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Comparative Study Between World Class and National Level in Female Futsal Players

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COMPARATIVE STUDY BETWEEN WORLD CLASS AND NATIONAL LEVEL IN FEMALE FUTSAL PLAYERS

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Abstract

The aim was to determine the differences between female futsal players of different competitive levels regarding reproductive factors, morphological characteristics, training routines, and sociodemographic profiles. The study consisted of n=169 female Brazilian futsal players assessed during the 28th Women's Brazil Futsal Cup. Participants were grouped based on their competitive caliber considering previously proposed frameworks: Brazilian National team (BNT), professional players (PP) and non-professional players (NPP). Players self-reported their competitive caliber, reproductive factors, training and sociodemographic information. Subsequently, anthropometric measurements were performed to estimate the regional body composition, fat percentage and determine morphological characteristics. The results revealed that BNT athletes (28.5±5.0 years) were older than the PP (25.0±4.4 years) and NPP (24.7±4.9 years); demonstrated a longer period involved in the futsal (17.4±6.5 vs 12.0±3.9 and 13.1±5.7 years) than PP and NPP, respectively. Regarding the volume (210.0±47.9 and 192.4±63.3 vs 160.2±74.4 min/day) and frequency of training (6.0±1.4 and 6.8±2.0 vs 4.4±1.5 sessions/week), the BNT and PP athletes demonstrated higher value than NPP, respectively. BNT athletes have a higher educational and socioeconomic level than the athletes from the other groups. Among BNT players, we observed that age, time playing futsal, training duration, volume and frequency, and socioeconomic level differed from PP and NPP.

Introduction

Futsal is a team sport played 5 x 5. Each team commonly plays with one goalkeeper, one defender, two wingers, and one forward. This sport is characterized by high-intensity intermittent, short-duration efforts, with decelerations and accelerations interspersed with short recovery periods between efforts [1, 2]. Women's futsal is relatively recent compared to men's futsal and is becoming increasingly popular all over the world. The popularity is confirmed by the inaugural 2025 FIFA Women's Futsal World Cup [3] that took place in Philippines and had Brazil as the first world champion [4].

Recent findings on the current state of research in women's futsal revealed that the most popular topics of investigation were strength & conditioning, psychology, career, anthropometric/morphology, medicine (injury), performance analysis (single skill/drill and match play), nutrition/hydration/supplements, physiology, sociology and biomechanics [5]. Studies with elite players (i.e., *players who compete at the best national league, international level or represent the national team*) represented 28% of publications and Brazil is among the countries with more research outputs [5]. Brazilian futsal is known to be popular in schools all around the country as being a common sport in the context of physical education classes [6], which may help explain the high interest and significant impact Brazil has in women's futsal research. In 2016, a Brazilian women's futsal match was broadcasted for the first time by a pay-per-view national channel and since then, women's futsal has been expanding in the country [5]. The most traditional competition is the *Taça Brasil de Futsal Feminino* (Brazilian Women's Futsal Cup) that had its first edition in 1992. According to the scoping review by Barreira et al. [5], the oldest publication related to women's futsal is from 2005 [7], conducted by our research team in the 10th edition of the Brazilian Women's Futsal Cup (that took place in 2001) and focused on determining the somatotype profile of elite players based on their tactical role. Our team also monitored the 20th (2011) and 28th (2021) edition of the tournament to help advance the understanding of anthropometric and somatotype trends and factors that may impact these outcomes [8, 9]. More specifically, when comparing the 20th and 10th editions, we found an increase in years of practice as well as mesomorphic profile combined with a decline in endomorphic rates [8]. Trend analysis of the 28th (2021) edition compared to the previous ones indicated higher age and lower percentage body fat, greater tensed arm and relaxed calf girths [9].

A systematic review found differences in anthropometric characteristics between elite and non-elite female futsal players. The results suggest that, to participate in high-level competitions in women's futsal, elite players must have greater weight, height, and BMI than non-elite players [10]. The effect of performance classification (i.e. participant tier) on physical qualities was reviewed in women's football players. The findings reveal substantial differences in physical performance across participant tiers as players progress from sub-elite to elite levels [11].

