External and internal load demands in small-sided games according to standard training games in elite rink hockey

Daniel Fernández, [1] **Gerard Carmona,** [2] **Franc García,** [1] [3] **Joan A. Cadefau,** [3] **Lorena Martín** [4]

[1]Sports Performance Area, Futbol Club Barcelona, Barcelona, Spain
[2]Escola Superior de Ciències de la Salut, Universitat Pompeu Fabra (UPF), Mataró, Spain
[3]Institut Nacional d'Educació Física de Catalunya (INEFC), Universitat de Barcelona (UB), Barcelona, Spain
[4]University of Southern California, Los Angeles, CA, USA

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Headline

Small-sided games (SSGs) are useful tasks in modern training methodology, and a growth trend in both practical and scientific fields (1). In outdoor sports like soccer, the evidence is clear regarding the manipulation of pitch area. The larger the absolute and relative space, the more external load (EL) and internal load (IL) demands (1); only accelerations and decelerations were void of a significant relationship respect the pitch area (2,3). In rink hockey, the relationship between space and EL and IL is unknown.

Aim

Therefore, the aim of our study was to quantify and assess differences in EL and IL between a standard training game format of 40 x 20 m versus a largely implemented training SSG drill in a format of 20 x 20 m training game.

Design and methods

Design

A retrospective observational study was carried out for the 2021-2022 season. A non-experimental descriptive method was used to identify the EL and IL demands in two different training game formats in this rink hockey professional team. EL was measured by an ultra-wide band (UWB) electronic performance tracking system (WIMU PRO^{TM}, Realtrack Systems, Almeria, Spain) and IL was measured using heart rate monitoring; all the data collected was later presented expressing the tasks demands relative to time (m·min^{-1}, n·min^{-1} or sec·min^{-1}). Data were collected throughout 17 weeks of in-season.

Athletes

Elite male professional rink hockey players (n = 8, age: 28.5 ± 5.07 years, weight: 78.6 ± 4.13 kg, height: 180.8 ± 4.13 cm, all measurements mean ± standard deviation) participated voluntarily in the study, whereas the goalkeepers were excluded. At the time of the study, the team was holding between 4 and 5 practice sessions a week (between 1 and 1.5 hours) and was playing 1 or 2 matches a week. The data analyzed came from the daily player monitoring, in which player activities in court were routinely measured throughout all season. The experimental procedures used in this study were approved by the local Ethics and Scientific Committee (The Ethics Committee for clinical research of the Catalan Sports Council, 29/CE-ICGC/2020) and all the players signed an informed consent form before participating.

Methodology

To compare different tasks, the activity profile of the players was monitored during each training session. Each player wore the same positioning system micro-technology device (81 × 45 × 15 mm, 70 g) throughout to reduce potential inter-unit variability (4). The WIMU PRO^{TM} units are equipped with four 3D accelerometers (full-scale output ranges are ± 16 g, ± 16 g, ± 32 g, ± 400 g, at 100 Hz sample frequency), three gyroscopes (8000°/s full-scale output range, at 100 Hz sample frequency), a 3D magnetometer (100 Hz sample frequency), a global positioning system (10 Hz sample frequency), and a local positioning system with UWB technology (18 Hz sample frequency). For better signal emission and reception, installation on the rink hockey court comprised of six UWB antennas located to form a hexagon (sampling frequency of 18 Hz for the positioning data). The WIMU PRO^{TM} system has been evidenced to have a high intra-class correlation coefficient value for the x-coordinate (0.65), a very high value for the y-coordinate (0.85), and a good percentage technical measurement error of 2.18% (5). For IL players wore a chest-worn heart rate monitor (Garmin HRM3-SS, Garmin Ltd., Olathe, USA). The heart rate monitor data was sent to WIMU PRO^{TM}, recorded at 18 Hz sample frequency, and treated together with the EL data.

The most standardized training game formats during the season were used to for the analysis. For instance, both were 4 vs. 4 players with goalkeepers in both teams. A 40 x 20 training game (TG40x20) was one of the analyzed tasks (area: 100 m^2 per player), and a 20 x 20 training game (TG20x20) was the other analyzed task (area: 50 m^2 per player). Both training games included official rules, but in the TG20x20 one of the sides were without fence (Figure 1) and every time the ball went out of bounds, a coach would put a neutral new ball in the court with the aim of avoiding stoppages. A total of 371 individual records (n = 329 for TG40x20 and n = 42 for TG20x20) were obtained. Analyzed game formats were conducted in the final part of the sessions. As the sample size reveals, the TG40x20 was a training game format that was used in a vast majority of the training sessions, and the TG20x20 was a training game format only used once in each microcycle.

