Suomen Suunnistusliitto

KIHU

RESULT REPORT

Training and physical characteristics of world-class orienteers

TRAINING AND PHYSICAL CHARACTERISTICS OF WORLD-CLASS ORIENTEERS
Result report

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Abstract

Limited research information is available on the training of elite orienteers and their physical characteristics. Thus, the aim of the present study was to describe the annual training characteristics among world-class orienteers at different age stages. In addition, the aim was to describe the orienteers' physical characteristics.

Data for the study was collected through a survey distributed to the world's best orienteers from various countries. The survey covered background information, training data from specific seasons, and personal best physical test results. The report presents results from 27 orienteers, comprising 10 women and 17 men, offering insights into their training and physical characteristics.

Key findings include similarities in training volumes between men and women, with a linear increase in training volume from junior to elite years. The annual training volumes were ~525 hours and ~560 hours for women and men, respectively. Endurance training intensity distribution followed a pyramidal model (82-86% low intensity, 10-13% moderate intensity, and 4-6% high intensity training). In addition to physical training, approximately two-thirds of the orienteers engaged in mental preparation at least weekly.

The results regarding physical characteristics of the orienteers highlight large individual variation. Maximal oxygen uptake (VO_{2max}) was 58 ± 6 (49-69) ml•kg•min-1 and 75 ± 8 (68-86) ml•kg•min-1 for women and men. The results showed a trend suggesting that the running performances of the top 3 orienteers were superior to those of the top 10 and top 50 orienteers.

While the report acknowledges the limitations of a relatively low response rate and the need for further research, it provides valuable insights into the training and physical characteristics of elite orienteers.

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1 Introduction

Orienteering is an endurance sport that demands various qualities from the physical, mental, skill and cognitive aspects. Successful performance in orienteering depends on high physical conditioning, where moments of anaerobically demanding tasks (jumps, climbs, sprints) occur during continuous aerobic demands. Furthermore, cognitive capacity and orienteering specific expertise are crucial factors for performance (Batista et al. 2020). Moreover, a characteristic feature of orienteering is that different forms of orienteering competitions, terrains and courses impose various demands on the orienteer. Elite orienteers have been shown to have high levels of aerobic capacity and running economy. In addition, anaerobic and muscle power abilities play important roles in orienteering performance at various stages of the course, rough direction, ascents, and sprints (Batista et al. 2020).

Only few studies have reported training characteristics of the world´s best orienteers. Tonnesen et al. (2015) reported data about the annual training from 8 world-champion orienteers. They found that the annual training periodization was very similar among the 8 elite orienteers during the most successful year of their athletic career. Their annual training volume was ~630 hours and endurance training consisted of 80% low intensity, 8% moderate and 12% high intensity endurance training. However, it is important to note that the training data was collected from a period of over 40 years (1979-2012). In general, there is only limited research information on the demands of orienteering and training of elite orienteers.

For the development of the sport, it is important to be aware of the demands of the discipline and understand how elite orienteers train, as well as how they trained when they were younger. Thus, the aim of the present study was to describe the annual training characteristics among world-class orienteers at different age stages of their careers. In addition, the aim was to describe the orienteers' physical characteristics.

2 Data collection

The starting point of the survey was to reach out to the world´s best orienteers from different countries and ask them to describe their training and provider their physical test results. The survey data was collected using the Webropol survey tool between October and November 2023. Informed consent was obtained from all athletes to include their personal training data and test results in analyses. Responses to the survey were provided anonymously. On October 19, 2023 the response link to the electronic questionnaire form was sent to the selected top athletes and head coaches of national teams, who then forwarded the link to the selected athletes. In total, the survey was sent to 41 women and 46 men orienteers from 18 different national teams. The head coaches received a single reminder about the survey on November 3, 2023. The survey was open until November 15th. The questionnaire was written in English.

The questionnaire consisted of 41 questions divided into 3 sections: 1) background information, 2) training data from the seasons 2022-2023, 2021-2022 and seasons when the athlete was 20 and 16 years old, 3) personal best physical test results during the seasons 2022-2023 and 2021-2022. The original questionnaire is available from the corresponding author upon request. Results from questions that received limited responses were not included in this report as it was not possible to analyze relevant group values.

