European Journal of Sport Sciences
Vol 3 | Issue 2 | May 2024
ISSN 2796-0048

RESEARCH ARTICLE

The Anthropometric and Physical Attribute Profile for Elite Female Ice Hockey Players in China

Qian Zhang[1,*], Lin Yang[2], Naiyuan Tian[3], Tieyi Wang[4], and Todd Edward Burkey[5,*]

ABSTRACT

The performance of ice hockey players is greatly influenced by their physical fitness and strength. This study set out to use various parameters to measure the physical strength of a player. The parameters include body mass (kilograms), height (centimeters), 30 m sprinting, vertical jump (centimeters), standing long jump (centimeters), 1 RM back squat (kilograms), 1 RM bench press (kilograms), pull-ups, 3 km running and body composition. The performance of a sample of 31 ice hockey players from China on the mentioned parameters was compared to the world's top performers in ice hockey games, USA, and it was realized that players with generally lower scores on the factors tend to perform dismally in the game. China has been behind the USA in the world's rankings, and their performances were generally lower compared to their US counterparts. Data was collected by trained experts and analyzed through Microsoft Excel software. The information from this research is basically an eye-opener to the Chinese female ice hockey stakeholders, including players, coaches, and medical personnel, on the areas that need attention to maintain world-class performances.

Keywords: Body composition, female ice hockey, standing long jump, vertical jump.

Submitted: March 26, 2024

Published: May 08, 2024

10.24018/ejsport.2024.3.2.158

[1] *Department of Research, NuoDeFu Sports Co, China.*
[2] *College of Sports Medicine and Physical Therapy, Beijing Sport University, China.*
[3] *China Ice Sports College, Beijing Sport University, China.*
[4] *Chinese Basketball Institute, Beijing Sport University, China.*
[5] *Boardman High School, USA.*

Corresponding Authors:
e-mail: qian.zhang@palmer.edu;
e-mail: todd.burkey@boardmanschools.org

1. Introduction

Ice hockey is a long-duration sport with varied levels of intensity, and it demands athletes to fulfill high requirements of muscular strength, endurance, power, and biomechanical fitness (Montgomery, 1988).

The sport of ice hockey has become a major female sport worldwide in the past few decades (Burns, 2016; Mike, 2018). According to the numbers from the International Ice Hockey Federation (IIHF), there were 205, 674 females registered to play ice hockey, and 39 countries had established female hockey programs, who attended both the 2019 IIHF World Women's Hockey Competition and U18 tournaments and training camps (IIHF, n.d.-b).

For the development of hockey, which consists of intensive and complicated biomechanics of the human body, it is paramount to examine the physical aspects of these elite female athletes' physical fitness and sports performance. The research conducted by Boland and Delude comprehensively assessed physiological attributes and off-ice testing variables regarding the National Collegiate Athletic Association NCAA Division I female athletes (Boland *et al.*, 2019). The study found that the percentage of body fat mass (%Fat) correlates negatively with skating times and produces a greater drop-off between repeated sprints (Boland *et al.*, 2019). Those results echoed the findings of Gilenstam *et al.* a study conducted on the physiological aspects involving Anthropometrics of height and weight, body composition related to muscle strength, and aerobic performance (Gilenstam *et al.*, 2011). They assessed the on-ice performance of agility, acceleration, and speed in women's and men's ice hockey, concluding that on-ice acceleration and speed had a significant positive correlation to body weight (Gilenstam *et al.*, 2011). Also, similar results were revealed from the study of Potteiger *et al.* (2010) to examine the body mass and composition, anaerobic power, muscular strength correlation, and on-ice skating speed in Division I men's hockey athletes.

Various research has been conducted worldwide regarding the physical characteristics of female ice hockey players. Recent research with elite athletes in the US, Canada, Finland, France, Japan, and others has examined physical anthropometrics and the correlation to team success in international competitions (Ransdell & Murray, 2011; Ransdell *et al*., 2013). These detailed studies revealed that there was a correlation between a team's success and such measurements as vertical jump, long jump, 4-jump average, elasticity ratio, pull-up, aerobic fitness, body mass, and body composition (%fat) (Ransdell & Murray, 2011; Ransdell *et al*., 2013).

