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Factorial Structure of Some Biological and Physical Measurements for Handball Goalkeepers

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Abstract

Sports scientific researches and studies are concerned with determining specifications required by each type of different sports activities and conditions that must be met in players to fit in with the type of practitioner activity. Selection based on scientific grounds contribute sports achievement.

Handball require special features in each player depending on his play position, handball goalkeeper has special requirements which may not be required in other players, that is to enable him to carry out his duties in variety of situations exposed during the games.

Handball is one of sports activities, which reached level of maturity and progress as a result of experts' interest in studying and addressing various problems in scientific methods to upgrade their players and access highest levels.

Handball goalkeeper efficiency directly affects the team results. As far as his physical ability high, as well as biological systems' performance level; as far as team results affects; because of his ability to continuity in performance with same starting level throughout the game to end.

Handball goalkeeper – due to his distinctive role and effective role - must be distinguished from the rest of the team with some physical, and physical, psychological and physiological criteria as well as the ability to predict the level which can be achieved be him and possibility of continue playing handball with high efficiency as goalkeeper is most important position in the in the team.

This research aiming to determine factorial structure of some biological (morphological, and physiological) measurements for handball goalkeepers, study sample included (14) handball goalkeepers from nine first grade clubs as follows: "Ahli (2), Zamalek (1), Police Union (2), Nasr City (1), Armed forces (1), Damanhour games (2), Olympic (2), Sporting (2), Smouha (1)" .

Results could determine five basic factors in morphological measurements (Abdomen depth, Skinfolds thickness for iliac prominence, Overall height), in physiological measurements (emotional stability) and in physical measurements(speed endurance.)

Most important recommendation were that there is necessity to focus on morphological, physiological and physical criteria extracted in this study (Speed endurance, Abdomen depth, Skinfolds thickness for iliac prominence, Overall height and Emotional stability) which could represent scientific base of handball goalkeepers selection, Giving attention to morphological, physiological and physical aspects as an important indicator for players' general physical condition, Selection process based on sound scientific principles, Choosing appropriate anticipated handball goalkeepers, Organizing and directing training programs for handball goalkeepers and upgrading handball sport at national level, developing handball sport at national level.

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Introduction

Sports scientific researches and studies are concerned with determining specifications required by each type of different sports activities and conditions that must be met in players to fit in with the type of practitioner activity. Selection based on scientific grounds contribute sports achievement.

Recent world have remarkable development in basic life areas which affects athletic performance's level. This is evident by its improvements it year after year in international and world tournaments and Olympics. However with the witnessed tremendous progress in our contemporary world in sport achievement levels, discovering performance characteristics and requirements of various sports activities has great deal of importance; if we aiming are to achieve high and sophisticated standards for our Egyptian teams (Rasha EMira, 2009: p2)

Handball require special features in each player depending on his play position, handball goalkeeper has special requirements which may not be required in other players, that is to enable him to carry out his duties in variety of situations exposed during the games.

Handball is one of sports activities, which reached level of maturity and progress as a result of experts' interest in studying and addressing various problems in scientific methods to upgrade their players and access highest levels.

Handball goalkeeper efficiency directly affects the team results. As far as his physical ability high, as well as biological systems' performance level; as far as team results affects; because of his ability to continuity in performance with same starting level throughout the game to end. (Kamal Darwish et al(1998): p14)

To determine criteria for each sporting activity or players positions; we must get it from research applied on high levels athletes, and as more as research done on high level athlete as more as its results more conforming for necessary success criteria in sports activity (Ali El Bel,1996 :p 87).

To access high performance levels; Handball goalkeeper must have many Biological (morphological, physiological) and physical criteria which help him to perform his duties distinctly; For these specifications must be obtained through research results applied on high in all sports, as well as players positions.

Handball goalkeeper – due to his distinctive role and effective role - must be distinguished from the rest of the team with some physical, and physical, psychological and physiological criteria as well as the ability to predict the level which can be achieved be him and possibility of continue playing handball with high efficiency as goalkeeper is most important position in the in the team.

Many handball experts and specialists in the opinion that goalkeeper is the most important position in the team either in defense or attack, because he is the player who has been guard team goal which is the aim of opposing team. Goalkeeper modest or weak performance level is the key factor in his team loss, while his outstanding performance contributes positively to team results. Goalkeeper performance method is built on what he has from physical and skill capabilities. Players performance level rise with promoting and developing their physical traits (Kamal Darwish et al,1998 : 17) (Mohammed Lotfy Taha, 2002 : 113) (Monir Gerges, 2004: p19).

From this point of view handball goalkeeper should have distinctive Biological (morphological, physiological) and physical criteria to qualify him for excellence in skills performance, Hence study importance appear in terms of identifying most important Biological (morphological, physiological) measurements and physical guards handball goal.

Research Objective

This research aiming to determine factorial structure of some Biological and physical measurements for handball goalkeepers

Research Procedures

Research Methodology

Descriptive approach was used with survey style because of its appropriateness of study nature.

Study sample: study sample included (14) handball goalkeepers from nine first grade clubs as follows: "Ahli (2), Zamalek (1), Police Union (2), Nasr City (1), Armed forces (1), Damanhour games (2), Olympic (2), Sporting (2), Smouha (1)" .

Research Domains

Time domain:

Study measurements was carried out during 2011/2012 season while goalkeepers for different national team gathering in Maadi Olympic Center in the period June 2nd to June 7th.