3 Results

3.1 BACKGROUND INFORMATION

A total of 27 orienteers (10 women and 17 men) responded to the survey. Thus, the response rate was 31%. Based on the competition success, 19% of the orienteers had won medals in World Orienteering Championships (WOC) during 2021-2023 (Figure 1). In addition, 74% of the orienteers were in the top ten in those competitions. 41% of the orienteers were in the top 50 in forest ranking (autumn 2023) and 56% of the orienteers were in the top 50 in sprint ranking (autumn 2023). Table 4 describes the physical characteristics of the orienteers.

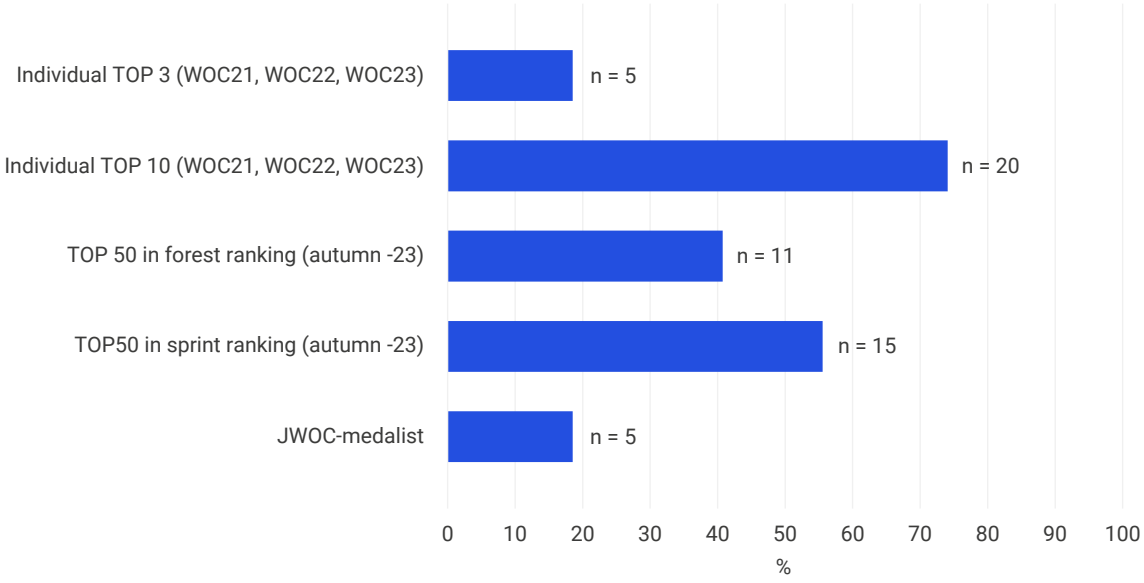

Figure 1. Percentages of the orienteers at different levels of competition success. n = number of athletes

3.2 TRAINING CHARACTERISTICS

The annual training characteristics during the seasons 2022-2023, 2021-2022 and the season when the athletes were 20 years old are presented in Table 1. Training volume was similar during the seasons 2022-2023 and 2021-2022 in women and men. The individual range in total training volume was ~320-780 hours. There was no significant difference in training volume between women and men during any of the analyzed seasons. Men tended to train slightly more than women during the seasons 2022-2023, 2021-2022 and at the age of 16, while at the age of 20, training volume was at the same level for both women and men. However, large individual variation was found in training volume (Figure 2). Training volume increased quite linearly from junior to elite years. Training volumes at the age of 16 years were 330 ± 157 hours and 371 ± 124 hours for women and men, respectively.

Endurance training was classified into three intensity zones; low intensity training (LIT; < 80% HR_{max}), moderate intensity training (MIT; 80-90% HR_{max}) and high intensity training (HIT; > 90% HR_{max}) as previously described by Seiler & Tonnesen (2009). Endurance training consisted of 82-86% LIT, 10-13% MIT and 4-6% HIT during the last two seasons for both the women and men orienteers.

Table 1. Annual training characteristics of the men and women orienteers during the seasons 2022-2023, 2021-2022 and at the age of 20-years (values are presented as mean ± standard deviation).

