Anthropometric and physiological characteristics of Melanesian futsal players: a first approach to talent identification in Oceania

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ABSTRACT: This study assessed the anthropometric and physiological characteristics of elite Melanesian futsal players in order to determine the best performance predictors. Physiological parameters of performance were measured in 14 Melanesian (MEL-G, 24.4±4.4 yrs) and 8 Caucasian (NMEL-G, 22.9±4.9) elite futsal players, using tests of jump-and-reach (CMJ), agility (T-Test), repeated sprint ability (RSA), RSA with change-of-direction (RSA-COD), sprints with 5 m, 10 m, 15 m, and 30 m lap times, and aerobic fitness with the 30-15 intermittent fitness test (30-15 IFT). The anthropometric data revealed significantly lower height for MEL-G compared with NMEL-G: 1.73±0.05 and 1.80±0.08 m, respectively; P=0.05. The CMJ was significantly higher for MEL-G than NMEL-G: 50.4±5.9 and 45.2±4.3 cm, respectively; P=0.05. T-Test times were significantly lower for MEL-G than NMEL-G: 10.47±0.58 and 11.01±0.64 seconds, respectively; P=0.05. MEL-G height was significantly related to CMJ (r=0.706, P=0.01), CMJ_{peakP} (r=0.709, P=0.01) and T-Test (r=0.589, P=0.02). No significant between-group differences were observed for sprint tests or 30-15 IFT, including heart rate and estimated VO_{2max}. Between groups, the percentage decrement (%Dec) in RSA-COD was significantly lower in MEL-G than NMEL-G (P=0.05), although no significant difference was noted between RSA and RSA-COD. Within groups, no significant difference was observed between %Dec in RSA or RSA-COD; P=0.697. This study presents specific anthropometric (significantly lower height) and physiological (significantly greater agility) reference values in Melanesians, which, taken together, might help coaches and physical fitness trainers to optimize elite futsal training and talent identification in Oceania.

INTRODUCTION

Futsal was accredited by the Fédération Internationale de Football Association (FIFA) in 1989, and the popularity of this attractive professional sport has been growing ever since. Although the literature remains sparse (52 Medline publications with the key word: futsal; August 2014), the physiological characteristics of well-trained, top-level futsal players have been well described [1,2,3,4]. Futsal is described as high-intensity exercise, heavily taxing the aerobic and anaerobic pathways, as emphasized by Castagna et al. [2]. The physiological parameters of performance in futsal have usually been assessed by field tests with short recovery periods to determine a player's ability to repeat short sprints with and without a change of direction [5,6] or by the intermittent incremental shuttle-run test [3,4,5]. Mainly aerobic performance parameters were investigated in these studies, and anaerobic parameters such as lower limb explosivity and agility, which are potential indicators of futsal performance, have been neglected. To our knowledge, only one study has investigated agility and speed as strong indicators of performance in elite female futsal players [7]. Several studies have focused on the

anaerobic parameters of performance in soccer players, mainly during small side games, which might be considered as similar to futsal games. But futsal has specificities regarding the ground and shoe adherence and smaller balls with 30% less bounce, which forces the players to develop the ability to accurately control and move the ball quickly on the ground [8,9]. We therefore assumed that these specificities merited further investigation. Furthermore, the reduced pitch dimensions and frequent turnovers during futsal match-play require fast decision-making and high sprint capabilities under pressure during the attacking and defending phases [10]. Thus, sprint performance and agility are required in the game [11], as in many team sports, and are likely to be pertinent indicators of performance.

Anthropometric data are also likely to be good performance predictors, as underlined by Wong et al. [12,13] in their study of world-class soccer players. Indeed, anthropometric and physiological characteristics were used to develop player profiles that were shown to have an impact on the playing style of each confederation analysed following the World Cups of 2002 (South Korea) and 2006

