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Original

## Anthropometric characteristics of male rink hockey goalkeeper's according to their competitive level



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### ABSTRACT

**Objective:** Evaluate the anthropometric characteristics of male rink hockey goalkeepers, and to compare the variation according to their competitive level (international vs. non-international).

**Methods:** Body mass, stature, sitting height, arm span, waist and hip circumferences and four skinfold measurements (triceps, medial calf, subscapular and supraspinale) of international (n = 12) and non-international (n = 23) goalkeepers were taken. Body mass index (BMI, weight/height<sup>2</sup>), the sum of four skinfolds, the sitting height/stature ratio, waist/hip ratio and the relative arm span were also calculated.

**Results:** International rink hockey goalkeepers have lower values of subcutaneous adiposity for the sum of the four skinfolds ( $P = 0.042$ ;  $d = 0.76$ ) particularly in the triceps ( $P = 0.016$ ;  $d = 0.87$ ) and are taller than non-international goalkeepers (+3.8 cm [2.2%];  $180.5 \pm 7.0$  vs.  $176.6 \pm 4.8$  cm;  $t = 1.920$ ;  $P = 0.064$ ;  $d = 0.65$ ).

**Conclusion:** The findings could indicate that stature and body fat may have important implications for scouts regarding the selection process and coaches that work with players on developing performance. Future research should investigate the extent to which different anthropometric measures influence performance in rink hockey goalkeepers.

**Keywords:** Anthropometry; Adiposity; Body Fat Distribution; Skinfold Thickness.

## Características antropométricas de los porteros masculinos de hockey sobre patines

### RESUMEN

**Objetivo:** Evaluar las características antropométricas de los porteros masculinos de hockey sobre patines y comparar las diferencias según su nivel competitivo (internacional vs. no internacional).

**Métodos:** Se midieron la masa corporal, altura, altura sentada, envergadura, circunferencia de cintura y cadera y cuatro pliegues cutáneos (tríceps, pantorrilla medial, subescapular y suprailíaco) de porteros internacionales (n = 12) y no internacionales (n = 23). También se calculó el índice de masa corporal (IMC, peso/altura<sup>2</sup>), la suma de los cuatro pliegues de grasa subcutánea, la relación altura/sentado, la relación cintura/cadera y la envergadura relativa.

**Resultados:** Los porteros de hockey sobre patines internacionales presentan valores más bajos de adiposidad subcutánea para la suma de los cuatro pliegues de grasa subcutánea ( $P = 0.042$ ;  $d = 0.76$ ) principalmente en el pliegue del tríceps ( $P = 0.016$ ;  $d = 0.87$ ) y son más altos do que los porteros no internacionales (+3.8 cm [2.2%];  $180.5 \pm 7.0$  vs.  $176.6 \pm 4.8$  cm;  $t = 1.920$ ;  $P = 0.064$ ;  $d = 0.65$ ).

**Conclusión:** Los resultados de este estudio pueden indicar que la altura y la grasa corporal pueden tener implicaciones importantes con respecto al proceso de selección tanto para los scouts como para los entrenadores que trabajan con los jugadores en el desarrollo del rendimiento. Estudios futuros deberían centrarse en investigar hasta qué punto las diferentes medidas antropométricas influyen en el rendimiento de los porteros de hockey sobre patines.

**Palabras clave:** Antropometría; Adiposidad; Distribución Grasa Corporal; Espesor Pliegue Cutáneo.

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## Características antropométricas dos guarda-redes masculinos de hóquei em patins de acordo com o seu nível competitivo

### RESUMO

**Objetivo:** Avaliar as características antropométricas dos guarda-redes masculinos de hóquei em patins e comparar as diferenças de acordo com seu nível competitivo (internacional vs. não internacional).

**Métodos:** Foi medida a Massa corporal, estatura, altura sentada, envergadura, circunferências da cintura e quadril e quatro pregas de gordura subcutânea (tricipital, geminal média, subescapular e suprailíaca) de guarda-redes internacionais (n = 12) e não internacionais (n = 23). O índice de massa corporal (IMC, peso/altura<sup>2</sup>), a soma das quatro pregas de gordura subcutânea, a relação altura/estatura sentada, relação cintura/quadril e a envergadura relativa também foram calculadas.

