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Ice Hockey-Specific Repeated Shuttle Sprint Test Performed on Ice Should Not Be Replaced by Off-Ice Testing

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Abstract

Legerlotz, K, Kittelmann, J, Dietzel, M, Wolfarth, B, and Böhlke, N. Ice hockey-specific repeated shuttle sprint test performed on ice should not be replaced by off-ice testing. *J Strength Cond Res* XX(X): 000–000, 2020—Although the importance of sport-specific testing has been stated in various studies, the application of standard tests that are little related to the requirements in competition is still widespread in performance diagnostics. Furthermore, the actual exercise mode in testing often deviates from the exercise mode in competition. The aim of this study was therefore to investigate how the performance in an ice hockey mimicking repeated sprint shuttle test conducted off-ice (RSS) differs from the on-ice performance (RISS). The two performance tests were completed by 21 male junior ice hockey players within one week. Anaerobic fatigue was significantly larger in RISS and did not correlate with RSS, whereas best run, mean run, total run time, turn and fly time, and total times in all three shifts correlated moderately. Although the best and mean run times did not differ, these times were achieved with different strategies depending on the test condition, indicated by significantly different split times. Aerobic fatigue in shift 3 was the only parameter where the off-ice measurement correlated strongly with the on-ice measurement. Our results imply that an off-ice test does not predict on-ice performance with sufficient precision, strongly advocating performance testing in the exercise mode used in competition.

Key Words: repeated sprint ability, anaerobic fitness, performance testing, fatigue, aerobic capacity

Introduction

Success in many team sports, including ice hockey, depends on the individual player's ability to accelerate maximally followed by maximum deceleration and quick changes in direction. Throughout an ice hockey game, players have to perform many of these short, maximal, work bouts between brief recovery periods. The ability to repeatedly get to the puck faster than the opponent and to sustain this ability throughout the duration of a game is an important performance criterion. This crucial performance criterion relies heavily on the so called Repeat Sprint Ability (RSA) (23), which manifests an important fitness criterion for most team sports. At the same time, the specific nature of RSA is highly dependent on the rules and regulations of a specific sport. In ice hockey, for example, the duration of single sprints is usually shorter than 10 seconds, whereas the recovery period on the ice is usually shorter than 60 seconds (made up of submaximal gliding on the ice). These periods do not allow full recovery and thus lead to a progressive performance decrement (13). At the same time, ice hockey players work in so called "*shifts*," i.e., after a series of short, maximum sprints interspersed with periods of active recovery, players leave the ice for a phase of passive recovery. Overall, it is important for coaches and sport scientists to identify the physiological variables predicting a sport-specific RSA. This enables them to assess the success of training programs and to tailor specific training interventions to the needs of individual athletes in their specific sport (1,2).

Although the importance of RSA in team sports is well accepted there is no consensus on how to measure it. This is not only because it has to be approached in a sport-specific way, but also because it constitutes a physiologically and biomechanically complex performance challenge. Because RSA depends at least partially on anaerobic power, highly reliable off-ice tests such as vertical jump tests (9,19) and the Wingate test (11) are traditionally used in the test battery of ice hockey players (20). In addition, the aerobic capacity, which can reliably be assessed by a graded exercise test (16), is a common element in the performance diagnostics battery of ice hockey players as it has also been related to RSA (23). Although these tests have been applied in performance testing for many years across many different team sports, allowing for comparison across different sports and within one sport across different decades, their application in a specific sport context, such as in ice hockey, has been criticized for lacking task specificity (20,22). Although those nonspecific tests have even been applied in the NHL Draft Combine used in the United States and Canada, their value in predicting the future success of individual players seems to be limited (8,20,26). Even more so, it is suspected that these tests have a low transference to on-ice performance, among other reasons, because of their dissimilar movement patterns to skating (22). For example, $\dot{V}O_2max$ values of 12 male collegiate ice hockey players (11 Division I players, and one Division II player) determined off-ice on a cycle ergometer did not correlate at all with $\dot{V}O_2max$ values determined on-ice and skating, highlighting the importance of the need for performance testing in a sport-specific manner (12). At the same time, there are certain advantages to using traditional, off-ice performance tests, because they tend to be quick and easy to apply

