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Title

Health conditions detected in a comprehensive periodic health evaluation of 558 professional football players

Author list

Arnhild Bakken PT MSc[1,2], Stephen Targett MBChB[1], Tone Bere PT PhD[1,3], Maria-Carmen Adamuz MD PhD[1], Johannes L Tol MD PhD[1,4,5], Rod Whiteley PT PhD[1], Mathew G Wilson PhD[1,6,7], Erik Witvrouw PT PhD[1], Karim M Khan MD PhD[1], Roald Bahr MD PhD[1,2]

Affiliations

[1]Aspetar Orthopaedic and Sports Medicine Hospital, Doha, Qatar

[2]Oslo Sports Trauma Research Center, Department of Sports Medicine, Norwegian School of Sport Sciences, Oslo, Norway

[3]Department of Orthopaedics, Oslo University Hospital, Oslo, Norway

[4]The Sports Physician Group, Department of Sports Medicine, St Lucas Andreas Hospital, Amsterdam, the Netherlands

[5]Amsterdam Center of Evidence Based Sports Medicine, Academic Medical Center, Amsterdam, the Netherlands

[6]Research Institute of Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, UK

[7]Research Institute of Sport and Exercise Sciences, University of Canberra, Australia

Correspondence to: Arnhild Bakken, Department of Sports Medicine, Aspetar Orthopaedic and Sports Medicine Hospital, Sport City street, PO Box 29222, Doha, Qatar, Phone: + 974 66 17 23 61, E-mail: arnhild.bakken@aspetar.com

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ABSTRACT

Background: Despite widespread use of periodic health evaluation (PHE) to detect and prevent injury and illness in athletes, its effectiveness in detecting health conditions and relevant risk factors is still debated. **Aim:** To assess health conditions detected by a comprehensive PHE in professional male football players and evaluate their consequences for participation clearance. **Methods:** A total of 558 professional football players in Qatar completed a PHE prior to the 2013 or 2014 seasons: history, general medical (including blood test), cardiovascular (12-lead electrocardiogram (ECG) and echocardiography), and a musculoskeletal examination, including a specific test battery targeting lower extremity strength and flexibility. Based on the PHE, players were either cleared or not cleared for participation. **Results:** In 533 players (95.5%), at least one health condition was detected requiring treatment or follow-up. Vitamin D deficiency or insufficiency (≤ 30 ng/mL) was the most common medical condition (n=499, 89.4%), followed by hepatitis B non-immunity or infection (n=164, 29.4 %). Cardiac screening identified 48 players (8.6%) with one or more abnormal findings [ECG (n=19, 3.4%) and echocardiography (n=14, 2.5%)]. Musculoskeletal conditions were observed in 180 players (32.3%); injuries to or strength deficits of the hip/groin and thigh accounted for the largest proportion. Medical clearance was temporarily not given in 69 players (12.4%), whilst further examinations were being conducted. One player was disqualified from competitive football. **Conclusion:** PHE revealed a high prevalence of health conditions requiring treatment or follow-up in professional footballers; however, only 12.4 % of conditions impacted on final clearance for participation.

What are the new findings?

- A targeted PHE of professional football players revealed a high prevalence of current health conditions that required clinical consideration.
- Management of health conditions ranged from reassurance, treatment, further investigations or recommendations to follow-up.
- General medical and musculoskeletal conditions were the most prevalent
- Delayed clearance was mainly due to abnormalities on the cardiovascular examination and current musculoskeletal injuries.
- Disqualification for competitive football was extremely rare in our group.

How might it impact on clinical practice in the near future?

- The current study documents that a PHE targeted to the characteristics of the population and sport in question detects a number of conditions (musculoskeletal, cardiovascular and medical), which are believed to be relevant for health and performance.
- However, whether many of these conditions (such as Vitamin D levels below 30 ng/mL) confer future health risk is not known. Prospective studies are needed to determine the benefits of screening (and subsequent targeted interventions) for each of the components of the PHE.

INTRODUCTION

A periodic health evaluation (PHE) or health screening is widely used to identify potential risk factors for diseases or disorders early with the view of implementing targeted prevention measures to reduce future morbidity and mortality.[1] Cancer screening (e.g. breast and prostate) and PHE in work settings (e.g. for hypertension, musculoskeletal disorders) represent integral elements of public health practice; however, evidence for their effect on total or cause-specific mortality is limited.[2, 3]

Professional sport including football is well-known for its high physical demands with high risk of injury, illness and potentially also negative long-term health consequences.[4-6] Protection of the health of the athlete is therefore of utmost importance for sports authorities.[7, 8] In the sport setting, the PHE also serves the purpose of detecting and managing current health problems which may influence the ability to train and compete, as well as to determine whether an athlete is medically suitable to participate in competitive sport. Although the International Olympic Committee (IOC) released a consensus statement on PHE of elite athletes in 2009, the extent and elements of the PHE varies widely between sport federations. It may vary from a short general health examination to a day-long comprehensive assessment that may include electrocardiogram (ECG) and echocardiography, as well as an extensive general medical and musculoskeletal assessment.[7, 9-11]

The Fédération Internationale de Football Association (FIFA) encourages all players to complete the FIFA Pre-Competition Medical Assessment (PCMA), which includes a comprehensive cardiovascular, general medical (including blood tests) and a musculoskeletal assessment.[7] Despite the debatable validity of ECG and echocardiography in detecting serious anomalies,[12, 13] cardiovascular screening with 12-lead ECG and echocardiography is mandated for some FIFA and the Union of European Football Association (UEFA) competitions.[14, 15] Most top-level football clubs worldwide complete a comprehensive pre-competition musculoskeletal screening, including questionnaires, functional testing and isokinetic strength testing of the lower extremity.[9, 16] While PHE is recommended by sports authorities such as FIFA and IOC [7, 8], there is little scientific evidence of its effectiveness.[17, 18] Considerations such as cost (time and financial), possibilities of significant findings, and impact of these are frequently discussed.[8, 19-21]

The purpose of this study was therefore: (1) to assess the health conditions detected on a PHE in professional male football players, and (2) to evaluate their consequences for participation clearance.