**Resultados:** Os guarda-redes internacionais apresentam menores valores de adiposidade subcutânea para a soma das quatro pregas de gordura subcutânea ( $P = 0,042$ ;  $d = 0,76$ ) principalmente na prega tricipital ( $P = 0,016$ ;  $d = 0,87$ ) e são mais altos do que os guarda-redes não internacionais (+3.8 cm [2.2%];  $180.5 \pm 7.0$  vs.  $176.6 \pm 4.8$  cm;  $t = 1.920$ ;  $P = 0.064$ ;  $d = 0.65$ ).

**Conclusão:** Os resultados deste estudo podem indicar que estatura e a gordura corporal podem ter implicações importantes no que diz respeito ao processo de seleção tanto para olheiros e treinadores que trabalham com jogadores no desenvolvimento de desempenho. Futuros estudos devem centrar-se em investigar até que ponto diferentes medidas antropométricas influenciam o desempenho dos guarda-redes de hóquei em patins.

**Palavras-chave:** Antropometria; Adiposidade; Distribuição Gordura Corporal; Espessura da dobra cutânea.

### Introduction

The importance of anthropometric characteristics in sport performance is well established.<sup>1-3</sup> Athletes with an optimal anthropometric profile for a specific sport are adjudged to be more successful. This anthropometric information has been used to evaluate the training status and identify talented male and female athletes.<sup>4</sup>

There are numerous different methods for estimating body composition that provide reasonably similar assessments of body composition, being that the body mass index (BMI) (weight [kg]/height<sup>2</sup> [m]) and skinfold thicknesses are perhaps the most widely used anthropometric indicators for body composition. Despite this the use of the BMI in a population of athletes' presents some limitations, given to the large body size (height and mass) and relative leanness, also, skinfold measurements present some degree of error. However, these two methods are a basic tool for estimating body size and configuration, despite of having limited accuracy, because they are portable and inexpensive, the procedures are non-invasive and minimal training is required.<sup>3</sup>

Most research that has assessed the anthropometric characteristics of rink hockey players are conducted in youth athletes.<sup>5,6</sup> However, sport-specific body composition profiles have been developed by use of the Dual-energy X-ray absorptiometry (DXA) and anthropometry.<sup>1</sup> This involved a sample of adult male rink hockey players (n = 49), whereby the majority were outfield players. However, despite the growing research effort afforded to rink hockey goalkeepers,<sup>7,8</sup> there remains a paucity of work assessing the anthropometric profiles of this bespoke position.

There are several studies that have profiled the anthropometric characteristics of elite ice-hockey players and the impact on athletic selection and performance.<sup>9,10</sup> In these studies it was identified that stature and body mass play an important role in the selection process with goalkeepers being the tallest players. However, little is known as to what extent these findings translate to rink hockey goalkeepers.

Anthropometric profiles of elite athletes can provide pertinent information regarding the morphological requirements to compete at a higher level. Therefore, the purpose of this paper is twofold: 1) to evaluate the anthropometric characteristics of male rink hockey goalkeepers, and 2) to compare the variation according to their competitive level (international vs. non-international). This information may be useful to scouts and coaches for talent identification and development procedures. We hypothesised that international goalkeepers would have a greater

stature, lower body mass and a reduced body fat compared with non-international goalkeepers.

### Methods

The study received approval from the scientific commission and was conducted in accordance with recognised ethical standards.<sup>11</sup> Each team provided written informed consent, while assent was obtained from individual athletes. Participants were also informed that participation was entirely voluntary and that they could withdraw at any time. This research was observational in nature and as such, no intervention was undertaken.

### Sample

A formal request to participate in the study was sent to all teams participating in the *Euro male senior Azeméis 2016* as well as to all teams of the Portuguese first league. Six of the eight teams participating in the *Euro male senior Azeméis 2016* agreed to participate in this study, while only one of the fourteen teams of the Portuguese first league did not participated in this study. The sample included 35 male rink hockey goalkeepers. The goalkeepers were classified as international and non-international. Twelve (two from each national team) international goalkeepers were selected for their national teams (Portugal, Spain, France, Germany, England and Austria) and participated in the *Euro male senior Azeméis 2016*, aged between 18 and 48 years old ( $29.9 \pm 8.1$ ). The non-international (23 goalkeepers) played in the Portuguese first league, aged between 17 and 42 years old ( $28.9 \pm 7.2$ ). No differences were observed in training time between the international goalkeepers ( $3.6 \pm 1.7$  sessions/week) and non-international goalkeepers ( $4.1 \pm 0.7$  sessions/week). All goalkeepers participated in a 10-month competitive season (September – June), involving 1 – 2 games/week.