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even to large groups (4), with well-established analytical routines, making the data easily interpretable by coaches and performance testing staff. In addition, limited on-ice time, especially during the off-season when player maintenance and progression tend to be particularly important (4), can make on-ice testing difficult or expensive. Thus, economical decisions in available time and other resources may lead to favoring off-ice testing, even in professional ice hockey teams (3).

Although nonspecific testing certainly holds many advantages, increasing evidence suggests that the internal validity of many nonspecific off-ice tests is limited—thus also their ability to predict on-ice performance (20,22,26). For practitioners in the field of performance sports, this can mean that those tests may lack the precision required to detect relevant impairments regarding the specific physical fitness of an ice hockey player. This necessitates the development of specific on-ice RSA tests (3). The repetitive ice shuttle sprint test (RISS), which has been developed on behalf of the Swiss Ice Hockey Association, mimics ice hockey-specific movement patterns such as short repetitive sprints characterized by maximal acceleration followed by maximal deceleration and 180° turns (27). Furthermore, it mimics the time a player tends to spend sprinting in a typical "shift" during an ice hockey game, which has been derived from the National Hockey League database (23). Construct validity of the RISS test has already been investigated by comparing it to the Wingate and vertical jump test, showing that the RISS was better able to differentiate between professional elite and nonprofessional elite ice hockey players than these conventionally used tests (27).

It remains to be established if the surface on which an RSA test is performed affects the assessments coaches and support staff members can derive from this test—or if, for economic reasons, the test can be performed on a running track instead. The aim of this study was therefore to investigate how the results of the RISS performed on-ice relate to the results when the test is performed off-ice. We hypothesized that there would be little or no correlation between the test results of the two test conditions due the specific nature of the movement patterns skating on vs. running off-ice.

Methods

Experimental Approach to the Problem

The two performance tests were performed by 21 male ice hockey players within one week of the ice hockey preseason. Both tests were started in the morning at the same time of the day (7.30 AM) to minimize diurnal variation. The tests were separated by one day, allowing full recovery. On the rest day, only low-to-moderate intensity training was performed. At first, a repeated shuttle sprint test was performed on a running track (Figure 1), and subjects wore running shoes, shorts, and shirts. Two days later, the same repeated shuttle sprint test was performed on ice, with the subjects wearing full ice hockey gear and carrying hockey sticks. The testing week was scheduled in the first week after the summer break. Thus, although the overall performance results may not be maximal, the athletes fully recovered.

Subjects

The study was conducted with 7 defensemen and 14 forwards of an elite junior team. All players were well trained with 10 sessions per week during the hockey season, including up to 6 on-ice training sessions and playing in the German National Development League (under 20). The players were 17.0 ± 0.9 years old (range 16–18 years) with a body height of 181 ± 7 cm and a body mass of 76 ± 8 kg (mean ± *SD*). Institutional review board approval was obtained from the Department of Sport Science, Humboldt University Berlin. The subjects were informed of the benefits and risks of the study before signing the institutionally approved consent form. Written, informed consent was given by the subjects and their parents or guardians for the ones under the age of 18. The study was performed in compliance with the Declaration of Helsinki.