Study measurements were carried out on handball goalkeepers in Alexandria during 2011/2012 season in the period July 9th to July 10th 2012.

Spatial domain:

Study measurements were applied in hall 2 in Maadi Olympic Center, Cairo

Study measurements were applied on handball goalkeepers in covered hall (Olympic - Sporting - Smouha - clubs and in Damanhour stadium in Behiara governorate province lake).

Measurements used in the study:

First: Biological measurements have been divided (morphological measurements - physiological measurements)

1. morphological measurements: -

- Total body height:

Total body height measured using restameter (Mohamed Hasanin, 2003: p51).

- Upper Limb height:

Measurement is done from sitting position on a backless seat.

- Lower Limb Height:

Lowing Limb Height is measured using measuring tape from thigh femoral nick to land (Mohamed Hasanin, 2003: p35)

- Weight: weight estimated by using medical scale. (Mohamed Hasanin, 2003:p 56)

- Circumference Measurement

Measuring tape is used to determine different body parts circumference (neck - shoulders - upper arm - chest - waist- thigh - knee – leg calf) (Mohamed Hasani, 2003: pp35, 54).

- Width Measurement

Belfometer is used to measure widths, it is a device similar to compass, where its twi ends fixed on measuring points and its scale indicate the width if measured area (Shoulder – iliac bone - hips) (Mohamed Hasanin, 2003:p 54, 55).

- Depth Measurements

Belfometer is used to measure depths ((Mohamed Hasanin, 2003: p55)

Body Mass Index (BMI):

BMI is calculated by dividing body weight in kg by the height square in meters, as follows:

Body mass index (kg 2) = weight (kg) ÷ height square (meters) (Hazaa Ben Al Hazaa, 201: p103) (Miller,1995: p622) (Kamal darwish et al,1998:p 14) (Baumgartner,1995:p 292) (Davis et al,1995:p 587).

- Skin folds thickness measurements: skin fold caliper used to measure skin folds

Measurement Places:

Area behind humerus in triceps muscle area , it is vertical skin fold - Chest area, it is diagonal skin fold -sub scapula area , it is diagonal skin fold - abdominal area, It is vertical skin fold - Sup iliac prominence, it is diagonal skin fold. - Iliac prominence, it is diagonal skin fold.-Thigh area, it is vertical skin fold.-Medial side of calf leg, it is vertical skin fold (Abo EL Eal ABd ElFatah,1988 : pp333-335)

- Palm area measurement:

It is measured using measuring tape from the middle of the wrist to the end of the middle finger while extended (Mohamed Hasanin, 2004:p 52)

2. Physiological measurements:

- Measuring heart rate at rest and effort: -

In rest: stopwatch used to measure the time of 30 pulses then pulse rate extracted (Abo ElEla Abd El Fatah,2004:pp58-59), (Blair V., 1999: p54)

In effort: subject do a particular effort such as a surprise attack several times, measurement is done immediately after the effort and after every two minutes till the heart returns to its rest rate (Zakia Fathy et al, 2001:p 233), (Foss M. et al, 1998: p53)

Vital capacity measurement:

Lungs vital capacity measured by dry Spiro meter o device, (Zakia Fathi et al, 2001:p4), (Mohamed Saad ElDin, 1997 :pp 257 - 258)

- Measurement of Maximum Oxygen Uptake VO2max:

Fox equation used, which is considered easy and simple equation to estimate maximum oxygen uptake, which created a linear relationship correlated with direct method sub-maximal heart recorded during the fifth minute on the with 150 watts intensity:

Maximum Oxygen Uptake (VO2MAX) = 6.3 - 0.093 X sub-maximal HR

Emotional stability measurement: - Hand stability device used to measure emotional stability (Mohammed Taha, 2004: pp113-114)

Highest Motor frequency measurement :

Paper and Pencil test used to measure highest motor frequency

(Moihammed Tahs, 2002: pp111-112)

- Motor Coordination measurement:

Rope jump is used to measure motor coordination. (Mohamed Hassanin, 2004 :pp 320- 321).

Measuring reaction speed: ruler test is used to measure reaction speed. S (Mohamed Hassanin, 2004: pp275- 276)

Neuromuscular coordination measurement

Tennis ball throwing on wall used to measure neuromuscular coordination

5 Tennis ball, Wall, line drawn on land; five meters away from the wall. (Mohammed hassanin, 2004:p 328)

Physical measurements:

- Accuracy Measurement:

Shooting with hand on overlapping rectangle tests used to measure accuracy. (Mohamed Hassanin, 2004:pp358-359)

Balance measurement

Standing with foot (longitudinal) on a beam test used to measure balance

(Mohamed Hassanin, 2004: pp344- 345) (Ted, A. et al., 1999: p229) (Mohamed Hassanin,2000:p 425) (Abo ElEla Abd Elfattah,1988: pp308-309)

- Measure muscular endurance:

Arm bent test from diagonal lying position used to measure muscular endurance

Mohamed Hassanin, 2004:pp 236- 237) (Mohamed Hassanin, 1995:p 241) (Abo ElEla Abd Elfatah, 1988: pp113 - 115) (Ted A. et al: 231).

- Speed endurance measurement:

100 meter sprint test used to measure speed endurance

- Muscle strength: represented in right and left handgrip strength, Manometer device is used to measure grip strength (Baumgartner,1995: p165) (Ted A. et al,1999 : 209)

- Flexibility:

Trunk bent forward from standing test used to measure flexibility

(Mohamed hassanin, 2004Lp265) (Ted A. et al , 1999:p 229).