In the 20th edition of the Brazilian women's futsal cup, we attempted to characterizing female-specific factors and their potential association with morphological variables [12]. The biological sex gap in sports science is clear with research primarily focusing on male athletes [13]. Female-specific analysis is justified by multiple factors, including physical and physiological differences associated with female reproductive characteristics [14]. Researchers have been advocating to further explore the effects of ovarian hormonal profile on sports performance [15], but only ~20% of research conducted with females in the context of exercise and sports science involve female-specific outcomes [13]. Recent research in large cohorts indicates that female athletes report high use of contraceptive methods (~40-50%) [16, 17]. Moreover, female individuals commonly describe menstrual cycle effects on their physical performance (~75%) [18]. In our study with futsal players who participated in the 20th edition of the Brazilian women's futsal cup, 47% were premenarche-trained, 59% had menarche age classified as "normal" (11-15 years), ~90% presented self-reported "regular" menstrual cycles and ~70% perceived to perform better during the follicular phase of the menstrual cycle [12]. Postmenarche-trained futsal players presented higher percentage body fat and lower ectomorphic rates. Early menarche players reported higher skinfold thickness and endomorphic rates compared to normal and late menarche group. Premenarche-trained elite futsal players had the menarche later than the postmenarche-trained group [12]. Building from the previous literature abovementioned, it is still unclear whether players who have represented the National team present unique morphological and reproductive characteristics compared to other elite players who did not have that opportunity yet. Moreover, considering the large sociodemographic variability of a developing country such as Brazil that may impact players' opportunities and how far they may achieve in their athletic careers, we added factors such as training volume and frequency, age of training onset, marital status, level of education, and family income to the analysis. In the context of futsal, the beginning of systematic training happens usually later for girls compared to boys [19] and further expands the biological sex gap not only from the physical and physiological characteristics, but also societal factors.

Therefore, the objective of our study was to determine the differences between female futsal players of different competitive levels regarding reproductive factors, morphological characteristics, sociodemographic, and physical training aspects. Our initial hypothesis was that players who represented the national team would display a greater mesomorphic somatotype with lower percent body fat as well as more training exposure [10]. Given the large interindividual variability in terms of oral contraceptive use impact on physical qualities [20] and menstrual cycle regularity [21], we could not formulate a plausible hypothesis related to the female-specific factors. However, we would anticipate a larger frequency of nulliparous among players in general but specially in those who have already representational team given that there are currently no sport-specific guidelines for female

athletes to provide support for training and matches during pregnancy [22], which may possibly prevent uni- or multiparous players reaching the national team level.

Results

From the n = 169 female Brazilian futsal players evaluated, 12 were classified as BNT, 58 were PP and 99 were NPP. Table 1 shows age and anthropometric characteristics. Difference was only found for calf skinfold between groups BNT (10.3±3.6 mm) and NPP (15.2±7.6 mm). Athletes from the BNT (28.5±5.0 years) were older than the PP (24.0±4.4 years) and NPP (24.7±4.9 years). Average body fat values ranged from 18 to 19% indicating balanced mesomorph-endomorph characteristics for BNT (4.4-4.3-1.4) and mesomorphic endomorph for PP (4.5-3.8-1.8) and NPP (5.0-3.9-1.7).

Table 1. Anthropometric characterization of female Brazilian futsal players stratified by competitive levels

Physical profile	Brazilian national team (n=12)	Professional players (n=58)	Non-professional players (n=99)	P-value
Age (years)	28.5±5.0	25.0±4.4[1]	24.7±4.9[1]	**0.042**
Body mass (kg)	61.0±4.9	59.6±8.3	60.8±11.0	0.572
Height (cm)	160.3±4.4	161.0±5.6	161.0±5.7	0.787
BMI (kg/m^2)	23.8±2.1	23.0±2.7	23.3±3.3	0.374
Skinfolds triceps (mm)	15.4±3.4	15.5±5.1	17.5±6.0	0.073
Skinfolds subscapular (mm)	12.7±2.4	13.7±4.5	15.6±6.7	0.120
Skinfolds supraspinale (mm)	13.3±4.5	14.0±5.6	15.6±7.0	0.211
Skinfolds suprailiac (mm)	17.3±8.4	17.4±7.3	19.0±8.7	0.482
Skinfolds abdominal (mm)	21.3±7.0	23.2±9.2	24.4±9.7	0.457
Skinfolds midthigh (mm)	27.0±7.5	26.2±10.8	28.9±10.0	0.142
Skinfolds medial calf (mm)	10.3±3.6	13.3±6.5	15.2±7.6[1]	**0.013**
RT/E	0.98±0.20	1.05±0.37	0.98±0.27	0.540
Extremities skinfolds (mm)	52.7±12.7	55.0±21.0	61.6±21.9	0.077
Trunk skinfolds (mm)	51.3±16.3	54.2±18.9	58.9±23.1	0.293
Body fat (% BF)	18.4±4.3	18.1±4.8	19.6±5.3	0.399
Body fat (kg BF)	11.4±3.4	11.1±4.4	12.3±5.9	0.310
Lean mass (kg LM)	49.7±3.0	48.5±5.0	48.4±6.0	0.331
Humerus width (cm)	5.6±0.2	5.6±0.3	5.6±0.3	0.903
Femur width (cm)	8.8±0.4	8.6±0.5	8.6±0.6	0.358
Biceps girth (relaxed) (cm)	27.4±1.5	27.0±2.4	27.4±3.6	0.636
Biceps girth (tensed) (cm)	28.3±1.4	27.8±2.4	28.2±3.5	0.435
Midthigh girth (cm)	49.4±3.1	48.9±4.4	48.3±4.9	0.323
Calf girth (cm)	36.3±1.6	35.5±2.4	35.7±3.1	0.338
Endomorph	4.4±0.9	4.5±1.2	5.0±1.4	0.092