Procedures

Repeated Shuttle Sprint (RSS), Off-Ice. The repeated shuttle sprint test was performed on an outdoor running track with a tartan surface (Polytan GmbH, Germany). All players were wearing training gear and running shoes. After individual warm up the players were instructed to perform 3 shifts consisting of four 30.5 m long shuttle runs as fast as they could. One shuttle run consisted of a 15.5 m run in one direction, followed by a 180° turn and run back to the starting point (Figure 1). The starting line was placed 0.5 m in front of the first speed trap (Speed Trap II; Brower Timing Systems, United Kingdom) to prevent the players from triggering the speed trap signal too early. The second speed trap was placed 10 m behind the first one. Further 5 m behind the second speed trap, a line marked the turning point, which had to be crossed with one foot. The speed traps recorded the total time and the split times. The total time was calculated from the first and second signal recorded at speed trap one. The start time was calculated from the first signal recorded at speed trap one and the first signal recorded at speed trap 2. The turn time was calculated from the first and second signal recorded at speed trap 2. The fly time was calculated from the second signal recorded at speed trap 2 and the second signal recorded at speed trap one. The player started a run on an acoustic signal every 20 seconds, allowing for ~14 seconds of rest between runs, whereas the next shift started 180 seconds after the start of the fourth and last run of the previous shift. The players performed the test in groups of 3. This meant in practice that when one player had completed his shift, players 2 and 3 performed their shifts in the rest period of player one. This allowed continuous testing; continuously starting runs every 20 s and completing one RSS test for 3 players in 12 minutes.

To allow comparison with the literature, the decrement score was also calculated (1,2,14,15,23,24). The analyzed parameters and their calculation are presented in Table 1.

Repeated Ice Shuttle Sprint (RISS), On-Ice. Although setup of the RISS test was the same as for the RSS test, the test was performed on ice in an indoor ice hockey arena. All players were wearing full ice hockey gear and carrying their hockey sticks. The players were instructed to complete a full hockey stop when turning during the shuttle runs. To ensure good ice quality allowing for fast runs, the ice was cooled to −12° C. Furthermore, the testing setup was moved sideways across the ice surface after a group of 3 players completed a RISS, allowing the next group of players to be tested on untouched ice. The RISS test was analyzed in the same way as the RSS test.

Statistical Analyses

For statistical analysis, SPSS statistics 22 was used. Normality of the data was tested using the Shapiro-Wilk test. Because all data

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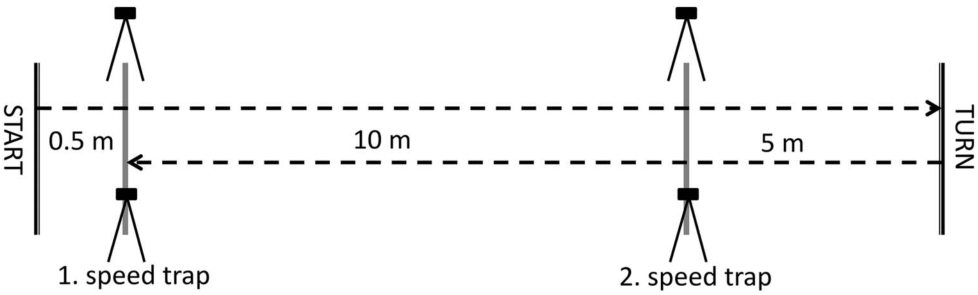

Figure 1. Depiction of the test setup for the RSS and RISS test. RSS = repeated shuttle sprint, off-ice; RISS = repetitive ice shuttle sprint test.

were normally distributed, the means between the RSS and RISS test were compared using a paired t-test and the effect size was calculated using Cohens *d*. Effects sizes between 0.2 and 0.5 were classified as small, between 0.5 and 0.8 as moderate, and above 0.8 as high. Means are presented with 90% confidence intervals.

To compare whether both the RISS and the RSS test were measuring the same constructs, principal component analyses with varimax rotation were performed. Factors with eigenvalues below 1 and those explaining less than 10% of the variance were excluded. The screen plot was used for the final identification of the main components. To establish relationships between parameters the Pearson correlation coefficient (r) was calculated. Correlations below 0.4 were qualitatively interpreted as weak, between 0.4 and 0.7 as moderate, and above 0.7 as strong. When correlations are presented as a scatter plot, the line of best fit and the coefficient of determination (R^2) are added. For all statistical tests, significance was established at $p \leq 0.05$.

