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On-ice and off-ice fitness profiles of elite and U20 male ice hockey players of two different national standards

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Abstract

Differences in body composition and performance were investigated between elite and U20 male ice hockey players of two different national standards. 179 players were recruited from the highest Finnish (n=82) and Danish (n=61) national level. In addition, one U20 team from Finland (n=19) and Denmark (n=17) participated. Body composition and countermovement jump performance (CMJ) were measured off-ice in addition to on-ice assessments of agility, 10 and 30-m sprint performance and endurance capacity (the maximal Yo-Yo Intermittent Recovery Level 1 Ice Hockey Test, Yo-Yo IR1-IH_{max}). Large differences in on-ice performances were demonstrated between Finnish and Danish elite players for agility, 10 and 30-m sprint performance (2-3%, $P \leq 0.05$) and Yo-Yo-IR1-IH_{max} performance (15%, $P \leq 0.05$). In contrast, no differences ($P > 0.05$) were present between elite players for CMJ ability or body composition. However, elite players possessed more body and muscle mass than U20 players. Finally, the Finnish U20 cohort had a similar performance level as the Danish elite players and superior 10-m sprint performance, whereas the Danish U20 level was inferior to the other groups in every performance assessment ($P \leq 0.05$). In conclusion, on-ice speed and endurance differ markedly between elite players of two national standards with no difference in body composition or CMJ ability. Moreover, the most consistent difference between U20 and senior elite players was related to body and muscle mass. These results highlight the usefulness of on-ice assessments and suggests the importance of on-ice high-intensity training in elite players in addition to training targeted the development of lean body mass in youth prospects.

Keywords: Level of competition, intermittent exercise performance, team sport, sprinting, agility.

INTRODUCTION

Elite ice hockey is a unique team sport due to the intense intermittent activity pattern, including repeated bouts of fast-paced skating in intervals often ranging from 30 to 60 s, interspersed by longer duration of passive recovery (~2-5 min) (7, 19, 21). Effective playing time normally ranges from 15 to 25 min with some individual players exposed to significantly more or less time on the ice (7, 19, 21). The skating pattern in ice hockey has been demonstrated to be highly demanding for both aerobic and anaerobic energy pathways (7, 21). For example, we recently demonstrated that peak muscle lactate and phosphocreatine values during an elite game were higher and lower, respectively, than observed during a soccer game (36), indicative of a large anaerobic contribution to the energy turnover. This metabolic response resulted in a markedly high glycogen degradation with almost 65% of individual fast and slow-twitch fibers being nearly emptied of glycogen following the game (36). In concert, average on-ice heart rate was ~85% of maximum values with peak values approaching maximal levels, demonstrating an additionally elevated cardiorespiratory loading. Thus, ice hockey players require a broad range of physical qualities in order to compete at the elite competitive level, including aerobic and anaerobic capabilities as well as strength and size for physical encounters.

Recently, we demonstrated large differences in body composition and on-ice measurements of endurance and high intensity performance between elite and sub-elite male ice hockey players, in a large sample-size study, suggesting that several fitness components are important at the elite level (35). These results are largely in accordance with previous findings in smaller sample-size studies comparing players of different competitive standards (3, 25, 30, 31). However, discrepancy exists with regards to aerobic capacity since some studies fail to report any differences between level of play, when assessed in a laboratory setting, contrasting our previous findings using on-ice assessments (13, 25, 32, 35). Thus, it has been demonstrated that maximal oxygen uptake and lactate threshold values vary markedly between cycling and skating based assessments, possibly due to different biomechanical requirements (8). In addition, no differences in VO_{2max} values have been demonstrated in soccer players across competitive levels, in contrast to large differences in specific intermittent running test performances (17, 33). Therefore, specific on-ice tests may be more valid and sensitive tests to detect differences in on-ice performance. However, no study has yet elucidated whether disparities in fitness components are present, even at the elite level when comparing two different national standards by the application of specific on-ice test procedures. Exploring this phenomenon is valuable for identifying important key performance indicators, for tailoring specific fitness regimens and for obtaining knowledge informing talent selection criteria. Thus, it may be hypothesized that, in two top-level national standards, all players will be characterized by a very high fitness level and potential differences therefore will be marginal. On the other hand, certain critical fitness components may still be important factors distinguishing between players of different national standards including diverse cultural sport settings, training approaches and international world ranking.

The principal objective of the present investigation was therefore to compare fitness profiles and body composition in elite players of two national standards in a large sample of players, applying specific on-ice and off-ice test procedures. A secondary aim was to compare the fitness level of players of these elite standards with U20 players from both countries to test for potential age-related differences. Finally, differences between specific positional roles were examined. Based on previous findings in elite and sub-elite players we hypothesized that elite players would substantially outperform U20 players in both endurance and high-intensity performance assessments, while variability between national elite standards would be small, but in favor of the top-ranked national level.