- Agility:

Multi-direction run test is used to measure agility (Mohammed Hassanin, 2004: 279)

- Speed: 15 seconds running in place test used to measure speed (Mohamed Hassanin, 2004: p292)

- Ability:

Long jump test is used to measure capacity (Mohamed Hassanin, 2004:p 307) (Ted A, 1999: p227) (Baumgartner et al, 1995: p230)

- Specific Power: To measure Specific Power Test was selected vertical jump of persistence (Sargent), (Mohamed Sobhy hassanin,1995: pp90-91)

Administrative Procedures:-

Before conducting research pilot and main studies, there were some procedures had to be taken to facilitate implementation of pilot and main studies to achieve study objectives , the following actions have been taken:

- Management Communications: approval obtained for conducting measurements on handball goalkeepers from from clubs, national teams goalkeepers' coach, Manager Of Maadi Olymic center

- Preparing measurements registration forms: registration form have been prepared for each measurement type (Morphology measurements form - physical measurements Form - physiological measurements Communications)

1. Preparation of place, tools and devices: Morphological, physical and some physiological measurements done in Hall (2) Maadi Olympic Center, some physiological measurements were conducted in International Cairo Stadium Medical Center, before conducting tests validity of devices, tools and forms used in research has been conformed taking into account the technical requirements to ensure access to accurate results, free from the errors that result from inappropriate devices and instruments.

2. Main study

Research morphological, physiological and physical measurements were conducted on first class goalkeepers in covered hall No. 2, Maadi Olympic Center in Cairo during the period of June 6th to June 7th. Also measurements were conducted on Alexandria handball goalkeepers through tests which got overall experts approval in the period from July 9th To July 10th 2012.

- Statistical Work: (arithmetic mean, standard deviation, skewness, kurtosis, factor analysis)

Results and Discussion

First: Factor analysis of biological measurements:

1. Factorial analysis of morphological variables

Table (1)

Mean, standard deviation, skewness coefficient, and kurtosis of research sample in morphological measurements

Variables \ Statistical indicators		Measurement unit	Mean	Standard Deviation	Skewness factor	Kurtosis
Body weight		Kg	83.71	6.94	-.96	.46
Heights	Overall height	Cm	179.57	7.47	-.52	-.27
	Lower limb	Cm	91.43	4.82	.29	-.76
	Upper limb	Cm	88.14	5.79	-.80	1.13
Circumferences	Neck circumference	Cm	37.79	6.74	-.28	.26
	Shoulders circumference	Cm	110.43	12.74	-.13	-.78
	Humerus circumference	Cm	33.43	6.87	.36	-.68
	Chest circumference	Cm	98.21	12.86	-.04	-.87
	Waist circumference	Cm	88.86	8.83	-1.03	-.09
	Thigh circumference	Cm	59.71	9.23	.06	-1.10
	Knee circumference	Cm	41.79	3.93	1.26	.77
	Calf circumference	Cm	41.57	5.50	.72	-.15
Widths	Shoulder width	Cm	15.07	1.75	-.45	-1.18
	Iliac bone width	Cm	13.82	1.28	-.79	.300
	Hips width	Cm	6.86	1.50	-.02	-.11
Depths	Chest depth	Cm	7.50	1.34	-.89	-.14
	Abdomen depth	Cm	8.39	1.43	.25	-.52
	Pelvic depth	Cm	7.61	1.48	.29	.310
Body Mass index (BMI)		%	25.82	2.52	.29	0.40
Skinfolds thicknesses	Behind humerus	millimeter	11.07	3.08	-.13	-1.61
	Chest	millimeter	14.36	6.32	.36	-0.92
	sub scapula area	millimeter	12.21	5.18	.52	-1.46
	Sup iliac prominence	millimeter	15.71	5.54	.38	-0.96
	iliac prominence	millimeter	16.21	6.70	.42	-0.34
	Abdominal area	millimeter	20.50	8.14	.24	-1.52
	Thigh area	millimeter	16.71	6.78	.38	-0.88
	Medial side of calf	millimeter	5.57	2.17	0.44	-1.42
Palm length		Cm	23.29	1.90	-0.11	-1.06

Table No. (1) results revealed that morphological variable for research sample members follow normal frequency distribution (normal curve) where skew factors were between (-1.61, 1.13) i.e. in between ± 3 and this gives an direct indication that sample represents normal society and free of abnormal distribution effects.

Table (2)
Correlation matrix between morphological indicators for research sample