METHODS

Participants and PHE procedure

All male football players eligible to compete in the Qatar Stars League (QSL) were asked to participate in this cross-sectional study. The players were recruited as they presented for their annual PHE at Aspetar Orthopaedic and Sports Medicine Hospital in Doha (Qatar), in the two pre-season periods from July through September in 2013 and 2014. The QSL is the highest professional football league in Qatar (including 14 teams), with the majority of players coming from the Middle East and Central Africa. The PHE is part of the qualification procedure for all players expected to play in the QSL, and was divided into two stages performed on the same day.

Stage one consisted of a comprehensive history and clinical examination (general medical, cardiovascular and musculoskeletal examination). At Stage two, all test results collected during Stage one were reviewed by a sport physician and medical clearance was determined. At inclusion, players provided written consent for their data being utilised for research. Refusal to consent or failure to complete key components (Stage two) of the PHE process resulted in exclusion from the study. Ethical approval was obtained from the Institutional Review Board, Anti-Doping Lab Qatar.

History and clinical examination

History and general medical examination was undertaken by a sport medicine nurse. History regarding injury and general medical, cardiovascular family history and personal symptoms was completed using the FIFA PCMA form.[7] The general medical examination included a visual acuity assessment, measurements of height (m) and body mass (kg), and respiratory function testing (spirometry (FEV, FEV_1, PEF, FEV_1/FVC)). Physical examination of bilateral brachial artery blood pressure, heart rate and precordial auscultation in supine and standing positions was performed by an experienced sports medicine physician.[22]

As the majority of football injuries are to the lower extremity, particularly hamstring and groin injuries,[6] the identification of potential risk factors for these injuries was the primary focus of the comprehensive musculoskeletal test battery. The examination, performed by 7 experienced sport physiotherapists, included isokinetic muscle strength tests of knee flexors and extensors using an isokinetic dynamometer (Biodex Multi-joint System 3; Biodex Medical Systems Inc. NY, USA), strength, flexibility, and pain provocation tests at the hip, groin, and ankle, and a functional movement test (Nine-test screening battery) (Table 1).[23-26] In addition to the musculoskeletal examination, all players underwent a general musculoskeletal examination by a sports physician using the FIFA PCMA clinical examination form [7] at Stage two.

Table 1 The comprehensive musculoskeletal examination and evaluation criteria for each test.

	Type of testing	Tests	Evaluation criteria*
Hamstring and Quadriceps muscle	Isokinetic muscle strength†	Concentric knee flexion and extension at 60^0/s and 300^0/s	Normal Minor abnormal: ±1SD Major abnormal:±2SD
		Eccentric knee extension 60^0/s	Normal Minor abnormal:±1SD Major abnormal:±2SD
	Flexibility	Hamstring AROM and PROM	Normal Abnormal: ±1SD
Hip and groin examination	Pain provocation tests	Hip adduction squeeze test in 0^0 and 45^0	Normal Abnormal: pain
		Impingement test	Normal Abnormal: Pain
		FABER test	Normal Abnormal: Pain
	Joint ROM and flexibility	Hip internal rotation in 90^0	Normal Abnormal: ±1SD
		Hip external rotation in 90^0	Normal Abnormal: ±1SD
		Hip internal rotation in prone	Normal Abnormal: ±1SD
		Bent knee fall out	Normal Abnormal: ±1SD
		ROM hip abduction side lying	Normal Abnormal: ±1SD
	Muscle strength	Eccentric hip adduction	Normal Abnormal: ±1SD
		Eccentric hip abduction	Normal Abnormal: ±1SD
Lower leg and ankle	ROM and flexibility	Ankle dorsiflexion in standing to a wall	Normal/abnormal
Functional movement test		Nine-test screening battery‡	Normal: ≤22 of 33 Abnormal: ≥21 of 33

*Evaluation criteria, based on normative data on QSL players from previous years, tests were considered abnormal if more than one standard deviation (SD) from the mean.
† The data from the isokinetic muscle strength tests were normalised to bodyweight.
‡ The Nine-test screening battery was considered abnormal if the total score was below 67% of the maximum score.[24, 26]
AROM, active range of motion; PROM, passive range of motion; FABER, flexion, abduction, external rotation; ROM, range of motion

Additional examinations

Additional examinations included laboratory blood tests, x-ray, ECG and echocardiography. Fasting blood samples and urine were sampled by a qualified phlebotomist, and underwent immediate analysis (Table 2). A chest X-ray was performed if clinically indicated.

A standard 12-lead ECG was obtained by a cardiac physiologist using a GE MAC 5500 (New York, USA) after a period of 5 min rest in supine position. All ECGs were interpreted by an experienced sports cardiologist using the Seattle ECG criteria.[27] Echocardiography was performed by an experienced sports cardiologist and according to protocols previously published for high-level athletes.[28] All athletes completed both an ECG examination and an echocardiography as standard.

Athletes with symptoms, a family history of heart disease and/or sudden cardiac death (SCD), or echocardiographic and/or ECG abnormalities indicating possible cardiac pathology were investigated further as indicated (24 h ECG, maximal exercise testing and/or cardiac MRI).

