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SUDDEN CARDIAC DEATH AT ALTITUDE – A MULTIFACETED PROBLEM

Dear Editor,

In their recently published review about sudden cardiac death (SCD) in the mountain environment Windsor et al. focus on coronary heart disease (CHD) as the main underlying risk factor [1]. They refer mainly to older papers and to those which investigate risk groups others than mountaineers. This causes a tendency of the text which may lead to false conclusions, especially for readers who are less detailed informed about altitude medicine. After a very fruitful discussion with the first author at the annual meeting of the Medical Commission of the Union Internationale des Associations d'Alpinisme (UIAA MedCom), held at Kathmandu / Nepal in November 2009, we decided to write some comments to clarify some points for the reader who is not specialized in mountain medicine.

First of all it is very important that the authors mentioned a problem which is of increasing importance in a more and more aging, but also more and more active and mobile society. In future we'll have to advice an increasing number of persons who are – potentially – at risk for SCD before, while and shortly after they perform any kind of sports, any discipline of mountaineering included. But at least two things must be pointed out: i. SCD is a headline which includes many other diseases than CHD, and ii. all data available about the topic are relatively weak.

There is no doubt that the risk for SCD increases with age and the presence of risk factors. But it is not proven that this risk is higher in mountaineering, if the person performs endurance sport regularly. On the other side it is proven, that a person reduces his / hers risk for SCD by regular endurance sports. The increased risk for SCD as stated by the authors does only exist for sedentary persons if they perform abrupt and without training any kind of high physical workload. In contrast to the author's statement there is no single paper which proves a principally increased risk for SCD in mountaineers compared to a normal population. In fact there are other data which indicate a very low risk of cardiac problems at altitude: The Himalayan Rescue Organization published their data of 148,000 trekkers in Nepal [2]. There were 23 deaths of which 11 were caused by trauma and there was no single cardiac death. And this must be interpreted with the background, that the age of trekkers differs significantly from those of "classic" mountaineering or even more from sport climbers: While classic mountaineers show an age distribution with two maxima, one around 25 years and the second at 45-50 years, and sport climbers a single maximum around 15-25 years, trekkers are significant older with one single maximum (Fig.1). With this a significant number of trekkers should be at risk for SCD if the data of an urban (sedentary) population are used for comparison. This interesting example of a study group which should be at risk but which obviously isn't, illustrates the dilemma.

And there is another problem: the risk given in several papers differs so tremendously that a reliable summarized risk estimation is simply impossible. The statement of the authors, that middle aged men show the highest risk is based on several sport disciplines at low altitude, but it is not true at high altitude. Our data from a study of 2,731 rescue operations in the central Alps (Switzerland and Austria) show a linear increase of cardiac problems with age (Fig.2). Data from other studies of our group show similar results [3, 4, 5, 6].

The paragraph "…that the incidence of acute cardiovascular events for every 10,000 person hours of physical activity is 0.3-2.7 in men and 0.6-6.0 in women. This represents a 7-14 fold increase in the risk of SCD…" will lead to a misinterpretation if stated like this without any comment: again these data were obtained from persons without regular endurance sports. Avoiding physical activity and sitting to reduce the risk for SCD is definitively the wrong alternative. The authors also refer to the paper of Faulhaber et al. [7] who report that 12.7% of hikers and 11.2% of (alpine) skiers reported a history of hypertension, cardiac arrhythmia or CHD. In fact this is significantly less than in an urban sedentary population.

The statement that "post mortem examinations have revealed that artheriosklerotic coronary heart disease is responsible for the vast majority of adult SCDs" ignores that different situations have to be taken into account: It may be true, that the majority of SCDs at moderate and possibly also at high altitude (Tab.1) is caused by CHD – again: data are weak – but there is consensus that at extreme altitude most so-called non-traumatic deaths which are not based on altitude disease are thromboembolic problems with secondary SCD.