Results

Structural Validity, Mean Differences, and Correlations Between RSS and RISS

Structural validity of the RSS and RISS test was similar, because principal component analyses identified 2 underlying main factors for both the RSS and the RISS test explaining 75% of the variance. For both tests mean run time and total time were the variables contributing with the highest loadings to the first factor, describing times, whereas the decrement score and the mean anaerobe fatigue were the variables contributing with the highest loadings to the second factor, describing fatigue.

Repeated shuttle sprint and the RISS did not differ regarding best run time, mean time over 12 runs, aerobic fatigue, and decrement score. However, split times and anaerobic fatigue differed significantly (Table 2). Regarding the split times, start and fly time were significantly shorter when performed on a running track, whereas turn times were significantly shorter when performed on ice. Anaerobic fatigue was more distinct in the RISS test with the last runs in the first and second shift, and the last and second last runs in the third shift being significantly slower when the test was performed on ice (Figure 2).

Regarding the shifts, total time of shift 3 was significantly longer in RISS compared with RSS. The anaerobic fatigue was larger on ice compared with that off-ice, reaching statistical significance in shift 2 and in the mean over all 3 shifts. Anaerobic fatigue and the decrement score in RISS and RSS did not correlate at all. Best run, mean run, total run time, turn and fly time and total times in all 3 shifts measured on ice (RISS) correlated moderately with the times measured on the running track (RSS) (Table 2 and Figure 3). Aerobic fatigue in shift 3 was the only parameter where the off-ice measurement correlated strongly with the on-ice measurement (Table 2). Over all test parameters presented in Table 2 mean R^2 was 0.24 ± 0.17.

Correlations Within the Tests

Regarding the continuity of performance throughout the shifts, total time in shift 1 correlated with total time in shift 2 and 3 both in RISS (0.907, $p < 0.001$; 0.812, $p < 0.001$) and RSS (0.890, $p < 0.001$; 0.686, $p < 0.001$). For the RISS anaerobic fatigue, shift 1 correlated with fatigue in shift 2 (0.525, $p = 0.014$) and with mean fatigue (0.691, $p = 0.001$), but not with anaerobic fatigue in shift 3 (0.113, $p = 0.627$). For the RSS, anaerobic fatigue in shift 1 correlated with anaerobic fatigue in shift 2 (0.492, $p = 0.023$) and shift 3 (0.469, $p = 0.032$) and with mean anaerobic fatigue (0.789, $p < 0.001$). For both RISS and RSS aerobic fatigue of shift 2 correlated with aerobic fatigue of shift 3 (0.553, $p = 0.009$ and 0.799, $p < 0.001$ respectively).

For both the RSS and the RISS, best run time correlated strongly with the mean run time. However, correlations of split times were different. For the RSS, mean start time strongly correlated with mean fly time (0.811, $p < 0.001$), whereas for the

Table 1

Analyzed parameters in the RSS and RISS test and their calculations.*

Test parameter	Calculation
Total time (s)	Sum of all 12 runs
Best run (s)	Fastest of all 12 runs
Mean run time (s)	Mean over 12 runs
Mean start time (s)	Mean over 12 starts
Mean turn time (s)	Mean over 12 turns
Mean fly time (s)	Mean over 12 fly times
Total time shift (s)	Sum of the 4 runs within the shift
Anaerobic fatigue shift (%)	Percentage time difference of the fourth to the first run in each shift: 100 × (fourth run time/first run time) − 100
Mean anaerobic fatigue (%)	Mean anaerobic fatigue over 3 shifts
Aerobic fatigue shift (%)	Percentage time difference of the total shift time in shift 2 and 3 compared to shift 1: 100 × (total shift time 2 or 3/total shift time 1) − 100
Decrement score (%)	Percentage decrease of the total time relative to the best run time multiplied by the number of runs: 100 × (total time/[best run × 12]) − 100

*RSS = repeated shuttle sprint, off-ice; RISS = repetitive ice shuttle sprint test.