	Season 2022-2023		Season 2021-2022		At the age of 20 years	
	Men	Women	Men	Women	Men	Women
All physical training (h)	566 ± 83	521 ± 114	554 ± 94	528 ± 121	432 ± 124	432 ± 171
Training sessions	539 ± 99	500 ± 78	526 ± 90	506 ± 74	386 ± 114	393 ± 112
LIT (h)	424 ± 113	362 ± 66	425 ± 106	373 ± 93	327 ± 144	274 ± 76
% AT	84 ± 23	82 ± 15	85 ± 21	86 ± 21	81 ± 36	84 ± 23
MIT (h)	51 ± 31	57 ± 26	50 ± 34	45 ± 23	47 ± 22	37 ± 13
% AT	10 ± 6	13 ± 6	10 ± 7	10 ± 5	12 ± 5	11 ± 4
HIT (h)	30 ± 24	25 ± 20	28 ± 20	17 ± 14	29 ± 19	16 ± 12
% AT	6 ± 5	6 ± 5	6 ± 4	4 ± 3	7 ± 5	5 ± 4
Running (h)	377 ± 121	283 ± 113	393 ± 102	250 ± 106	277 ± 82	185 ± 130
% AT	75 ± 24	64 ± 25	78 ± 20	58 ± 24	55 ± 16	46 ± 33
O-specific running (h)	127 ± 77	106 ± 57	115 ± 89	80 ± 35	113 ± 44	65 ± 24
% AT	25 ± 15	24 ± 13	23 ± 18	18 ± 8	22 ± 9	16 ± 6
Strength training (h)	41 ± 25	53 ± 16	51 ± 30	55 ± 13	36 ± 17	40 ± 24
Other training (h)	216 ± 80	144 ± 48	165 ± 69	190 ± 60	161 ± 76	209 ± 68
Days injured	43 ± 50	10 ± 8	31 ± 35	38 ± 42	23 ± 19	30 ± 27
Days sick	10 ± 8	11 ± 4	11 ± 5	8 ± 7	10 ± 10	9 ± 9

% AT = percentage of total aerobic training hours, LIT = low intensity endurance training (< 80% HR_{max}), MIT = moderate intensity endurance training (80-90% HR_{max}), HIT = high intensity endurance training (> 90% HR_{max}), O-specific running = orienteering specific running/running-based orienteering practice (including both sprint and forest training).

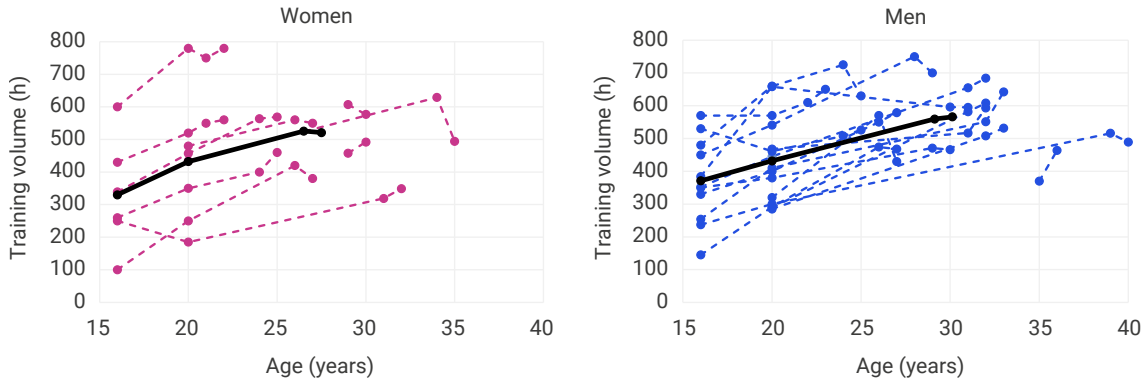

Figure 2. Individual (dashed line) and mean (black line) annual training volume in the women and men orienteers from the age of 16-years to the season 2022-2023.