China as a country was dominant in Asian ice hockey tournaments back in the 1990s. In the recent 2022 Beijing Winter Olympics and IIHF World Championship games, the Chinese women's ice hockey team competed historically well and moved their world ranking from 20th to 16th (IIHF, n.d.-a).

However, there is limited information regarding Chinese ice hockey players, such as their anthropometrics, movement ability, strength and power metrics, and on-ice performances. It is necessary to do a detailed baseline test of their physical profile, which will provide coaches, athletes, sports medicine personnel, strength and conditioning coaches, and on-ice performance specialists with a better understanding of the physical demands of ice hockey players. This will facilitate an improvement in training programs and educate as to any current weakness in on-ice and off-ice testing (Bracko & George, 2001; Ransdell *et al*., 2013). The primary purpose of this retrospective and descriptive study was to provide detailed physical anthropometrics for elite-level Chinese female ice hockey players, which has never been done before. Additionally, to enhance overall performance, this research provides a fundamental framework for future researchers to explore the connection between training and physical condition in female ice hockey.

2. Method

2.1. Subjects

Thirty-one female athletes were selected from Women's Ice Hockey Elite Camp, where they were training for potential opportunities to be identified by professional coaches and officials in an attempt to earn a spot on the team that will compete for the World Championship game. Twenty-three of these athletes participated in this research. 15 out of 23 athletes from this camp had previous world championship tournament experience. Before signing the consent form, all participants were verbally informed about the experiment procedures and potential risks. Approval was received from the Head Coach, Coordinator of Sports Performance, and Head Team Doctor. Identities were removed from the data to ensure confidentiality. Demographic information is provided in Table I.

TABLE I: Physical Profile of the Participants

Fitness characteristics (n = 23)	Elite female ice hockey players (M ± SD and range [low to high value])
30-meter sprint (s)	4.93 ± 0.14 (4.64–5.17)
Vertical jump (cm)	37.53 ± 4.16 (30.66–48.67)
Standing long jump (cm)	202.69 ± 13.03 (182.30–231.40)
Pull-ups (repetitions)	5.26 ± 2.71(3.00–13.00)
Bench press (kg)/body weight (%)	49.65 ± 6.00 (38.00–61.00)/0.77 ± 0.09 (0.55–0.92)
Back squat (kg)/body weight (%)	85.74 ± 14.97 (63.00–132.00)/1.32 ± 0.17 (1.08–1.62)

2.2. Physical Condition Assessment

To examine the basic physicality of elite female hockey athletes in China, anthropometric and physical performance tests were considered as the primary evaluation tools. Within the experiment, athletes tested in the following 10 parameters: body mass, height, 30 m sprinting, vertical jump, standing long jump, 1 RM back squat, 1 RM bench press, pull-ups, 3 km running, and body composition (Harman & Garhammer, 2008). After the test of 1 RM bench press and 1 RM back squat complete, their data was divided by body mass and multiplied by 100 to receive their relative upper body strength and lower body strength (based on similar calculations in other studies).

2.3. Procedure

Testing was administered at Lan Di training facility in Beijing, China. All the tests were performed, and data was collected by certified individuals. The standardized procedures were completed over a two-day period. Athletes were instructed to fully rest 24 hours prior to preparing for the test. Fifteen minutes prior to the, a general dynamic warm-up was performed. Day one consisted of 30-meter sprints, 1 RM back squat, and 1 RM bench press. Vertical jump, standing long jump, and pull-up were done on the second day. Anthropometric parameters (height, weight, and body composition) were measured in the early morning of the first day. The athletes were instructed to have no water or food intake prior to anthropometric measuring to ensure validity.