### Anthropometry

Body mass, stature, sitting height, arm span, skinfold assessments at four anatomical locations (triceps, medial calf, subscapular and supraspinale), and waist and hip circumferences were taken by a singled experienced observer following the protocol described in Lohman et al.<sup>12</sup> Goalkeepers wore shorts and a T-shirt and shoes were removed. Body mass index (BMI, weight/height<sup>2</sup>), the sum of four skinfolds,<sup>13</sup> the sitting height/stature ratio,<sup>14</sup> the waist/hip ratio<sup>15</sup> and the relative arm

span<sup>16</sup> were calculated. Skinfolts were measured to the nearest mm using a Lange caliper (Beta Technology, Ann Arbor, MI, USA). Technical errors of measurement for body mass (0.47 kg), stature (0.27 cm), sitting height (0.31 cm), arm span (0.74 cm), skinfolts (0.47 – 0.72 mm) and circumferences (0.29 – 0.74 cm) were well within the range of several health surveys in the United States and a variety of field surveys.<sup>14</sup>

**Statistical analysis**

The Kolmogorov-Smirnov test was used to examine the degree of normality. Student *t*-tests were used to compare the anthropometric characteristics of the international and non-international goalkeepers. The magnitude of the effects was interpreted as follows: < 0.20 (trivial); 0.20 to 0.59 (small); 0.60 to 1.19 (moderate); 1.20 to 1.99 (large); 2.00 to 3.99 (very large); ≥ 4.00 (extremely large).<sup>17</sup> Alpha was accepted as *p* ≤ 0.05 prior to analyses. Statistical analysis was completed using IBM SPSS Statistics (version 22.0, Chicago, Illinois, USA).

**Results**

International goalkeepers, on average played more games than non-international rink hockey goalkeepers (+7.1 games [24%]; 29.5 ± 7.2 vs. 22.4 ± 14.6 games; *t* = 1.931; *P* = 0.062; *d* = 0.61) (Table 1 and Figure 1)

Compared to non-international, international rink hockey goalkeepers are taller (+3.8 cm [2.2%]; 180.5 ± 7.0 vs. 176.6 ± 4.8 cm; *t* = 1.920; *P* = 0.064; *d* = 0.65). International goalkeepers had lower values of subcutaneous adiposity on the sum of 4 skinfolts compared with non-international goalkeepers (-14.6 mm [32.9%] 44.4 ± 16.6 vs. 59.0 ± 19.7 mm; *t* = -2.119, *P* = 0.042; *d* = 0.76) (Table 2).

International goalkeepers have lower fat content in the triceps (-3.8 mm [28%] 9.9 ± 4.1 vs. 13.7 ± 4.3 mm; *t* = -2.527; *P* = 0.016; *d* = 0.87). Moderate differences existed between groups in the supraspinale skinfold measurement (-6.0 mm [29%] 14.5 ± 6.9 vs. 20.5 ± 10.0 mm; *d* = 0.64), however this did not reach statistical significance (*P* = 0.073) (Figure 1).

**Discussion**

The purpose of this study was to evaluate the anthropometric characteristics of male rink hockey goalkeepers in relation to their competitive level. The results obtained in our study demonstrate that there is some differences in stature between international and non-international goalkeepers, although they are not statistically significant, have less body fat, and compete in a higher volume of games compared with non-international rink hockey goalkeepers. These data are novel and have implications for rink hockey talent identification staff networks attempting to identify goalkeepers based on their physical characteristics.

In the present study, international goalkeepers taller compared to non-international goalkeepers. The sample international goalkeepers are in the 95<sup>th</sup> percentile while non-international goalkeepers are in the 75<sup>th</sup> percentile in relation to the reference population of rink hockey players.<sup>1</sup> However, when comparing our results with professional ice-hockey goalkeepers, the values of our population are substantially lower.<sup>9,10</sup> These results are surprising given the similar competitive level and nature between the sports. Stature can determine the selection of goalkeepers, with those that are taller typically preferred in sports such as handball,<sup>8</sup> ice hockey<sup>9,10</sup> and football.<sup>19</sup> Therefore, determining the extent to which stature impacts upon goalkeeper performance is an avenue for future work.