The EL recorded variables were distance covered (m·min^{-1}), distance covered at high-speed skating (>18 km·h^{-1}, m·min^{-1}), number of high-intensity accelerations (> 2 m·s^{-2}, n·min^{-1}), and the number of high-intensity decelerations (> 2 m·s^{-2}, n·min^{-1}). The IL recorded variable was the time spent above 90% of maximal heart rate (HRmax) (sec·min^{-1}). All the EL intensity thresholds were established based on previous studies (6). As Abad et al (7) recommended in their research, we used the highest individual heart rate registered during all training and friendly games between August and December of 2021, as their methodology revealed its efficiency being comparable to maximal tests to calculate individual maximal heart rate.

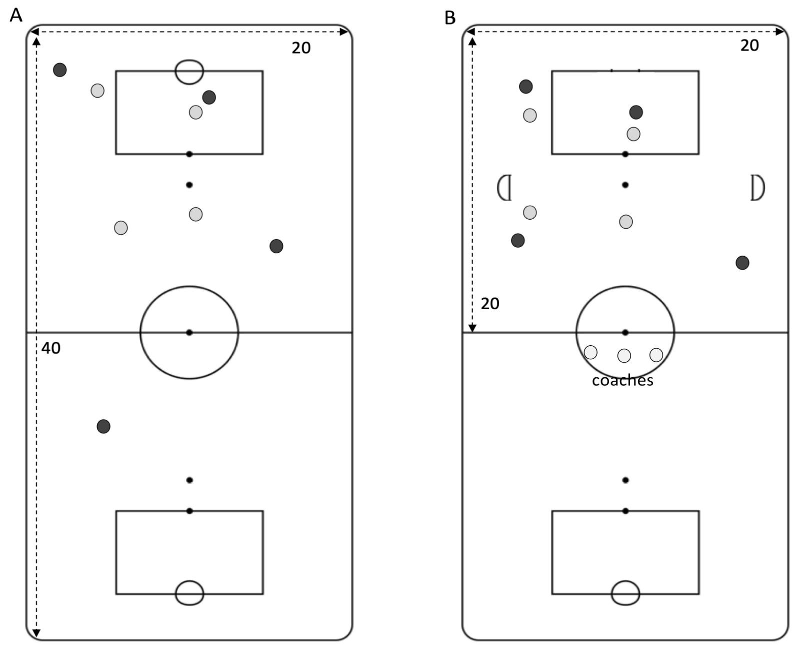

Fig. 1. Court diagram of the training games. A: 40 x 20 training game (TG40x20), and B: 20 x 20 training game (TG20x20).

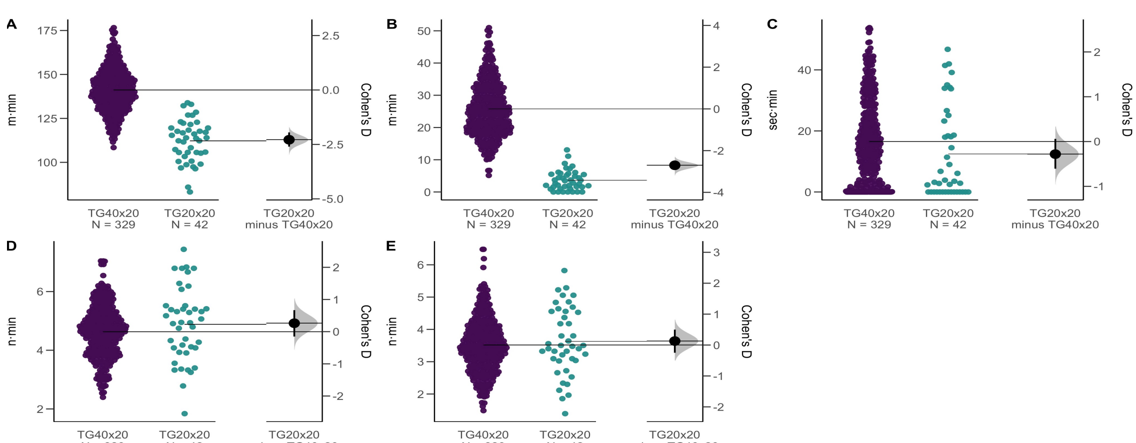

Fig. 2. Distribution and Cohen's D differences between game formats in all the studied variables. A: Distance covered ($m\cdot min^{-1}$), B: High-speed skating ($m\cdot min^{-1}$), C: Time >90% HRmax ($sec\cdot min^{-1}$), D: High-intensity Accelerations ($n\cdot min^{-1}$) and E: High-intensity Decelerations ($n\cdot min^{-1}$). Note. TG40x20: Training game 40x20; TG20x20: Training game 20x20.