Table 2 Laboratory blood analyses performed in PHE

			Selected reference range*†
Haematology	Complete blood count (CBC)		
	Ferritin		26-388 ug/L
	C-reactive protein (CRP)		<9.1 mg/L
	Erythrocyte sedimentation rate (ESR)		
Serology	Hepatitis B		Reactive or non-reactive
	Hepatitis C		Non-reactive
	Human Immunodeficiency virus (HIV)		Negative
Renal function	Urine analysis dipstix (protein, blood, glucose)		Negative
	Creatinine		71-115 umol/L
Cardiovascular	Fasting lipids	Total cholesterol	<5.2 mmol/L
		Triglycerides	<1.7 mmol/L
		HDL	1.04-1.55 mmol/L
		LDL	<2.60 mmol/L
	Fasting glucose		4.1-5.9 mmol/L
Bone/muscle	Vitamin D, 25(OH)[29]	Severe deficiency	<10 ng/mL
		Deficiency	10-20 ng/mL
		Insufficiency	20-30 ng/mL
		Sufficiency	>30 ng/mL
	Calcium		2.12-2.52 mmol/L
	Corrected calcium		
	Alkaline phosphatase		50-136 U/L

*Reference ranges were those of the Laboratory Department of Aspetar Orthopaedic and Sports Medicine Hospital. These ranges were derived from several hundred athletes tested over an extended period of time and verified for use with this patient population.

†All reference ranges are available in Supplementary, Table 1

Evaluation and clearance status

At the end of the PHE (stage two), a sport physician evaluated all results and documented the clinical findings detected on a report form. The physician noted if there were any abnormalities. A diagnostic code (the Sport Medicine Diagnostic Coding System[30]) was assigned (if possible) to each and recommended management recorded as free text. Based on the interpretation of the results, the sport physician determined whether to give the player medical clearance or to withhold it. Clearance was given if clinical findings were considered to have: no, mild, or minimal risk for the player's future health. Clearance was temporarily withheld when clinical findings were considered as a moderate risk to the

player's health (usually requiring further investigation or treatment). Permanently not cleared is reserved for a player diagnosed with a health condition considered unsafe for participation in competitive football. At the end of stage two, the test results were discussed with the player and club doctor and the report form was given to the club medical staff.

Data management and analyses

The clinical findings documented on the report form made the basis for the current analyses. A health condition was defined as any condition sufficient to require either treatment, further investigation, or recommendation to follow-up. Only health conditions requiring follow-up as per definition above were included for analysis.

History, clinical, and report form data from the PHE were entered into a database in Excel (Microsoft Excel 2010 for Windows, Microsoft Office Professional Plus, v14.0.7147.5001, California, USA) for analysis. In the case of abnormal cardiovascular findings, detailed information on ECG, echocardiography, clinical examination and results of follow-up tests were also entered.

Based on the physician's diagnosis and/or clinical findings on the report form, the general medical and musculoskeletal findings were classified post-hoc by the researcher (AB) and head physician (ST) at Aspetar Screening Department, into groups based on the IOC consensus statement on PHE of elite athletes and IOC injury and illness surveillance protocol for analysis.[8, 31, 32] Haematology data was classified by the authors into two categories: iron deficiency (serum ferritin < 30) with or without anemia (haemoglobin lower than laboratory normal range) and other CBC alterations. We also grouped infection/immunology into hepatitis B and other infective immunology. Health conditions not fitting the categories were classified as 'other'. The musculoskeletal findings were classified according to body part and type of condition, grouped as current problem (injury or current physical complaint), abnormal finding on examination or positive history (previous injury or physical complaint reported on history taking).

Descriptive statistics are presented as mean values with standard deviations, unless otherwise noted. Frequencies are reported as absolute numbers with percentages.

RESULTS

Participants

During the two-year study period, 858 male professional elite football players attended the annual PHE (Figure 1). In total, 22 players (2.6%) did not consent and were excluded. Five players (0.6%) were excluded for not completing Stage 2. Of the 490 players screened in 2014, 273 had already been screened in 2013, and their repeat PHE were removed from the analysis. Thus, the final sample included 558 unique players (age: 25.5 ± 4.8 years; height: 177 ± 7 cm; body mass: 72.3 ± 9.2 kg; BMI: 23.0 ± 2.0 kg/m^2). The players were mainly of Arab (n=316, 56.6%), Black (n=155, 27.8%), Caucasian (n=33, 5.9%) and Persian (n=33, 5.9%) ethnic origin.

Distribution of health conditions detected on PHE

In 533 players (95.5%), at least one health condition was detected that required further assessment, treatment or recommendation to follow up. Of all players (n=558), 522 (93.5%) were identified with a general medical condition, 180 (32.3%) with a musculoskeletal condition and 48 (8.6%) with a cardiovascular condition. More than one-third of the players (n=205, 36.7%) were identified with two conditions from the three main domains, while 12 (2.1%) were identified with a condition in all three (Figure 2).

Of all players identified with a health condition (n=533), a total of 1211 health conditions were reported. The total number of conditions for the three main screening components and the type of follow-up required are presented in Table 3.

Table 3 Health conditions detected and type of follow up required for the 533 players detected with a health condition.

	Total conditions N (%)	**Further investigations**	**Treatment**	**Prevention recommendations**	**Repeat examinations**
General medical	933 (77)	83	698	77	75
Cardiovascular	53 (4.4)	51	-	-	2
Musculoskeletal	225 (18.6)	50	31	142	2
Total n (%)	1211 (100)	184 (15.2)	729 (60.2)	219 (18.1)	79 (6.5)

General Medical findings

Vitamin D deficiency or insufficiency (≤30 ng/mL) was identified in 89.4% (n=499) of players and accounted for the majority of the medical condition detected (Figure 3). Hepatitis B non-immunity or infection was the second most frequent (29.4%, n=164), followed by dyslipidaemia (10.6%, n=59), iron deficiency/anaemia (10%, n=56), reduced visual acuity (6.5 %, n=38) and abnormal urinalysis test results [blood, glucose or protein] (6.8% n=36).

In 74.8% of the medical conditions detected, treatment was required and initiated (Table 3 and 4). Further investigation was required in 8.9% of cases, and 8.2% required prevention recommendations (primarily dietary advice), while 8.0% of the conditions required repeat examinations.

