

# Understanding physiology could give more athletes a chance of Olympic glory

The Winter Olympics include many exciting and demanding sports – but, with fewer events and categories available than in the Summer Olympics, there are reduced opportunities for athletes. Recently, Professor Kjell Hausken of the University of Stavanger, Norway, looked in detail at the physiological demands of five Winter Olympic sports. As a result, Professor Hausken was able to propose a new format for the Winter Olympics, one that will allow a fairer and more exciting event for both athletes and spectators.

While the Winter Olympics may not have as high a profile as its Summer counterpart, the featured events are some of the most diverse and exciting sports around. From bobsleigh and luge to figure skating, and from ski jumping to ice hockey and speed skating, the 15 Winter Olympic disciplines push athletes to their gold-medal-winning limits.

Since the first Winter Olympics in 1924, the Games have evolved. Some sports have been added while others have been dropped; in the case of skeleton (a hair-raising event in which an athlete rides a small sled, face down and head first, down a steep and winding ice track), for example, the event has been removed and reinstated several times

over the last century. Within each sport, the various entry categories have been adjusted over time, not least to include women's events; in 1924, women could only compete in figure skating. In addition, some events have been altered to better suit a TV audience (with group rather than individual starts, for example). These changes mean that the reasons behind including or excluding certain events or categories have sometimes become obscure. Why, for example, is the shortest skiing distance in women's biathlon (a combination of cross-country skiing and rifle shooting) 6km, whereas their longest distance in speed skating is 6.4km?

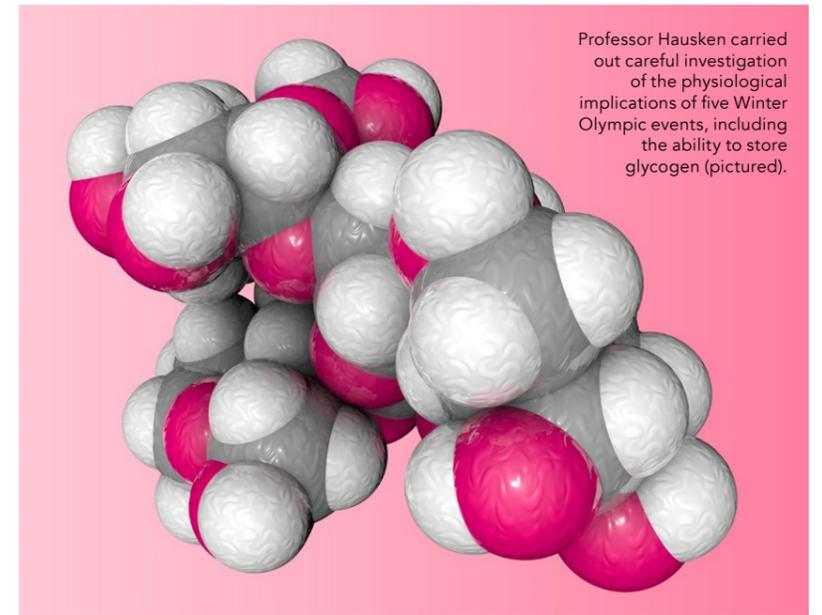
When compared to the range of events at the Summer Olympics,

the Winter Olympics offer athletes a narrower choice of category. This means that athletes with certain physiological characteristics – those that mean they are better suited to short sprint events, or endurance, for example – have greater opportunities to compete, and to win, in their chosen sport. For example, an athlete who is physiologically suited to short sprints is currently unlikely to find success in cross-country skiing, and an athlete suited for endurance is unlikely to find success in speed skating. With this in mind, re-assessing the range of events on offer could potentially allow more athletes to compete, as well as improving the experience for spectators.

## POWER AND SPEED IN SKIING AND SKATING

Recently, Professor Kjell Hausken of the University of Stavanger, Norway, examined the different physiological requirements of five Winter Olympic Sports. These events – cross-country skiing, biathlon, Nordic combined (cross country skiing and ski jumping), speed skating and short-track speed skating – all require an activity of mechanical propulsion, over either snow or ice, from start to finish. Through careful investigation of the physiological implications of the five events, Professor Hausken aimed to develop new recruitment criteria and event formats for these Winter Olympic sports, offering expanded, and fairer, opportunities for athletes.

