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**A COMPARISON OF FIELD AND LABORATORY TESTING OF  
SPORTS SPECIFIC FITNESS FOR FEMALE  
FIELD HOCKEY PLAYERS**

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## ABSTRACT

There are many methods to measure the physical fitness of athletes, including tests that can be applied in the field or in the laboratory. Much of the recent research with regard to fitness of team sport players has been undertaken using laboratory testing to measure aerobic power, anaerobic power and capacity, strength and flexibility. Field tests are an alternative method to measure the fitness of players without the expense, time and expertise required for the laboratory testing, especially in developing countries.

The purpose of this study is to establish procedures for the application of contemporary sports science practice for Indonesian female field hockey players, including determination of the precision of field tests of the physical and performance characteristics of field hockey players in Indonesia; determination of the physical and performance characteristics of Indonesian female field hockey players; identification of the performance demands and distance covered during competitive field hockey at the national level in Indonesia; comparison of the physical and performance characteristics of national level female field hockey players in Indonesia with those of club level players in Australia; and determination of the relationships between field and laboratory tests of physiological performance capacity for field hockey.

This study was conducted on 26 Indonesian and 11 Australian female field hockey players. The mean values for age, height, mass, BMI and skinfold thickness of the Indonesian players were  $22.0 \pm 3.4$  years,  $156.3 \pm 4.9$ cm,  $51.2 \pm 6.2$ kg,  $20.9 \pm 2.0$ kg·m<sup>-2</sup>, and  $99.4 \pm 17.9$ mm, respectively. The mean values for VO<sub>2</sub>max (20m srt), VJ, leg power, SBJ, sit and reach, and 40m sprint were  $38.7 \pm 3.2$ ml·kg<sup>-1</sup>·min<sup>-1</sup>,  $39.3 \pm 4.3$ cm,  $70.7 \pm 1.0$ kg·m·sec<sup>-1</sup>,  $183.3 \pm 17.0$ cm,  $+14.7 \pm 5.7$ cm,  $6.99 \pm 0.39$ s, respectively.

The mean HR values at the end of the first and second half of a game of field hockey were  $171.0 \pm 8.7$ bpm and  $161.3 \pm 18.2$ bpm, respectively. The mean values for blood lactate concentration at the end of the first and second half of play were  $5.3 \pm 1.2$ mmol·L<sup>-1</sup> and  $5.1 \pm 1.7$ mmol·L<sup>-1</sup>, respectively. The mean total distance covered by the players during the complete game was  $2841.8 \pm 432.2$ m. The mean time spent walking and at more than walking pace (jogging, running and sprinting) during the game were 46:08min and 24:18min, respectively. The mean values for temperature and humidity were  $38.2 \pm 4.1$ °C and  $57.5 \pm 9.8$ %, respectively.

The mean values for age, height, mass, BMI and skinfold thickness of the Australian players were  $24.0 \pm 3.9$  years,  $165.7 \pm 3.4$ cm,  $64.8 \pm 4.1$ kg,  $24.0 \pm 1.6$ kg·m<sup>-2</sup>, and  $77.9 \pm 17.3$ mm, respectively. The mean values for VO<sub>2</sub>max (20m srt), VJ, leg power, SBJ, sit and reach, and 40m sprint were  $42.1 \pm 4.7$ ml·kg<sup>-1</sup>·min<sup>-1</sup>,  $37.5 \pm 4.4$ cm,  $87.2 \pm 7.0$ kg·m·sec<sup>-1</sup>,  $174.9 \pm 18.3$ cm,  $+11.2 \pm 6.4$ cm, and  $6.46 \pm 0.30$ s, respectively. The mean values for VO<sub>2</sub>max (treadmill running), isokinetic strength, 10 sec maximal ergometer sprint test, and 5 x 6 sec repeat effort cycle ergometer test were  $46.3 \pm 3.8$ ml·kg<sup>-1</sup>·min<sup>-1</sup>,  $88.2 \pm 10.6$ N·m (left hamstring),  $58.1 \pm 13.8$ N·m (right hamstring),  $152.9 \pm 27.0$ N·m (left quadriceps),  $152.6 \pm 19.2$ N·m (right quadriceps),  $58.6 \pm 6.9$ % (left hamstring/quadriceps ratio),  $57.9 \pm 5.3$ % (right hamstring/quadriceps ratio),  $103.7 \pm 10.8$ J·kg<sup>-1</sup> (total work),  $12.5 \pm 1.0$ W·kg<sup>-1</sup> (peak power),  $261.2 \pm 25.6$ J·kg<sup>-1</sup> (total work),  $9.3 \pm 5.4$ % (work decrement) and  $5.7 \pm 3.8$ % (power decrement),