Table 4 Type of follow up required for the general medical findings

	Total conditions	**Further investigations**	**Treatment**	**Prevention recommendation**	**Repeat examination**
	n	n	n	n	n
Vitamin D	499	-	496	3	0
Hepatitis B	164	4*	160	0	0
Lipids	59	-	-	47	12
Iron deficiency/anemia	56	9	38	7	2
CBC alterations (other)	42	24	-	1	17
Vision	38	29	-	9	0
Urological	36	2	-	3	31
Endocrine/metabolic	12	-	1	1	10
Pulmonary	12	8	2	1	1
Ear, nose, throat (ENT)	3	3	-	-	-
Infective/immunology (other)	2	1	-	-	1
Dermatological	2	1	-	1	-
Neurological	2	1	1	-	-
Other	6	1	-	4	1
Total	933	83	698	77	75

* Hepatitis B, 4 of the players were seropositive. Three of the 4 were chronic carriers under long term follow up (one was lost to follow up) with normal or near normal liver function tests, whereas 1 was core antibody positive following previous infection.

Cardiovascular findings

Among the 48 (8.6%) players presenting with one or more cardiovascular finding (Table 3), 19 had ECG features associated with cardiac pathology, 14 had abnormal echocardiographic

findings, 11 reported symptoms suggestive of cardiac disease (including dizziness and/or chest pain during exercise and/or syncope) and/or a family history of SCD in a 1st relative, while 8 players presented with a resting blood pressure ≥140/90 mmHg (Figure 4).

The most common ECG anomalies were T-wave inversion (n=14), profound 1st degree AV block [>300ms] (n=2), prolonged QT interval [>490m] (n=1), profound sinus bradycardia (<30 bpm) (n=1), with information missing in one case. Echocardiographic abnormalities included reduced right ventricular free wall contractility (n=3), increased right ventricular dimensions above upper physiological limits (n=3), mitral valve prolapse (n=1), abnormal coronary artery origin (n=1), abnormal diastolic function (n=1), profound hypertrabeculation (n=1) and poor subcostal echo windows (n=4).

Almost all (n=51, 96.2%) cardiovascular anomalies required further investigation (Table 3). Consequently, a total of 74 additional cardiovascular investigations were ordered. These included 28 x exercise stress tests, 16 x 24h Holter ECGs, 22 x cardiac magnetic resonance imaging with late gadolinium enhancement, 6 x 24h Holter BP, 1 x tilt test and 1 x cardiac CT scan.

Musculoskeletal findings

Among the 180 players presenting with musculoskeletal conditions, 225 conditions were detected. Musculoskeletal conditions in the lower extremity accounted for 86.2% (Table 5). Of the 225 conditions, 97 represented a current problem (injury or physical complaint), 113 an abnormal finding on musculoskeletal assessment (strength deficits, flexibility or decreased ROM) but not limiting play or training, while 15 resulted from self-reported injury history. The majority of the musculoskeletal conditions identified led to prevention recommendations (n=142, 63.1%); 68.3% of these were based on abnormal findings from the musculoskeletal assessment. Prevention recommendations consisted primarily of referral to the club physiotherapist for general prevention programs (strength training, stretching). Conditions leading to further investigations (n=50, 22.2%) and treatment (n=31, 13.8%) were mostly due to current musculoskeletal problems (injury or ongoing physical complaint).

Table 5 Musculoskeletal conditions detected related to body part and type of condition (n=558)

Body part	**Total conditions**	**Total players**	**Current problem**	**Abnormal finding**	**Injury history**
	n	%	n	n	n
Neck/cervical spine	2	0.4	2	-	-
Sternum/upper back	1	0.2	-	1	-
Low back/pelvis	8	1.4	7	1	-
Shoulder/clavicle	5	0.9	4	-	1
Forearm	1	0.2	1	-	-
Wrist	4	0.7	4	-	-
Hip/groin	62	11.1	21	38	3
Thigh	56	10.0	13	42	1
Knee	32	5.7	20	5	7
Lower leg/Achilles tendon	9	1.6	4	5	-
Ankle	33	5.9	19	11	3
Foot/toe	2	0.2	2	-	-
Other	10	2.0	-	10	-
Total	225	40.3	97	113	15

Medical clearance status

Immediate medical clearance was given in 481 (86.2%) players (Table 6). In 8 cases (1.4%), clearance was temporary waiting for test results (general medical, n=2; cardiovascular, n=1), pending completion of the specific musculoskeletal assessment (n=1) or pending ongoing rehabilitation for current injury (n=3), and due to cardiovascular findings suggestive but not diagnostic of apical hypertrophic cardiomyopathy, requiring a repeat examination after 6 months (n=1).

In 69 (12.4%) cases, medical clearance was temporarily not given whilst further investigations or treatment were being done. Following the further investigations, one player was disqualified from competitive football (abnormal coronary origin) (Table 6), whereas another player with high suspicion of long QT syndrome was still not provided with medical clearance pending additional investigations. The player left the country before completing these. Thus, final clearance status could not be concluded. However, the player was advised against competitive football.

Table 6 Medical clearance status for all players who underwent PHE (n=558).

	Total	Yes		No	
		Cleared	Temporarily cleared	Temporarily not cleared	Permanently not cleared
		n (%)	n (%)	n (%)	n (%)
All players	558	481 (86.2)	8 (1.4)	68 (12.2)	1 (0.2)
General medical	522	508 (97.3)	2 (0.4)	12 (2.3)	0 (0)
Cardiovascular	48	16 (33.3)	2 (4.2)	29 (60.4)	1 (2.1)
Musculoskeletal	180	143 (77.8)	4 (2.2)	32 (17.8)	0 (0)

DISCUSSION

The key finding from the current study was that a targeted and comprehensive PHE identified at least one health condition requiring further assessment, treatment or recommendation to follow-up in 95.5% of professional football players. General medical and musculoskeletal components had the highest prevalence with 93.5% and 32.3%, respectively. The cardiovascular examination with ECG and echocardiography identified a cardiovascular condition in 8.6% of players. However, the vast majority of cases were given immediate medical clearance for competitive football (12.4% were temporarily not cleared).

