
Nutrition Analysis During Patrouille Des Glaciers – Do Recreational Ski Mountaineers Eat and Drink Adequately?

Running head: Optimal nutrition in Patrouille des Glaciers

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Abstract

The aim of this study was to analyze nutritional behavior of recreational ski mountaineers participating at Patrouille des Glaciers (PDG) the largest ski-mountaineering race of the Alps. To analyze nutritional habits of participants thirteen male Ski mountaineers absolving the Parcours Zermatt-Arolla-Verbier (average race time: 13 hour 18 min \pm 66 min) and five male Ski mountaineers absolving the Parcours Arolla-Verbier (average race time: 6 hour 32 min \pm 30 min) were asked via semi-quantitative questionnaire concerning their nutritional and fluid intake. Total average intake of fluid was 5.6 ± 4.8 liter for Zermatt-Arolla-Verbier and 3.8 ± 2.4 liter for Arolla-Verbier ($p = 0.24$). Total energy intake was 5500 ± 2145 kcal for Zermatt-Arolla-Verbier and 5000 ± 4327 kcal for Arolla-Verbier ($p = 0.55$). All participants consumed warm tea, while isotonic sport drinks were consumed by less than one fourth of the participants, only one person consumed bouillon with the potential of high salt intake. 84% ate dried fruits and chocolate was eaten by 62% of analyzed ski-mountaineers. The relatively low fluid intake might be a result of the fact that participants were quite well hydrated in the start not drinking a lot during the first three to four hours of the race during the night in the cold. Maybe the constant usage of an isotonic carbohydrates-electrolyte beverage could help to reduce energy and fluid deficit during the race helping to improve overall performance.

Keywords: Patrouille des Glaciers, Ski-mountaineering, energy intake, fluid intake, Zermatt-Arolla-Verbier

Introduction

Back country skiing gained increased attention and has developed from a niche sports to a recreational sport for everybody [1, 2, 3,4]. In Switzerland with the current conditions' backcountry tours can be made during November till April around half a year [6, 7]. Increased

attention gained ski mountaineering races such as Tris Rotondo, the Gastlosen Trophy, the Davos Race and especially Patrouille des Glaciers (PDG). The race of PDG has not changed a lot over the last years and starts in Zermatt to Tête Blanche to Col du Bertol to Arolla and Rosablanche to Verbier [8,9]. The requirements on human performance are also with good tracks and the nowadays existing nutritional stations large [8,9]. Despite all difficulties the demand to participate at PDG has increased [8,9]. This yields besides the important aspect of equipment to the question of optimal nutrition when participating. Competitive ski mountaineering is characterized by an important cardio-pulmonaire strain and requires a high degree of physical fitness [10]. Furthermore, it has to be considered that ski mountaineers are confronted with cold temperatures often in deep minus degree, whereby warm nutrition helps in order to optimally regulate body temperature. [5, 6, 11, 12,13] For this race, whereby until nowadays well-trained patrols need around 8 to 14 hours nutrition is crucial. For such a long time of exercising body needs carbohydrates, and fluids in order to successfully complete the race [12-24]. In principle, for long lasting exercises also electrolyte balance is key, however newest findings relativize the necessity of special planning of salt intake. [15, 16, 19, 20,21]. In contrast to e.g. other races with several hours exercise times such as triathlon Hawaii requirements due to low temperature are contrary.[8,9,13,23] Normally start is during the night whereby shortly an altitude of 2000 Meter is reached with minus degrees. Furthermore, winds have to be kept in mind whereby temperatures around zero yield to felt minus 20 degree. [6,7,8,13,14] As a consequence also elite patrols drink warm beverages and gels or bars are probably less often consumed compared to other long endurance competitions such as e.g. Triathlon Hawaii. [23] From a metabolic point of view, such long lasting exercises are absolved in fat metabolism. [25,26] However, exercising of several hours is only possible with continuous energy and fluid intake. [12,13,17-25] Total energy need is higher than 6500 kcal respectively 30000 kj (around one kilo of human body fat tissue) pinpointing relevance of fat metabolism. [12,13,17-25] Furthermore, in order to absolve PDG a sufficient intake of fluid is very important. [12] Assuming that per hour racing one liter of fluid is needed, at least 5-6 liter are necessary, due to low temperatures and high altitude probably more. [5, 6, 13, 17, 18, 27,28] The capacity of glycogen stores is not that relevant in comparison e.g. to shorter races such as marathon. [24,25] Focusing on ski-mountaineering several studies address some aspects of physiological demands. [29-35] Although some hints exist concerning optimal nutrition, the question concerning adequacy of nutritional behavior is not directly elucidated for recreational ski mountaineers at PDG. The above-mentioned yields to the aim of the study to analyze nutritional and fluid intake during the race. As Hypothesis with potential falsification it shall be stated, that the majority of ski mountaineers does consume less energy and fluid than it its assumed to be necessary for the chosen course. [11, 12, 13, 17, 18, 27, 28, 37]



Fig. 1: *the impressive scenery during PDG – one the left picture the shoulder of Matterhorn can be seen [8]*

Methods

Participants

Thirteen male (45.6 ± 12.6 years / 178.4 ± 4.9 cm / 71.8 ± 4.9 kg) ski mountaineer which absolved the Parcours Zermatt-Arolla-Verbier and five male (60.4 ± 5.4 years / 170.4 ± 6.2 cm / 71.4 ± 6 kg) absolving Zermatt-Arolla-Verbier were questioned concerning their nutritional intake.