respectively. The mean values for temperature and humidity were  $11.8 \pm 1.8^{\circ}\text{C}$  (outdoor),  $20.5 \pm 3.3^{\circ}\text{C}$  (indoor),  $60.4 \pm 2.6\%$  (outdoor) and  $50.6 \pm 6.8\%$  (indoor), respectively.

There were no significant differences between Indonesian and Australian players in age,  $\text{VO}_2\text{max}$  (20m SRT), VJ, SBJ, S&R, and acceleration measurements ( $p > 0.05$ ). However, there were significant differences between Indonesian and Australian players in height, mass, BMI, skinfold thickness, leg power, speed, and combined acceleration and speed measurements ( $p < 0.05$ ). The Australian players were significantly taller and heavier than the Indonesian players. The Indonesian players had higher values for the sum of 7 skinfolds than the Australian players. The Australian players had significantly higher values for leg power than the Indonesian players. The Australian players were significantly faster than the Indonesian players.

Among the Australian players there was a significant difference between the  $\text{VO}_2\text{max}$  value during treadmill running and the  $\text{VO}_2\text{max}$  estimated from the 20m srt ( $t = 0.003$ ,  $p < 0.05$ ). There was a significant correlation between the  $\text{VO}_2\text{max}$  value during treadmill running and the  $\text{VO}_2\text{max}$  estimated from the 20m srt ( $r = 0.66$ ,  $p < 0.05$ ). The correlations between the leg power (estimated from the vertical jump test) and the isokinetic power of the quadriceps muscle group was not significant ( $p > 0.05$ ). The correlation between the running speed (estimated from the combined acceleration and speed score from the 40m sprint test) and the peak power from the 10s maximal ergometer sprint test ( $r = -0.55$ ) was not significant ( $p > 0.05$ ).

In conclusion, the present study found that the Indonesian female field hockey players (at the national level) were comparable to the Australian female field hockey players (at the club level) in some physical and performance test results. However, they were also different on other physical and performance characteristic measurements, with the Indonesian players generally have lower values, for other performance measurements.

## CONTENTS PAGE

	PAGE NO.
TITLE PAGE.....	i
ACKNOWLEDGEMENTS.....	ii
ABSTRACT.....	iii
CERTIFICATE OF COMPLETION OF REQUIREMENTS.....	v
CERTIFICATE OF AUTHORSHIP OF THESIS.....	vi
CONTENTS PAGE.....	vii
LIST OF TABLES.....	xiii
LIST OF FIGURES.....	xv
ABBREVIATIONS.....	xvii
<b>CHAPTER 1 – LITERATURE REVIEW.....</b>	<b>1</b>
INTRODUCTION.....	1
HISTORICAL BACKGROUND OF FIELD HOCKEY.....	1
FIELD HOCKEY IN INDONESIA.....	3
TECHNICAL DEVELOPMENT OF FIELD HOCKEY.....	4
PHYSIOLOGICAL RESPONSES TO PLAYING FIELD HOCKEY.....	6
PHYSICAL AND PERFORMANCE CHARACTERISTICS OF FIELD HOCKEY PLAYERS.....	8
Age.....	8
Height.....	11
Mass.....	15
Body Mass Index (BMI).....	18
Skinfold Thickness.....	21
Percentage Body Fat.....	24
Somatotype.....	27
Maximal Oxygen Uptake (VO <sub>2</sub> max).....	29
Strength.....	33
<i>Grip Strength</i> .....	33
<i>Isokinetic Strength</i> .....	35
Anaerobic Power Capacity.....	35
<i>Standing Broad Jump</i> .....	36