General medical examination

In this study, general medical conditions represented more than 9 in 10 of the health conditions requiring treatment, further investigation or recommendations to follow-up. This was predominantly because of a high prevalence of Vitamin D deficiency or insufficiency and hepatitis B non-immunity. Almost 90% of players were vitamin D deficient or insufficient. This is consistent with previous findings on Qatari athletes, including footballers,[33] but much higher than reported for athletes in western countries.[34] Cultural clothing and training outside of sun hours in Qatar are believed to be the main cause in this population.

The potential role of vitamin D on performance, musculoskeletal health (injury risk, stress fractures), immune function and inflammatory response has increased the awareness of detecting athletes with deficiency upon treatment can be initiated.[35, 36] Oral supplementation was the most common treatment initiated. Supplementing athletes with Vitamin D levels below 25 ng/mL may have improved athletic performance;[37] however,

whether or not to supplement is a topic of debate.[38, 39] A recent systematic review on athletes from different sport suggests there is limited evidence for an association between low vitamin D levels and injury risk or performance. [36] Also, there is currently no consensus on the optimal level of vitamin D, neither for general health, for sport-specific benefits, nor for ethnicity.[40] Thus, it is debatable at what level supplementation is beneficial.

Almost one third of the players were treated (vaccination) for Hepatitis B non-immunity. A previous study from our group has shown that the prevalence of Hepatitis B among sportsmen in Qatar is markedly higher than observed in Australian Rules footballers or sumo wrestlers.[41] Our study population includes large groups originating from countries known not to have routine vaccination schedules;[41] regular screening for hepatic infection/ immunity is therefore beneficial in our athlete population.

Of interest was the relatively high prevalence of dyslipidemia (10.6%). This is in contrast to Meyer & Meister,[42] who documented much lower rates among German professional football players. However, it supports the findings of Eliakim et al[43] and Fallon et al,[44] who found substantial levels of dyslipidemia in a mixed-sport population. Similar to Eliakim et al,[43] several players in our study had a family history of dyslipidemia. In almost all cases, players were referred to a dietician or given dietary advice.

Contrary to expectations, there was a surprisingly low prevalence of respiratory symptoms (n=12, 2.2%) and gastrointestinal (GI) complaint (0%) that required further investigations, treatment or recommendation for follow-up in this study. Airway hyperresponsiveness/asthma, respiratory infections and GI problems are common among elite athletes and are the most frequent affected system reported from elite sports events including FIFA World Cup.[32, 45-47]

The lack of cold air and minimal pollens in Qatar is believed to be one cause for the low prevalence. Another explanation for the low number may be that the lung function test in this study was performed only with a general spirometry test at rest along with self-reported history. Lung function testing with bronchodilator reversibility and bronchoprovocation tests are required to detect bronchial hyperresponsiveness associated with training.[46] These tests were not routinely performed in the current study.

GI problems are more common in endurance athletes than other athletes including football players.[48] Also, the fact that PHE is only a snapshot of the time and the limited in depth questions about GI symptoms in the standard PCMA questionnaire, may explain the lack of GI symptoms in this study.

Cardiovascular examination

ECG abnormalities gave reason for further testing in 19 players (3.2 %), mostly due to T-wave inversion, and were the main reason for the cardiovascular abnormalities detected. None of the players with T-wave inversions showed any sign of cardiac pathology after additional testing. However, ECG revealed probable long QT syndrome in one player, who was advised against competitive football pending further investigations.

The discussion regarding routine inclusion of an ECG in the PHE of athletes is ongoing, with opposing recommendations from the US and Europe.[12, 49] The concern is the ability of ECG to correctly differentiate physiological adaptation owing to sustained and intensive exercise from inherited or congenital cardiac pathology.[27] Our prevalence of 3.2% of players with an ECG abnormality is lower than that reported by previous studies of footballers or athletes from various sports.[50, 51] In this study, the ECG results were interpreted according to the Seattle criteria, which have reduced the rate of abnormal ECG markedly.[52-54]

It is argued in the literature that the value of including echocardiography is limited.[52, 55] We found that echocardiography gave reason for additional testing in 15 players (2.5%) and resulted in a diagnosis of abnormal coronary artery origin in one player who presented with a normal ECG. The player was disqualified for competitive football due to elevated risk of SCD.

Musculoskeletal examination

Our targeted and comprehensive musculoskeletal test battery focusing on the lower extremities identified at least one musculoskeletal condition necessitating further investigation, treatment or recommendation for follow-up in more than 1 in 3 players.

Interestingly, we found that the hip/groin was the region most frequently affected, with 11% of the players identified with a hip/groin problem requiring follow-up. However, this may be a reflection of the screening program, which included a series of tests targeting the groin (pain provocation tests and strength test).

More than one-third of the conditions were identified as a current injury or ongoing physical complaint, which led to further investigation or treatment and resulted in the athlete being temporarily not cleared to play. Given that previous injury and unresolved injuries represent the greatest risk factor for recurrent injury, it is important that these are identified.[56] However, self-reported history of previous injury resulted in follow-up in only 15 cases. Most likely, this represents gross underreporting of past injuries, given that data from injury surveillance of QSL players have reported that a player can expect at least one injury per season.[5]

Ideally, the PHE should also be used to identify athletes at risk for future injury. In the current study, half (50.2%) of the musculoskeletal findings represented an abnormal test result, leading to prevention recommendations. However, the predictive value of the tests used is debatable.[20, 57] Lower adductor strength is identified as a risk factor for groin injuries, whereas there are low levels of evidence for the predictive value of testing isokinetic muscle strength, flexibility, ROM and functional movement tests.[20, 58, 59]

Considering these results, using a targeted physical examination based on careful history seems beneficial in detecting current injury and musculoskeletal problems. However, prospective studies are necessary to assess whether identifying such risk factors and acting on them reduces future injury risk.