METHODS

Experimental Approach to the Problem

The study is based on data collected from teams from the highest Finnish and Danish ice hockey divisions as well as at U20 level in both countries during the pre-season period. The Danish and Finnish highest national standards differ in international ranking as the Finnish teams currently are awarded five spots – the maximum number – in the highest international competition, The Champions Hockey League, whereas the Danish teams are awarded only one spot, based on previous international success. Moreover, Finland is currently ranked 3rd in the International Ice Hockey Federation world ranking for national teams, whereas Denmark is ranked 12th, which may be an indirect reflection of the level of play in the respective national leagues. The teams included were tested in a randomized order after allowing for a minimum of 1 week of familiarization with skating movements following the summer break. We evaluated body composition and performance differences between elite and U20 players from both countries representing various positions applying a simple field-test battery consisting of off-ice and on-ice tests. The players refrained from practice games or heavy exercise for 24 hours prior to testing. Moreover, all players were instructed to follow their habitual diet leading up to training and games, and to avoid alcohol and tobacco for 12 hours prior to testing. All testing procedures were performed in the morning around 10-12 a.m. Exclusion criteria were injuries leading to absence from training for more than 3 days in the 3 weeks preceding the testing sessions.

Subjects

In total, 179 competitive male ice hockey players were recruited. 143 players (17-38 years) from three Finnish (n=82) and three Danish elite teams (n=61) competing in their respective top national leagues participated in the study comprising: 79 forwards, 50 defensemen and 14 goaltenders (goaltenders were only included in the positional analyses). Additionally, the remaining 36 players were U20 players (16-20 years) recruited from one Finnish U20 team (n=19) and one Danish U20 team (n=17). These comprised: 25 forwards and 11 defensemen, whereas no goaltenders from this level of play were included since no analyses of positional differences at the U20 level were performed. All players were informed of the potential risks and benefits of their participation in the data collection. The study was conducted in accordance with the Declaration of Helsinki and approved by the local ethics committee in each country, and all players (or parents if players were below 18 years of age) gave their written informed consent to participate.

Procedures

Test procedures were completed for each team within a single test-session consisting of off-ice tests followed immediately by on-ice tests in a standardized order.

Off-ice testing.

Off-ice tests comprised body composition measured on a bio-impedance scanner (InBody 270, InBody, USA, California), height measurements (Tanita Leicester Height Measurer, Invicta Plastics Limited, Leicester, United Kingdom) and countermovement jump (CMJ) performance (Swift Performance jump mat, Swift Performance Equipment, Australia). A 5-min standardized warm-up consisting of body weight exercises (airsquats and lunges) was performed followed by 4-5 familiarization jumps before testing. Three maximal attempts were allowed interspersed by a 1-min recovery period, as previously described (28). Countermovement jumps were performed with arms fixed at the hip and without bending the knees during the flight or landing phase before contact with the mat, strictly supervised by the test leaders. The reliability of the countermovement jump tests has previously been assessed demonstrating a high reliability with an intraclass correlation coefficient of 0.98 (20). For InBody measurements strong correlation coefficients have previously been demonstrated for body fat percentage (>0.95) and muscle mass (>0.78) between these devices and Dual-Energy X-ray absorptiometry scans which is considered the golden standard test (15).

On-ice testing.

On-ice tests were performed in full hockey gear with stick in hand. These included the 5-10-5 Pro Agility test, a 10 and 30 m linear sprint test and the maximal Yo-Yo Intermittent Recovery Ice Hockey Test (Yo-Yo IR1-IH_{MAX}). A standardized warm-up was performed on-ice prior to testing including ~10 min of sub-maximal skating at increasing intensity followed by specific warm-up prior to each test as described below.

Agility performance was measured using the on-ice 5-10-5 Pro Agility test as previously described (14, 35). Three cones were positioned separated by 5 m and the players positioned at the middle cone facing forward next to a starting gate (Witty Gate Wireless Training Timer Photocells, Microgate with a precision of 0.001 s). A dual beam setup was used to prevent interference from swinging limbs or the stick accidently activating the timers prematurely. The test was initiated by the players accelerating either left or right (in the order right, left and optional during the three attempts recorded), making a cutting turn at the next line before accelerating back through the start gate to the opposite line and back to the starting line again. The players had to turn on the right leg when going right and the left leg when going left to ensure that both legs were utilized as outer legs during the maneuvers. The players were familiarized and warmed up by 2-3 self-paced attempts before the maximal test. The players had 2 min of recovery between each attempt which was supervised by experienced test personnel. Attempts were discarded if the players turned early or did not turn on the proper leg. The fastest agility time was obtained and included in the analysis. The reliability of the test has previously been demonstrated to be high with an intraclass correlation coefficient of 0.82 (23)

Linear sprint ability was measured using 10- and 30-m split times, with the players starting from a standing position 1 m behind the first timing gates. The same timing system was used as during the agility test, ensuring a high level of precision. 2-3 self-paced warm-up and familiarization attempts were performed before the two maximal attempts separated by 2 min of recovery. The fastest time for 30 m was recorded and used in the analysis together with the 10-m split time from that same attempt. An intraclass correlation coefficient of 0.92 has previously been reported for this test demonstrating a high reliability (12).