(Germany). "For example, Sweden and Germany are known for discipline and tactical play; Japan and South Korea for team work; Brazil and Argentina for individualism and skilful play at the service of the group and Nigeria and Cameroon for high speed play" [6]. This study, however, reported no information about the Oceania Football Confederation (OFC), the confederation to which the players of the present study belong. Oceania is a large region in the Pacific Ocean of approximately 9 million square kilometres with a population of nearly 5 million islanders (Wallacea, Australia, New Guinea, Melanesia, Micronesia, and Polynesia). Historically, the best athletes from these countries have migrated to continents where sport has a professional status. Some of these athletes are highly coveted in professional sports such as rugby, soccer, and American football. However, it has been difficult or even impossible to obtain objective data on their physical characteristics (i.e., combined force and speed to obtain power, endurance, agility and flexibility) because the scientific literature has remained sparse [14]. In their literature review, these authors pointed out that the anthropometric and/or physiological characteristics of Micronesian and Melanesian populations (i.e., the western Pacific) were lacking. In the present study, we focused on the Melanesian people, the indigenous Melanesian population of Oceania, a region where soccer is highly developed and futsal is growing in recognition and level of practice. We therefore followed the selection process of the National New Caledonian futsal team for which Melanesian and Caucasian natives, living and training in New Caledonia, present as candidates.

In the present study, our goal was to: (1) determine the relationships between the parameters of performance and the anthropometric profiles of the players and (2) analyse the similarities and differences between the two ethnic groups and the literature data to set the basis for futsal talent identification and training design in Oceania.

MATERIALS AND METHODS

Subjects. Fourteen Melanesian futsal players and eight Caucasian futsal players participated in this study. All were well trained and had been pre-selected by the Fédération Calédonienne de Football to participate in the qualifying tournament of the Oceanian Football Confederation (OFC) for the 2011 FIFA Futsal World Cup. New Caledonia was ranked 5th out of 11 national teams of the OFC at the time of the study. At the end of the precompetitive period (3 weeks after the end of this study), 16 of them were selected for the national New Caledonian team. The Melanesian group (MEL-G) and the non-Melanesian group (NMEL-G) were 24.4 ±4.4 and 22.9±4.9 years old, trained 4 to 5 times per week for 7.75±1.78 h·wk^{-1} and 7.64±1.93 h·wk^{-1} excluding matches, and had been playing futsal for 10.5±6.8 and 9.3±8.4 years, respectively. The anthropometric and physiological data are presented in Tables 1, 2, and 3. All participants gave informed written consent before participating in the protocol, which was in accordance with legal requirements and the Declaration of Helsinki and approved by the Ethics Committee of University of New Caledonia, Noumea, New Caledonia. The entire national preselected group participated in this study (n=22).

Testing protocol

Futsal is a high-intensity intermittent sport that heavily taxes the aerobic and anaerobic pathways [2]. During matches, it requires high-intensity effort every 23 seconds [15] and changes in locomotor activities every 3.28 seconds [16]. Many anthropometric characteristics of soccer players have been reported in the literature over the last decade, providing evidence of a specific soccer profile for each FIFA continental zone. Concerning futsal, however, the literature remains sparse. Moreover, there is a general lack of anthropometric and physiological information concerning Pacific Islanders, and this is particularly so for Melanesian futsal players [17]. This study was thus designed to determine whether the anthropometric and physiological characteristics of Melanesian futsal players are significantly correlated in order to establish a scientific basis for talent identification in Oceania and help coaches to develop a playing style according to the profile of their futsal players. Although the number of participants could be considered as relatively low, we assumed that the high playing level displayed during the national selection process would compensate for the low number of futsal players tested. Indeed, of the 22 futsal players tested, 16 participated in the qualifying tournament of the Oceanian Football Confederation (OFC) for the 2011 FIFA Futsal World Cup.

The testing sessions were held over 2 days. Day 1 consisted of anthropometric measures, jump-and-reach tests and sprint sessions (5 m, 10 m, 15 m, 30 m). On day 2, the participants performed the repeated sprint ability test (RSA) and the RSA with change of direction (RSA-COD), the agility T-Test [18], and the 30-15 intermittent fitness test (30-15IFT) [19]. The 30-15IFT was performed as described and validated by Buchheit [19]. This 30-15IFT was chosen because (1) the physiological work of futsal has been described as high-intensity effort every ~23 seconds [15], which corresponds roughly to the 30 seconds of work of the 30-15IFT; (2) the work in futsal is intermittent, like in handball, for which the 30-15IFT was developed [19]; and (3) the futsal playing surface and dimensions are also similar to those of handball. Each player was instructed and verbally encouraged to give his maximal effort. The tests were performed between 9 AM and 2 PM. In the 24 hours before the experiment, the participants were asked (1) to abstain from exercise on the day preceding any assessment, and (2) not to drink caffeinated beverages on the days of the tests [20]. The study took place during the precompetitive period of 2011.