	Body weight	lights			circumferences								widths			depths		(BMI)	Skinfolds thicknesses							Palm length
		Overall height	Lower limb	Upper limb	Neck	Shoulders	Humerus	Chest	Waist	Thigh	Knee	Calf	Shoulder	Iliac bone	Hip	Chest	Abdomen	Pelvic		Behind humerus	Chest	sub scapula area	Sup iliac prominence	Iliac prominence	Abdominal area	Thigh area	Medial side of calf	
Body weight																												
Overall height	0.20																											
Lower limb hight	-0.18	0.622*																										
Upper limb hight	0.525*	0.765**	-0.02																									
Neck circumference	0.901**	0.110	-0.43	0.50																								
Shoulders circumference	0.827**	0.060	-0.28	0.37	0.817**																							
Humerus circumference	0.602*	-0.49	-0.629*	-0.11	0.712**	0.765**																						
Chest circumference	0.804**	0-0.01	-0.66	0.796**	0.868**	0.962**	0.750																					
Waist circumference	0.851**	0.657*	0.06	0.18	0.716**	0.589*	0.16	0.558**																				
Thigh circumference	0.520	0.00	-0.22	0.00	0.609*	0.627*	0.611*	0.718*	0.260																			
Knee circumference	0.600*	-0.40	-0.620*	0.01	0.692**	0.720**	0.914**	0.764**	0.220	0.578*																		
Calf circumference	0.50	-0.48	-0.765*	0.66	0.609*	0.666**	0.883**	0.681**	0.180	0.47	0.926**																	
Shoulder width	0.962**	0.23	-0.2	0.37	0.862**	0.839**	0.668*	0.830**	0.801**	0.561*	0.696**	0.606*																
Iliac bone width	0.859**	0.08	-0.22	0.4	0.758**	0.676**	0.679**	0.726**	0.661*	0.620*	0.650*	0.556*	0.872**															
Hips width	0.908**	0.13	-0.33	0.623*	0.880**	0.851**	0.753**	0.802**	0.725**	0.562*	0.772**	0.715**	0.919**	0.727**														
Chest depth	0.839**	0.4	-0.06	0.29	0.811**	0.683**	0.280	0.670*	0.797**	0.42	0.28	0.15	0.718**	0.682**	0.592*													
Abdomen depth	0.861**	0.09	-0.22	0.41	0.851**	0.818**	0.727**	0.767**	0.617*	0.671**	0.797**	0.626*	0.878**	0.777**	0.907**	0.610												
Pelvic depth	0.847**	0.20	-0.19	-0.20	0.861**	0.771**	0.671**	0.578*	0.691**	0.626*	0.711**	0.591*	0.877**	0.842**	0.898**	0.668	0.949**											
Body Mass Index (BMI)	0.536*	-0.581*	-0.542*	0.29	0.575*	0.629*	0.891**	0.862**	0.090	0.36	0.776**	0.752**	0.555*	0.590*	0.600*	0.290	0.584*	0.527*										
Behind humerus Skinfoldsthickness	0.820**	0.4	-0.26	0.694**	0.788**	0.824**	0.672**	0.787**	0.619**	0.686**	0.629*	0.629*	0.820**	0.697**	0.827**	0.567*	0.710**	0.690**	0.51									
Chest Skinfolds thickness	0.748**	0.28	-0.24	0.535*	0.796**	0.622**	0.22	0.581*	0.723**	0.22	0.25	0.28	0.666**	0.641*	0.574*	0.776**	0.27	0.41	0.26	0.658*								
sub scapula area Skinfoldsthickness	0.781**	0.18	-0.36	-0.09	0.718**	0.766**	0.577*	0.719**	0.585*	0.562*	0.566*	0.552*	0.757**	0.670**	0.722**	0.612*	0.569*	0.52	0.41	0.820**	0.869**							
Sup iliac prominence Skinfolds thickness	0.660**	-0.28	-0.47	0.61	0.709**	0.756**	0.869**	0.772**	0.200	0.42	0.826**	0.776**	0.711**	0.659*	0.708**	0.650	0.729**	0.674	0.882**	0.625*	0.600	0.50						
Iliac prominence Skinfoldsthickness	0.714**	0.04	-0.66	0.36	0.708**	0.679**	0.48	0.713**	0.582*	0.37	0.66	0.67	0.660*	0.569*	0.585**	0.627	0.41	0.24	0.29	0.720**	0.800**	0.862**	0.520					
Abdominal area Skinfolds thickness	0.705**	-0.12	-0.613*	0.38	0.782**	0.762**	0.609*	0.809**	0.564*	0.61	0.668*	0.701**	0.709*	0.622*	0.689**	0.622	0.563*	0.52	0.563*	0.727**	0.683**	0.711**	0.706**	0.875**				
Thigh area Skinfolds thickness	0.647*	-0.11	-0.621*	0.592*	0.767**	0.724**	0.778**	0.789**	0.600	0.808**	0.772**	0.785**	0.682*	0.724**	0.757**	0.60	0.683**	0.669**	0.69	0.787**	0.569*	0.785**	0.543*	0.630*	0.692**			
Medial side of calf Skinfolds thickness	0.751**	0.21	-0.39	-0.29	0.725**	0.668**	0.565*	0.667**	0.656*	0.50	0.610*	0.668*	0.768**	0.661*	0.794**	0.47	0.590*	0.612*	0.21	0.880**	0.678**	0.822**	0.470	0.725**	0.704**	0.795**		
Palm length	0.28	0.817**	-0.565*	0.565*	0.150	0.08	-0.43	-0.060	0.564*	-0.19	-0.61	-0.551*	0.120	0.02	0.08	0.562*	0.05	0.16	-0.260	-0.04	0.260	0.08	0.280	0.00	0.17	-0.29	-0.06	

Table (3)
Rotated Component Matrix for goalkeepers morphological variables
Final results after removing loads less than ±(0.35)
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization