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Table 2

Mean values for RSS and RISS test parameters presented with standard deviation and 90% confidence intervals (CIs) of the means.*

Test parameter	RSS, mean ± *SD* (90% CI)	RISS, mean ± *SD* (90% CI)	Effect size, *d*	Correlation RSS & RISS, *r* (*p*)
Total time (s)	73.1 ± 1.6 (72.5–73.7)	73.9 ± 2.2 (73.1–74.7)	−0.42	0.570 ($p = 0.007$)
Best run (s)	5.82 ± 0.15 (5.76–5.87)	5.87 ± 0.19 (5.80–5.94)	−0.37	0.693 ($p < 0.001$)
Mean run time (s)	6.09 ± 0.14 (6.04–6.14)	6.16 ± 0.18 (6.09–6.23)	−0.43	0.578 ($p = 0.006$)
Mean start time (s)	1.96 ± 0.06 (1.94–1.99)	2.10 ± 0.09‡ (2.07–2.13)	−1.39	0.143 ($p = 0.537$)
Mean turn time (s)	2.50 ± 0.08 (2.47–2.52)	2.36 ± 0.10‡ (2.32–2.40)	1.77	0.668 ($p = 0.001$)
Mean fly time (s)	1.64 ± 0.04 (1.62–1.65)	1.70 ± 0.04‡ (1.69–1.72)	−1.73	0.555 ($p = 0.009$)
Total time shift 1 (s)	23.97 ± 0.66 (23.72–24.22)	24.20 ± 0.74 (23.92–24.48)	−0.38	0.635 ($p = 0.002$)
Total time shift 2 (s)	24.43 ± 0.55 (24.22–24.63)	24.65 ± 0.84 (24.34–24.97)	−0.32	0.563 ($p = 0.008$)
Total time shift 3 (s)	24.72 ± 0.53 (24.52–24.92)	25.04 ± 0.73‡ (24.77–25.32)	−0.48	0.497 ($p = 0.022$)
Anaerobic fatigue shift 1 (%)	4.1 ± 2.4 (3.2–5.0)	5.5 ± 2.8 (4.4–6.5)	−0.45	0.293 ($p = 0.198$)
Anaerobic fatigue shift 2 (%)	5.7 ± 2.7 (4.7–6.7)	7.9 ± 3.3‡ (6.6–9.1)	−0.62	0.353 ($p = 0.116$)
Anaerobic fatigue shift 3 (%)	5.9 ± 2.4 (5.0–6.8)	6.7 ± 3.3 (5.5–8.0)	−0.21	−0.063 ($p = 0.786$)
Mean anaerobic fatigue (%)	5.2 ± 2.0 (4.5–6.0)	6.7 ± 2.3‡ (5.8–7.6)	−0.59	0.350 ($p = 0.120$)
Aerobic fatigue shift 2 (%)	1.9 ± 1.3 (1.5–2.4)	1.9 ± 1.4 (1.3–2.4)	0.04	0.360 ($p = 0.109$)
Aerobic fatigue shift 3 (%)	3.2 ± 2.1 (2.4–4.0)	3.5 ± 1.9 (2.8–4.2)	−0.21	0.715 ($p < 0.001$)
Decrement score (%)	4.8 ± 1.3 (4.4–5.5)	5.0 ± 1.5 (4.4–5.5)	−0.11	0.243 ($p = 0.289$)

*RSS = repeated shuttle sprint, off-ice; RISS = repetitive ice shuttle sprint test; CI = confidence interval.

†Significant differences between RISS and RSS including effect sizes and correlations between the 2 test setups are depicted.

‡Significant difference between RSS & RISS ($p < 0.05$).

RISS, mean turn time moderately correlated with mean start (0.508, $p = 0.019$) and fly time (0.497, $p = 0.022$).