Mesomorph	4.3±1.0	3.8±1.0	3.9±1.2	0.234
Ectomorph	1.4±0.9	1.8±1.0	1.7±0.9	0.293

Data are presented as mean ± standard deviation.

Abbreviations: mm, millimeter; cm, centimeter; kg, kilogram; %, percentage; BMI (kg/m^2), Body mass index in kilograms per square meter. RT/E: relationship between trunk and extremity skinfolds (subscapular+suprailiac+abdominal / triceps+midthigh+medial calf); Extremities skinfolds (triceps+midthigh+medial calf); Trunk skinfolds (subscapular+suprailiac+abdominal). [1]Significant difference ($p < 0.05$) to National Brazilian team.

Table 2 displays the reproductive health characteristics of female Brazilian futsal players stratified by competitive levels. No differences were found between groups. Most athletes (overall sample) do not use oral contraceptives (90%), had menarche between 11-15 years (88%), have regular menstrual cycle (71%), reported their perceived best performance at the follicular phase of the menstrual cycle (59%) and have never been pregnant (96%).

Table 2. Reproductive health characteristics of female Brazilian futsal players stratified by competitive levels

Reproductive factors	Brazilian national team (n=12)	Professional players (n=58)	Non-professional players (n=99)	X^2 P-value
Age at menarche (years)	13.2±1.5	13.2±1.5	12.9±1.7	0.271
Contraceptive use (n=169)				
Yes (%)	2 (17%)	3 (5%)	12 (12%)	0.060
No (%)	10 (83%)	55 (95%)	87 (88%)	
Age of Menarche; categorical (n=169)				
≤10 years (Early) (%)	0 (0%)	1 (1%)	3 (3%)	0.932
11-15 years (Normal) (%)	11 (92%)	50 (86%)	86 (88%)	
≥16 years (Late) (%)	1 (8%)	4 (7%)	7 (7%)	
Do not remember (%)	0 (0%)	3 (5%)	2 (2%)	
Menstrual cycle length regularity (n=168)				
Regular (%)	11 (92%)	40 (70%)	69 (70%)	0.786
Irregular (%)	1 (8%)	16 (28%)	29 (29%)	
Amenorrheic (%)	0 (0%)	1 (2%)	1 (1%)	
Perception of best performance (n=154)				
Menses (%)	2 (17%)	9 (15%)	18 (18%)	0.778
Follicular phase (%)	8 (66%)	37 (64%)	55 (56%)	
Luteal phase (%)	2 (17%)	12 (21%)	26 (26%)	
Pregnancy status (n=169)				
Uni- or Multiparous (%)	0 (0%)	1 (2%)	5 (5%)	0.349
Nulliparous (%)	12 (100%)	57 (98%)	94 (95%)	

Note: For associations analysis likelihood ratio was applied

Table 3 illustrates information concerning sleep, training and sociodemographic characteristics of female Brazilian futsal players stratified by competitive levels. Even though the values are slightly favorable to the BNT athletes, the quantity and quality of sleep did not differ between the groups. The same trend was observed regarding the age at which participants began playing futsal. Players in the BNT group have been playing futsal for longer than other sub-groups. In relation to the volume (min/day) and frequency (times/week) of training routine, the BNT and PP practice more minutes per day and more times per week than the NPP. The sociodemographic information suggests that the BNT athletes have a higher educational and socioeconomic level than the athletes of the other groups. However, they do not differ in marital status and sleep pattern.