Anthropometry

After height and body mass measurements (Tanita HA 503, Tanita Corporation, Tokyo, Japan), body fat content was estimated from the skinfold thickness, expressed in mm (sum of four skin areas: biceps, triceps, subscapular, and suprailiac) measured by an experienced assessor on the right side of the body with the Harpenden skinfold

caliper (HSB-BI, Burgess Hill, West Sussex, UK), following the method described by Durnin and Rahaman [21]. Body mass index (BMI) was calculated according the formula BMI=kg/(height in metres^2). Two independent measures were taken at each fold. If the second measure was not within 5% of the first, subsequent folds were measured until two folds were within 5%; their mean was then retained. The equation of Durnin and Rahaman [21] was used to determine the percentage of fat body mass (%FBM). Lean body mass (LBM) in kg was determined from body mass and FBM.

Jump-and-reach test

The jump-and-reach test was performed using a Myotest Pro (Myotest SA, Sion, Switzerland). The participants were asked to perform a series of five counter-movement jumps (CMJ) in which they began in a standing position, dropped into the semi-squat position, and immediately jumped as high as possible using their arms. One minute of recovery was allowed between the jumps. The jump height was given automatically by the Myotest Pro, which is considered a valid method [22]. The power output during the jump-and-reach test was determined by entering the jump height and body weight variables into the equation of Sayers et al. [23]:

CMJ_{peakP} (W) = 51.9xCMJ height (cm)+48.9xbody mass (kg)–2007,

where CMJ_{peakP} is the peak power obtained with the CMJ and CMJ height is the height attained. A standardized 15-minute warm-up was performed by all participants 10 minutes before the jump-and-reach tests.

The 5 m, 10 m, 15 m, and 30 m sprints tests

The same day of the anthropometric measurements, the participants performed three 30 m sprints with 5 m, 10 m, 15 m lap-times on an indoor synthetic court, and the best performance was kept as their best performance for each distance. During the recovery period (2-3 minutes between sprints), the participants walked back to the starting line and then waited for the next sprint. Time trials were recorded using photo-cell gates (Brower Timing Systems, Salt Lake City, Utah, USA, accuracy of 0.01 s) placed 1 m above the ground. The participants started the sprint at the starter signal 0.5 m behind the starting line. Stance for the start was consistent for each subject.

Repeated sprinting ability with and without change of direction

The RSA consisted of straight-line sprints (6x25 m with 25 s active recovery) while the RSA-COD consisted of a 180-degree change of direction in the middle of the sprint distance [19] [6x(2x12.5 m with 25 s active recovery)]. During the active recovery, participants jogged slowly back to the starting line and waited for the next sprint. Time trials were recorded using photo-cell gates (Brower Timing Systems, Salt Lake City, Utah, USA, accuracy of 0.01 s) placed 1 m above the ground. Investigators used a hand-held stopwatch to monitor recovery time. The participants started the sprint at the starter signal 0.5 m behind the starting line. The stance for the start was consistent for each subject.

The following data were recorded during the RSA and RSA-COD performances: the fastest time (FT), the average time (AT) and the total time (TT), the number of sprints x fastest sprint time (Ideal sprint time) of all sprints, and the percentage decrement (%Dec) score as reported by Glaister et al. [24]. The use of TT was recommended by previous studies of RSA and RSA-COD [25]. The %Dec has recently been reported as the most valid and reliable method for quantifying fatigue in RSA tests [24].

The T-Test

The T-Test was organized using the protocol outlined by Semenick [26] with minor modifications proposed by Pauole et al. [18]. Three test trials were recorded using photo-cell gates (Brower Timing Systems, Salt Lake City, Utah, USA, accuracy of 0.01 s) placed 0.4 m above the ground. The participants commenced the sprint when ready from a standing start 0.5 m behind the timing gate. The reliability and validity of the T-Test were reported by Pauole et al. [18].