Race characteristics

Start for the long race is in Zermatt 1616 m to Tête Blanche (3650 m), Col Bertol (3268 m), Plans de Bertol (2664 m) and Arolla (1986 m). Further to Col de Riedmatten (2919 m), Pas du Chat (2581 m), La Barma (2458 m), Rosablanche (3160 m), Col de la Chaux (2940 m) and Les Ruinettes (2192 m) to Verbier (1520 m), whereby long courses encompasses Zermatt-Arolla-Verbier and short course Arolla-Verbier. PDG takes place every second year. [8,9] In 2018 around 1600 patrols respectively 4800 participants received permission to take part in the race. [8,9] All participants respectively patrols had to participate with a high-standard ski mountaineering equipment including a mobile phone (GPS-track), Microchips (by all participants to be wear during the whole race around the neck), map, a dynamic rope, altimeter, compass, sanitary material, helmet, avalanche transceiver, avalanche shovel, avalanche probe, headlamp, ice pick, climbing harness, rescue blanket. [8,9]

Measurement procedures

Around 50 participants of a voluntarily Swiss Army mountaineering course were personally questioned during the course or via Email after the course concerning their participation and their potential nutritional and fluid intake during PDG with a semi-quantitative questionnaire. (Fig. 2) Participants were informed and consent was achieved. In order to quantify and to compare the performance of the two course parts Zermatt-Arolla-Verbier versus Arolla-Verbier the concept of performance km was used. [6,7] This widely used and recommended concept by Swiss Alpine Club implies that one km of horizontal distance as well as 100 meters ascent or 200 meters descent are one performance correlate – a performance km. [6,7] The whole race has around 53km distance and 4000 Meters ascent as well as 4100 Meters descent yielding to a total of around 110 performance km for the Parcours Zermatt-Arolla-Verbier and for Arolla-Verbier with a distance of 26km and about 1900 meters ascent as well as 2300 Meters descent to around 56 performance km. [6,7]

Statistical Procedures

Descriptive statistics were calculated with mean respectively standard deviation for Course times, estimated total Energy intake, estimated total fluid intake, fluid per hour, calories per hour, Fluid intake per performance km and calories per performance km. For calculating means of fluid and caloric intake the arithmetic mean of the class range was used. Percent of participants consuming a respective beverage respectively nutritional were calculated. Correlative relationships (Pearson correlative coefficient) were calculated between energy intake respectively fluid intake and course time. Differences in estimated fluid and nutritional intake as

well as calories per performance km and fluid intake per performance km were compared between long and short course with two-sided heteroscedastic t-Tests. Calculations were made with Graph pad Prism (Graph Pad Software, Inc., La Jolla, California, USA) and Microsoft Excel (Microsoft Inc., Redmond, Washington, USA).

Nutritional Behavior during PDG

Which race did you absolve?

- Zermatt-Arolla-Verbier
- Arolla-Verbier

How many times did you already absolve PDG?

- one two three four five six seven eight ten or more

What was your course time? _____

What did you eat during the race Was?

- Chocolate Bread dried fruits Cake Sportbars fruits Dried meat
- Gels other _____

What did you drink during PDG?

- warm Tea cold Tea isotonic Sport drinks (Gateroad etc.)
- Water Bouillon Other sweetened beverages (Coca-Cola)

How much did you drink?

- Up to 2 Liter 2 - 3 Liter 3 – 4 Liter 4- 5 Liter 5 – 6 Liter 6 – 7 Liter
- 7- 8 Liter 8 – 9 Liter 9 – 10 Liter 10 – 11 Liter

What do you estimate how much calories you did eat?