Table 3. Sleep, training characteristics and sociodemographic associations of female Brazilian futsal players stratified by competitive levels

Variable	Brazilian national team (n=12)	Professional players (n=58)	Non-professional players (n=99)	P-value
Sleep quantity and quality				
Sleep quality - yes (%)	10 (83%)	41 (71%)	73 (74%)	0.660
Sleep duration (h/night)	7.9±0.5	7.6±1.1	7.5±1.1	0.236
Training profiles				
Age began playing futsal (years)	11.0±3.6	12.1±3.1	11.7±4.4	0.333
Number of years playing futsal	17.4±6.5	12.0±3.9[1]	13.1±5.7[1]	**0.021**
Training volume (min/day)	210.0±47.9	192.4±63.3	160.2±74.4[1-2]	**<0.001**
Training frequency (sessions/week)	6.0±1.4	6.8±2.0	4.4±1.5[1-2]	**<0.001**
Marital status (n=166)				
Single (%)	11 (92%)	53 (95%)	93 (94%)	0.360
Married (%)	0 (0%)	2 (4%)	4 (4%)	
Divorced (%)	1 (8%)	0 (0%)	0 (0%)	
Living common-law	0 (0%)	1 (1%)	2 (2%)	
Academic degree (n=165)				
High school (%)	0 (0%)	3 (5%)	22 (23%)	**0.002**
Undergraduation (%)	4 (33%)	35 (62%)	42 (44%)	
University certificate (%)	8 (67%)	19 (33%)	32 (33%)	
Household income (n=155)				
>15 minimum salary (%)	0 (0%)	0 (0%)	1 (1%)	**0.021**
05-15 minimum salary (%)	3 (25%)	8 (15%)	3 (3%)	
03-05 minimum salary (%)	5 (42%)	9 (17%)	13 (14%)	
01-03 minimum salary (%)	3 (25%)	18 (35%)	49 (54%)	
<1 minimum salary (%)	1 (8%)	17 (33%)	25 (28%)	

Note: Data are presented as mean (standard deviation). [1]Significant difference to Brazilian National Team; [2]Significant differences to Professional Players. *For association analyses likelihood ratio was applied.

Discussion

The aim of this study was to determine the differences between female futsal players of different competitive levels regarding reproductive factors, morphological characteristics, sociodemographic, and physical training aspects. The main findings suggest that BNT players are older, have more years of experience playing futsal, greater training frequency and volume, and higher academic degree and household income compared to PP and NPP. However, no statistically significant differences were found for reproductive health factors and self-reported sleep quantity and quality when the three performance groups were compared. Although no anthropometric differences were identified among the three groups, the somatotype categories for BNT (4.4-4.3-1.4) represented a balance between fat and lean mass (i.e., did not differ by more than half unit for the first two numbers), while for PP (4.5-3.8-1.8) and NPP athletes (5.0-3.9-1.7), the fat component predominated (i.e., greater by more than half unit for the first number compared to the second one). Ectomorphic profile was low in all the three groups [28].

The training characteristics of Brazilian female futsal athletes stratified by competitive levels revealed that the BNT athletes demonstrated a significantly longer period playing futsal (17.4±6.5 vs 12.0±3.9 and 13.1±5.7 years) than PP and NPP players, respectively. This trend coincides with the fact that the BNT athletes are older (28.5±5.0 vs 25.0±4.4 and 24.7±4.9 years, respectively). Our previous study comparing starters (n=60: 22.8±3.6 years) and non-starters (n=55: 21.1±4.0 years) who participated in the 20th (2011) Women's Brazil Futsal Cup depicted similar trends in age difference and practice time (9.9±4.4 vs 8.0±4.0 years) but in a smaller extend than the current study [29]. Previous evidence from others supports the idea that experience is a relevant factor that influences sporting success and is directly related to the time of training, the age of starting sports practice and participation in competitions [30, 31, 32]. It is worth highlighting that the age participants began playing futsal in the present study did not differ between competitive levels, ranging from 11 to 12.1 years old. However, when compared to futsal players (n=115) who were assessed 10 years before in the same tournament, the current generation of players appears to have a slightly earlier onset (13.0±3.6 years old back in 2011) [33].