Morphological Variables	Factor				Communalities
	First	Second	Third	Fourth	
Abdomen depth	0.936				0.963
Pelvic depth	0.918				0.95
Shoulder width	0.817	0.466			0.924
Hips width	0.817	0.398			0.907
Body weight	0.79	0.556			0.969
Skinfolds thickness, sup iliac prominence	0.774		-0.487		0.932
Neck circumference	0.76	0.565			0.918
Shoulders circumference	0.754	0.494			0.851
Iliac bone width	0.741	0.401			0.765
Chest circumference	0.726	0.487			0.856
Humerus circumference	0.707		-0.605		0.955
Knee circumference	0.702		-0.543		0.922
Body Mass index (BMI)	0.687		-0.629		0.929
Skinfolds thickness, iliac prominence	0.601	0.54		0.413	0.827
Skinfolds thickness, iliac prominence		0.901			0.909
Skinfolds thickness, iliac prominence		0.872			0.89
Skinfolds thickness, Abdominal area	0.425	0.77			0.881
Skinfolds thickness, sub scapula area	0.394	0.757			0.851
Skinfolds thickness, Medial side of calf	0.396	0.648		0.535	0.863
Upper limb height		0.621	0.616		0.876
Chest depth	0.594	0.606	0.365		0.873
Waist circumference	0.532	0.577	0.531		0.905
Overall height			0.96		0.981
Palm length			0.866		0.886
Lower limb		-0.439	0.748		0.786
Calf circumference	0.527		-0.653		0.904
Skinfolds thickness, thigh	0.48	0.465		0.651	0.961
Thigh circumference	0.537			0.635	0.718
Eigen value	10.44	7	5.1	2.41	24.95
Variance percentage after rotation	37.27%	25.01%	18.22%	8.62%	

Table (3) results reveal that factorial analysis after rotation of morphological indicators matrix for handball goalkeepers resulted in four factors, the fourth factor have been excluded , due to the fact that it has less than three variables, variance for first factor was 37.27% , second factor 25.01% , third factor 18.22% and fourth factor was 8.62%

Table (4)
Final extracted factors from factorial analysis using orthogonal rotation of morphological variables for handball goalkeepers

Factor Rank	Indicator Name	Loading on Factor
First	Abdomen depth	0.936
Second	Skinfolds thickness, iliac prominence	0.901
Third	Overall height	0.960

Table (4) results reveal that factorial analysis of morphological indicators for goalkeepers resulted in three key factors; where abdomen depth came in first factor with loading of 0.948, Skinfolds thickness of iliac prominence came in second factor worth loading of 0.901 and overall height came in third factor with loading of 0.960

2. Factorial analysis of physiological variables

Table (5)
Mean, standard deviation, skewness coefficient, and kurtosis of research sample in physiological measurements

Variables \ Statistical indicators		Measurement unit	Mean	Standard Deviation	Skewness factor	Kurtosis
Heart rate	Rest	Pulse/minute	60.71	7.76	0.03	-1.1
	Effort	Pulse/minute	170.93	21.46	-0.33	-1.4
Vital capacity		Milliliter/minute	4155.36	4155.36	873.21	-0.26
Absolute Maximum Oxygen Uptake (VO2max absolute)		Milliliter/minute	3232.14	3232.14	728.32	-0.11
Relative Maximum Oxygen Uptake (VO2max relative)		Milliliter/minute/Kg.	38.07	38.07	8.07	-0.11
Reaction speed		Second	12.14	12.14	1.75	-0.15
Neuromuscular coordination		Second	14.21	14.21	4.92	-0.24
Emotional stability		Number	3.50	3.5	1.51	-0.36
Motor coordination		Second	3.38	3.38	1.5	-0.44
Highest Motor frequency	1st attempt	Number	58.5	12.77	0.1	-1.07
	2nd attempt	Number	52.93	10.91	0.29	-1.21
	3rd attempt	Number	53.21	11.06	-0.23	-1.64
	4th attempt	Number	52.57	11.82	0.22	-0.83

Table No. (5) results revealed that physiological variable for research sample members follow normal frequency distribution (normal curve) where skew factors were between (-1.80 to – 0.64) i.e. in between ± 3 and this gives an direct indication that sample represents normal society and free of abnormal distribution effects.

Table (6)
Correlation matrix between physiological indicators for research sample

	Heart rate at rest	Heart rate at effort	Vital capacity	Absolute Maximum Oxygen Uptake (VO2max absolute)	Relative Maximum Oxygen Uptake (VO2max relative)	Reaction speed	Neuromuscular coordination	Emotional stability	Motor coordination	Highest Motor frequency 1st attempt	Highest Motor frequency 2nd attempt	Highest Motor frequency 3rd attempt	Highest Motor frequency 4th attempt
Heart rate at rest													
Heart rate at effort	.888**												
Vital capacity	-.781-**	-.667-**											
Absolute Maximum Oxygen Uptake (VO2max absolute)	-.838-**	-.760-**	.976**										
Relative Maximum Oxygen Uptake (VO2max relative)	-.913-**	-.792-**	.911**	.944**									
Reaction speed	0.21	0.27	0.03	-0.06	-0.3								
Neuromuscular coordination	-.915-**	-.859-**	.832**	.885**	.943**	-0.38							
Emotional stability	.868**	.829**	-.851-**	-.911-**	-.893-**	0.21	-.950-**						
Motor coordination	-.881-**	-.818-**	.787**	.843**	.883**	-0.32	.933**	-.940-**					
Highest Motor frequency 1st attempt	-.830-**	-.739-**	.789**	.790**	.831**	-0.18	.883**	-.884-**	.901**				
Highest Motor frequency 2nd attempt	-.710-**	-.740-**	.757**	.739**	.719**	-0.05	.786**	-.814-**	.841**	.927**			
Highest Motor frequency 3rd attempt	-.821-**	-.796-**	.787**	.809**	.824**	-0.24	.904**	-.941-**	.946**	.940**	.919**		
Highest Motor frequency 4th attempt	-.803-**	-.690-**	.764**	.744**	.804**	-0.18	.842**	-.838-**	.886**	.964**	.912**	.942**	