Subsequently, the players performed the Yo-Yo IR1-IH_{MAX} as previously described (35). Thus, players skated intermittently back and forth between two lines separated by 20 m at increasing speeds until exhaustion. The players were allowed one warning the first time they failed to keep up with the pace of the test before being withdrawn after the second warning. The total distance covered after the withdrawal from the test was recorded as the final score. The players were given strong verbal encouragement to provide a maximal effort. Ice-lanes were changed mid-way through the test after level 17.1 in order to maintain optimal ice conditions. The reliability of the Yo-Yo IR1-IH_{max} has previously been reported for other team sports with a coefficient of variance of 4.9% (16).

Statistical analyses

Data are presented as mean ± SD. Data normality was checked using a Shapiro-Wilk test. Differences between level of play and positional roles were assessed using a one-way analysis of variance (one-way ANOVA). Goaltenders were excluded of the overall analyses of differences between level of play and only included in the positional analyses at the elite level. When a significant interaction was found, multiple comparison procedures were applied using the Holm-Sidak method to detect where a significant difference existed. For comparisons between positional roles, only elite players were included due to the lower number of players in the U20 sample. Effect size measures were calculated for differences between groups. Correlations were calculated between anthropometric variables and performance measures as well as between test performances using a Pearson Product Moment Correlation only within the Danish and Finnish total pool of elite players. Correlation coefficients were interpreted in accordance with guidelines by Cohen (6) as small (r = 0.10-0.29), medium/moderate (r = 0.30-0.49) or large ($r \geq 0.5$), while effect sizes were also interpreted as small (d = 0.20-0.49), medium (d = 0.50-0.79) or large ($d \geq 0.80$). Significance was accepted at $p \leq 0.05$. All statistical analyses were performed using the statistical software SigmaPlot (SigmaPlot for Windows version 14.0, Systat Software Inc., London, United Kingdom).

RESULTS

Body composition

Differences in body composition are shown in Table 1 and Figure 1. There were no differences in height between any groups, while the elite players of both Finland and Denmark were 7-13% heavier than their U20 counterparts ($P \leq 0.05$, ES=0.7-1.3). There were no differences in body fat content, while muscle mass was 13-16% higher in the elite players of Denmark and Finland compared to Danish U20 players ($P \leq 0.05$, ES=1.2 and 1.5). In addition, Finnish elite players possessed 9% more muscle mass than Finnish U20 players ($P \leq 0.05$, ES=0.9)

**** Table 1 around here ****

**** Figure 1 around here ****

Off-ice and on-ice performance

Differences in off-ice and on-ice performance are shown in Table 1 and Figure 2. No difference was apparent in CMJ height between Finnish and Danish elite players, while there was also no difference between these elite groups and Finnish U20 players. Instead, all three groups jumped higher (7-14%) than Danish U20 players (P≤0.05, ES=0.8-1.5). In the on-ice 5-10-5 Pro Agility Test, Finnish elite players performed 2% better than the Danish elite players (P≤0.05, ES=1.1), while all groups performed 4-7% better than the Danish U20 players (P≤0.05, ES=1.5-2.8). In the 10-m linear sprint test, Finnish elite and U20 players performed 2-3% better than Danish elite players (P≤0.05, ES=0.5-0.8). Unfortunately, results for this particular test were not obtained for Danish U20 players for comparison. In the 30-m sprint test, all groups performed 6-7% better than Danish U20 players (P≤0.05, ES=1.3-2.9), while Finnish elite players performed 3% better than Danish elite players (P≤0.05, ES=1.1) In addition, the Yo-Yo-IR1-IH_{max} distance covered was 40-55% greater in all groups compared with Danish U20 players (P≤0.05, ES=1.7-2.6). Finally, Finnish elite covered 15 and 11% more distance (P≤0.05, ES=0.8-1.0) than Danish elite and Finnish U20 players, respectively, while no difference was apparent between the latter two groups.

**** Figure 2 around here ****

Positional differences

Positional differences were assessed within the elite level in Finland and Denmark independently (see Table 2 and Figure 2). There were no significant differences between forwards and defensemen in either country, nor between goaltenders, defensemen and forwards for the off-ice and body compositional tests, in which these were compared.

**** Table 2 around here ****

Relationships between body composition and performance

There were small correlations between height, body mass and 10-m sprint performance (r=0.21 and 0.29, P≤0.05). In addition, height correlated weakly with 30-m sprint performance (r=0.20,

$P \leq 0.05$), while body fat percentage displayed a weak association with agility performance ($r=0.20$, $P \leq 0.05$). Moreover, CMJ performance was weakly correlated with weight and body fat percentage ($r=-0.18$ and -0.21, $P \leq 0.05$), and moderately correlated with agility, 10 and 30-m sprint performance ($r=-0.40$, -0.41 and -0.47, $P \leq 0.05$, respectively). Finally, agility performance was moderately correlated with Yo-Yo IR1-IH_{max} distance covered ($r=-0.40$, $P \leq 0.05$).