- Up to 1000 calories 1000-2000 calories 2000-3000 calories
- 3000-4000 calories 4000-5000 calories 5000-6000 calories
- 6000-7000 calories 7000-8000 calories 8000-9000 calories
- 9000-10000 calories 10000-11000 calories 11000-12000 calories

How large are you? _____

How old are you? _____

What is your weight? _____

Thank you for your participation and wonderful tours

Fig. 2:the administered Questionnaire after absolving PDG

Résulté

Eleven Ski mountaineers participated the first time at PDG, three Ski mountaineers participated the second respectively third time and one questioned ski mountaineer absolved PDG six times. Two participants from the long course were from the same patrol. The average course time of the long distance from Zermatt to Arolla and Verbier was 13 hour 18 min ± 66 min and for the short distance from Arolla to Verbier 6 hour 32 min ± 30 min. Total average intake of fluid was 5.6 ± 4.8 liter for Zermatt-Arolla-Verbier and 3.8 ± 2.4 liter for Arolla-Verbier (p = 0.24) and total energy intake was 5500 ± 2145 kcal for the whole course and 5000 ± 4327 kcal for the short course (p = 0.55). Fluid per hour was 0.42 ± 0.25 liter in Zermatt-Arolla-Verbier and 0.99±0.59 liter for Arolla – Verbier (p = 0.24) and energy intake was 413.7±174.5 kcal for Zermatt-Arolla-Verbier and 765.3±373.7 kcal for Arolla-Verbier (p = 0.18). Calories per performance km were with 50 ± 21.5 versus 89 ± 22.7 not significantly higher in the short versus the long course (p = 0.88). Furthermore, fluid intake per performance km with 0.05 ± 0.03 liter in the long course versus 0.07 ± 0.03 in the short course differed not significantly (p = 0,54). Taken the assumption of 10 performance km per hour a fluid intake of about half a liter resulted implying a reasonable stated amount by participants. Tab. 1 summarizes the results of the analysis. Some interesting aspects were detected. Although all members of a patrol had the same finishing time while affecting each other and yielding to limitations concerning potential associations, nevertheless for the long course, the higher the energy intake, the higher the course time (r = 0.422 / R² = 0.178). Furthermore, the higher the fluid intake the lower the course time becoming highly significant (r = -0.0194 / R² = 0.000376).

course	Zermatt-Arolla-Verbier		Arolla-Verbier	
	MEAN	SD	MEAN	SD
Distance and height in performance km	110		56	
Course times (min)	797.63	66.6	392	28.3
estimated total Energy intake	5500	2145	5000	4327
estimated total fluid intake	5.6	4.8	3.8	2.4
fluid per hour	0.42	0.25	0.99	0.59
calories per hour	413.7	174.5	765.3	373.7
Fluid (liter) per performance km	0.05	0.03	0.07	0.03
calories per performance km	50	21.53	89.03	22.68

Tab. 1: Descriptive statistics of the race separated for Zermatt-Arollla- Verbier (n = 13) and the short course (Arollla-Verbier) (n = 5)

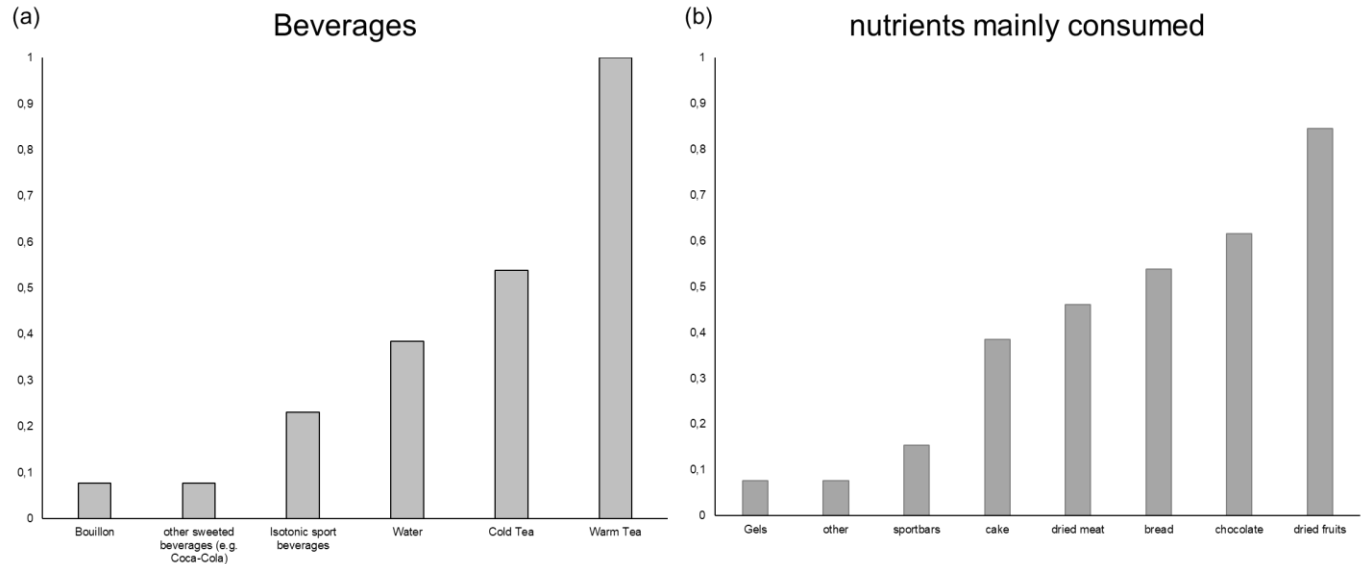


Fig. 3: Main nutritionals consumed (a) and Main beverages consumed (b) (y-axis entails percent of person consuming the respective beverage or food)