Discussion

The primary goal of this study was to investigate how the results of a repetitive sprint shuttle test performed on-ice relate to the results when the test is performed off-ice. The degree of correlation between the test results of the two test conditions should indicate whether a repetitive sprint shuttle performance test on-ice can be replaced by off-ice testing. Our results suggest that although the off-ice test is measuring the same construct, it does not predict on-ice performance with sufficient precision, explaining, at most, 51% of the on-ice results. Although there were significant correlations in many parameters, these correlations were moderate only (range 0.497–0.693) with the exception of one parameter (aerobic fatigue in shift 3, $r = 0.715$). This highlights an important discrepancy which affects the performance prediction ability of the two tests, comparatively. For example, with the parameter total time, which is a parameter favored by many coaches, the player ranked 11th on-ice was only ranked 21st off-ice, whereas the player ranked 6th off-ice was only ranked 16th on-ice (Figure 3). Although it seems obvious that skating is not just running on ice, but requires a specific technique, this means in practice that fast runners are not necessarily fast skaters (18)—and vice versa.

Our study suggests that the motion-specific technical and physical requirements of running and skating lead to differences in performance results when a seemingly identical diagnostic test is performed. Split times and fatigue behavior differed

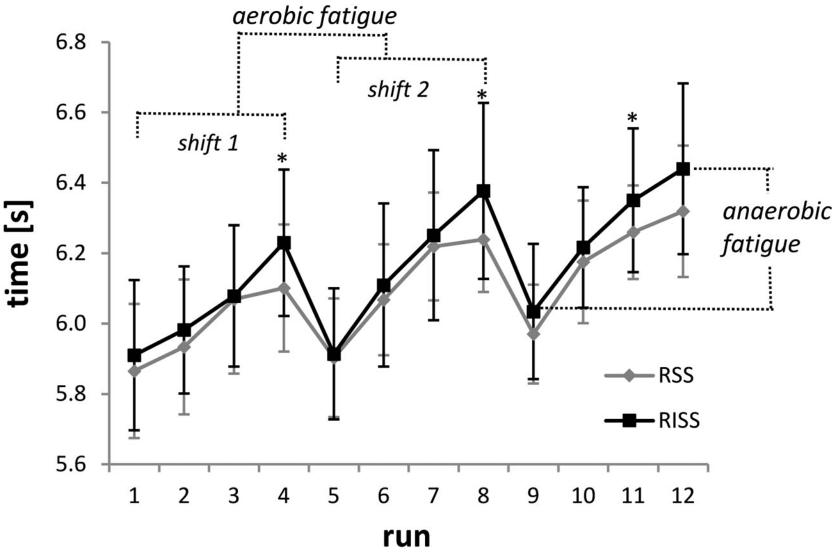

Figure 2. Mean run time for each of the 12 runs performed in the RSS and RISS test. Depiction of how the parameters aerobic and anaerobic fatigue are derived from the data. *Significant difference between RSS & RISS ($p < 0.05$). RSS = repeated shuttle sprint, off-ice; RISS = repetitive ice shuttle sprint test.