30-15 intermittent fitness test

The 30-15IFT was performed as described and validated by Buchheit [19] on an indoor synthetic track where ambient temperature ranged from 24 to 26℃. The 30-15IFT consisted of 30 s shuttle runs (40 m) interspersed with 15 s passive recovery periods. The initial running velocity was set at 8 km·h^{-1} for the first 30 s and speed increased by 0.5 km·h^{-1} every 30 s thereafter. Running pace was governed by a prerecorded audio signal. Participants were instructed to complete as many (30 s) "stages" as possible, and the test ended when the player could no longer maintain the required running speed (i.e., when players were unable to reach a 3 m zone near each marked line at the time of the audio signal on three consecutive occasions). The speed at the last completed stage (VIFT) showed good reliability. VO$_{2max}$ can be estimated from the VIFT according to the following formula: eVO$_{2max}$30-15IFT (ml·min^{-1}·kg^{-1}) = 28.3 - 2.15 G - 0.741 A -0.0357 W + 0.0586 A x VIFT + 1.03 VIFT, where G stands for gender (female=2; male=1), A for age, and W for weight. Each player was encouraged verbally to make a maximal effort during all tests. During the 30-15IFT, heart rate at rest (HR$_{rest}$) and heart rate peak during exercise (HR$_{peak}$) were collected using a long-range telemetry system (Suunto t6, Suunto Oy, Finland) that enabled real-time exercise intensity checking. Data were recorded every second of the 30-15IFT until the end of the test.

Statistics

All values are expressed as means ± standard deviation (SD). A two-way (time x group) ANOVA was applied for repeated measures. When statistical significance was observed, post-hoc analysis was performed: MEL-G was compared with NMEL-G through unpaired Student t-tests performed on all anthropometric, physiological and performance variables: height, weight, BMI, %FBM, eVO$_{2max}$, CMJ$_{peakP}$, peak power output, T-Test, RSA and RSA-COD (FT, AT, TT, Ideal sprint time, %Dec) and 30-15IFT, as well as HR$_{rest}$ and HR$_{peak}$ of

the 30-15IFT. Pearson's product moment correlations describe the relationships between the individual anthropometric variables and the physiological parameters of performance in MEL-G and NMEL-G. A stepwise multiple linear regression was used to determine the best predictors of performance in MEL-G and NMEL-G. The Systat 5.0 statistical package was used. For all statistics, a significance level of $P<0.05$ was pre-set.

RESULTS

The anthropometric data revealed significantly lower height for MEL-G compared with NMEL-G ($P=0.05$) and a trend ($P=0.06$) for BMI. The other anthropometric characteristics showed no significant differences, as noted in Table 1.

The jump-and-reach test showed significantly higher values for MEL-G compared with NMEL-G ($P=0.03$; Table 2). The T-Test showed a significantly higher performance for MEL-G compared with NMEL-G ($P=0.05$; Table 2). No significant differences were observed for the 5 m, 10 m, 15 m, and 30 m sprint performances (Table 3) between groups or for the 30-15IFT ($P=0.07$), including HR_{peak} and eVO_{2max} ($P=0.06$; Table 2).

No significant between-group differences were observed for RSA. However, the first RSA sprint showed a significantly lower intra-group value for MEL-G compared with NMEL-G ($P=0.01$; Table 3).

Within groups, RSA-COD and its components (i.e., FT, AT, TT, Ideal sprint time) showed significantly higher values compared with RSA components in both groups ($P=0.001$; Table 3). However, between groups, no significant differences were observed between the %Dec of RSA and RSA-COD ($P=0.697$), and the %Dec of RSA-COD was significantly lower in MEL-G compared with NMEL-G ($P=0.05$).

TABLE 1. Anthropometric data observed in MEL-G and NMEL-G.