Fig. 3a and Fig. 3b reveal the main beverages and energy and nutritionals consumed. All participants consumed warm tea, while isotonic sport drinks were consumed by less than one fourth of the participants, only one person consumed bouillon with the potential of high salt intake. Around 84% ate dried fruits and chocolate was eaten by 62%. When analyzing the questionnaire in detail, there seemed that faster participants more often consumed sports nutrition such as isotonic sport beverages or sportbars in line with findings from others. [17,18,23,27,28] Furthermore, results showed that ski mountaineers often eat classic nutritionals such as dried meat or sausages with a high share of fat. From a physiological point of view, this is probably only partly necessary due to stored fat in human body. The high share of salt in classic mountain food (cheese and sausages) might be an advantage to reduce prevalence of exercise induced hyponatremia. [15,16,17-22]

Discussion

The aim of this study was to analyze the nutritional behavior of recreational ski mountaineers in PDG. The identified total energy respectively fluid intake seems relatively low with around 5500 kcal ± 2145 kcal respectively 5.6 ± 4.8 liter for Zermatt-Arollla-Verbier and with 5000 ± 4327 kcal respectively 3.8 ± 2.4 liter for Arollla-Verbier. That longer distances yielded to higher intake is intuitive and in line with other findings. [17, 18, 27, 28]

Furthermore, energy intake was relatively low implying an energy deficit. [13,14,17,18,27,28]The initially stated Hypothesis seems therefore possible to falsify. However, energy and fluid intake were only estimated questioned with respective problems of validity. That multi-hour ski mountaineering energy balance is under extreme conditions negative respectively energy intake is below consumption was several times indicated. [14,31,32] Especially fluid intake seems low with around half a liter per hour, although a relatively high standard deviation was detected. One explanation would be that participants were quite well hydrated or even hyper-hydrated in the start not drinking a lot during the first three to four hours of the race during the night in the cold. Start for PDG is usually during the early morning e.g. 1 p.m. (increased probability of avalanches during the later morning and afternoon due to warmer temperatures). A smooth pace in the beginning (not too fast) is key for optimal usage of performance potential. [12,35]Given this fact fluid intake is probably in the middle and the end of the race during the day higher in contrast to the first hours in the normally cold night while developing only small individual urge to drink. However, that fluid as well as energy intake was low is from an organizational point of view astonishing. Organizers of PDG offer Tee, Bouillon and nutrition making it not necessary to carry all food on its own, however to support participants with its own nutritionals and beverages is only allowed in some parts of the race.¹Furthermore, convenience during the race of the participant such as feeling the cold influenced by the local climatic situation (winds or sunlight - in the shadow normally much colder) can make it hard to stop at the offered stations developing an urge to move further in order to give the body the opportunity to produce heat.

Focusing on what was eaten, it was detected, that recreational ski mountaineers often used classic mountain nutritionals such as dried fruits, bread or dried meat. All questioned ski-mountaineers drank warm tea during the race. In contrast to general recommendations, a carbohydrate-electrolyte solution was seldom consumed in line with other findings from ultra-endurance races such as the Race Across America, were also pure water was the main beverage. [22]

To sum up, especially fluid intake seems relatively low. Food intake was often classic alpine food. Given the detected relatively low fluid intake ski mountaineers might profit from constantly drinking, especially a carbohydrate-electrolyte beverage. Studies with larger samples parallel analyzing blood serum and hormones could give further hints concerning optimal fluid and energy intake.

Practical Applications

Focusing on what was eaten, it was detected, that recreational ski mountaineers during the race often used classic mountain nutritionals such as dried fruits, bread or dried meat. The ski-

¹ Supporting the patrol with nutritionals and beverages is for security reasons (especially avalanches) only allowed at the following stations in special marked areas: Süd Schönbiel, Tête Blanche, Col de Bertol, Arolla (Fontanesses), Col de Riedmatten, Col de Tsena Réfien, La Barma, La Rosablanch, Col de la Chau.

mountaineers preferably drank warm tea during the race in contrast to the general recommendation of a carbohydrate-electrolyte beverage.

Furthermore, fluid intake was relatively low probably due to race characteristics such as low temperatures and starting in the night.. Participants are advised to be well hydrated at the start and to constantly drink during the race. If tolerated a carbohydrate-electrolyte beverage might be an advantage to perform successfully.

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