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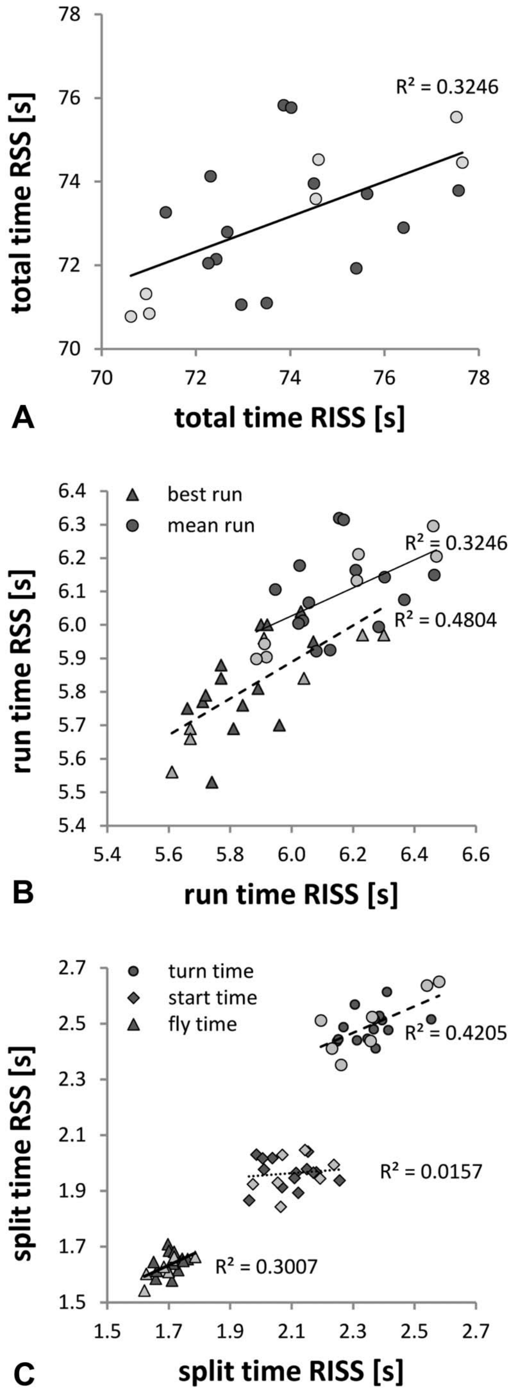

Figure 3. Relationship of the total run time (A); best and mean run time (B); and split times (C) performed on and off ice. Forwards are represented by dark gray and defense by light gray symbols. Each variable is presented with individual data points, the line of best fit and the coefficient of determination R^2.

significantly between the tests. Although both best and mean run times did not differ between RSS and RISS, these gross times were achieved with different strategies depending on the surface. For example, the specificity of the skating technique led to longer start and fly times, whereas the turn times were shorter. Furthermore, sprinting on ice seemed to be more fatiguing, which was reflected by longer times on ice compared with off-ice in the fourth run of each shift and differences in the anaerobic fatigue index. This difference in fatigue behavior between running and skating is supported by a study investigating the 30–15 intermittent fitness test performance on and off ice (7). The 30–15 intermittent fitness test was originally developed for running, and its reliability and validity have been demonstrated (5,6). It consists of 30-second shuttle runs interspersed with 15-second passive recovery periods, with the running velocity being preset in the initial stage at 8 $km\cdot h^{-1}$ and increased by 0.5 $km\cdot h^{-1}$ every stage thereafter. The athletes are instructed to complete as many stages as possible, while the test ends when the athletes are not able to run with the required velocity (7). The test has been adopted for the skating modality arguing that the physiological capacities of ice hockey players should be assessed on ice, while wearing hockey attire and performing in their usual competition environment, taking the specificity of the skating movement into account. As anticipated, on-ice and off-ice performance differed, with the on-ice test being more fatiguing. As a result, the young elite ice hockey players (first Cadet and Junior French National Leagues) were not able to complete the same number of stages when skating as when running. The specificity of the on-ice test was furthermore highlighted by the fact, that there was no correlation for postexercise lactate values between both tests (7).

Both individual technical abilities affecting skating economy and the ice hockey equipment have been identified as likely contributors leading to discrepancies between on-ice and off-ice performance (7). It has been demonstrated in the literature that ice hockey equipment negatively affects players maximal speed and mechanical efficiency, whereas the additional energy costs may be more related to the design of the outer clothing, causing a hindrance to limb motion, than to the relative mass of the ice hockey equipment (18). In addition, it has been shown that wearing the ice hockey-specific protective equipment leads to the elevation of body temperature, increased sweat loss, and greater accumulation of blood lactate, resulting in reduced power output compared with that wearing undergarments only (21). In contrast to the effect of the ice hockey equipment, which is basically the same for all players and may thus be a variable less important to consider in this context, the influence of different levels of technical skills on performance test results is likely to vary significantly between players. Indeed skating economy has been shown to be a moderate correlate of fatigue during a repeated-shift performance test (17).