Despite no significant differences for body mass existing between groups, international goalkeepers have lower values of BMI than the non-international. According to the World Health Organization,<sup>15</sup> the BMI of the international goalkeepers is considered normal (18.5 – 24.9) while non-international goalkeepers are overweight (25.0 – 29.9). However, these data must be interpreted with caution as the inherent limitations associated with BMI, such that that this measure does not account for differences in fat and muscle-mass, which could lead to erroneous and misleading conclusions.<sup>20</sup>

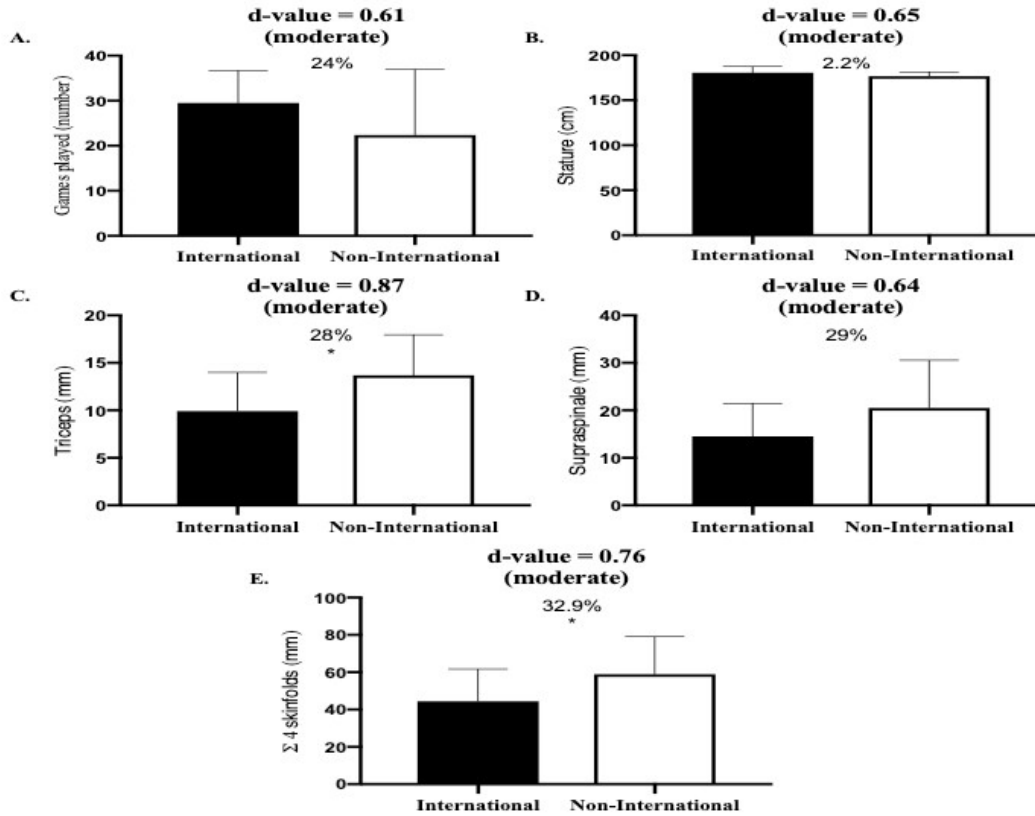
Moderate between-group differences in the sum of the four skinfolts and each of the individual sites were established. Specifically, our results show that non-international goalkeepers have higher values of subcutaneous adiposity, which could be

**Table 1.** Characteristics of the sample and comparisons between international and non-international rink hockey goalkeepers.

Variable	International level (n = 12)	Non international level (n = 23)	Comparison			Effect size
	Mean ± SD	Mean ± SD	t	P	d-value	qualitative
Chronological age (years)	29.9 ± 8.1	28.9 ± 7.2	0.391	0.698	0.18	trivial
Training experience (years)	22.0 ± 7.7	22.4 ± 6.5	-0.159	0.874	0.06	trivial
Training sessions (sessions/week)	3.7 ± 1.7	4.2 ± 0.8	-0.969	0.350	0.33	small
Games played (number)	29.5 ± 7.2	22.4 ± 14.6	1.931	0.062	0.61	moderate

**Table 2.** Descriptive statistics for anthropometric and composite anthropometric variables and comparisons between international and non-international rink hockey goalkeepers.

