Analysis From Patrouille Des
Glaciers**

Running head: steadiness in Patrouille des Glaciers

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Abstract

Background

It is generally known that in endurance sports the steadier the pace the better the performance. This is a consequence of biological restrictions from aerobic metabolism. Most knowledge from this is from running and cycling. However, analyses from ski-mountaineering are missing yielding to the aim of the study to analyze steadiness during the largest ski-mountaineering race in the West-Alps Patrouille des Glaciers (PdG) from Zermatt to Arolla and Verbier.

Material and Methods

A total of 207 Patrols (three alpinists) from race one from Zermatt-Arolla-Verbier, 344 patrols from race two from Zermatt-Arolla-Verbier as well as 374 patrols from race one of the short distance from Arolla-Verbier and 375 from race two Arolla-Verbier with an average age in female of 39.1 ± 10.2 years and male 41.4 ± 10.9 years were analyzed concerning steadiness of absolving PdG original course from Zermatt to Arolla and Verbier (53 km horizontal distance / 3994 meter ascent / 4090 meter descent) or the short course from Arolla to Verbier (26 km horizontal distance / 1914 meter ascent / 2374 meter descent). In order to compare the different parts of the race the concept of performance km was applied which states that 100 meter ascent, 200 meter descent and 1 km of horizontal distance are a performance correlate.

Results

For both races fastest parts were during descents with a high share of downhill skiing. Furthermore, a close association between steadiness of absolving PdG and course time for the

original race from Zermatt to Arolla to Verbier ($R^2 = 0.76$) as well as for the short race from Arolla to Verbier ($R^2 = 0.699$) were detected.

Discussion

Results imply that lowest course times are achieved when absolving the course as steady as possible. Therefore, it is especially recommended not to start too fast in order to keep a steady pace during the whole race.

Introduction

Mountaineering and especially ski-mountaineering competitions have gained increased attention in the last years. (Burtschert, 2016; Burtschert et al. 2005; Faulhaber et al. 2007; PDG, 2018). The demand to participate at the biggest Ski-mountaineering race of the alps Patrouille des Glaciers (PdG) is still increasing (PDG, 2018). The enormous improvement of equipment combined with a well-prepared track and the official support stations has yield to an increase in security additionally increasing the demand to participate. The physical requirements still have to be taxed as high and even well-trained alpinists need around 12 hours to successfully absolve the original race. As most of the time the race takes part in the high alps the time to absolve PdG is highly dependent from conditions such as snow surface (wet spring snow versus powder snow), temperature or wind. (Winkler & Brehm, 2008a; Winkler & Brehm, 2008b; Albisser, 1992)

In the younger past different analysis concerning steadiness during endurance competitions such as Triathlons, Duathlons, Cross-country skiing competitions or Vasaloppet have been conducted. (Nikolaidis et al. 2018; Nikolaidis et al. 2017) Some interesting aspects were elucidated. In tendency a smooth pace yields to best results.

(Knechtle et al. 2015; Knechtle et al. 2015; Nikolaidis et al. 2017) This is a general finding which is also supported from Marathon running: steady pace is key for optimal usage of performance potential. (Steffny, 2008; Steffny, 2010) Best results are achieved with a constant usage of human body capabilities over the whole race. (Steffny, 2008; Steffny, 2010) This implies that when neglecting other aspects such as snow conditions, temperature or wind as well as ascent respectively descent the same time per km over the whole distance yields to best results. (Steffny, 2008; Steffny, 2010, Zintl, 1997) Undoubtedly, motivated by other participants and the motivating atmosphere many patrols are over motivated absolving the first part of a race too fast yielding to the necessity to slow down during the second part of a race. (Steffny, 2008; Steffny, 2010; Zintl, 1997) However, in principle the steady absolving of a race should yield to best results yielding to the general question: Is there an effect of pacing on course time? As hypothesis with potential falsification it shall be stated that there is no association between steadiness of absolving PdG and course time. (Popper, 1969)

Material & Methods

Participants

A total of 207 Patrols (three alpinists) from race one from Zermatt-Arolla-Verbier, 344 patrols from race two from Zermatt-Arolla-Verbier as well as 374 patrols from race one of the short distance from Arolla-Verbier and 375 from race two Arolla-Verbier with an average age in female of 39.1 ± 10.2 years and male 41.4 ± 10.9 years were analyzed concerning steadiness of absolving PdG original course from Zermatt to Arolla and Verbier (53 km horizontal distance / 3994 meter ascent / 4090 meter descent) or the short course from Arolla to Verbier (26 km horizontal distance / 1914 meter ascent / 2374 meter descent).