Table (7)
Rotated Component Matrix for goalkeepers morphological variables
Final results after removing loads less than ±(0.35)
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization

Physiological Variables	Factor		Communalities
	First	Second	
Emotional stability	-0.953		0.93
Highest Motor frequency 3rd attempt	0.942		0.915
Highest Motor frequency 1st attempt	0.939		0.89
Absolute Maximum Oxygen Uptake (VO2max absolute)	0.935		0.875
Motor coordination	0.932		0.935
Neuromuscular coordination	0.93		0.966
Vital capacity	0.921		0.872
Relative Maximum Oxygen Uptake (VO2max relative)	0.92		0.892
Highest Motor frequency 4th attempt	0.912		0.841
Heart rate at rest	-0.902		0.852
Highest Motor frequency 2nd attempt	0.901		0.813
Heart rate at effort	-0.829		0.76
Reaction speed		0.98	0.967
Eigen value	10.13	1.38	11.51
Variance percentage after rotation	77.93%	10.59%	

Table (7) results reveal that factorial analysis after rotation of physiological indicators matrix for handball goalkeepers resulted in two factors, the second factor have been excluded , due to the fact that it has less than three variables, variance for first factor was 77.93% and second factor 10.59% , third factor 18.22% and fourth factor was 8.62%

Table (8)
Final extracted factors from factorial analysis using orthogonal rotation of physiological variables for handball goalkeepers

Factor Rank	Indicator Name	Loading on Factor
First	Emotional stability	-0.953

Table (8) results reveal that factorial analysis of physiological indicators for goalkeepers resulted in one key factor; where emotional stability came in first factor with loading of 0.953,

Second: Factor analysis of the physical variables:

Table (9)
Mean, standard deviation, skewness coefficient, and kurtosis of research sample in physical measurements

Statistical indicators / Variables	Measurement unit	Mean	Standard Deviation	Skewness factor	Kurtosis
Right Handgrip strength	Kg.	47.21	7.45	-0.85	-0.42
Left Handgrip strength	Kg.	42.5	8.7	-0.43	-1.12
Flexibility	Centimeter	17.32	2.58	0.41	0.64
Speed	Number	31.93	5.93	0.09	-0.87
Agility	Second	16.62	3.74	0.61	-1.03
Capacity	Centimeter	216.36	11.71	-0.09	-1.18
Power	Centimeter	75.79	32.18	-0.18	-1.93
Accuracy	Marks	10.21	3.36	-0.6	-0.57
Balance	Second	11.57	3.73	1.14	2.17
Muscular endurance	Number	42.36	7.88	-0.09	0.16
Speed Endurance	Second	13.25	2.04	0.71	-0.6

Table No. (9) results revealed that physical variable for research sample members follow normal frequency distribution (normal curve) where skew factors were between (-1.93 to 2.17) i.e. in between ± 3 and this gives an direct indication that sample represents normal society and free of abnormal distribution effects.

Table (10)
Correlation matrix between physical indicators for research sample

	Right Handgrip strength	Left and grip strength	Flexibility	Speed	Agility	Capacity	Power	Accuracy	Balance	Muscular endurance	Speed nduranc e
Right Handgrip strength											
Left Handgrip strength	.869**										
Flexibility	-0.44	-0.47									
Speed	-0.15	-0.13	0.566*								
Agility	0.15	0.17	-.614-*	-.836-**							
Capacity	-0.25	-0.37	0.572*	0.921**	-.816-**						
Power	-0.17	-0.19	0.589*	0.853**	0940-**	0.822**					
Accuracy	-0.12	-0.01	0.605*	0.782**	0779-**	0.624*	0.780**				
Balance	-0.18	-0.29	0.49	0.579*	-0.48	0.632*	0.43	0.47			
Muscular endurance	-0.05	0.1	0.52	0.867**	-.787-**	0.683**	0.713**	0.881**	0.600*		
Speed Endurance	0.24	0.25	-.611-*	0.880-**	0.906**	0.842-**	0.936-**	0.887-**	0.560-*	0.812-**	

Table (11)
Rotated Component Matrix for goalkeepers physical variables
Final results after removing loads less than ±(0.35)
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization

Physiological Variables	Factor		Communalities
	First	Second	
Speed Endurance	-0.948		0.93
Speed	0.943		0.896
Agility	-0.924		0.866
Muscular endurance	0.918		0.854
Power	0.911		0.846
Capacity	0.897		0.805
Accuracy	0.854		0.812
Flexibility	0.619	-0.507	0.64
Balance	0.613		0.444
Right Handgrip strength		0.979	0.962
Left Handgrip strength		0.924	0.858
Eigen value	6.61	2.3	8.91
Variance percentage after rotation	60.10%	20.91%	

Table (11) results reveal that factorial analysis after rotation of physical indicators matrix for handball goalkeepers resulted in two factors, the second factor have been excluded , due to the fact that it has less than three variables, variance for first factor was 60.10% and second factor 10.59% , third factor 18.22% and fourth factor was 20.91%