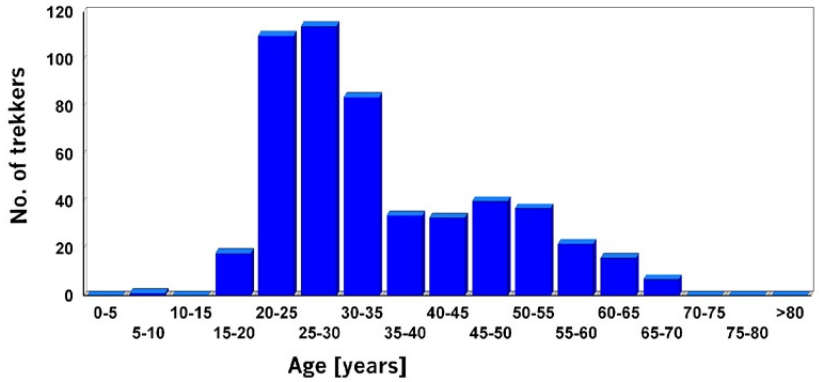
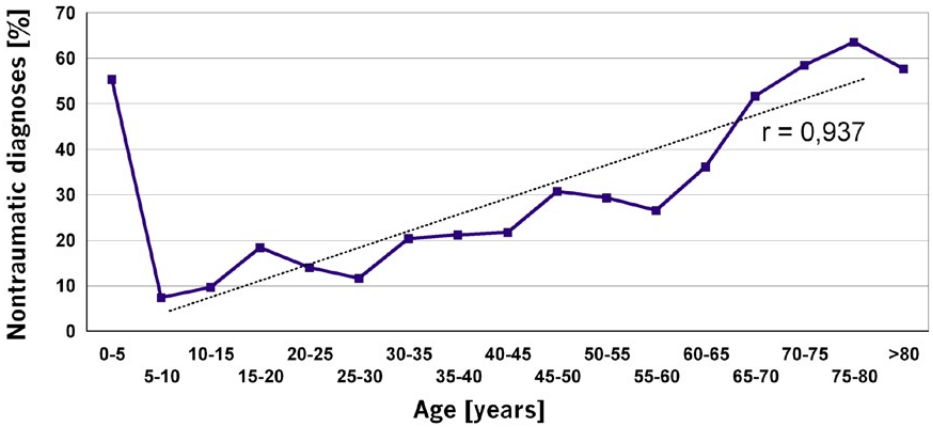


Figure 1. *Age distribution of trekkers on the Annapurna Trail (n = 516; data from [12, 13, 14])*



Figurre 2. *Non-traumatic emergencies (most cases cardiac diagnoses) of the different age groups, given as percentage of the diagnoses in the respective age group (n = 2,731 alpine rescue operations). Correlation was calculated with the age group of 0-5 years being excluded (from: [15])*

Table 1. *Altitude and physiological consequences [16]*

Phrasing	Altitude [m a.s.l.]	Physiological consequences
Low altitude	< 1,500 m	–
Moderate altitude	1,500 – 3,500 m	Acute adaptation
High altitude	3,500 – 5,300 m	Acclimatization necessary, complete acclimatization possible
Extreme altitude	> 5,300 m	Acclimatization necessary, complete acclimatization impossible

It is not proven that hypoxia caused by altitude sojourns triggers SCD (severe cases of CHD excluded). In contrast, the myocardium is able to cope with surprisingly low pO_2. Cold and other environmental factors are a potential risk factor for some of the patients with CHD only (so-called "cold induced angina pectoris"). I would not agree with the author's statement that the cardiac work is increased during much of the time spent in the mountain environment – at least if we talk about moderate and high altitude and exclude extreme altitude (Tab.1). After the first phase of acclimatization where a stress situation takes place, the pulse frequency returns to normal values as the blood pressure does with increasing or completed acclimatization. The increased vagotonus which causes lower maximal pulse rates at altitude can be assumed as protecting factor which limits the oxygen consumption of the myocardium. The decrease of plasma volume is of advantage, not of disadvantage, at altitude, if it is not too extreme: With reduced plasma volume there are more oxygen transporting units (erythrocytes) per unit blood volume which increases oxygen transport to the tissue. Only in situations with extreme dehydration (hematocrite >55%) there will be a disadvantage because the significant increase in blood viscosity causes a decrease of blood flow and therefore of oxygen transport.

I completely agree with the authors that persons with individual risk factors or any cardiac disease should get special and individual advice how to perform their altitude sojourn as safe as possible. This advice should be given according to standard literature [8, 9, 10], especially to the UIAA MedCom recommendations [11]. Much research is still necessary to sort the jungle of – often not consistent – data and to optimize our strategies to minimize the risk of SCD in the mountains.

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Dear Editor,

We would like to welcome the comments made by Dr Kupper. Like him, we believe that the subject of sudden cardiac death (SCD) in the mountain environment is of, "increasing importance in a more and more ageing, but also more and more active and mobile society". Whilst coronary heart disease is just one precipitant of SCD in the mountain environment it is by far the most common cause and therefore warranted the focus of our article. Dr Kupper is absolutely correct to point out that only limited epidemiological data is available in this area. At no stage did we attempt to compare the risk of SCD between different physical activities, instead we simply set out to highlight the incidence of SCD in the mountain environment. From the evidence that is available it is clear that SCD's are commoner during mountain hiking and downhill skiing compared to normal sedentary activities, whilst those who regularly participate in endurance events display the lowest risk of SCD.

Although we agree with the vast majority of Dr Kupper's letter, we would like to take exception to his assertion that cardiac work is not increased at altitude. There is very little evidence to suggest that sympathetic drive and its effects (increased heart rate and systemic blood pressure) are reduced after days or even weeks spent in the mountain environment. As we stated in our article, the effects of "hypoxia, sleep deprivation, dehydration, missed meals, anxiety and extremes of temperature" all have the potential to play a part in a prolonged increase in sympathetic stimulation and the triggering of SCD in vulnerable individuals.

Despite this small disagreement we share Dr Kupper's views and believe SCD is a real risk in the mountain environment and that much research still needs to be done.

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