All the tests were selected based on the previous research. Also, those tests were selected from the recommendations of the National Strength and Conditioning Association to represent athlete's strength, power, speed, body composition, and endurance (Harman & Garhammer, 2008; Harman, 2008; Ransdell & Murray, 2011; Ransdell *et al*., 2013).

2.3.1. Anthropometric Measures

Height was measured by athletes standing against the wall. Testers used a stadiometer to measure the distance from the bottom of the foot to the top tip of the head. Weight and body composition were measured through the Inbody 770 (Beverly Hills, California, USA) unit according to the manufacturer's instruction.

2.3.2. 30-Meter Sprint

Off-ice speed was measured through a 30-meter sprint (Janot *et al*., 2015; Matthews *et al*., 2010). The athlete started with a 10-minute warm-up consisting of light jogging and dynamic stretching on the indoor track. Each athlete was allowed two trials, and testers collected the best record of these two trials through a Smart Speed timing system (Fusion Sport, Milton, QLD, Australia). There was a 5-minute rest interval between each trial to make sure athletes received full recovery.

2.3.3. Standing Long Jump

The horizontal power of the lower extremity was measured through the standing long jump (Harman & Garhammer, 2008; Harman, 2008; Ransdell & Murray, 2011; Ransdell *et al*., 2013). All athletes were tested on the track of the indoor stadium. The rope ruler was placed alongside the jumping area. The starting point was marked with tape, and testing candidates were behind the starting point. Athletes were instructed to perform a front jump to the best of their ability, and a marker was placed behind the athlete's heel. Testers recorded the best result to the nearest 0.1 cm from 3 trials.

2.3.4. Vertical Jump

The vertical jump test could also measure the lower extremity's vertical power (Harman & Garhammer, 2008; Harman, 2008; Ransdell & Murray, 2011; Ransdell *et al*., 2013). A smart jump board (Fusion Sport, Milton, QLD, Australia) was used to determine the jumping height for the participants. Athletes were instructed to stand on the jumping board, hands on the side of the hips. The athlete was instructed to start from a flexed knee and dorsiflexed ankle position. Then, jump vertically as high as possible with an upward arm swing. Athlete started by bending the knees and dorsiflexing their ankles, then jumping vertically as high as possible with an arm swing upward. Each athlete was allowed a couple of warm-up attempts before the trials. There was a one-minute rest interval between trails. The best measures of 3 jumps were recorded to the nearest 0.1 cm.

2.3.5. Lower Extremity Muscular Strength

A 1 RM back squat (kilograms) was used to assess the strength of the lower body as research shows that a one-repetition maximum (1 RM) back squat could be used to determine maximal strength, which also highly correlated with a variety of athletic performance (de Hoyo *et al*., 2016; Hammami *et al*., 2018). The athlete was allowed to do 1 set of 5–10 repetitions of a warm-up of 60% of the maximum load recommended before the test. For safety purposes, two testers were spotted at each side of the squat area, and one trained tester was spotted behind the athlete performing the test. Athletes were instructed to stand with their feet shoulder-width apart, and the top of their feet were allowed to rotate between 15–30 degrees externally. The athletes started the test by performing one back squat with 85% of their recent maximum load, and they were allowed to add weight in their favor until they failed. The athletes had to squat below the level of the femur parallel to the floor using a proper technique. Any inability to maintain the posture was considered a failure. Athletes were allowed to use weight belts as protection for the test. Each athlete has 3 trials for one selected weight. The maximum number of repetitions without failure was recorded. The relative lower body strength was calculated by 1 RM back squat divided by body mass, multiplied by 100, and recorded as a percentage.

2.3.6. Upper Extremity Muscular Strength

A 1 RM bench press (kilograms) was used to assess upper extremity strength (Harman & Garhammer, 2008; Harman, 2008; Ransdell & Murray, 2011). Athletes were allowed to do 1 warm-up set of

5–10 repetitions with different loads and 2 heavier sets of 3–5 repetitions with heavier weights. Athletes were instructed to perform a bench press starting with 85% of their recent maximum load. They were allowed to add weight in their favor until they failed. Any inability to complete the test or improper technique would cause a failure. The athlete's relative upper extremity strength was calculated by 1 RM bench press divided by body mass, multiplied by 100, and recorded as a percentage.