Table (12)
Final extracted factors from factorial analysis using orthogonal rotation of physical variables for handball goalkeepers

Factor Rank	Indicator Name	Loading on Factor
First	Speed Endurance	-0.948

Table (12) results reveal that factorial analysis of physiological indicators for goalkeepers resulted in one key factor; where speed endurance came in first factor with loading of 0.948,

Table (13)
Standard T-scores for morphological, physiological and physical variables derived from factor analysis of Handball goalkeepers

Speed endurance		Abdomen depth		Skinfolds thickness, iliac prominence		Overall height		Emotional stability	
Raw score	Standard score	Raw score	Standard score	Raw score	Standard score	Raw score	Standard score	Raw score	Standard score
11	70.36	6	68.23	7	69.07	165	30.49	0	37.9
11.3	63.5	7	64.73	8	66.09	168	34.51	1	42.74
11.5	61.05	8	57.74	12	55.65	172	39.86	2	47.58
11.8	56.14	9	54.25	13	52.66	177	46.56	3	52.42
12	53.69	9.5	47.25	17	51.17	178	47.9	4	57.26
13.37	50.6	10.5	40.26	18	45.21	179	49.24	5	62.1
14	43.88	11	33.27	20	43.71	180	50.57		
14.5	42.9			27	37.75	185	57.27		
15.5	41.43			29	36.26	187	59.94		
16	40.45					189	62.62		
17.4	38.98					190	63.96		

Table (13) demonstrates standard T-scores of morphological, physiological and physical variables derived from factor analysis of handball goalkeepers. For speed endurance lowest raw score were 17.4 which correspond to 38.98 standard score and the highest raw score were 11 which correspond to 70.36 noting that the arithmetic mean 13.37 correspond to 50.6 standard score. For abdomen depth lowest raw score were 11 which correspond to 33.27 standard score and the highest raw score were 6 which correspond to 68.23 noting that the arithmetic mean 9. correspond to 54.25 standard score. For skinfolds thickness of iliac prominence lowest raw score were 29 which correspond to 36.26 standard score and the highest raw score were 7 which correspond to 69.07 noting that the arithmetic mean 17 correspond to 51.7 standard score. For overall height lowest raw score were 165 which correspond to 30.49 standard score and the highest raw score were 190 which correspond to 63.96 noting that the arithmetic mean 179 correspond to 49.24 standard score. For emotional stability lowest raw score were 0 which correspond to 37.90 standard score and the highest raw score were 5 which correspond to 62.10 noting that the arithmetic mean 3 correspond to 52.42 standard score.

Table (14)
Percentile ranking of morphological, physiological and physical variables derived from factor analysis of Handball goalkeepers

Percentile rank	Speed endurance	Abdomen depth	Skin folds thickness, iliac prominence	Overall height	Emotional stability
95	11	6	7	190	0
90	11.15	6.5	7.5	189.5	0
85	11.3	7	11	188.5	0
80	11.3	7	8	187	0
75	11.45	7	8	185.5	0
70	11.65	7.5	12	185	0.5
65	11.8	8	17.5	180	2
60	11.8	8	16	183.75	1.25
55	11.95	8	12.25	180	2
50	12.69	8	13	179.5	2.5
45	13.53	8.25	18	179	3
40	14	9	18	178.25	3.75
35	14	9	18	179	3
30	14.25	9.25	19	177.5	4.5
25	14.75	9.5	20	175.75	5
20	15.5	9.5	20	169	5
15	15.88	10.25	25.25	172	5
10	16.7	10.75	28	166.5	5
5	17.4	11	29	165	5

Table (14) shows that for speed endurance percentile rank (5) correspond to 17.40 score, percentile rank (95) correspond to 12.69 and percentile rank (50) correspond to 12.69. For abdomen depth percentile rank (5) correspond to 11 score, percentile rank (95) correspond to 6 and percentile rank (50) correspond to 8. For skinfolds thickness for iliac prominence percentile rank (5) correspond to 29 score, percentile rank (95) correspond to 7 and percentile rank (50) correspond to 13. For overall height percentile rank (5) correspond to 165 score, percentile rank (95) correspond to 190 and percentile rank (50) correspond to 179.5. For emotional stability percentile rank (5) correspond to 5 score, percentile rank (95) correspond to 0 and percentile rank (50) correspond to 2.5

Discussion of Factorial analysis results

After arrived to inter-correlation matrix, factorial analysis aiming to interpret those correlation between measurements in the light of minimum number of factors, where are these factors descriptive names for series of tests or variables which are highly correlated, also it is supposed that they have common characteristics.

Hotelling's Principle Components method used in analyzing factorial matrix for research variables, this method have been chosen as it is distinguished from other factorial analysis methods because it draws the maximum variation of as explained by Safwat Farag (1985, p99)

Kaiser criterion proposed by Guttman used to determine accepted factors, and this criterion accept factors that have Eigen values more than 1.00 (R: 129)

Since the number of factors expected is directly linked to number of tests used in accordance with the following equation:

$$r = \frac{1}{2}\left[(2n+1) - \sqrt{8n+1}\right]$$

Where r = number of factors
n = number of tests.

Orthogonal Rotation

Orthogonal Rotation is rotation of Axes lead to form of simpler and more systematic extracted factors and this facilitates interpretation of factors according to the appropriate reference framework to get closer solutions for building Simple Factorial Structure, then rotate the factors perpendicular with Varimax Rotation (Safwat Farag, 1985: p124).