The training characteristics of the TOP 10 (WOC 21-23) and TOP 50 (Ranking -23) orienteers are presented in Table 2. Training volume is lower in the TOP 10 orienteers compared to TOP 50 orienteers. On the other hand, volume of the orienteering specific training and HIT is higher in the TOP 10 orienteers compared to the TOP 50 orienteers. Furthermore, the TOP 10 orienteers have fewer days when they are injured than the TOP 50 orienteers.

Table 3 presents the training characteristics of the orienteers aiming for sprint and forest orienteering. The total training volume and volume of the orienteering specific training are higher in the forest orienteers compared with the sprint orienteers. In addition, the volume of LIT is higher in the forest orienteers.

Table 2. Annual training characteristics of TOP 10 (WOC 21-23) and TOP 50 (ranking) orienteers during the seasons 2022-2023, 2021-2022 and at the age of 20-years (values are presented as mean ± standard deviation).

	Season 2022-2023		Season 2021-2022		At the age of 20-years	
	Top 10	Top 50	Top 10	Top 50	Top 10	Top 50
All physical training (h)	528 ± 85	606 ± 108	514 ± 81	625 ± 123	384 ± 116	542 ± 134
Training sessions	521 ± 96	545 ± 70	507 ± 79	606 ± 81	370 ± 114	483 ± 44
LIT (h)	387 ± 98	469 ± 93	374 ± 74	505 ± 116	274 ± 111	411 ± 68
% AT	81 ± 21	88 ± 17,5	83 ± 16	90 ± 21	79 ± 32	87 ± 14
MIT (h)	55 ± 33	50 ± 12	48 ± 36	50 ± 11	43 ± 23	44 ± 9
% AT	12 ± 7	9 ± 2	11 ± 8	9 ± 2	12 ± 7	9 ± 2
HIT (h)	34 ± 23	13 ± 10	31 ± 19	9 ± 7	29 ± 18	15 ± 13
% AT	7 ± 5	2 ± 2	7 ± 4	2 ± 1	8 ± 5	3 ± 3
Running (h)	335 ± 132	368 ± 106	335 ± 115	367 ± 143	220 ± 94	326 ± 97
% AT	70 ± 28	69 ± 20	74 ± 20	65 ± 25	64 ± 27	69 ± 21
O-specific running (h)	122 ± 83	91 ± 21	107 ± 82	90 ± 60	102 ± 50	98 ± 23
% AT	26 ± 17	17 ± 4	24 ± 15	16 ± 11	29 ± 15	21 ± 5
Strength training (h)	43 ± 23	50 ± 23	49 ± 23	60 ± 31	34 ± 20	47 ± 12
Other training (h)	163 ± 68	293 ± 67	119 ± 43	341 ± 79	147 ± 81	243 ± 52
Days injured	41 ± 41	71 ± 66	30 ± 36	46 ± 41	24 ± 19	29 ± 28
Days sick	8 ± 6	13 ± 5	10 ± 6	10 ± 7	9 ± 9	14 ± 11

% AT = percentage of total aerobic training hours, LIT = low intensity endurance training (< 80% HR_{max}), MIT = moderate intensity endurance training (80-90% HR_{max}), HIT = high intensity endurance training (> 90% HR_{max}), O-specific running = orienteering specific running/running-based orienteering practice (including both sprint and forest training).

Table 3. Annual training characteristics of the orienteers aiming for sprint and forest orienteering during the seasons 2022-2023 and 2021-2022 (values are presented as mean ± standard deviation).

	Season 2022-2023		Season 2021-2022	
	Forest (n = 12)	Sprint (n = 6)	Forest (n = 6)	Sprint (n = 14)
All physical training (h)	591 ± 92	495 ± 93	598 ± 106	514 ± 93
Training sessions	592 ± 78	463 ± 95	635 ± 66	501 ± 74
LIT (h)	489 ± 69	369 ± 74	563 ± 108	365 ± 75
% AT	85 ± 12	82 ± 16	88 ± 17	83 ± 17
MIT (h)	50 ± 35	57 ± 27	62 ± 23	43 ± 33
% AT	9 ± 6	13 ± 6	10 ± 4	10 ± 7
HIT (h)	37 ± 28	24 ± 15	13 ± 16	30 ± 19
% AT	6 ± 5	5 ± 3	2 ± 4	7 ± 4
Running (h)	389 ± 125	363 ± 126	418 ± 202	326 ± 96
% AT	68 ± 22	81 ± 28	66 ± 32	74 ± 22
O-specific running (h)	133 ± 85	63 ± 23	211 ± 144	76 ± 34
% AT	23 ± 15	14 ± 5	33 ± 23	17 ± 8
Strength training (h)	48 ± 25	44 ± 22	49 ± 13	52 ± 32
Other training (h)	176 ± 66	87 ± 25	271 ± 90	105 ± 32
Days injured	35 ± 49	13 ± 6	15 ± 19	33 ± 32
Days sick	7 ± 5	8 ± 6	12 ± 8	9 ± 4