	MEL-G	NMEL-G
Height (m)	1.73 ± 0.05 *	1.80 ± 0.08
Body mass (kg)	72.11 ± 6.92	73.81 ± 11.45
Bicipital (mm)	4.46 ± 2.69	3.85 ± 0.65
Tricipital (mm)	7.11 ± 2.86	7.75 ± 2.26
Suprailiac (mm)	7.76 ± 3.57	8.78 ± 2.87
Subscapula (mm)	12.08 ± 3.67	11.3 ± 2.10
Total skin fold (mm)	31.41 ± 11.35	31.68 ± 6.85
BMI (kg·m^{-2})	24.24 ± 2.7	22.73 ± 1.90
Density	1.06 ± 0.01	1.06 ± 0.01
Fat body mass (%)	17.68 ± 4.01	18.15 ± 2.68
Lean body mass (kg)	59.17 ± 4.02	60.25 ± 8.45

Note: *Significantly different between groups, $P<0.05$; 1-beta =0.676.

TABLE 2. results of the first set of field tests for MEL-G and NMEL-G.

	MEL-G	NMEL-G
T-Test (seconds)	10.47 ± 0.58	11.01 ± 0.64
CMJ (cm)	50.44 ± 5.88	45.16 ± 4.34
CMJ$_{peakP}$ (W)	4292 ± 423	4030 ± 498
VIFT (km·h^{-1})	18.71 ± 1.33	19.5 ± 0.6
eVO$_{2max}$ (ml·kg·min^{-1})	51.46 ± 3.2	52.74 ± 1.94
HR$_{rest}$	67.44 ± 17.95	74.75 ± 12.16
HR$_{peak}$	193.56 ± 8.26	187.88 ± 12.68
Lean body mass (kg)	59.17 ± 4.02	60.25 ± 8.45

Note: *Significantly different between groups; $P<0.05$. T-Test for agility (1-beta=0.487), counter-movement jump (CMJ; 1-beta=0.557) for explosivity, CMJpeakP for an estimation of peak power according to the Sayers formula [23] and the intermittent, incremental shuttle-run test (30-15IFT [19]) to obtain the speed at the last completed stage (VIFT), estimated VO$_{2max}$ (eVO$_{2max}$) and values of heart rate at rest (HR$_{rest}$) and at maximal exercise (HRpeak).

TABLE 3. Results of the second set of field tests for MEL-G and NMEL-G

	MEL-G	NMEL-G
5m time (sec)	1.41 ± 0.11	1.35 ± 0.08
10m time (sec)	2.18 ± 0.12	2.13 ± 0.13
15m time (sec)	2.82 ± 0.15	2.84 ± 0.12
30m time (sec)	4.72 ± 0.17	4.80 ± 0.15
RSA 6x25m		
Time 1 (sec)	3.82 ± 0.23 $^{\$*}$	4.13 ± 0.22 $^{\$}$
Time 2 (sec)	3.95 ± 0.23 $^{\$}$	4.13 ± 0.28 $^{\$}$
Time 3 (sec)	3.98 ± 0.19 $^{\$}$	4.04 ± 0.19 $^{\$}$
Time 4 (sec)	4.05 ± 0.25 $^{\$}$	4.08 ± 0.19 $^{\$}$
Time 5 (sec)	4.01 ± 0.23 $^{\$}$	4.06 ± 0.11 $^{\$}$
Time 6 (sec)	4.15 ± 0.25 $^{\$}$	4.11 ± 0.19 $^{\$}$
Average time RSA	3.99 ± 0.17 $^{\$}$	4.09 ± 0.17 $^{\$}$
Fastest time RSA	3.77 ± 0.19 $^{\$}$	3.92 ± 0.19 $^{\$}$
Total sprint time RSA	23.96 ± 1.05 $^{\$}$	24.55 ± 1.01 $^{\$}$
Ideal sprint time RSA	22.64 ± 1.12 $^{\$}$	23.52 ± 1.13 $^{\$}$
%Dec score RSA	5.90 ± 3.11 $^{\$}$	4.44 ± 1.76
RSA-COD 6x(2x12.5m)		
Time 1 (sec)	5.38 ± 0.21	5.54 ± 0.23
Time 2 (sec)	5.41 ± 0.23	5.50 ± 0.22
Time 3 (sec)	5.43 ± 0.23	5.48 ± 0.11
Time 4 (sec)	5.51 ± 0.27	5.56 ± 0.17
Time 5 (sec)	5.50 ± 0.20	5.58 ± 0.18
Time 6 (sec)	5.57 ± 0.26	5.56 ± 0.24
Average time RSA-COD	5.47 ± 0.19	5.53 ± 0.15
Fastest time RSA-COD	5.29 ± 0.19	5.31 ± 0.18
Total time RSA-COD	32.79 ± 1.14	33.21 ± 0.92
Ideal sprint time RSA-COD	31.71 ± 1.15	31.86 ± 1.07
%Dec score RSA-COD	3.42 ± 0.96 *	4.25 ± 0.84