To clear or not to clear?

In 86.2% of the players, the health conditions did not restrict the athlete from competitive sport, suggesting that most were interpreted as not being severe. However, they may be significant from the point of view of the athlete. By identifying these conditions, treatment and prevention strategies can be initiated to potentially prevent future health/injury risk.[8] The purpose of PHE is to ensure safe participation for the player, but at the same time not to disqualify athletes unless there is an evidence-based medical reason.[60] For the 12.4% of

players not given immediate clearance, the delay was caused by the need for further investigations, with suspected cardiovascular conditions as the main reason. However, after follow-up investigations only one player (abnormal coronary artery) was permanently disqualified whereas one player (possible long QT syndrome) was advised against competitive football.

Methodological considerations

The strength of the present study was that it was undertaken in one sports medicine hospital with a large group of male football players. This allowed for development of a PHE targeting history and examination characteristics thought to be relevant for the population and sport in question.[61]

A further strength of our study is that several sports medicine physicians performed the Stage two assessment. This provides good generalisability, but also adds uncertainty to the reliability of the evaluation of findings and conditions identified. We only included health conditions requiring further investigation, treatment or recommendations for follow-up. This may have been subjective, depending on the physician's experience or field of expertise. Also, we evaluated each athlete's PHE as a separate encounter even if the player had performed PHE during preceding seasons. We do not know how this may have influenced the physician's interpretation of the results.

It should be noted that, in contrast to cardiovascular conditions, there is limited evidence to help clearly define what constitutes a significant general and musculoskeletal finding. In our study, this was a decision based on the interpretation of the physician, most likely representing a source of inconsistency. We also acknowledge that as our study included a homogenous group of male professional football players in a specific setting, this limits the generalisability of the findings to other sports, settings, age groups and women. Furthermore, the relatively small numbers of players in ethnic groups other than Arabic and black means that the results may not be relevant to other populations.

Positive findings can only be found in tests that are conducted. We recognise that the relative prevalence described here are in part an artefact of the screening battery chosen. We suggest that this is reflective of clinical practice; however, more work needs to be done

to establish its veracity through prediction of injury and illness events. For PHE to be effective, however, the characteristics of the population and sport in question should be taken into consideration.[61] The PHE in the present study used the standardised PCMA based on knowing our populations. For example, Vitamin D deficiency and hepatitis B are known to be prevalent in our population from previous studies.[33, 41] Although the health conditions detected in this study may not be prevalent in other sport settings/groups, we believe the elements used in our PHE are beneficial to other sport setting in the frame that each sport setting knows the characteristics of their population.

Finally, a major limitation to this study is the cross-sectional design, which does not allow us to infer the predictive value of the conditions detected on future health risk. Prospective studies are warranted to address this question. Also, considering the high prevalence of conditions requiring follow-up, longitudinal follow-up studies are required to examine the usefulness of interventions.

Conclusion

This study demonstrated that a targeted PHE in professional Qatari football players is beneficial in detecting current health conditions for which treatment, investigation, or prevention management can be instigated. However, the clinical relevance and benefits on future health are still unclear.

Twitter: Arnhild Bakken at @phbakken

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ETHICAL APPROVAL

The study has been reviewed and approved by the Institutional Review Board, Anti-Doping Lab Qatar (ADLQ), Doha, Qatar.

CONTRIBUTORSHIP STATEMENT

AB designed the study, contributed in data collection, analysed and interpreted the data, and drafted the article. RB and KMK designed the study, interpreted the data, revised the article and approved the final revision of the article. ST, MCA and MGW contributed to quality control and interpretation of the medical data, and revision of the manuscript. TB, JLT, RW and EW contributed to the final paper.

COMPETING INTERESTS

One declared. Karim Khan is Editor in Chief of BJSM and was arms length (and blinded) from the review process in BJSM.