The different levels of skating economy (17), different active muscle groups while skating compared with other modes of exercise (12) and sport-specific skeletal muscle adaptations (10) are potential factors leading to different results in on-ice and off-ice testing. Thus, it is not surprising that $\dot{V}O_2$max values determined by treadmill running differed significantly from treadmill skating (16), nor that $\dot{V}O_2$max values determined by a graded exercise test on-ice differed significantly from the ones determined by a graded exercise test on a cycle ergometer (12). However, more important than the differences in absolute values is that the $\dot{V}O_2$max values off-ice did not correlate at all with the $\dot{V}O_2$max values on-ice (12), challenging the usefulness of non–sport-specific test setups to assess the aerobic capacity.

Studies have shown that some performance variables of a repeated sprint shuttle test can be affected by aerobic capacity (23,25). A study in college ice hockey players (Division I, Division II and Elite Junior level) indicated an association between RSA, determined by a repeated shift test on ice consisting of 8 maximal skating bouts, and aerobic capacity, determined by a graded

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exercise test performed on a skating treadmill. In that study, $\dot{V}O_2$peak and final stage completed during the graded exercise test significantly correlated with second gate decrement, a measure for fatigue in the repeated shift test (23). This underlines that measures for aerobic fatigue can be determined by a repeated sprint shuttle test, such as the RISS test, if the sport specific conditions, such as the specific mode of locomotion, the competition environment and sport specific attire, are considered and kept constant. However, it has also been shown that generic measures of aerobic fitness seem to correlate with markers of repeated sprint ability particularly in less well-trained subjects; although such measures do not seem to be an important determinant of repeated sprint ability in well-trained elite athletes (1). Thus, no correlations between $\dot{V}O_2$peak and repeated sprint ability have been detected in a homogenous group of elite female hockey players (1), whereas soldiers with low aerobic fitness show a far more pronounced decrease in sprint speed during a repeated sprint ability test than soldiers with higher aerobic fitness (25). A certain level of aerobic capacity may need to be developed to facilitate recovery between bouts of anaerobic activities. However, once a certain threshold is passed, a ceiling effect may prevent further increases in aerobic capacity to affect the RSA.

One limitation of the study is that, for organizational reasons, the two tests were not completed in randomized order. Thus, order effects cannot be excluded, with possible effects on the comparison of the means. However, this would not affect correlations between the two tests, which are the main focus of this study. Furthermore, our results are predominantly applicable to forwards, because they composed two-thirds of the investigated team. Future studies with a larger sample size may show whether the level of correlation varies with covariates such as the position of the player.

Practical Applications

Our study highlights the importance of sport-specific testing. For performance diagnostic staff members, aiming to identify sport-specific strengths and weaknesses of a particular player, it is advisable to conduct repeated sprint tests not only with a work-rest ratio specific to that of a given sport, but also to perform the test in an exercise mode similar to the competition mode. Only this will yield valid information on the individual's sport-specific performance capacity and his or her specific areas for improvement. If ice time is limited, it may be practical to look for ways to shorten the test duration instead of deferring to non–sport-specific test conditions. In the RISS, it might be feasible, for example, to shorten the test from 3 shifts to one shift, as in our study the total time of the first shift strongly correlated with the second and third shift.

A careful selection of tests which are more sport-specific, concentrating on diagnostic markers proven to relate to ice hockey players' on-ice performance, may reduce financial costs and time and help identify more targeted training interventions.

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In accordance with ethical obligations as researcher, the authors report no conflicts of interest that may affect the research reported in the enclosed paper. The authors declare that the results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

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