Note: *Significantly different between groups for sprint 1 and %Dec score RSA-COD; $P<0.05$ and 1-beta=0.811 and 0.491; respectively. $^{\$}$ Significantly different compared with RSA-COD within groups; $P<0.05$. Sprint performances (5 m, 10 m, 15 m and 30 m) are presented. The repeated sprint ability test (RSA) consisted of straight-line sprints (6 x 25 m with 25 s active recovery) while the repeated sprint ability with change of direction test (RSA-COD) consisted of a 180-degree change of direction in the middle of the sprint distance [6x(2x12.5 m with 25 s active recovery)].
During RSA and RSA-COD, performances were recorded: the fastest time (FT), the average time (AT) and the total time (TT); ideal sprint time of all sprints; and the percentage decrement score (%Dec) as reported by Glaister et al. [24]

Simple regression analysis demonstrated some relationships between the anthropometric data and physiological parameters of performance. In particular, the height of MEL-G was significantly related to: CMJ ($r=0.706$, $P=0.01$), CMJ_{peakP} ($r=0.709$, $P=0.01$), T-Test ($r=0.589$, $P=0.02$), and %Dec RSA ($r=-0.502$, $P=0.04$). BMI was significantly and inversely related to CMJ ($r=-0.583$, $P=0.05$). LBM was significantly related to CMJ_{peakP} ($r=0.619$, $P=0.03$). In NMEL-G, CMJ_{peakP} was significantly related to height ($r=0.894$, $P=0.03$), body mass ($r=0.866$, $P=0.003$), bicipital ($r=0.728$, $P=0.04$) and subscapular ($r=0.703$, $P=0.05$) thicknesses, and LBM ($r=0.846$, $P=0.008$). The stepwise multiple linear regression demonstrated that height contributed to the physiological parameters of performance (T-Test, $R^2=0.34$; CMJ, $R^2=0.42$; CMJ_{peakP}, $R^2=0.503$; Figure 1) in MEL-G.
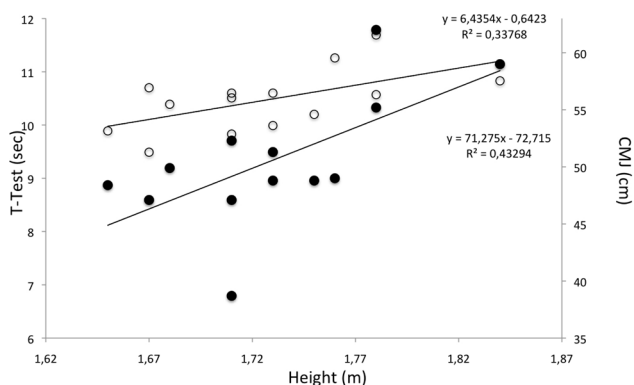
FIG. I. Prediction of performance (R^2) between t-test and height (white circles), and t-test and CMJ (black circles), of MEL-G. Note: $P=0.02$ and $P=0.01$, respectively.

DISCUSSION

In this study, we provide for the first time the specific characteristics of Melanesian athletes and, more specifically, of elite futsal players. We also show significant relationships between height and both agility and explosivity in these Melanesian futsal players and suggest that the combination of these parameters may serve as a determinant for performance in futsal. Moreover, specific anthropometric and physiological characteristics were observed in the Melanesians, and these may contribute to building an anthropometric and physiological profile of Melanesian futsal players. All these parameters should be taken into consideration to improve talent identification and the training of Oceanian futsal players.