Regarding the volume (210.0±47.9 and 192.4±63.3 vs 160.2±74.4 min/day) and frequency of training (6.0±1.4 and 6.8±2.0 vs 4.4±1.5 sessions/week), the BNT and PP athletes demonstrated significantly higher values than NPP, respectively. The fact that athletes (BNT and PP) are paid to play allows them to dedicate more time to training, unlike other players who probably need to spend part of their time focused on other careers. The weekly training volume analysis of all players combined (n=169) revealed an increase of more than 50% compared to our observations from the same tournament organized 10 years before [29]. Professional female futsal athletes typically train 5–6 sessions per week, with total weekly training volume averaging around 7–10 h/week, often

including individual gym sessions in addition to team practices [34]. It is expected that a training routine with greater frequency and weekly volume will positively impact on the athletes' performance, as long as load management is properly done to avoid non-functional overreaching and overtraining.

Our analysis did not show any differences between the three performance groups regarding age at menarche, contraceptive use, self-reported menstrual length regularity, perception menstrual cycle phase with best performance, and pregnancy status. However, most of these indicators are represented by categorical variables, which reduces individual variance and would require much larger percentage differences among groups for the real-world sample size available (i.e., n=169 as these are all participants available to be recruited and represent the population of female futsal players who took part in this competition). Thus, a deeper dive into the descriptive statistics can be helpful in this context. For instance, we noted that only six players out of 169 (3.6%) reported having had pregnancy(ies) in the past. To the best of our knowledge, there are no guidelines to support female athletes navigate pregnancy when it comes to adjusting training and competition accordingly [22]. The qualitative study by Dietz et al. [35] analyzed the "triple career of athletes" and explored the potential challenges of pregnancy among female elite athletes. Eleven challenges emerged, including environmental support, time management, travelling, financial insecurity, insecurity in sponsoring and contracts, reaching personal sport goals, finding the "right time", having the "right partner", uncertainty about their ability to be a good mother, keeping autonomy, and concerns about physical performance and health. Although not statistically significant, it is worth highlighting that nobody in the NBT group reported being uni- or multiparous (despite being older than the other two groups), and almost all who had experienced pregnancy were in the NPP group (n = 5 out of 6). These results reinforce the importance of the message left in the review paper by Hassan et al. [22] on pregnancy in the context of soccer that is part of the "FIFA Female Health Project". Authors indicated the need to develop support systems that consider physiological changes associated with pregnancy (and postpartum) and the individual needs of players to optimize their athletic experience and safeguard their careers during motherhood transition [22]. Current players and new generations may benefit from educational programs to help reduce physical concerns about exercise and pregnancy and promote mentorship and support in navigating pregnancy [35].

The financial insecurity reported by Dietz et al. [35] is not exclusively highlighted when players consider pregnancy, but in their sport careers in general. A recent scoping review in the context of female soccer identified six working conditions categories to help inform future research and policy development [36]. Authors identified that finances (57%) were the most recorded in the reviewed documents, in addition to performance support (56%), health support (41%), team environment (32%), organizational environment (38%), and discrimination (21%). Our study outlined an association between education level (p=0.002) and household income (p=0.021) with

performance level. More specifically, BNT players were the ones with greater education achievements and higher household income. In addition, NPP players had much higher rates of the two lowest household incomes (75% versus 60% in the PP and only 33% in the BNT). Although not collected in our study, household income of non-professional players (NPP) is likely achieved by balancing two careers and/or requiring major support from another household member, which may restrict their possibilities to further develop in the sport. The latest "FIFA Female Health Project" study on the professionalization of the sport reported that 72% of players in superior performance tiers earn a reliable income from football alone, compared with just 58% and 21% in the two subsequent lower tiers, respectively [37]. According to the authors, players in the most superior performance tier were also more likely to sign contracts, access superior training and medical facilities and benefit from maternity and childcare support. Conversely, players in lower tiers were more likely to hold dual careers, as both athletes and professionals in other fields. The participation for women and girls in sports depend on economic, sociocultural, sporting culture, specific infrastructure and career opportunities [38, 5]. We support researchers' call for further research, education, and investment in players' support [37], as we also highlight the importance of greater consideration for developing countries in which socioeconomic disparities may be even more pronounced at the same pace that investments can be much lower.