% AT = percentage of total aerobic training hours, LIT = low intensity endurance training (< 80% HR_{max}), MIT = moderate intensity endurance training (80-90% HR_{max}), HIT = high intensity endurance training (> 90% HR_{max}), O-specific running = orienteering specific running/running-based orienteering practice (including both sprint and forest training).

In addition to physical training, 8-9% of the orienteers had non-physical, mental preparation routines (including working with maps) on a daily basis (Figure 3). Approximately two-thirds of the orienteers engaged in mental preparation at least once per week during the seasons 2022-2023 and 2021-2022, whereas at the age of 20, the proportion was lower (approximately one-third).

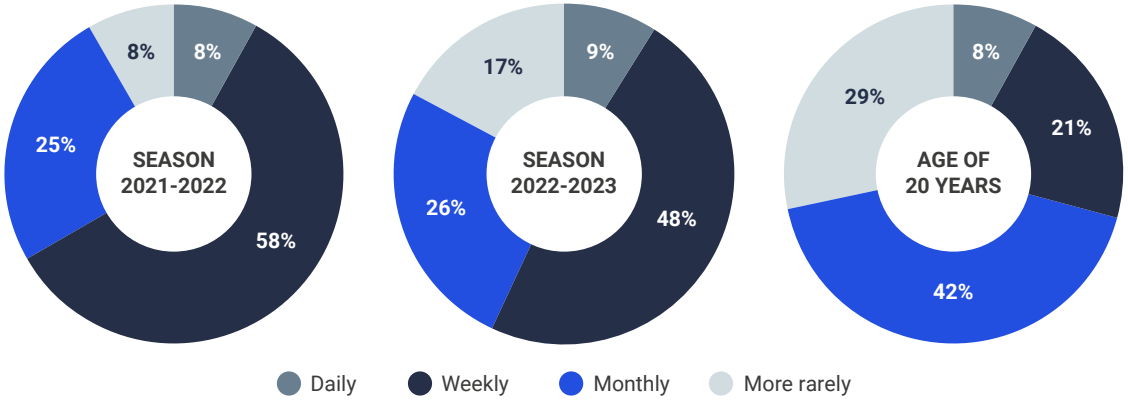

Figure 3. Prevalence of (non-physical) mental preparation routines (including working with maps) among the orienteers during the analyzed seasons.

3.3 PHYSICAL CHARACTERISTICS

The physical characteristics of the orienteers are presented in Table 4. Due to the limited number of respondents, only maximal oxygen uptake and blood lactate concentrations (women: 10,7 ± 2,8 mmol/l, men: 13,5 ± 4,8 mmol/l) are reported from laboratory tests.

Table 4. Characteristics of the orienteers (values are presented as mean ± standard deviation (min-max values).

	Women	Men
Age	28 ± 4 (22-35) (n = 10)	30 ± 4 (23-40) (n = 17)
Height (m)	1.69 ± 0.06 (1.58-1.83) (n = 10)	1.83 ± 0.06 (1.75-1.95) (n = 15)
Weight (kg)	57 ± 5 (45-63) (n = 10)	70 ± 5 (63-79) (n = 15)
VO2max (ml/kg/min)	58 ± 6 (49-69) (n = 5)	75 ± 8 (68-86) (n = 5)
Best 5000 m running time (mm:ss)	17:34 ± 00:47 (16:42-18:41) (n = 5)	14:33 ± 0:27 (13:49-15:23) (n = 12)
Best 3000 m running time (mm:ss)	10:29 ± 00:22 (09:56-11:00) (n = 6)	08:26 ± 00:15 (08:01-08:46) (n = 10)

n = number of athletes; VO_{2max} = maximal oxygen uptake

The 3000 m and 5000 m running records describe maximal aerobic endurance performance of the orienteers (Figure 4 and Table 5). Large individual variation was found in the running performances. The results showed a trend that the running performances of the TOP 3 orienteers are better than the TOP 10 and TOP 50 orienteers. Significant correlations were not found between the running performances and training characteristics.