2.3.7. Upper Extremity Muscular Strength and Endurance

Upper extremity strength and endurance were assessed by the athlete completing a maximum number of pull-ups (Ransdell & Murray, 2011; Ransdell *et al*., 2013). The athletes were instructed to perform overhead pull-ups on the pull-up bar. The maximum number of pull-ups with the proper form of chin above the bar and full repetitions were recorded.

2.4. Descriptive Data Analyses

Means and SDs were calculated using Microsoft Excel to examine arthrometric and physical abilities (v16.40).

3. Results

Participants in this sample had mean body weight and height of 65.12 kg and 169.15 cm, respectively, with standard deviations of 7.78 and 5.43. Subjects ranged in height from 157.4 cm to 179.8 cm for the tallest and shortest, respectively. The smallest weight is 52.5 kg, while the highest is 82.4 kg. The average percentage of body fat revealed by the body composition test is 22.45 percent, with a standard deviation of 4.81. 31.3% is the highest, and 10.5% is the lowest body fat percentage. Results for fitness characteristics of female ice hockey athletes are shown in Table I.

4. Discussion

Research in sports and kinesiology regarding female ice hockey was scarce. Limited research found elite female ice hockey players from the USA were the subject of physical studies by earlier researchers, either at the professional or college levels.

As far as we know, this is the first anthropometric and physical characteristics research of Chinese female hockey athletes. This study established a foundation for future research because no one or any organization had ever previously investigated any of China's elite female athletes. Important findings from this research include: 1. Regarding height, weight, and body fat percentage, sketch out the typical physical characteristics of an outstanding Chinese female ice hockey player. 2. The entire exam thoroughly reviewed the physical attributes of female ice hockey players, including strength, agility, endurance, and speed.

According to the IIHF (International Ice Hockey Federation), female ice hockey in the USA ranks No. 2 globally, and China ranks No.14 (IIHF, n.d.-c). Comparing anthropometric and physical characteristics, it is predictable that elite female ice hockey athletes from the USA have better physical condition than those in China. Ice hockey as a sport not only contains complex plays and sets, but it is also a highly intensive sport associated with body contact and physical attributes. Athletes need to train their bodies both on ice and off ice.

Elite Chinese female ice hockey players' average height of 169.15 cm is comparable to that of elite American female athletes, according to research by the Ransdell research group (Ransdell & Murray, 2011). Elite Chinese female ice hockey players' body weight and body fat percentage suggested room for improvement. Evaluating upper body muscular strength and endurance in terms of pull-ups and 1 RM bench, Chinese female ice hockey athletes average 5.30 in pull-ups and 49.65 (kg). The data from research on elite USA female ice hockey athletes' pull-up average of 10.10 and bench press average of 65.30 (kg) (Ransdell & Murray, 2011). One of the possible issues is the psychological aspect of Chinese females, which may make them unwill to develop a "Masculine" physique (Bona, 2016). In Chinese culture, women are considered gentle and slight and should be protected by men. They tend not to develop hypertrophy in their upper body because they want a lean outer appearance. Female athletes in China prefer cardiovascular conditioning as their major training method.

The lower extremity muscular power was measured through vertical and standing long jumps. Chinese athletes' standing long jump average is 202.69 cm, while the vertical jump average is 37.53 cm. The standing long jump average for elite female American ice hockey players is 214.80 cm, and the vertical jump average is 50.30 cm, according to Ransdell Research Group. (Ransdell & Murray, 2011). The possible reason is that elite USA athletes have developed more fast twitch muscle fibers, and Chinese athletes have developed more slow twitch fibers. However, there is no testing regarding lower body muscular endurance, so we cannot determine if there is a muscle fiber type difference, which potentially causes the disparity between Chinese athletes and elite USA athletes.