Compared to recent larger studies indicating a hormonal contraceptive use among athletes between ~40-50% [16, 17], our analysis indicated that use between 5-17% in the three groups investigated. Due to our original plan to conduct all assessments in-person and minimize the time devoted to participate in the study, we have not explored important factors to better understand their hormonal contraceptive profiles, including the kind of hormonal contraceptives (e.g., oral contraceptive, intra-uterine devices, etc.), the length of the use, contraceptive method hormonal pattern (e.g., combined estrogen and progesterone versus progestin-only), among others. Their inclusion would have substantially improved these methodological elements as we are limited to the understand of hormonal contraceptive use or not, which does not allow us to reach the minimal bronze tier recently recommended in research involving hormonal contraceptive users in sports science [39]. Nonetheless, the low percentage use in these Brazilian futsal players highlights the need to further investigate this topic, which is already one of our priorities for the next timepoint of assessments. Considering the recent recommendations and resources shared to guide researchers investigate female-specific topics [39, 40, 41], we also advocate for their broad implementation in sports sciences. It is worth noting that the scoping review by Barreira et al. [5] in female futsal research did not identify any studies involving female-specific factors as an area previously investigated. We hope that our preliminary findings can promote further investigation and focus on this topic, as not only

the biological sex gap is prevalent in research, but also female-exclusive studies that incorporate female-specific factors in their analysis are still limited [13].

Although not statistically significant, BNT players more frequently self-reported a normal age at menarche (11-15 years; 92%) and regular menstrual cycle length (92%) compared to the other two groups (86% and 88% for normal age at menarche in the PP and NPP, and 70% for regular menstrual cycle length for both PP and NPP). It is possible that players from the BNT have access to more resources that may reduce potential risk factors of menstrual irregularities. Their higher education level and household income could also play a role. Menstrual irregularities are commonly associated with low energy availability that is a root cause for relative energy deficiency in athletes. If not properly screened and addressed, low energy availability may negatively impact health and performance. The systematic review of Gallant et al. [42] found that athletes with low energy availability may have decreased endurance performance, training response, coordination, concentration, judgement, explosive power, and agility, which are usually important performance indicators in the context of futsal [43]. The meta-analysis by Compton et al. [11] demonstrated that endurance performance, lower body power and speed are key differentiators of performance in various female football tiers; however, a similar analysis is yet to be developed in the context of female futsal. It would be relevant to further investigate players (e.g., case studies) who indicated menstrual irregularities in terms of cycle length to confirm this irregularity (e.g., longitudinal observational designs), verify if other irregularities may be present (e.g., number of bleeding days, menstrual bleeding heaviness), identify the onset of these irregularities and more importantly, investigate their potential impact on futsal performance and health indicators.

Even though our findings regarding the menstrual phase in which players perceive to best performance agree with the previous literature by showing lower preference during menses and luteal phases compared to the late follicular phase [44], there is still a large portion of players who preferred these two phases in all the three sub-groups (34-42% for menses and luteal phases combined). Although not assessed in the present study, research suggests that the presence of negative menstrual-cycle related symptoms is usually connected to lower performance perception, which is most commonly reported during menses and luteal phase (i.e., especially days leading up to menstruation and first few days of menstruation) [45, 21]. Again, future studies could investigate if in the context of female futsal menstrual cycle-related symptoms are determinants of the phase in which performance is self-perceived as best.

The literature has compared the anthropometric characteristics of female futsal players across different competitive levels (university context, elite-level athletes, starters and substitutes). Athletes in the university context [46, 47] usually display the highest fat percentages compared to elite-level athletes [9, 48]. This suggests that the players in higher competitive tiers tend to present lower fat

percentages (%BF) and higher lean mass (LM). A comparison among futsal athletes by status (i.e., starters versus substitutes) has revealed significant differences in anthropometric characteristics (body mass, BMI, and body fat percentage) [29]. However, body composition may vary substantially depending on the evaluation method and the sample used in the study. For example, Rocha et al. [49] used Faulkner's equation [50] to estimate the fat percentage in the Brazilian national team (25.9±2.9 years) and Campos et al. [51] used a dual energy X-ray absorptiometry (DXA) to associate the metabolic profile with the body composition of recreational female futsal players (21.2±1.4 years). The equation used in the first study is not recommend for female individuals which could play a role in their interpretation [52]. In the study involving DXA, fat percentage was higher than usually reported, representing an average of 30.2% (16.8±3.8 kg BF and 38.9±3.4 kg LM) with a wide variation in body mass (61.3±17.6 kg).