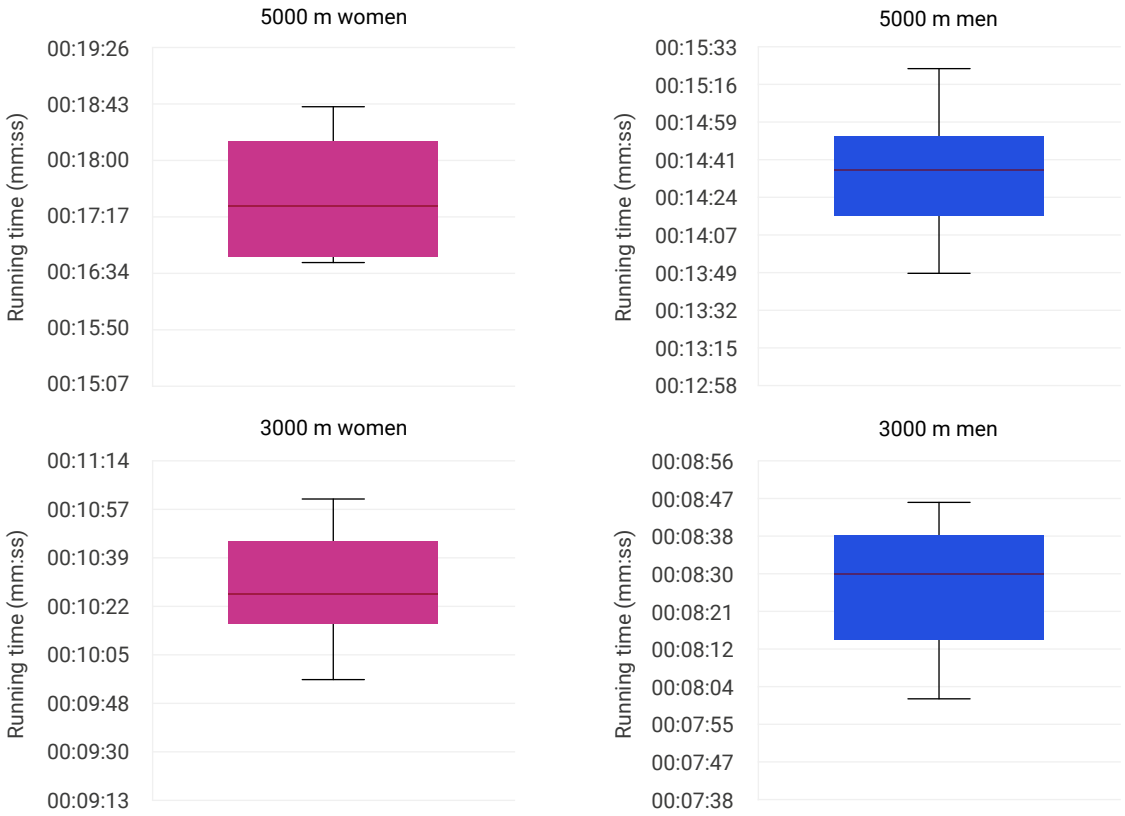

Figure 4. Running performance (on track) of 3000 m and 5000 m in the women and men orienteers. The box plots represent the median values (solid line), 50th percentile values (box outline) and minimal/maximal values (whiskers).

Table 5. Running performance (on track) of 3000 m and 5000 m in the TOP 3, TOP 10 and TOP 50 women and men orienteers.