Measurement procedures

Several concepts exist to quantify performance of hiking and mountaineering (Tobler, 1993; Magyari-Saska et al. 2012; Scarf, 2007; Minetti et al. 2002; Langmuir, 1984) The most often used for mountaineering in the Alps is the performance km concept. (Winkler & Brehm, 2008a; Winkler & Brehm, 2008b) This concept implies that one km of horizontal distance as well as 100 meter ascent or 200 meters descent is one performance correlate – a performance km.

Statistical Analysis

All parts of the classic distance as well as the short race were quantified with the performance km concept and mean and standard deviation of all parts were calculated. As indicator of steadiness standard deviation of all parts for each patrol were calculated. For the short course as well as the long course linear regression between standard deviation and course time and coefficient of determination (R^2) were calculated. (Stier, 1996) Analyses were conducted with Graphpad Prism (GraphPad Software, Inc., La Jolla, California, USA) and Microsoft Excel (Microsoft Inc., Redmond, Washington, USA).

Results

In order to analyze differences in average speed for different parts of the race average performance km was calculated. (Tab. 1) Interestingly, the average speed per performance km was with 6.5 ± 0.7 minutes in the original race faster than in the short race with 7.5 ± 1.6 minutes despite a total higher work load in the original race. ($p < 0.001$) After calculating performance km for all patrols per part standard deviation of all parts per patrol were calculated as approximation for steadiness. It is detectable, that an unsteady pace yields to higher course times. (Fig. 1) For the original race the calculated regression shows a close relationship between course time and steadiness with a high coefficient of determination of 0.76 implying a potential close association between course time and steadiness of pace. Furthermore, this result is supported from analysis of the short course from Arolla-Verbier with a coefficient of determination of 0.699. (Fig. 2)

	horicontal distance	Ascent	Descent	Performance km	Mean SD	Mean SD
Zermatt-Süd Schönbiel	8.0	1078		18.8	7.2 0.5	
Süd-Schönbiel-Tete Blanche	8.0	956		17.6	7.3 0.7	
Tete Blanche-Col de Bertol	4.0	50	371	6.4	6.1 0.8	
Col de Bertol-Plans de Bertol	3.0		615	6.1	2.5 0.4	
Plans de Bertol-Arolla	5.0		678	8.4	1.9 0.2	
Arolla-Col de Riedmatten	5.0	933		14.3	6.8 0.7	5.1 0.7
Col de Riedmatten-Pas du Chat	2.0		338	3.7	9.6 2.0	11.8 2.9
Pas du chat-La Barma	3.0	50	123	4.1	18.2 2.9	20.9 5.4
la Barma-Rosablanche	5.0	702		12.0	8.2 1.2	9.2 2.0
Rosablanche-Col de la chaux	4.0		220	5.1	9.0 1.3	10.5 2.6
Col de la chaux-les Ruinettes	4.0	170	745	9.4	1.9 0.6	2.2 0.7
Les Ruinettes-Verbier	2.0		643	5.2	2.9 0.6	3.1 1.0
Total	53/26	3994/1914	4090/2374	111.1	6.5 0.7	7.5 1.6

Tab. 1: The average performance km in minutes for the original course from Zermatt-Arolla-Verbier (n = 561) as well as for the short distance Arolla-Verbier. (n = 944)

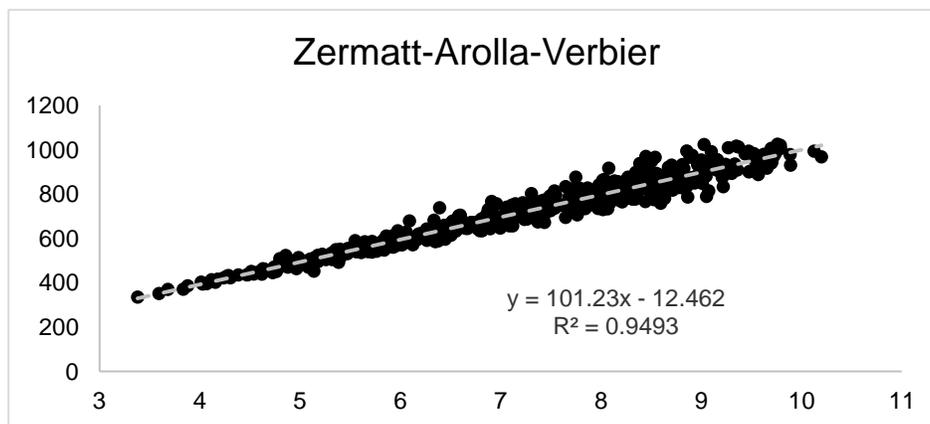


Fig. 1: the steadier, the better the course time for Zermatt-Arolla-Verbier. The y-axis shows the course time of the whole race whereas the x-axis shows the standard deviation of average speed quantified with performance km in minutes for the different parts of the race.