<i>Stairclimb Velocity</i> .....	36
<i>Vertical Jump</i> .....	38
<i>Wingate Test</i> .....	40
<i>10 Seconds Maximal Ergometer Sprint</i> .....	40
<i>5 x 6 Seconds Repeat Effort Test (Cycle Ergometer)</i> .....	42
Acceleration and Speed.....	44
Flexibility.....	45
SUMMARY OF THE LITERATURE REVIEW.....	47
PURPOSE OF THE STUDY.....	49
LIMITATIONS AND DELIMITATIONS.....	50
<b>CHAPTER 2 – METHODS</b> .....	<b>51</b>
OVERVIEW.....	51
The Indonesian Female Field Hockey Players.....	51
Subjects.....	51
Procedures.....	51
Physical Characteristics .....	52
Age.....	52
Height.....	52
Mass.....	52
BMI.....	52
Skinfold Thickness.....	53
Physical Performance Tests .....	53
VO <sub>2</sub> max.....	53
Vertical Jump.....	56
Standing Broad Jump.....	56
Sit and Reach.....	56
Acceleration and Speed.....	57
Game Analysis.....	57
Heart Rate.....	58
Blood Lactate.....	58
Distance Covered.....	58
Time Spent Walking/Running.....	59

Environmental Conditions.....	59
Statistical Analysis.....	59
The Australian Female Field Hockey Players.....	60
Subjects.....	60
Procedures.....	60
Physical Characteristics .....	60
Age.....	60
Height.....	60
Mass.....	61
BMI.....	61
Skinfold Thickness.....	61
Physical Performance Tests .....	61
<i>Field Tests</i> .....	61
VO <sub>2</sub> max.....	61
Vertical Jump.....	62
Standing Broad Jump.....	62
Sit and Reach.....	62
Acceleration and Speed.....	62
<i>Laboratory Tests</i> .....	63
VO <sub>2</sub> max.....	63
Isokinetic Strength and Power.....	65
10 Seconds Maximal Ergometer Sprint.....	66
5 x 6 Seconds Repeat Effort Test (Cycle Ergometer).....	66
Environmental Conditions.....	68
Statistical Analysis.....	68
<b>CHAPTER 3 – RESULTS.....</b>	<b>69</b>
The Indonesian Female Field Hockey Players.....	69
Physical Characteristics .....	69
Age.....	69
Height.....	69
Mass.....	69
BMI.....	69
Skinfold Thickness.....	69



Physical Performance Tests .....	70
VO <sub>2</sub> max.....	70
Vertical Jump.....	70
Standing Broad Jump.....	70
Sit and Reach.....	71
Acceleration and Speed.....	71
Game Analysis.....	71
Heart Rate.....	71
Blood Lactate.....	72
Distance Covered.....	72
Time Spent Walking/Running.....	75
Environmental Conditions.....	75
The Australian Female Field Hockey Players.....	77
Physical Characteristics .....	77
Age.....	77
Height.....	77
Mass.....	77
BMI.....	77
Skinfold Thickness.....	77
Physical Performance Tests .....	78
<i>Field Tests</i> .....	78
VO <sub>2</sub> max.....	78
Vertical Jump.....	78
Standing Broad Jump.....	78
Sit and Reach.....	78
Acceleration and Speed.....	78
<i>Laboratory Tests</i> .....	79
VO <sub>2</sub> max.....	79
Isokinetic Strength.....	79
Isokinetic Power.....	80
10 Seconds Maximal Ergometer Sprint.....	81
5 x 6 Seconds Repeat Effort Test (cycle Ergometer).....	81
Environmental Conditions.....	81