First, Professor Hausken assessed the differences in track length, and the associated event times, for the five sports. Next, he calculated the ratios between the longest and shortest distances, and between the times needed to complete those distances. Professor Hausken then considered the implications of these ratios for the physiological demands made on the athlete: muscle mass and muscle type, and qualities such as the ability to store glycogen (a form of glucose used for energy storage) and anaerobic threshold (the point at which the body switches from aerobic to anaerobic, or “without oxygen,” metabolism). Professor Hausken also compared these qualities in athletes competing



Professor Hausken carried out careful investigation of the physiological implications of five Winter Olympic events, including the ability to store glycogen (pictured).

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		EXERCISE ZONES									
		AGE									
		20	25	30	35	40	45	50	55	65	70
BEATS PER MINUTE	100%	VO <sub>2</sub> Max (Maximum effort)									
	90%	180	176	171	167	162	158	153	149	140	135
	80%	Anaerobic (Hardcore training)									
	70%	Aerobic (Cardio / endurance training)									
	60%	Weight Control (Fitness training / fat burning)									
50%	Moderate Activity (Maintenance / warm up)										
	100%	200	195	190	185	180	175	170	165	155	150
	90%	160	156	152	148	144	140	136	132	124	126
	80%	140	137	133	130	126	123	119	116	109	105
	70%	120	117	114	111	108	105	102	99	93	90
	60%	100	98	95	93	90	88	85	83	78	75

Heart rate increases with increasing level of activity. Different Olympic events have different physiological demands on athletes.

## Re-assessing the range of events on offer could allow more athletes to compete and improve the experience for spectators.

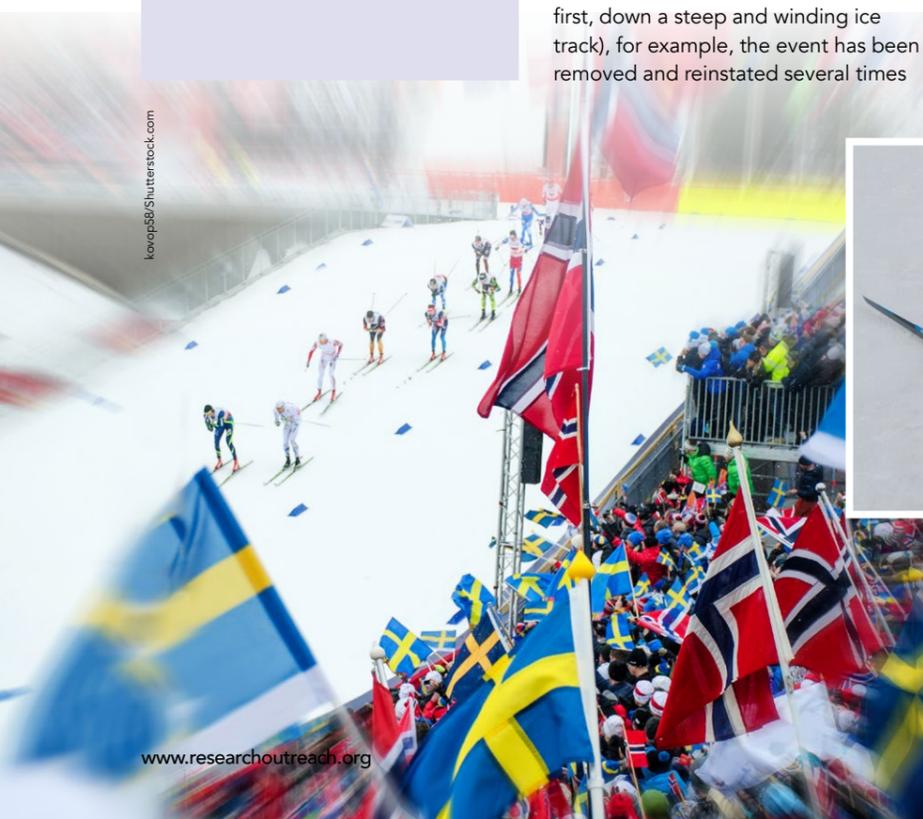
in the five Winter Olympic disciplines with three other sports: running, walking and swimming.

Professor Hausken found that the ratio between the longest and shortest distances in Olympic running is 422. In contrast, this ratio is much smaller, ranging between 2 and 41.5, for the five Winter Olympic disciplines. This means that there is currently a much

bigger difference between the longest and shortest events in running, allowing more athletes to compete at a wider variety of distances, when compared to Winter Olympic sports.

### EVOLVING SPORTS

The physiological differences between sprint and endurance athletes can be best illustrated by the founding sport of the Summer Olympics: running.



Professor Hausken explored the physiological demands of five Winter Olympic sports. He proposes a new format that will allow a fairer and more exciting event for both athletes and spectators.