Physiological parameters
Explosivity and agility
A significantly higher CMJ and better T-Test performance were observed in MEL-G compared with NMEL-G (Table 2). These observations were reinforced by significant correlations between height and the T-Test, CMJ and CMJ_{peakP} (Figure 1). The CMJ is considered to be a stretch-shortening cycle (SSC) performance jump. This type of effort is important in the initial phase of sprinting because of the longer ground-contact phases during the first steps [17]. This physiological aspect could be an advantage in futsal, where players change their locomotion activity approximately every 3 seconds and 28 milliseconds [16], with 8.6 activities per minute and high-intensity exercise every 23 seconds [15]. Moreover, 5-12% of the game is sprinting or work at high intensity [15,27,28]. Explosivity is known to contribute to agility [29], and it surely contributed to the T-Test performances since MEL-G attained significantly better performances for this test (Table 2). Indeed, the participants performed five accelerations approximately every 2 seconds, with a mean time of 11 seconds, and greater explosivity would have enhanced agility during the T-Test. Among agility tests, the T-Test is reliable [18] even in soccer players ($r=0.73$, $P<0.05$; Sporis *et al*. [30]). In the present case, we can hypothesize that a lower centre of gravity (due to significantly lower height) combined with better explosivity and agility in MEL-G contributed to a specific motor pattern in the MEL-G futsal players, and we suggest that this would help technicians in defining a specific Oceanian playing style.

Sprints and repeated sprint ability with and without change of direction
It is interesting to note that MEL-G showed significantly lower %Dec in RSA-COD than in RSA. Furthermore, the fatigue index of RSA-COD was significantly lower in MEL-G than in NMEL-G (Table 3). In this context, one of the main performance determinants of futsal is the ability to repeat sprints whether or not they include diverse types of change of direction [3,4,5,30]. This ability has also been recently described in soccer [5,6], but it is even more important in futsal [31]. During RSA, energy is initially supplied by anaerobic metabolism (i.e., ATP-PC and glycolysis), which is gradually reduced during subsequent sprints as the participation of aerobic metabolism increases [32]. In contrast, no evidence of the source of energy metabolism in RSA-COD has been reported [6]. Even though RSA and RSA-COD are similar, with both requiring repeated short-duration, high-intensity efforts with brief rests, Wong *et al*. [6] suggested that these two types of abilities are independent. The authors based this suggestion on the report of Dellal *et al*. [5], who found that the physiological impact of intermittent shuttle sprints was substantially higher than that of intermittent in-line running. Also, Lakomy and Haydon [34] found that increased fatigue and slower sprint times during multiple (>10) sprint trials occurred for enforced deceleration within 6 m after the finish line as compared with sprints without forced deceleration. In addition, a specific running technique and neuromuscular adaptations have been implicated in tests similar to the RSA-COD [29]. Although a specific running technique does not seem likely to explain the significantly lower fatigue in RSA-COD than RSA in MEL-G, the hypothesis of greater neuromuscular adaptations, as indicated by higher explosivity, seems plausible for MEL-G. As explained above (i.e., in the explosivity and agility paragraph), the CMJ is considered to be a slow SSC performance jump. Castillo-Rodriguez

et al. [35] very recently demonstrated that the CMJ was the best predictor of the dominant COD sprint field test. This type of effort is thus considered to be important in the initial phase of sprinting because of the longer ground-contact phases during the first steps [17]. It may have contributed to each 180° directional change of the RSA-COD and consequently resulted in the significant difference between RSA-COD and RSA in MEL-G and the significantly lower %Dec in RSA-COD in MEL-G compared with NMEL-G. It is also possible that the lower centre of gravity in MEL-G due to lower height combined with better explosivity significantly reduced %Dec in the RSA-COD condition compared with NMEL-G. If this is so, it suggests a physiological determinant of performance in Melanesian futsal players.