DISCUSSION

The main findings of the present study were that elite players across two different national standards differed markedly in on-ice test performance, including aerobic and speed-related high intensity exercise assessments. In contrast, no significant differences were demonstrated in off-ice countermovement jump performance or body composition. In addition, elite players were overall heavier and had higher muscle mass than the U20 cohorts within the same national standard, while no differences were observed in body fat percentage. Performance metrics revealed that both elite national standards and the U20 Finland standard were superior to the sample of Danish U20 players in all off- and on-ice tests, whereas U20 Finland players performed at a comparable level as the Danish elite standard and even better in some aspects of sprint performance.

Our findings demonstrate that, even at the elite level, when comparing two national standards from nations differing in international world ranking, variations in fitness components are present and may be important distinguishing factors between players. Thus, large differences appeared in both aerobic and speed-related high-intensity on-ice performance, suggesting that these characteristics are important to compete at the highest level of play. This is in accordance with previous observations suggesting that high-intensity exercise components distinguish between different competitive standards (5, 25, 30, 31). For example, Peterson et al. (25) demonstrated that elite ice hockey players had superior vertical jump height, Wingate peak power and on-ice sprint ability than sub-elite players. In contrast, no difference was observed in laboratory-assessed aerobic capacity, which is supported by other previous studies in opposition to our findings (5, 13, 25, 32). However, in support of the present results, we recently demonstrated that on-ice endurance capacity differed between elite and sub-elite Danish players, but the gap in fitness abilities between these samples was remarkably high for every component measured (35). Thus, as endurance capacity measured by the application of a specific on-ice test in the present study differed markedly, this suggests that aerobic fitness components are indeed important, even in elite players. The discrepancy in the literature may relate to the differences between specific on-ice testing and laboratory-based assessments with regards to oxygen uptake kinetics during intermittent skating, specific biomechanical requirements, muscle fiber recruitment patterns and movement efficiency (18, 24, 27). The suggested importance of a high aerobic capacity may be related to a faster recovery during and between shifts by a rapid resynthesis of phosphocreatine, a muscle glycogen sparing effect induced by a lower anaerobic contribution to the energy yield and an increased fat oxidation during the game (1, 2, 9-11).

The importance of ice hockey-specific test procedures is supported by the finding of no difference in off-ice performance with regards to CMJ ability in the present study, despite on-ice sprint and agility performance substantially differing. This also suggests the need of specific on-ice training in order to develop speed and agility in ice hockey given the highly specific requirements when accelerating and changing direction on the ice. Therefore, in addition to off-ice development of the fundamentals of strength and power, on-ice drills may be vital for optimal transference to ice hockey performance. However, as only one off-ice test was performed it is possible that the results of other off-ice tests would yield different results and future studies should assess this. Explanations for the observed variability in on-ice and off-ice high intensity performance could potentially relate to strength in the specific muscle groups required for skating movements, skating technique, anthropometric characteristics needed to optimize performance on the ice or several other factors. For example, Buckeridge et al. (4) demonstrated that high-performing skaters exhibited greater hip adduction angles at initial contact with the ice enabling them to produce force during hip abduction over a longer range of motion and also exhibiting greater hip extension at toe-off. Likewise, Robbins et al. (29) demonstrated differences in skating mechanics, including greater ankle inversion during push-off and recovery, greater knee extension and external rotation at push-off, and greater hip flexion during the stride in high-performing skaters, even when controlling for differences in speed. However, one caveat for the use of on-ice testing procedures may be that it can be complicated to distinguish between purely physical or technical limitations when performing a needs analysis of a player.

In addition to analyses of differences in average values across national standards, further analyses were made of the heterogeneity in performance within each sample. Thus, for example, whether a larger deviation between the top and poor performers at the Danish elite level was evident or whether disparity primarily existed in peak performances between the most fit players in each sample. By analyzing the differences in performance by evaluation of the individual plots (see Fig. 2), it is apparent that not only the poor performers are slower in the agility and sprint tests, but this is also the case for the peak-performing players in the Danish compared to the Finnish sample. Thus, collectively, in the majority of the fitness characteristics, peak, average and bottom performances all seem to vary in line with the national competitive standard.