In the present study and in others from our research team, we monitored the changes and trends over time using anthropometric measurements. Regardless of the group they belong to in our analysis (i.e., BNT, PP or NPP), anthropometric characteristics were not different. The same applied for their somatotype scores (i.e., endomorphy, mesomorphy, and ectomorphy) that did not differ statistically. However, the distribution pattern favoured balanced mesomorphs (i.e., similarities between endomorphy and mesomorphy) for BNT players versus an endomorph-mesomorph (greater endomorphy predominance) in the PP and NPP groups. The BNT pattern agrees with findings from Petri et al. [53] in ~173 female soccer players while the PP and NPP groups outlined a somatotype that is more characteristic of the general female population.

Sleep duration and self-reported quality were also included in our analysis. Although there was no difference between the groups, on average, the BNT athletes reported a higher proportion of quality (83%) and duration of sleep (7.9±0.5 h/night) than the others. Based on the recommended sleep duration, as established by the National Sleep Foundation, adults are encouraged to sleep 7 to 9 hours per night for overall health and well-being [54]. Sleep is an essential component for athlete recovery due to its physiological and psychological restorative effects [55]. Evidence supports the idea that adequate sleep prevents sports injuries and reduces the likelihood of stress-related problems [56, 57]. Conversely, poor sleep can impair muscle strength, speed, and other aspects of physical performance [58].

The most important limitation of the study comes from its cross-sectional design. All players were assessed over a relatively short period (e.g., 10 days), which limited the possibility that seasonal variations significantly influenced the results. In addition, this study focused on reproductive and sociodemographic factors, training profile, and anthropometric characteristics in futsal players of different competitive levels. Factors associated with motor skills, motor performance, and indicators of aerobic and anaerobic fitness were not observed. Although we have attempted to incorporate

female-specific factors into our 2021 characterization analysis, we are limited to the understand of age at menarche, contraceptive use, menstrual cycle length regularity, perception of menstrual cycle phase with best performance, and pregnancy status. Although this limitation is frequently observed in cross-sectional analysis, we encourage the use of recent recommendations to further understand these female-specific factors and better characterize aspects of menstrual cycle regularity (e.g., bleeding days length, cycle length variations, menstrual flow, medical diagnosis of well-known clinical irregularities) and use of hormonal contraceptives (e.g., contraceptive method, length of use, reasons to use, formulation and hormonal concentration) [39, 21] in future research.

Although we are limited in the depth of female-specific factors understanding, this is one of the rare studies in which a relatively large sample of professional female futsal players was studied across a set of variables related to these factors. We were also able to assess a sub-sample of players who represented the BNT in the past, which describes a unique group of female athletes and how they compared to those who had not had this opportunity yet at the time they were assessed.

We conclude that BNT players were older, have more years of experience playing futsal, greater training frequency and volume, and higher academic degree and household income compared to PP and NPP. Although, no statistically significant differences were found for reproductive health factors and self-reported sleep quantity and quality when the three performance groups were compared, some characteristics were more frequently noted in the BNT players: i- all nulliparous; ii- slightly greater perceived sleep quality, and; iii- more frequent normal age at menarche and self-reported menstrual cycle regularity compared to the other groups. Readers should interpret it with caution due to the small sub-group sample size, but these trends may contribute to future research directions. Moreover, BNT players presented a balanced endomorph-mesomorph somatotype versus a predominant endormorph-mesomorph profile in the PP and NPP players.

Methods

Study design and subjects

Study design is a cross-sectional comparative analysis. For this study, the sample (n=169) was obtained from 13 teams that participated in the 28th Taça Brasil de Futsal Feminino (Brazilian Women's Futsal Cup; location and year: Pato Branco, Parana, Brazil; 2021). This is a congested tournament that lasted for ~10 days (depending on team's performance). The competition occurs each year in a different state of Brazil, and players can represent teams for any of the 27 states. The 28th edition counted with 12 states. The principal investigator carries out a large follow-up study in which anthropometric and morphological data is collected every 10 years since 2001. A 20-year analysis on the trends in anthropometric and somatotype profiles has been described before [9]. The study protocol was approved by the local Institutional Ethics Committee for Human Research and was conducted in accordance with the Declaration of Helsinki (Process n. 039/2011). All participants were fully informed regarding the study procedures and provided written informed consent prior to data collection.

Procedures for data collection

A general information questionnaire was developed in-house and applied to obtain information on the areas described below.