The intermittent, incremental shuttle-run test

The 30-15IFT showed no differences in eVO_{2max} between MEL-G and NMEL-G, who had mean values of 51.4 ± 3.2 ml·min^{-1}·kg^{-1} and 52.7 ± 1.9 ml·min^{-1}·kg^{-1}, respectively. These values are below those commonly observed for aerobic capacity in professional futsal players (>60 ml·min^{-1}·kg^{-1}; Barbero-Alvarez *et al*. [27]). The VIFT values (18.7 ± 1.3 km·h^{-1} and 19.5 ± 0.6 km·h^{-1} for MEL-G and NMEL-G, respectively) agree with the literature regarding regional and national team-sport athletes tested with the 30-15IFT [33]. However, we expected some differences in VIFT between MEL-G and NMEL-G, given that VIFT is "a 'composite' of several physical qualities determinant in team sports" [19]. Indeed, VIFT is closely related to several physical abilities such as COD [33], acceleration, jump height, and repeated sprint ability [19]. Here we found no significant differences in VIFT between groups, whereas %Dec in RSA-COD indicated a better ability to repeat sprints with COD in MEL-G. The HR$_{peak}$ measured at the end of the 30-15IFT (193.6 ± 8.3 and 187.9 ± 12.7 bpm for MEL-G and NMEL-G, respectively) was in line with the values observed at the end of the futsal intermittent endurance test (FIET) of Barbero *et al*. [31] or those obtained using Carminatti's intermittent shuttle running test [4]: HR$_{max}$ of 193 ± 8 and 193 ± 9 bpm, respectively. Thus, the 30-15IFT showed high values of HR at the end of the test similar to those in the futsal literature, which indicates that it may also be an adapted field test for futsal.

Anthropometric data

The anthropometric parameters showed significantly lower height of MEL-G compared with NMEL-G, 1.73 ± 0.05 m and 1.80 ± 0.08 m, respectively (Table 1), although body mass was not significantly different: 72.1 ± 6.9 kg and 73.8 ± 11.4 kg, respectively (Table 1). According to the literature, top-level Spanish and Brazilian futsal players [1,2] have higher mean height (1.77 m and 1.76 m) and body mass (75.4 kg and 74.5 kg) than MEL-G. It is well known that height and body mass are reasonable predictors for participation in and success at the highest level in soccer [12,13,36]. While no data for the Melanesian players of the OFC were revealed in Wong's review [12], other confederations showed systematically higher heights for soccer players in comparison with the present study results, with a mean of 1.81 m for all confederations.

The BMI tended to be significantly higher in MEL-G than in NMEL-G ($P<0.07$): $24.2 \pm 2.7\%$ and $22.7 \pm 1.9\%$, respectively. Once again, no data were revealed for the Melanesian players of the OFC in Wong's review [12], but the BMI of elite soccer players showed a mean of 23.1 ± 1.3 kg/m^2 for all FIFA confederations analysed. Beyond this index, the %FBM measured in the present study showed higher values in both groups (17.6 ± 2.4 and 18.1 ± 2.6 %FBM) when compared with Brazilian futsal players, who showed mean values of 9.9 ± 3.2 %FBM [4]. Two observations could explain these differences. First, the level of practice of our Melanesian futsal players was lower than that of professional players. Second, the lifestyle of Pacific Islanders has changed because of the migration to and urbanization of Melanesia [14]. Indeed, sedentary lifestyles, diets high in fats and refined sugars, and decreased infant breastfeeding are now common among Pacific Islanders and have all been associated with obesity [14,37]. Although not obese, the present futsal players (MEL-G and NMEL-G) may have a lifestyle that partially explains the high percentage of FBM observed. Melanesian futsal coaches thus may have to promote healthier diets and lifestyles to improve the body composition of their players. The present anthropometric data could be considered as the first evidence of a distinct profile of Melanesian futsal players, as they had lower body height and a higher %FBM compared with non-Melanesian players.

CONCLUSIONS

This study showed for the first time specific anthropometric and physiological parameters in Melanesian futsal players. Especially, significant relationships between height and both agility and explosivity were noted in the Melanesian players. This was accompanied by a significantly lower fatigue index for RSA-COD in MEL-G when compared with: (1) %Dec of RSA in MEL-G and (2) %Dec of RSA-COD in NMEL-G. These anthropometric and physiological performance parameters should help futsal coaches and fitness coaches to define an objective basis for talent identification and provide training perspectives to develop a specific Oceanian playing style. However, further studies are needed to improve anthropometric and physiological knowledge of Pacific Islanders, especially Melanesian athletes.

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Melanesian futsal player characteristics

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