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Speed skating currently offers the shortest distance of any Winter Olympic event, in the form of a 500m race. These relatively short distances tend to exclude athletes with long-distance or endurance physiological characteristics.

The athletes competing at the two extremes of running – the 100m sprint and the marathon – have both obvious and less visible physical differences. Sprint athletes tend to be heavier, with a greater muscle mass. Those muscles have a high proportion of “fast twitch” muscle fibres, which are needed for short bursts of power and speed. In contrast, long-distance athletes are often lighter, with lean muscles that are loaded with the “slow twitch” fibres suited to endurance events. Interestingly, in terms of the physiological diversity of the competing

suggests that cross-country skiing could be broadened to be as varied as running at the Summer Olympics. For example, sprint categories could be introduced, offering opportunities for competitors with a sprinter-type physiology. For women, cross-country skiing distances above the current limit of 30km could be launched to allow endurance athletes to prove their skill (for men, a 50km event exists).

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athletes, there is currently no Winter Olympic equivalent to 100 running, and no Winter Olympic equivalent to marathon aside from 50km cross country skiing for men.

Superficially, running and cross-country skiing are similar events: both involve moving from A to B in the shortest possible time. Currently, however, there are far fewer categories in cross-country skiing, excluding athletes who do not have the necessary physiology to be competitive. Professor Hausken

race. The longest speed skating event is 10km (for men; 5km for women). These relatively short distances tend to exclude athletes with long-distance or endurance physiological characteristics. To remedy this, Professor Hausken proposes the addition of longer races, potentially even up to 100km. While some might argue that a lengthy event of this type would not be interesting for TV viewers, other races that are longer in duration, such as the marathon, cycling (e.g. Tour de France), or racewalking are often televised in full.

### THE FUTURE OF THE WINTER OLYMPICS?

While both Winter and Summer Olympics can attract athletes who can compete in more than one event, Winter Olympians are more likely to be generalists, while those competing in the Summer games tend to be specialists. This is due to the sparser options of the Winter Olympics. While skiers might compete in both the shortest race of 1.5km and the longest of 50km, it is unheard-of – if not actually impossible – for a runner to enter both the 100m sprint and the marathon. However, a runner might realistically compete at two, possibly even three, similar distances: the 100m and 200m, or 800m and 1500m, for example.

By offering a wider choice of distances, Professor Hausken believes that the Winter Olympics can both attract more specialised athletes and allow a greater number of competitors the opportunity to compete at Olympic Games. In particular, athletes at the physiological extremes of either sprint or endurance abilities will benefit from the enhanced chances to compete.

Professor Hausken proposes 26 new events or categories that could potentially be included in future Winter Olympics – with equal distances for men and women. While female athletes tend to be slightly slower than their male counterparts in most sports, this difference is most pronounced in sprint events and those that require upper-body strength. In long-distance and endurance events, however, the time gap narrows (to just 5.3% over a 100km run, for example), meaning that there is little justification for preventing women from competing at these longer distances. Gender equity considerations also suggest equal distances for men and women.

Professor Hausken believes that the proposed new format for the Winter Olympics would support and enhance the existing recruitment criteria of the Games, which include maximising the popularity of the Games and ensuring their relevance to young people. Beyond that, the new format would ensure a fairer, more inclusive and more exciting event for the two groups of people at the heart of the Games: the athletes and the spectators.



# Behind the Research Professor Kjell Hausken

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## Research Objectives

Kjell Hausken’s research explores the physiology of skiing, skating and running.

## Detail

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### Bio

Kjell Hausken is Professor at the University of Stavanger where he does research on economics, risk analysis, and athletics. He has instructed step aerobics since 2009 and Les Mills BodyPump since 2010, and has his own youtube channel on step aerobics; <https://youtube.com/channel/UCogxMrs1pFUny6c8zW9u-2A>. He received his PhD from the University of Chicago, was a postdoc at the Max Planck Institute in Cologne, and has published 250 articles in peer reviewed journals.

### Collaborators

Dr Øyvind Sandbakk is thanked for useful discussions.



## References

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## Personal Response

### Which of your proposed changes would you like to see as a priority for the Winter Olympics?

Changes to the Winter Olympics format may most suitably start with extending the ranges for cross country skiing and speed skating downwards to 100 meters for both men and women, upwards to 50km for women’s cross country skiing, and upwards to 100km for speed skating for both men and women. Thereafter similar changes may be made for biathlon and Nordic combined.