There was limited research using a 30-meter sprint as an off-ice test for speed. The research used a 20-meter sprint and 40-yard dash (36.5 meters) to test the speed of female ice hockey athletes (Henriksson *et al*., 2016; Janot *et al*., 2015). However, the results were incomparable since different distances were utilized. The length of a hockey rink is 197 feet (60 meters), which is double the distance of 30 meters, so it is reasonable to test athletic speed with a 30-meter sprint off-ice (O'Halloran, 2023).

Ice hockey is a sport with intensive speed and body contact. Research has studied high-intensity skating in top-class ice hockey match-play in relation to training status and muscle damage (Lignell *et al*., 2018; Matthews *et al*., 2010). Considering the finding of below-average upper and lower body strength and lower body power, it would be interesting to study the injury rate for those athletes further since musculature can protect against injury for the human body. Also, with the fat percentage of Chinese female ice hockey athletes being higher than elite USA athletes, more research could be done regarding the direct trauma soft tissue injury rates between these two groups since fat tissue is considered to be a shock absorber during direct contact.

This study examined off-ice performance of basic anthropometric, upper body and lower body muscular strength, and power and speed. However, other factors could also have affected the performance of those athletes. Those factors are aerobic and anaerobic fitness, upper-body and lower-body muscular endurance, agility, coordination, proprioception, and balance (Paul *et al*., 2016; O'Halloran, 2023). An important consideration is that we did not test the correlation between their off-ice test and on-ice performance.

5. Practical Applications

This is the first study regarding elite Chinese female ice hockey players and their general physical fitness levels and anthropometrics. China made a significant financial investment in ice hockey, and Beijing had the opportunity to host the Winter 2022 Olympics. Team China achieved unprecedented success compared to past Olympic games and IIHF World Championship games for both men's and women's teams and boosted their world rank. This study provides coaches, performance specialists, strength conditioning coaches, and sports medicine professionals with an overall profile of elite Chinese female ice hockey players. This may help those professionals understand their athletes' strengths and weaknesses and facilitate improvement in their training programs to build their athletes better. The deficiencies revealed in this study are that national team coaches could utilize this information to improve their current preparation for the next Olympic training cycle. The most critical application is that this study provides a guideline for the Chinese ice hockey community to realize the physical gap between elite Chinese female athletes and the elite athletes in the world. Now, all coaches and specialists can have a general idea of the athletes' overall fitness level. The knowledge of this information may awaken minds and provide more ideas and instincts in their daily practice.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

References

Boland, M., Delude, K., & Miele, E. M. (2019). Relationship between physiological off-ice testing, on-ice skating, and game performance in division I female ice hockey players. *The Journal of Strength and Conditioning Research*, *33*(6), 1619–1628.

Bona, E. (2016, July 29). Why are female athletes criticised for developing a masculine physique? *Vice*. https://www.vice.com/en_us/article/pgnav7/why-are-female-athletes-criticised-for-developing-a-masculine-physique.

Bracko, M. R., & George, J. D. (2001). Prediction of ice-skating performance with off-ice testing in women's ice hockey players. *The Journal of Strength and Conditioning Research*, *15*(1), 116–122.

Burns, K. C. (2016). *The effect of professional sports success on youth participation: Growing the game of women's ice hockey* [Unpublished senior's thesis]. University of South Carolina.

de Hoyo, M., Gonzalo-Skok, O., Sañudo, B., Carrascal, C., Plaza-Armas, J. R., Camacho-Candil, F., *et al.* (2016). Comparative effects of in-season full-back squat, resisted sprint training, and plyometric training on explosive performance in U-19 elite soccer players. *The Journal of Strength and Conditioning Research*, *30*(2), 368–377.