Comparison of Physical Characteristics and Physical Performance Test Results between the Indonesian and Australian Female Field Hockey Players.....	84
Physical Characteristics .....	84
Physical Performance Test Results .....	85
Comparison of Field and Laboratory Tests of the Australian Female Field Hockey Players.....	100
<b>CHAPTER 4 – DISCUSSION.....</b>	<b>104</b>
Physical and Physiological Demands of Playing Field Hockey Game at the National Level in Indonesia.....	104
Heart Rate.....	104
Blood Lactate.....	104
Distance Covered.....	105
Time Spent Walking/Running.....	106
Comparison of Physical Characteristics and Physical Performance Field Test Results between the Indonesian and Australian Female Field Hockey Players.....	107
Physical Characteristics.....	107
Age.....	107
Height.....	107
Mass.....	108
BMI.....	109
Skinfold Thickness.....	110
Physical Performance Tests.....	110
Vertical Jump.....	110
Standing Broad Jump.....	112
Sit and Reach.....	112
VO <sub>2</sub> max.....	113
Acceleration and Speed.....	113
Physical Performance Characteristics of the Australian Female Field Hockey Players Measured from Laboratory Tests.....	116
VO <sub>2</sub> max.....	116

Isokinetic Strength.....	116
Isokinetic Power.....	117
10 Seconds Maximal Ergometer Sprint.....	118
5 x 6 Seconds Repeat Effort Test (Cycle Ergometer).....	119
Environmental Conditions.....	121
Comparison of Field and Laboratory Tests of the Australian Female Field Hockey Players.....	122
CONCLUSIONS.....	123
RECOMMENDATIONS FOR FURTHER RESEARCH.....	124
REFERENCES.....	125

## LIST OF TABLES

<b>Table 1:</b> Mean values for age (years) of field hockey players derived from literature reports.	9
<b>Table 2:</b> Mean values for body height (cm) of field hockey players derived from literature reports.	12
<b>Table 3:</b> Mean values for body mass (kg) of field hockey players derived from literature reports.	16
<b>Table 4:</b> Mean values for BMI ( $\text{kg}\cdot\text{m}^{-2}$ ) of field hockey players derived from literature reports.	19
<b>Table 5:</b> Mean values for sum of skinfolds (mm) of field hockey players derived from literature reports.	23
<b>Table 6:</b> Mean values for body fat (%) of field hockey players derived from literature reports.	25
<b>Table 7:</b> Mean values for somatotype of field hockey players derived from literature reports.	28
<b>Table 8:</b> Mean values for $\text{VO}_2\text{max}$ ( $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ) of the field hockey players derived from literature reports.	31
<b>Table 9:</b> Mean values for grip strength (kg) and isokinetic strength ( $\text{N}\cdot\text{m}\cdot\text{kg}^{-1}$ ) of field hockey players derived from literature reports.	34
<b>Table 10:</b> Mean values for standing broad jump (cm) and stairclimb velocity ( $\text{m}\cdot\text{s}^{-1}$ ) of field hockey players derived from literature reports.	37
<b>Table 11:</b> Mean values for vertical jump (cm) of field hockey players derived from literature reports.	39
<b>Table 12:</b> Mean values for 10 seconds work ( $\text{J}\cdot\text{kg}^{-1}$ ) and peak power ( $\text{W}\cdot\text{kg}^{-1}$ ) of field hockey players derived from literature report.	41
<b>Table 13:</b> Mean values for 5 x 6 seconds maximal ergometer sprint ( $\text{J}\cdot\text{kg}^{-1}$ ), work decrement (%) and power decrement (%) of field hockey players derived from literature report.	43

<b>Table 14:</b> Mean values for acceleration and speed (s) of field hockey players derived from literature report.	46
<b>Table 15:</b> Mean values for physical and performance characteristics of field hockey players derived from literature reports.	48
<b>Table 16:</b> Skinfold measurements on the female field hockey players (adapted from Norton et al. 2000).	54
<b>Table 17:</b> Physical characteristics, physical performance test results, and game analysis results of the Indonesian female field hockey players.	76
<b>Table 18:</b> Physical characteristics and physical performance test results of the Australian female field hockey players.	83
<b>Table 19:</b> The weighted mean values for physical characteristics and physical performance test results for female field hockey players from the literature review and from the present study.	115
<b>Table 20:</b> The weighted mean values for physical performance tests results for female field hockey players from the literature review and from the present study.	120