The comparison of the U20 sample of Danish and Finnish players revealed large differences in physical abilities as the Finnish U20 players outperformed the Danish U20 players in all fitness tests both off- and on-ice. By way of exception, body composition was similar. Interestingly, body fat percentage did not vary across any of the elite or U20 playing standards, suggesting that body fat percentage is a trivial performance indicator in elite and sub-elite male ice hockey players. This is contrary to previous observations in one study showing deviation in body fat percentage among elite and sub-elite players (25). Conversely, the results are in accordance with ours (35) and other's (13) earlier findings of no overall difference in body fat percentage between elite and sub-elite players, though we did observe that high-intensity peak performance was achieved by players in the lower range for body fat percentage (35). Likewise, the present study showed merely weak associations between body fat percentage and agility performance and no inter-individual relationship between body fat and sprint ability. The Finnish U20 players were even at a comparable performance level with the Danish elite players and displayed superior 10-m sprinting performance, but exhibited a smaller body mass. In addition, only Yo-Yo IR1-IH_{max} performance differed between U20 Finnish and elite players, in addition to a larger body- and muscle mass in the elite sample. Thus, these observations suggest that the most consistent variations among youth and senior elite players are associated with body- and muscle mass. Moreover, these results highlight the differences in caliber of play across these countries, with Finland having a greater tradition for playing ice hockey, a larger sample of ice hockey players and a higher international world ranking than Denmark which is reflected in fitness level. This also implies that while the majority of Finnish U20 players possess a well-developed fitness profile comparable to the average elite scores, this is the case for only ~50% or less of the Danish youth sample, with an obvious impact on the options for player selection and performance development strategies.

Finally, no positional differences in body composition or performance were present within the elite samples. This is in line with our previous findings in a large sample of elite Danish players (35) and with measurements of endurance capacity obtained in defensemen and forwards at the NHL Combine from 2001 to 2003 (34), but in contrast to the findings from the same event from 1998 to 2006, where defensemen had a higher peak power and absolute maximal aerobic level than forwards (5). In addition, others have reported differences in body mass, with defensemen being heavier than forwards (5, 26, 34). However, these numbers were obtained for more than 20 years ago and it is plausible that the game demands and body composition of positional roles have evolved or alternately, that our samples simply differ from the NHL population. Thus, despite recent evidence pointing to differences in the game requirements of forwards and defensemen, with a greater amount of high-intensity skating per minute performed in shorter on-ice bouts for forwards compared to defensemen (19), this does not appear to translate into detectable differences in physical capacity.

The present study adds to the growing literature showing critical differences in physical performance between standards of play by comparing two divergent elite national levels for the first time in a large sample-size of ice hockey athletes. In addition, the results of a smaller sample of U20 players from each nation has been included in the study to add further perspective to the differences in performance across age groups in each national standard. However, since the results of the U20 players were obtained from only one team from each country, conclusions from this sample should be interpreted cautiously. Thus, it is possible that in particular the participating U20 teams do not fully represent the overall level of play of the two countries. However, the results of the Danish U20 players in the present study were very similar to results obtained for Danish U20 players included in a previous investigation (35). Lastly, we used bio-impedance scans to assess body composition which is not as accurate as dual-energy X-ray absorptiometry, although high correlation coefficients have previously been reported (15). Thus, some individual variation in the present data may be attributed to the methodology applied for measuring body composition, although at group level these measurements have shown an acceptable level of accuracy (22).

In conclusion, marked differences in endurance and high intensity performance measures were present between two elite male national standards differing in international world ranking. Thus, Finnish elite ice hockey players overall elicited a superior performance compared to Danish elite players, at least during on-ice test procedures, suggesting that these fitness components are important distinguishing factors even among elite players. In contrast, no overall disparities in body composition between elite players emerged, while these were larger in terms of body- and muscle mass than their U20 counterparts. Finally, the Finnish U20 group was at a comparable level in performance measures to the Danish elite level, whereas all groups significantly outperformed the Danish U20 sample in all performance tests, emphasizing the differences in performance across national standards.

PRACTICAL APPLICATIONS

The results of the present investigation suggest the use of specific on-ice testing procedures, including the Yo-Yo IR1-IH_{max} test and on-ice sprint and agility tests, since these prove effective for distinguishing between performance levels in elite players. The differences in both endurance and high-intensity on-ice performance qualities between players of different national standards also emphasize the need for a major focus on the development of on-ice high-intensity speed and agility performance in addition to conditioning aspects. Finally, as the most consistent discrepancy between U20 and senior elite players was in terms of size and muscle mass, we suggest a major focus on resistance exercise aimed at optimizing muscle mass in youth prospects in order to prepare them for the requirements at the elite level.

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Legends to figures

Figure 1. Differences in body composition among Finnish elite and U20 and Danish elite and U20 players for A) height, B) weight, C) body fat percentage and D) muscle mass. Data are presented as mean and individual values.

Figure 2. Differences in performance among Finnish elite and U20 and Danish elite and U20 players for E) countermovement jump, F) agility, G) 30-m sprint and H) Yo-Yo IR1-IH_{max} performance. Data are presented as mean and individual values.