Competitive caliber:

Players were asked the following question: "*Have you ever played for the Brazilian National Futsal Team? Yes/No. If yes, which year(s)?*" Those who answered "*Yes"* were assigned to the group "*Brazilian National Team*" (BNT). Since the FIFA futsal women's world ranking was done for the first time in 2024, we opted not to use a tier 4 (elite/international level) or 5 (world class) classification and simply call this group as "*Brazilian National Team*". Merging tiers 4 and 5 was also done by Compton et al. [11] when benchmarking physical fitness in women's football as part of the systematic review and meta-analysis conducted in the "*FIFA Female Health Project*". For those who answered "*No*", the following question was used to separate the ones who had a fixed salary derived from being a futsal player ("*Professional players*"; PP) and the players that did not have any fixed income from being a futsal player ("*Non-professional players*"; NPP). It is worth to mention that both "PP" and "NPP" subgroups could be classified as Tier 3 (highly trained/national level) according to McKay et al. [23] and Compton et al. [11]. However, considering the reality of female futsal players in Brazil at the National level (having or not a fixed salary), we opted to make this sub-classification. We should also mention that all players classified as "BNT" reported to receive a fixed salary when the questionnaire was completed.

Reproductive factors:

The questions about reproductive health were closed-ended questions and self-reported by the athletes [12, 24]. The information collected refers to:

- Age at menarche: provided as continuous variable (years) and further categorized as *≤10 years (Early); 11-15 years (Normal); ≥16 years (Late); Do not remember*.
- Contraceptive use: *Yes; No*.
- Menstrual cycle length regularity (i.e., 21-35 days): *Yes; No*.
- Perception of best performance (i.e., menstrual cycle phase): *Menses; Follicular; Luteal*.
- Pregnancy status: *Uni- or Multiparous; Nulliparous*.

Training and sociodemographic information:

- Training volume (min/day) and Training frequency (times/week): These data were also obtained with a close-ended question "*What is your training volume? And what is your training frequency?*". They were asked to report training volume in min/day. Training frequency was reported in times/week.
- Age in which athletes began playing futsal (years) and years playing futsal (years): This was measured based on a close-ended question "*What was your age, in years, of onset of training?*". The number of years playing futsal (years) was calculated from the age of onset to the age at data collection.
- Quantity and quality of sleep: Sleep quality was considered positive (yes) when the athlete "*had no interruptions in sleep and woke up feeling refreshed*". The athletes recorded their perceived sleep duration, in hours and minutes, after answering the question: "*How many hours a night do you usually sleep?*".
- Marital status: These data were also obtained with a close-ended question (*What is your marital status?* Options were *single; Married; Divorced; Living common-law*).
- Level of education: These data were also obtained with a close-ended question "*What is your level of education?"* Options were: *High school; Undergraduate; Post-graduation certificate*.
- Family income: These data were also obtained with a close-ended question "*What is your family income?"* Options were *≥15 minimum salary; 05-15 minimum salary; 03-05 minimum salary; 01-03 minimum salary; ≤1 minimum salary* (based on minimum salary definition pre-determined by the Brazilian government).

Anthropometric and morphological evaluation:

Anthropometric measurements (body mass, height, girth, width, skinfolds) follow the procedures described by the International Standards for Anthropometric Assessment [25]. Body fat percentage was calculated using sum of three skinfold thicknesses (triceps + supra iliac + midthigh) to determine body density [26]. Subsequently, fat and lean mass profile was estimated using Siri

equation [27]. The regional body composition was obtained by relationship between trunk and extremity skinfolds (skinfolds subscapular+suprailiac+abdominal / triceps+midthigh+medial calf), sum extremities skinfolds (triceps+midthigh+medial calf) and sum trunk skinfolds (subscapular+suprailiac+abdominal). The somatotype components (e.g., endomorphy, mesomorphy, and ectomorphy) were calculated according to the Heath and Carter Anthropometric Somatotyping Method [28]. More details of the protocols of measurements can be also seen in the most recent previous publication related to the assessment of longitudinal trends including 2021 [9].

Statistical analysis

All data are expressed as mean ± standard deviation. The normality of the variables was assessed using the Shapiro-Wilk test. For non-parametric data, comparisons were performed using the Kruskal-Wallis test with pairwise comparison. Associations between categorical variables were assessed using the chi-square test with likelihood ratio correction. A p-value of <0.05 was considered statistically significant. All analyses were performed using SPSS version 26.0.

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Data Availability

The datasets generated or analyzed during the current study are available from the corresponding author upon reasonable request.

Informed consent

The authors have no conflicts of interest to disclose.

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