## LIST OF FIGURES

<b>Figure 1:</b> The Indonesian female field hockey players performing the 20 metre shuttle run test.	55
<b>Figure 2:</b> An Australian female field hockey player performing the VO <sub>2</sub> max test in the laboratory.	64
<b>Figure 3:</b> An Australian female field hockey player performing an isokinetic strength and power in the laboratory.	67
<b>Figure 4:</b> Mean heart rate responses of the athletes to playing field hockey.	73
<b>Figure 5:</b> Lactic acid responses of the athletes to playing field hockey ( $X \pm SD$ ).	74
<b>Figure 6:</b> Values for age (years) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	86
<b>Figure 7:</b> Values for height (cm) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	87
<b>Figure 8:</b> Values for body mass (kg) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	88
<b>Figure 9:</b> Values for BMI ( $\text{kg} \cdot \text{m}^{-2}$ ) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	89
<b>Figure 10:</b> Values for skinfold thickness (mm) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	90
<b>Figure 11:</b> Values for vertical jump (cm) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	91
<b>Figure 12:</b> Values for leg power ( $\text{kg} \cdot \text{m} \cdot \text{sec}^{-1}$ ) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	92
<b>Figure 13:</b> Values for standing broad jump (cm) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	93
<b>Figure 14:</b> Values for sit and reach (cm) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	95
<b>Figure 15:</b> Values for VO <sub>2</sub> max ( $\text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	96

<b>Figure 16:</b> Values for acceleration (s) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	97
<b>Figure 17:</b> Values for speed (s) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	98
<b>Figure 18:</b> Values for combined acceleration and speed (s) of the Indonesian and Australian female field hockey players ( $X \pm SD$ ).	99
<b>Figure 19:</b> Correlation between the $VO_2\text{max}$ ( $\text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ) during treadmill running and the $VO_2\text{max}$ estimated from the 20 metre shuttle run test.	101
<b>Figure 20:</b> Correlation between the leg power ( $\text{kg} \cdot \text{m} \cdot \text{sec}^{-1}$ ) and the isokinetic power ( $\text{N} \cdot \text{m}$ ).	102
<b>Figure 21:</b> Correlation between the 40 metres sprint (s) and the 10 seconds maximal ergometer sprint ( $\text{J} \cdot \text{kg}^{-1}$ ).	103

## ABBREVIATIONS

### Selected abbreviations used throughout the text

- b·m<sup>-1</sup>**: breaths per minute  
**bpm**: beats per minute  
**cm**: centimetre/centimetres  
**°C**: temperature in degrees centigrade  
**F<sub>E</sub>O<sub>2</sub>**: fractions of oxygen in expired air  
**F<sub>E</sub>CO<sub>2</sub>**: fractions of carbon dioxide in expired air  
**HR**: heart rate/heart rates  
**J**: joule/joules  
**J·kg<sup>-1</sup>**: joules per kilogram  
**kg**: kilogram/kilograms  
**kg·m<sup>-2</sup>**: kilograms per metre square  
**kJ·min<sup>-1</sup>**: kilojoules per minute  
**km**: kilometre/kilometres  
**kg·m·sec<sup>-1</sup>**: kilograms metre per second  
**La**: lactic acid  
**L·min<sup>-1</sup>**: litres per minute  
**m**: metre/metres  
**mm**: millimetre/millimetres  
**ml·kg<sup>-1</sup>·min<sup>-1</sup>**: millilitres per kilogram per minute  
**ml·min<sup>-1</sup>**: millilitres per minute  
**mmol·L<sup>-1</sup>**: millimoles per litre  
**m·s<sup>-1</sup>**: metres per second  
**N·m**: Newton metres  
**N·m·kg<sup>-1</sup>**: Newton metres per kilogram  
**s**: second/seconds  
**30°·sec<sup>-1</sup>**: 30 degrees per second  
**60°·sec<sup>-1</sup>**: 60 degrees per second  
**180°·sec<sup>-1</sup>**: 180 degree per second  
**20m srt**: 20 metres shuttle run test



**$V_{EQ} O_2$** : ventilatory equivalents of oxygen

**$V_{EQ} CO_2$** : ventilatory equivalents of carbon dioxide

**$VCO_2$** : volume of carbon dioxide

**$VO_2$** : volume of oxygen

**$VO_{2max}$** : maximum oxygen uptake

**W**: watts

**$W \cdot kg^{-1}$** : watts per kilogram