Tables

Table 1. Age, body composition and performance of elite and U20 male ice hockey players from the highest Finnish and Danish level of play

	Finnish elite (n=74)	Danish elite (n=55)	Finnish U20 (n=19)	Danish U20 (n=17)	Effect size
Age (yrs.)	25.9±5.4 (24.7-27.2)§&	23.9±4.5 (22.7-25.1)§&	18.7±0.9 (18.3-19.2)*#	18.1±1.7 (17.2-18.9)*#	0.4, NS, 1.6, 1.5, 1.3, 1.4
Height (cm)	183.0±6.4 (181.5-184.5)	182.3±6.0 (180.7-183.9)	180.0±7.2 (176.5-183.4)	179.0±5.9 (176.0-182.1)	NS
Body mass (kg)	86.1±7.8 (84.3-87.9)§&	84.3±8.3 (82.0-86.5)§&	78.6±8.4 (74.5-82.6)*#	75.7±10.1 (70.5-80.9)*#	NS, NS, 1.3, 1.0, 0.7, 1.0
Body fat (%)	12.6±3.1 (11.9-13.4)	13.3±3.2 (12.4-14.2)	13.8±3.2 (12.2-15.3)	13.4±4.6 (11.0-15.9)	NS
Muscle (kg)	43.5±4.6 (44-44.6)§&	42.0±4.4 (40.8-43.2)&	39.4±4.5 (37.2-41.5)*	36.5±4.7 (34.1-38.8)*#	NS, NS, 1.5, 0.9, NS, 1.2
CMJ (cm)	45.1±4.2 (44.0-46.1)&	43.3±4.1 (42.1-44.4)&	42.7±4.9 (40.3-45.1)&	39.0±3.9 (37.0-41.0)*#§	0.4, 0.8, 1.47, 0.5, NS, 1.1
Agility (s)	4.68±0.09 (4.66-4.70)#&	4.79±0.12 (4.76-4.83)*&	4.74±0.16 (4.66-4.82)&	5.01±0.19 (4.91-5.10)*#§	1.1, 1.5, 2.8, NS, NS, 1.5
Sprint 10-m (s)	1.71±0.04 (1.70-1.72)#	1.77±0.10 (1.74-1.79)*§	1.72±0.06 (1.69-1.74)#	N/A	0.8, N/A, N/A, NS, 0.5, N/A
Sprint 30-m (s)	4.06±0.09 (4.04-4.08)#&	4.19±0.14 (4.15-4.22)*&	4.12±0.12 (4.06-4.18)&	4.38±0.16 (4.30-4.46)*#§	1.1, 1.8, 2.9, 0.6, 0.5, 1.3
Yo-Yo IR1-IH (m)	2880±392 (2783-2977)#§&	2505±383 (2396-2613)*&	2600±248 (2476-2723)*&	1862±358 (1677-2045)*#§	1.0, 2.4, 2.6, 0.8, NS, 1.7

Data are presented as mean ± SD and 95% confidence intervals. Total numbers of players are compared between elite and U20 level of play in both countries while positional differences are analyzed only at the elite level of play within each country. Goaltenders are excluded from these comparisons. * = significant difference from Finnish elite players; # = significant difference from Danish elite players; § significant difference from Finnish U20 players; & = significant difference from Danish U20 players, $P \leq 0.05$. Effect sizes are presented in the order Finnish elite vs Danish elite, Finnish U20 vs Danish U20, Finnish elite vs Danish U20, Finnish elite vs Finnish U20, Danish elite vs Finnish U20 and Danish elite vs Danish U20. NS = non-significant. N/A = not applicable.

Table 2. Positional differences in age, body composition and performance in players from the highest Finnish and Danish level of play