Gilenstam, K. M., Thorsen, K., & Henriksson-Larsén, K. B. (2011). Physiological correlates of skating performance in women's and men's ice hockey. *The Journal of Strength and Conditioning Research*, *25*(8), 2133–2142.

Hammami, M., Negra, Y., Billaut, F., Hermassi, S., Shephard, R. J., & Chelly, M. S. (2018). Effects of lower-limb strength training on agility, repeated sprinting with changes of direction, leg peak power, and neuromuscular adaptations of soccer players. *The Journal of Strength and Conditioning Research*, *32*(1), 37–47.

Harman, E. (2008). Principles of test selection and administration. In T. R. Baechle, R. W. Earle (Eds.), *Essentials of strength training and conditioning* (2nd ed., pp. 238–247). Human Kinetics.

Harman, E., & Garhammer, J. (2008). Administration, scoring, and interpretation of selected tests. In T. R. Baechle, R. W. Earle (Eds.), *Essentials of strength training and conditioning* (2nd ed., pp. 250–292). Human Kinetics.

Henriksson, T., Vescovi, J. D., Fjellman-Wiklund, A., & Gilenstam, K. (2016). Laboratory-and field-based testing as predictors of skating performance in competitive-level female ice hockey. *Open Access Journal of Sports Medicine*, *7*, 81–88.

IIHF (n.d. -a). *IIHF China*. International Ice Hockey Federation. https://www.iihf.com/en/associations/334/china.

IIHF (n.d. -b). *IIHF Sports & Development*. International Ice Hockey Federation. https://www.iihf.com/en/static/5068/women-s-hockey.

IIHF (n.d. -c). *IIHF World Ranking*. International Ice Hockey Federation. https://www.iihf.com/en/worldranking.

Janot, J. M., Beltz, N. M., & Dalleck, L. D. (2015). Multiple off-ice performance variables predict on-ice skating performance in male and female division III ice hockey players. *Journal of Sports Science and Medicine*, *14*(3), 522–529.

Lignell, E., Fransson, D., Krustrup, P., & Mohr, M. (2018). Analysis of high-intensity skating in top-class ice hockey match-play in relation to training status and muscle damage. *The Journal of Strength and Conditioning Research*, *32*(5), 1303–1310.

Matthews, M. J., Comfort, P., & Crebin, R. (2010). Complex training in ice hockey: The effects of a heavy resisted sprint on subsequent ice-hockey sprint performance. *The Journal of Strength and Conditioning Research*, *24*(11), 2883–2887.

Mike, M. (2018, August 20). Women's hockey is growing strong. *The Ice Garden*. https://www.theicegarden.com/2018/9/5/17759722/growing-strong-womens-hockey-growing-popularity-growth-usa-pyeongchang-nwhl-cwhl.

Montgomery, D. L. (1988). Physiology of ice hockey. *Sports Medicine (Auckland, N.Z.)*, *5*(2), 99–126.

O'Halloran, M. (2023, August 18). Hockey rink dimensions, size, diagram. *Sports, Feel Good Stories*. https://www.sportsfeelgoodstories.com/hockey-rink-dimensions-size-diagram/.

Paul, D. J., Gabbett, T. J., & Nassis, G. P. (2016). Agility in team sports: Testing, training and factors affecting performance. *Sports Medicine*, *46*(3), 421–442.

Potteiger, J. A., Smith, D. L., Maier, M. L., & Foster, T. S. (2010). Relationship between body composition, leg strength, anaerobic power, and on-ice skating performance in division I men's hockey athletes. *The Journal of Strength and Conditioning Research*, *24*(7), 1755–1762.

Ransdell, L. B., & Murray, T. (2011). A physical profile of elite female ice hockey players from the USA. *The Journal of Strength and Conditioning Research*, *25*(9), 2358–2363.

Ransdell, L. B., Murray, T. M., & Gao, Y. (2013). Off-ice fitness of elite female ice hockey players by team success, age, and player position. *The Journal of Strength and Conditioning Research*, *27*(4), 875–884.