	Women		Men	
	5000 m running (mm:ss)	3000 m running (mm:ss)	5000 m running (mm:ss)	3000 m running (mm:ss)
TOP 3 (WOC 21-23)	16:45 ± 00:04 (n = 2)	09:56 (n = 1)	14:21 ± 00:19 (n = 3)	08:01 (n = 1)
TOP 10 (WOC 21-23)	17:17 ± 00:43 (n = 2)	10:24 ± 00:24 (n = 4)	14:36 ± 00:29 (n = 7)	08:24 ± 00:17 (n = 6)
TOP 50 (ranking)	18:41 (n = 1)	10:51 (n = 1)	14:21 ± 00:19 (n = 2)	08:31 ± 00:16 (n = 3)

n = number of athletes;

4 Summary and conclusions

The orienteers who responded to the survey represent the most successful orienteers in the world at the moment. Most of them (74%) have placed in the top 10 in World Championships during the recent years. Thus, the survey provided valuable information about the training and physical characteristics of world-class orienteers.

However, when interpreting the results, it should be noted the relatively low number of responses. All results may not necessarily comprehensively represent the characteristics of elite orienteers, especially when the results have been examined by sub-groups (e.g. top 10 vs. top 50 or sprint vs. forest orienteers). When the subgroups are small, the result of an individual orienteer carries significant weight and may not necessarily represent a broader group. Furthermore, only limited information was obtained about training during the junior age categories, especially at the age of 16 years. This is understandable, because some orienteers were not training systematically and were not collecting training data at that time. However, self-reported training characteristics, especially training duration and intensity distribution, have shown to be highly reliable among elite endurance athletes (Sylta et al. 2014). In the results, some inconsistent responses of the single orienteers were observed, but at the group level the results can be considered reliable in the present study.

The mean level training volume of the women (~525 h) and men (~560 h) orienteers were quite similar to what has been reported (500-700 h) in endurance runners in previous studies (Sandbakk et al. 2021). There is only limited research information about the training of elite orienteers. Tonnesen et al. (2015) reported slightly higher training volumes (women 613 h, men 636 h) among eight World Champions compared to the present study, while the number of training sessions were at a similar level (~500). In the present study, training volume of the forest orienteers was similar (~600 h) to that reported by Tonnesen et al. (2015). It is important to note the wide range of total training volumes reported by the orienteers in the present study. The highest reported annual training volumes exceed 700 hours, whereas the lowest volumes were around 300 hours, influenced in part by injuries and illnesses.

On average, the training volume increased linearly from the age of 16 to the elite years. An interesting observation was that the TOP 10 orienteers trained significantly less (~380 hours) at the age of 20 years compared to the TOP 50 orienteers (~540 hours) and they had more high-intensity training and relatively more orienteering specific training.

Training hours based training intensity distribution (82-86% LIT, 10-13% MIT and 4-6% HIT) of the orienteers was typical for endurance athletes (e.g. Tjelta 2016). Many of the previous studies present a “pyramidal” training intensity distribution with a high proportion of high volume, low-intensity training (Stöggl et al. 2015). In the present study, 15-20% of training was at moderate and high intensity training. It is noteworthy that there is a trend indicating that the most successful orienteers had more high-intensity training.

In addition, the most successful orienteers had more orienteering specific training, whereas the TOP 50 orienteers had more other type of training. This could be related to the finding that among the TOP 50 orienteers, there were more days when they were injured compared to the TOP 10 orienteers and they had to modify their training.

Maximal oxygen uptake is considered to be one of the most important factor in determining aerobic endurance performance. Thus, it is reasonable that the results of the present study indicate relatively high maximal oxygen uptake values. The results correspond well to the maximal oxygen uptake values reported by Batista et al. (2020). A more comprehensive depiction of orienteers' aerobic characteristics is provided by the 3000 m and 5000 m running performances, as there were significantly more respondents. The results showed a trend where the running performances of the TOP 3 orienteers were better than the TOP 10 and TOP 50 orienteers emphasizing the importance of running performance in orienteering. Based on the results of this study, the differences in running performance are clearly more pronounced among women.

The current study provided additional research data on the training and physical characteristics of elite orienteers, despite a low response rate. Still, there is limited research information on the physical demands of orienteering, the training of elite orienteers, and their physical characteristics, so further research is needed.

Acknowledgements

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