	Finnish elite players			Danish elite players		
	Forwards (n=46)	**Defensemen (n=28)**	**Goaltenders (n=8)**	**Forwards (n=33)**	**Defensemen (n=22)**	**Goaltenders (n=6)**
Age (yrs.)	25.8±5.4 (24.0-27.3)	26.2±5.7 (24.2-28.1)	23.8±4.0 (19.4-29.7)	23.8±4.0 (22.5-26.1)	24.0±5.3 (21.8-25.0)	23.5±5.1 (17.5-28.5)
Height (cm)	182.2±6.6 (180.3-184.2)	184.2±6.1 (181.8-186.5)	189.1±5.2 (184.8-193.5)	182.1±6.4 (179.8-184.4)	182.5±5.4 (180.1-184.9)	185.2±7.8 (177.0-193.3)
Body mass (kg)	86.1±8.4 (83.6-88.6)	86.2±6.8 (83.6-88.9)	86.5±6.9 (80.8-92.2)	84.1±7.8 (81.3-86.9)	84.5±9.0 (80.5-88.5)	82.6±6.1 (76.3-89.0)
Body fat (%)	13.0±3.0 (12.1-14.0)	11.9±3.2 (10.6-13.2)	11.9±4.4 (8.1-15.6)	13.3±3.0 (12.2-14.3)	13.3±3.6 (11.7-14.9)	13.2±4.2 (8.8-17.6)
Muscle (kg)	43.1±4.7 (41.6-44.6)	44.2±4.4 (42.3-46.0)	43.7±3.2 (38.9-43.9)	42.0±4.9 (40.2-43.7)	42.0±3.7 (40.4-43.6)	41.1±3.6 (37.3-44.8)
CMJ (cm)	44.5±4.3 (43.1-45.9)	46.2±3.8 (44.4-48.0)	40.8±5.2 (35.9-45.6)	43.4±3.7 (42.0-44.7)	43.1±4.7 (41.0-45.3)	43.7±5.2 (37.3-50.2)
Agility (s)	4.67±0.09 (4.64-4.70)	4.71±0.14 (4.65-4.72)	N/A	4.77±0.13 (4.72-4.81)	4.83±0.10 (4.79-4.88)	N/A
Sprint 10-m (s)	1.71±0.04 (1.69-1.72)	1.71±0.05 (1.69-1.73)	N/A	1.77±0.10 (1.73-1.81)	1.76±0.11 (4.79-4.88)	N/A
Sprint 30-m (s)	4.05±0.09 (4.02-4.08)	4.07±0.10 (4.03-4.11)	N/A	4.19±0.13 (4.14-4.23)	4.18±0.15 (4.12-4.25)	N/A
Yo-Yo IR1-IH (m)	2933±402 (2803-3063)	2800±369 (2651-2949)	N/A	2534±396 (2387-2682)	2460±367 (2288-2631)	N/A

Data are presented as mean ± SD and 95% confidence intervals. Positional differences are compared within elite players of each independent country only. No significant differences between positions were present ($P \geq 0.05$). N/A = not applicable.

Figures

Fig 1.