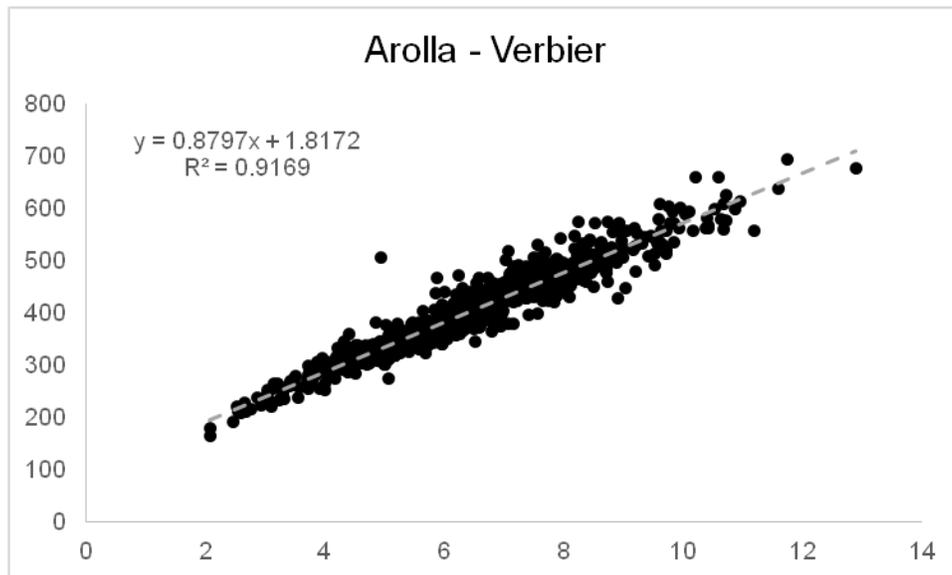


Fig. 2: *the steadier, the better the course time for Arolla-Verbier. The y-axis shows the course time of the whole race whereas the x-axis shows the standard deviation of average speed quantified with performance km in minutes for the different parts of the race.*

Discussion

The aim of the study was to analyze effects of steadiness of exercising on course time while absolving Patrouille des Glaciers. An impressive close relationship between steadiness and course time was detected for the original race from Zermatt-Arolla-Verbier and for the short course from Arolla-Verbier with high coefficients of determination of $R^2 = 0.76$ respectively $R^2 = 0.699$ allowing to falsify the initially stated hypothesis. The well-known rule of thumb, steadiness is key also seems to have validity for ski-mountaineering. In pure ascent parts average performance km are around 5-7 min per performance km, in downhill parts about 2 minutes per performance km and in relatively flat parts such as from Pas du Chat – la Barma up to 20 minutes can be found. (Winkler & Brehm, 2008a; Winkler & Brehm, 2008b)

The faster average course times in the original race are probably due to the fact that the original race is more often absolved by elite oriented respectively highly trained patrols while short race attracts more recreational ski mountaineers. Furthermore, it was detectable for both races that the large descent parts were absolved relatively fast with average performance km in a range of around one to three. This seems intuitive due to the fact that it is easily possible for an avid skier to ski down a height of 1000 meter in 10 minutes.

Furthermore, in both races highest average speed was found in the part from Pas du Chat to La Barma. This is probably due to the special conditions in this part due to the microtopography. This part follows a lake. It is relatively flat most of the time but always goes a little bit up and down what becomes a special challenge for patrols. Sometimes it's faster to skate, sometimes to move forward with skins is an advantage. Especially for slower patrols absolving this part in the

later morning when snow has become often wet yielding to sticky conditions a decrease in average speed is the consequence.

Discussing the key result of the close association probably the training state of the ski-alpinist has to be mentioned. It probably corresponds to the individual ability to choose a smooth and steady pace able to perform during the whole race. Furthermore, the steadiness is in well trained patrols higher due to the fact that experienced ski mountaineers are faster in changing equipment from downhill to ascent parts or vice versa. This might be one additional reason, why the average performance km in the both races were very high in the Pas du Chat – la Barma part with its lots of small up and downs. Especially by less experienced patrols skies were probably pulled on several times which further needs some minutes increasing average performance km. These procedures are probably more time consuming for recreational versus elite patrols, who often make special training for reducing times to change or just were strong enough to skate and push during the little ascents in this part of the race. A last explanation might be from downhill skiing: less experienced ski-mountaineers are probably often underestimating the required force and pace to fast in advance of difficult descents further increasing standard deviation of performance km of different parts.

Practical Implications

A close association between steadiness of absolving and course time at PdG for the original race from Zermatt-Arolla-Verbier as well as for the short race from Arolla to Verbier with a high coefficient of determination (R^2) of 0.76 respectively 0.699 was detected.

It is recommended to start not too fast and to keep in mind, that best results are achieved while performing as steady as possible.

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