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FIGURE LEGENDS

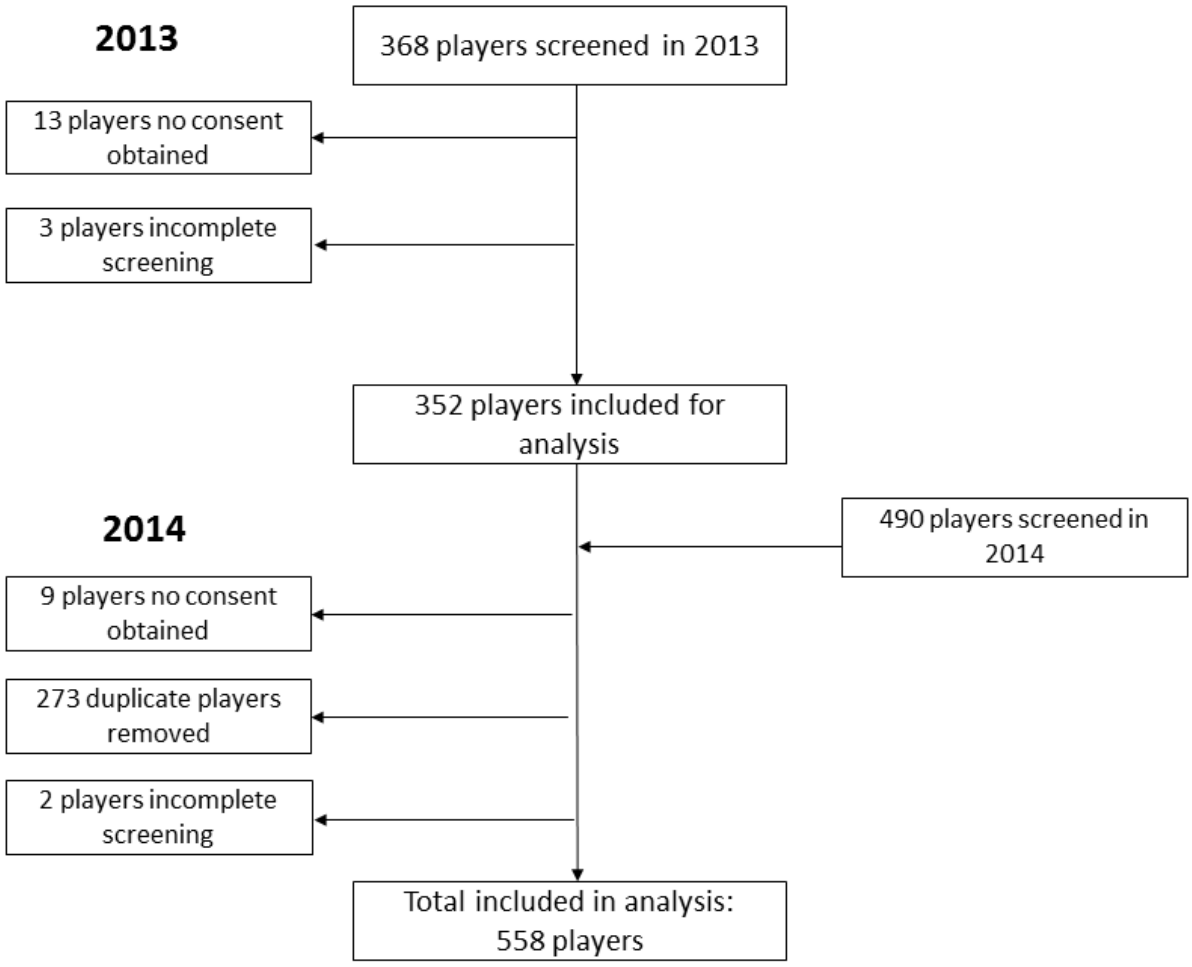

Figure 1 Flow chart showing the inclusion of subjects during the two year study period.

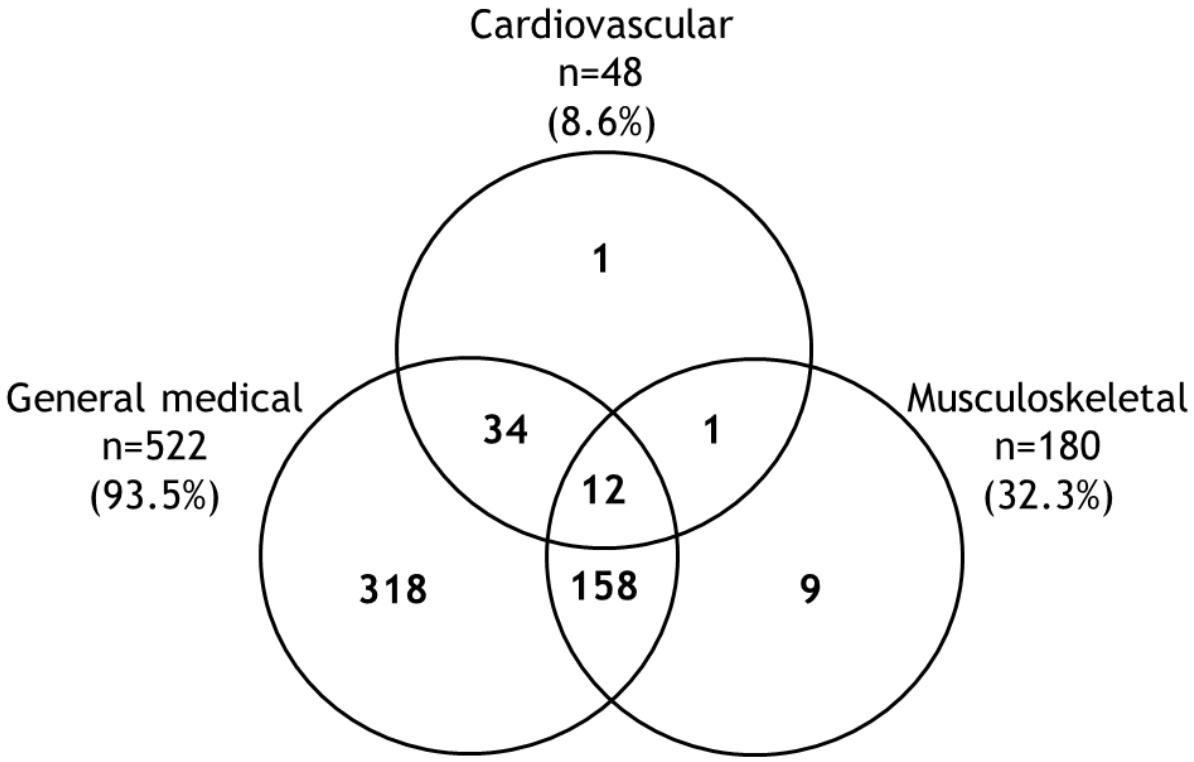

Figure 2 Venn diagram of players detected with one or more health conditions in the PHE (n=558).