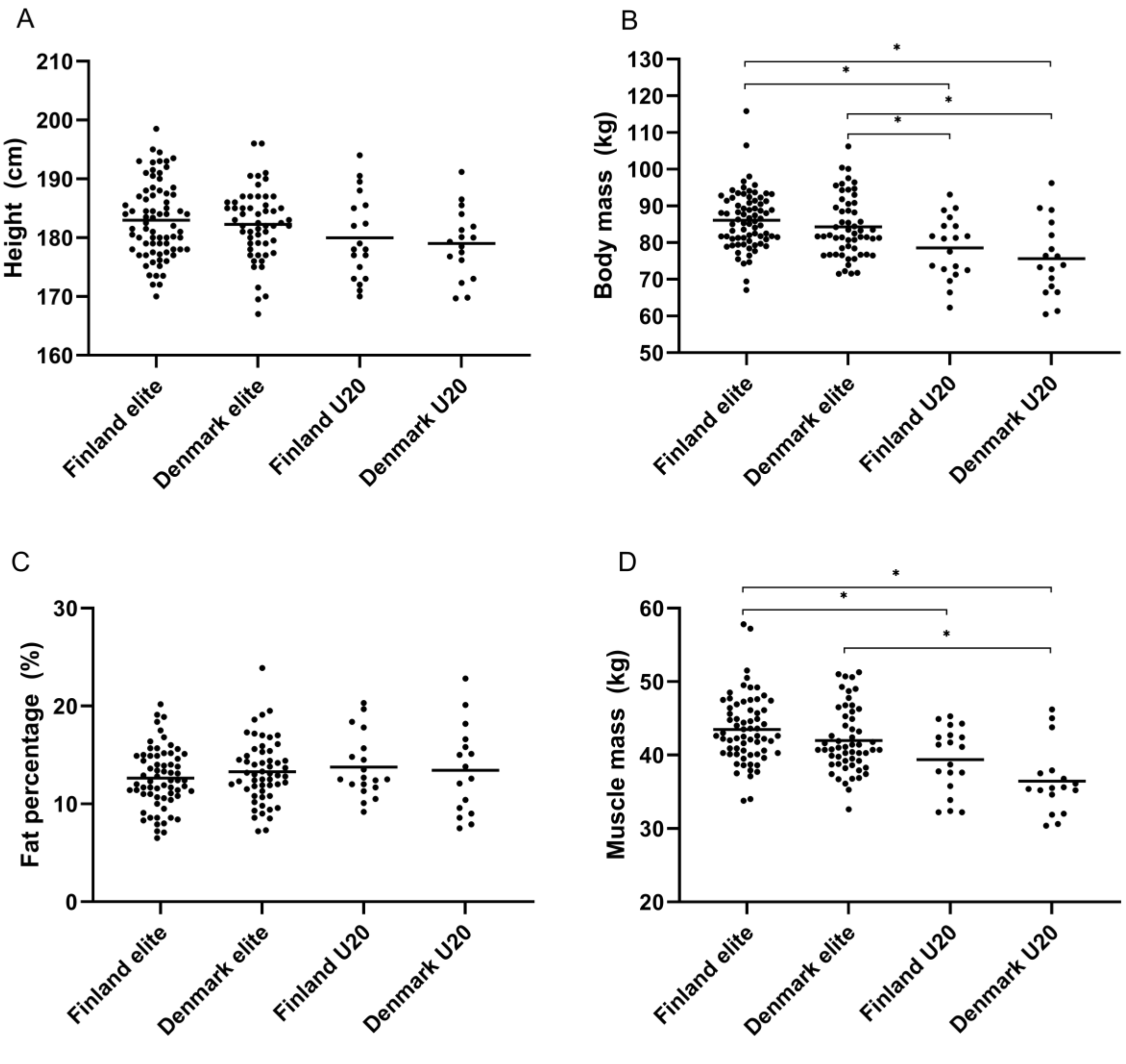
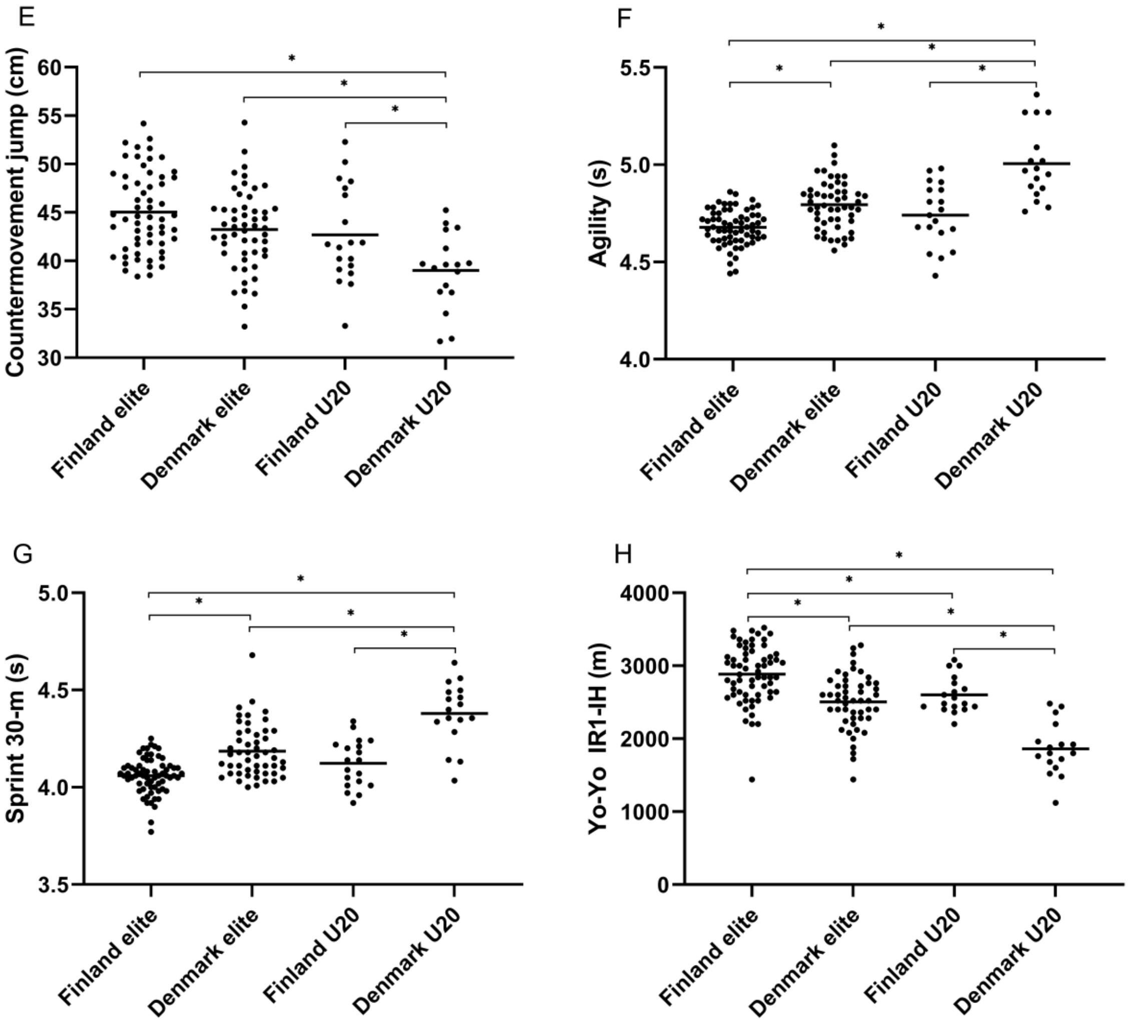


Fig 2.


E
Countermovement jump (cm)
60
55
50
45
40
35
30
Finland elite
Denmark elite
Finland U20
Denmark U20
F
Agility (s)
5.5
5.0
4.5
4.0
G
Sprint 30-m (s)
5.0
4.5
4.0
3.5
H
Yo-Yo IR1-IH (m)
4000
3000
2000
1000
0