Statistical analysis

All statistical analyses were conducted with RStudio version 1.4.1103 (RStudio, Inc.). Descriptive results were reported as mean ± standard deviation. The assumptions for homogeneity of variance (Levene's test) and for normality Shapiro–Wilk test were violated. As a result, a bootstrap confidence interval (CI) approach was used to perform the hypothesis test to assess the differences between training games format (8,9,10). A residual resampling model with 5,000 bootstrap samples and 95% bias-corrected and accelerated method (BCa 95% CI) was used to calculate the CI of Cohen's D for each variable11. Thresholds for effect size (ES) statistics were (ES <0.20), trivial; (0.20 < ES <0.59), small; (0.60 < ES <1.19), moderate; (1.20 < ES <1.99), large; and (ES > 2.0), very large (12).

Results

The descriptive results of the EL and IL variables from the two training games formats analyzed are displayed below in Table 1. The inferential analysis with bootstrapped resampling is presented in Figure 2. Results revealed that only distance covered ($p < 0.001$; ES 95%CI = 1.95-2.60), and high-speed skating ($p < 0.001$; ES 95%CI = 2.47-2.92) had significant differences between the two training game formats.

Table 1. Descriptive results (mean ± standard deviation) of studied variables in different training games formats.

	40 x 20 Training Game	20 x 20 Training Game
Distance covered (m·min^{-1})	141 ± 12.8	112 ± 12.0
High-speed skating (m·min^{-1})	25.8 ± 8.61	3.65 ± 3.10
High-intensity Accelerations (n·min^{-1})	4.63 ± 0.90	4.88 ± 1.26
High-intensity Decelerations (n·min^{-1})	3.51 ± 0.86	3.63 ± 1.04
Time >90% HRmax (sec·min^{-1})	16.5 ± 14.4	12.5 ± 14.9

Discussion

The aim of this research was to quantify and assess differences in EL and IL between a standard training game (TG40x20) versus a SSG training drill (TG20x20). To the best of our knowledge, this is the first study to compare training game drills in rink hockey. Our results revealed large significant differences in distance covered and high-speed skating between tasks; but no differences in the number of accelerations, decelerations and the time spent above 90% of HRmax.

The absolute and the relative space reduction of the pitch size could be the principal reason that players cover less meters, and particularly at higher speeds. This could be due to the difficulty in achieving and maintaining high velocities in a smaller space with the same number of opponents (1). Our results are in line with previous research conducted in SSGs and pitch size, either outdoor or indoor sports (1,13,14) where the lesser space used, the lesser the distance covered.

On the other hand, the other studied variables did not reveal significant difference. Results showed that there aren't differences between TG20x20 and TG40x20 in high-intensity accelerations and decelerations, and time spent above 90% of HRmax. Starting with EL metrics, it seems that the space reduction doesn't affect the capacity of the players' high-intensity accelerations and decelerations, which could be due to the relative space used in the TG20x20 that entails a need for the players to perform the same amount of change of directions, reception movements and cuts equal to a normal game. The literature is incongruent in this respect, some studies have shown results in line with a non-reduction of these EL variables in SSGs in relation to a standard game (1), but other research have shown evidence that accelerations and decelerations decrease when the space is reduced (2,3). The internal load metric analyzed in this research did not reveal any significant difference between the two game formats, despite the space reduction. The IL of the task remained the same level of that of a standard game. Our findings, in conjunction with the EL findings encourages us to conjecture that the maintenance of similar values of high-intensity accelerations and decelerations between TG20x20 and TG40x20, is consistent with IL values. Research in soccer is well-defined in terms of the behaviour of internal load. The majority of studies reporting an increased heart rate, perception of effort and blood lactate concentration response with increased pitch area (15). Only Kelly & Drust (16) were the exception in that their study failed to find significant differences in heart rate peak between three different SSG formats.

To conclude, this research allows professionals of rink hockey to be cognizant of the effects of reducing the pitch size in a training game drill. It seems that the reduction of the space reduces the distance that players travelled, but yet still allow them to reach the same high-intensity accelerations, decelerations, and time spent above 90% of HRmax. This study's finding allows coaches to know what happens on the court when they manipulate training constraints such as pitch size. Finally, based on the work of Buchheit & Laursen (17), classification of metabolic and neuromuscular load in high intensity interval training, reducing space is a feasible application that concentrates on neuromuscular load.

Practical applications

The findings of this study can be applied by coaching staff working directly with athletes and being mindful of the pitch size and its impact on EL and IL.

- It's interesting to point that the reduction of the space in the analyzed tasks didn't affect the IL intensity response of the players, noting that players had same effort levels doing less EL than in a standard match.
- Based on our findings, the use of the TG20x20 allow players to stimulate the neuromuscular system doing the same amount of high-intensity accelerations and decelerations, with less distance covered.
- Future studies would include increasing the relative pitch area (i.e., 3 vs. 3 in 40x20 meters pitch), as it would be interesting to examine if that would increase the IL response.

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Declaration of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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