It is clear from the reference framework available to researchers that orthogonal rotation is the most commonly used type of rotation in physical education research and studies.

Safwat Farag (1985, p261) explains that orthogonal rotation retain an angle of (90°) between the axes and as the angle cosine equal to zero, this means that the correlation between any perpendicular factors equal to zero, and this means that extracted factors by this method of rotation are independent and not overlapping factors. (Ahmed Sayed Ahmed, 2005: pp295-300)

Tables (4), (8), (12) factor matrixes after orthogonal rotation using Varimax method for research sample, and loading values on the five extracted factors .

Factors interpretation and determining of morphological measurements:

Extracted factors through orthogonal rotation were interpreted using the following conditions:

- Following Thurston instructions referred to by Safwat farag (1985, 278) which represented in economy in factorial description, highlight unique aspects and different factor loading with concentration on factors that have meaning.(Safwat farag,1985: p278)
- Safawat Farag (1985, p365) quoting from Guilford indicates that we can - through the factor rotated matrix – factors characteristics and define its identity , so the factor is accepted only if there are three factors – at least 0-loaded in it provided that loading of each of them is not less (± 0.3)

In light of the previous terms to accept factor, there were three (3) accepted factors, table (4) demonstrates these factors according to their order in the factor matrix.

- Table (3) demonstrates that abdomen depth loaded on first factor with percentage of (37.27%) from total research variables, while skinfolds thickness for iliac prominence loaded on second factor with percentage of (25.01%) of total research variables, and overall height loaded in third factor with percentage of (18.22%) from total variables.
- It is shown by this study that morphological factors which have highest loading and will be used as indicators for selection process will be consisted of number of measurements representing the extracted factors , i.e. one test or each factor, with the highest loading as shown in table (4)

Accordingly, the units selected in each morphological measurement extracted in this study are as its loading on other factors is not essential.

Factors interpretation and determining of physiological measurements:

Extracted factors through orthogonal rotation were interpreted using the following conditions:

- Following Thurston instructions referred to by Safwat farag (1985, 278) which represented in economy in factorial description, highlight unique aspects and different factor loading with concentration on factors that have meaning.(Safwat farag,1985: p278)

In light of the previous terms to accept factor, there were one (1) accepted factor, table (8) demonstrates these factors according to their order in the factor matrix.

- Table (7) demonstrates that emotional stability loaded on first factor with percentage of (77.93%) from total research variables. It is shown by this study that physiological factors which have highest loading and will be used as indicators for selection process will be consisted of number of measurements representing the extracted factors , i.e. one test or each factor, with the highest loading as shown in table (8)

Accordingly, the units selected in each morphological measurement extracted in this study are as its loading on other factors is not essential.

Factors interpretation and determining of physical measurements:

Extracted factors through orthogonal rotation were interpreted using the following conditions:

- Following Thurston instructions referred to by Safwat farag (1985, 278) which represented in economy in factorial description, highlight unique aspects and different factor loading with concentration on factors that have meaning.(Safwat farag,1985: p278)
- Safawat Farag (1985, p365) quoting from Guilford indicates that we can - through the factor rotated matrix – factors characteristics and define its identity , so the factor is accepted only if there are three factors – at least 0-loaded in it provided that loading of each of them is not less (± 0.3)

In light of the previous terms to accept factor, there were one (1) accepted factors, table (12) demonstrates these factors according to their order in the factor matrix.

- Table (11) demonstrates that speed endurance loaded on first factor with percentage of (60.1%) from total research variables. It is shown by this study that morphological factors which have highest loading and will be used as indicators for selection process will be consisted of number of measurements representing the extracted factors , i.e. one test or each factor, with the highest loading as shown in table (12)

From the previous interpretation for the five factors and based on morphological, physiological and physical measurements, and and extracting highest loaded variable from each factor; it is possible to determine five factors as it is demonstrated in table (4), (8), and (12) which includes: (Speed endurance, Abdomen depth, Skinfolds thickness for iliac prominence, Overall height and Emotional stability)

Conclusions

As per factor analysis of this study data and within study objective and procedures, and statistical results, researchers could conclude the following:

Accepting five basic factors in Biological and physical measurements for Handball goalkeepers, namely:

First: Biological measurements:

- Determined morphological measurements were: (Abdomen depth, Skin folds thickness for iliac prominence, Overall height)

- Determined physiological measurements were: emotional stability

Second: the physical variables:

- Determined physical measurements were: speed endurance.

Recommendations

In light of conclusions reached in this study the following is recommended:

There is necessity to focus on Biological(morphological, physiological) and physical criteria extracted in this study (Speed endurance, Abdomen depth, Skin folds thickness for iliac prominence, Overall height and Emotional stability) which could represent scientific base of:

1. Using extracted measurements in selection of handball goalkeepers

2. Giving attention to Biological (morphological, physiological) and physical aspects as an important indicator for players' general physical condition.

3. Selection process based on sound scientific principles.

4. Choosing appropriate anticipated handball goalkeepers .

5. Organizing and directing training programs for handball goalkeepers and upgrading handball sport at national level.

6. Continuing achievements and winning world championships.

7. Further scientific studies on Biological (morphological, physiological) and physical criteria for handball international teams' goalkeeper and comparing it with handball national teams' handball goalkeepers and then take advantage of them scientifically and practically.

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