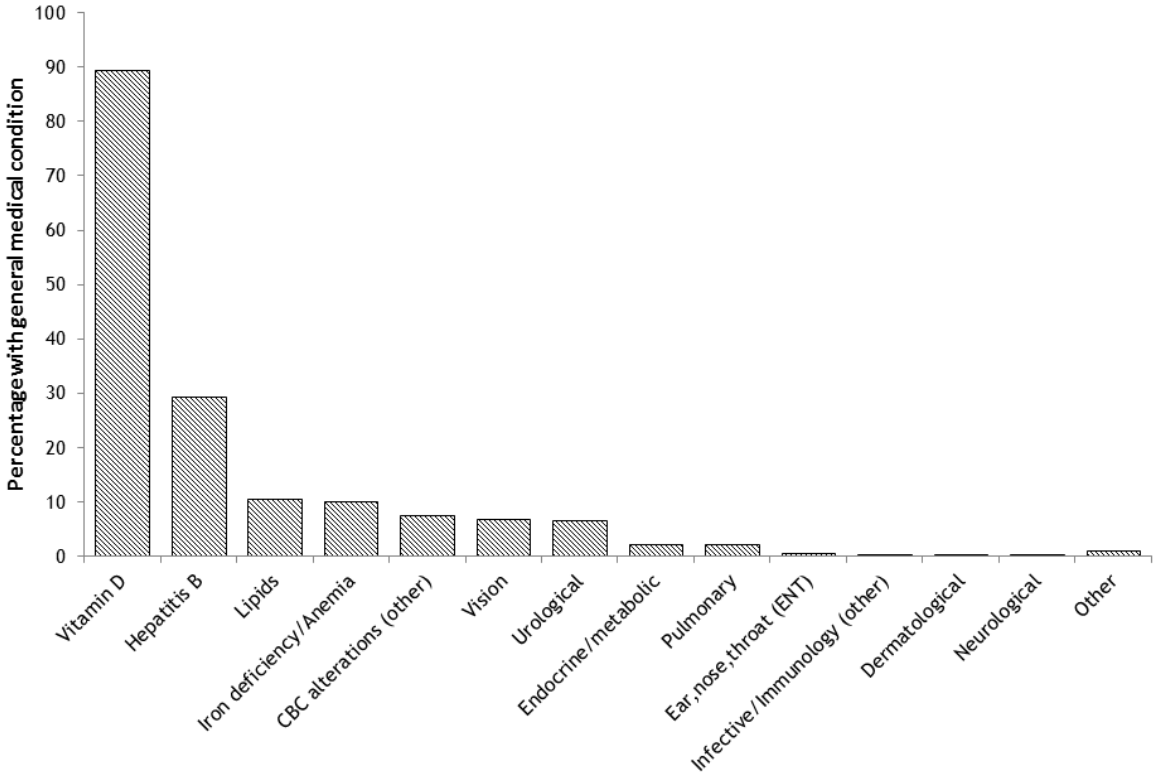

Figure 3 Proportion of players with general medical conditions detected on PHE (n=558).

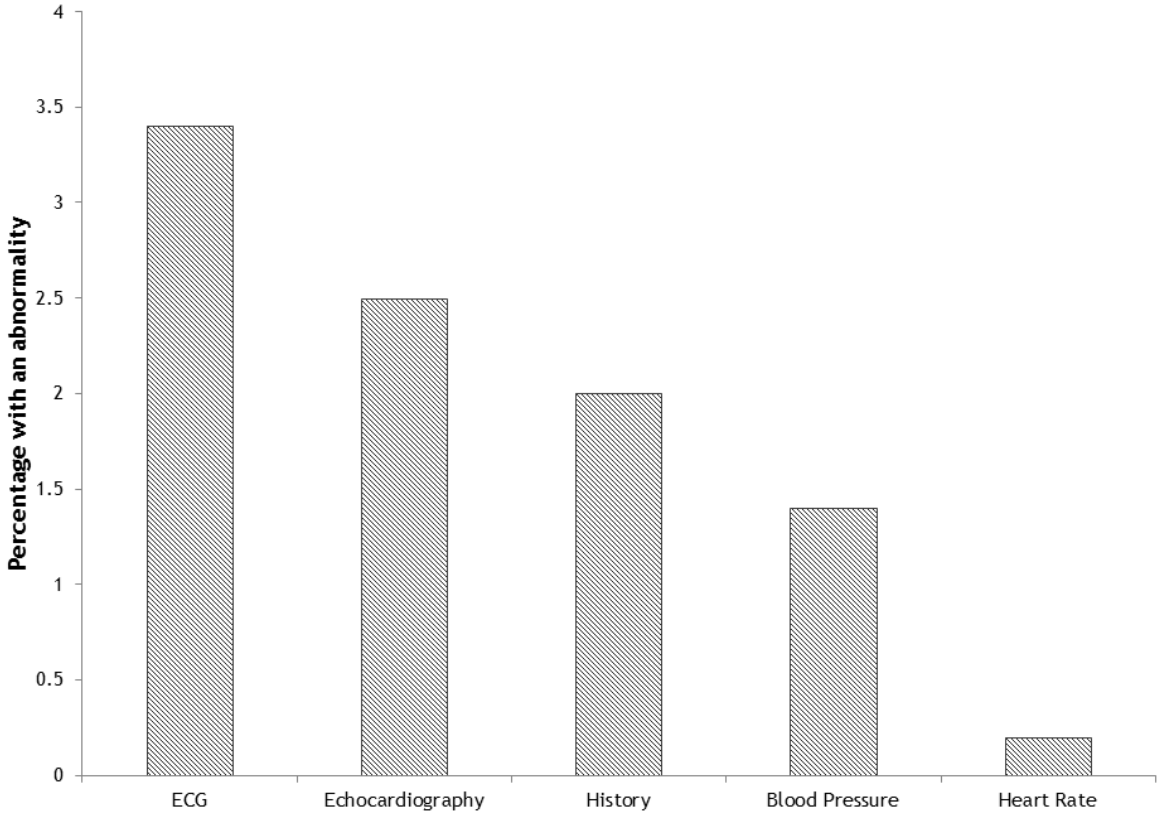

Figure 4 Proportion of players detected with an abnormality on cardiovascular screening (n=558).