Variable	International level (n = 12)	Non international level (n = 23)	Comparison			Effect size
	Mean ± SD	Mean ± SD	t	P	d-value	qualitative
Stature (cm)	180.5 ± 7.0	176.7 ± 4.8	1.920	0.064	0.65	moderate
Body mass (kg)	81.0 ± 12.3	81.4 ± 7.5	-0.118	0.908	0.04	trivial
Sitting height (cm)	95.3 ± 3.7	94.7 ± 3.1	0.525	0.603	0.18	trivial
Arm span (cm)	190.3 ± 8.7	186.6 ± 5.6	1.517	0.139	0.10	trivial
Skinfolts :						
Triceps (mm)	9.9 ± 4.1	13.7 ± 4.3	-2.527	0.016	0.87	moderate
Subscapular (mm)	13.3 ± 5.0	15.9 ± 6.1	-1.302	0.202	0.44	small
Supraspinale (mm)	14.5 ± 6.9	20.5 ± 10.0	-1.852	0.073	0.64	moderate
Medial Calf (mm)	6.8 ± 3.3	8.8 ± 3.6	-1.623	0.114	0.55	small
Waist circumference (cm)	84.5 ± 8.6	88.0 ± 7.0	-1.293	0.205	0.45	small
Hip circumference (cm)	97.8 ± 5.7	99.6 ± 4.3	-1.061	0.296	0.36	small
BMI (%)	24.8 ± 2.8	26.1 ± 2.4	-1.486	0.147	0.50	small
Σ 4 skinfolts (mm)	44.4 ± 16.6	59.0 ± 19.7	-2.119	0.042	0.76	moderate
Sitting height/stature ratio (%)	52.8 ± 1.1	53.6 ± 1.5	-1.647	0.109	0.56	small
Waist/hip ratio (%)	86.3 ± 4.6	88.3 ± 4.7	-1.177	0.248	0.41	small
Relative arm span	105.4 ± 2.0	105.7 ± 2.4	-0.310	0.759	0.13	trivial



**Figure 1.** Games played (A), stature (B), triceps (C), supraspinale (D) and,  $\Sigma$  4 skinfolds (E) in international rink hockey goalkeepers (black bars) and non-international rink hockey goalkeepers (white bars). Mean differences between groups (international vs. non-international level). \* Indicates difference between the groups ( $P < 0.05$ ).

explained by the small sample used for the study. Rink hockey goalkeepers must perform dynamic movements, and maintain postural stability, whilst restricted by protective gear and in a crouched position.<sup>5,7,8,21</sup> This additional fat mass may have a major impact on non-international goalkeepers mobility, postural stability and performance.<sup>22,23</sup> The differences in subcutaneous adiposity between groups could be a consequence of the additional games played by the international goalkeepers. It is well documented that higher levels of training and competition exercise is correlated with a reduced body fat percentage.<sup>24,25</sup> However, a casual relationship between the number of games played and the amount of body fat cannot be confirmed. Further studies involving rink hockey goalkeepers should investigate the relationship between body compositions on subsequent performance.

Although the current study provides novel insights into such a specific population, our research has limitations. Specifically, the sample size was relatively small and only represents goalkeepers who had agreed to participate in the study. The use of anthropometry has some degree of measurement error, however is still a feasible tool available for coaches as opposed to expensive technology (e.g., air displacement, DXA etc.).<sup>3</sup> The discrepancy in number of goalkeepers used for each group, could potential confound the statistical inferences drawn from our research. Furthermore, there are disparities in training volume between national teams from different countries, thus the extent to which our findings translate to the rink hockey goalkeepers in other countries are unknown. Anecdotally, it is expected that international goalkeepers are superior to non-international pertaining to performance. However, due to the absence of performance measures, this premise was unable to be confirmed, leaving our data without valid conclusion as to how these measures influence performance. Therefore, this opens an avenue

for future investigative work that could quantify a range of performance metrics alongside taking anthropometric measures in order to determine whether correlations are present between the two variables.

This study assessed the anthropometric characteristics of male rink hockey goalkeepers according to their competitive level (international vs. non-international). In agreement with the hypothesis, our findings suggest that international goalkeepers, play more games, are taller and have less subcutaneous adiposity compared to non-international goalkeepers. The differences found between the two groups could indicate that stature and subcutaneous adiposity can be used for scouting networks as part of a talent identification tool. However, it is key that future studies assess the effect that stature and subcutaneous adiposity have on subsequent performance in rink hockey goalkeepers.

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