RESEARCH

A comparison of the balance skills, personality, and temperament traits between elite sports athletes and football players

Bożena Wojciechowska-Maszkowska[1*], Dorota Borzucka[1] and Aleksandra M Rogowska[2]

*Correspondence: b.wojciechowska-maszkowska@po.edu.pl
[1]Faculty of Physical Education and Physiotherapy, Opole University of Technology, Prószkowska 76, 45-758 Opole, Poland
Full list of author information is available at the end of the article
†Equal contributor

Abstract

Background: Although research on balance skills and personality were explored in the field of sports science, little is known about the relationship between the two phenomena. This study aims to investigate the association of postural balance with traits of personality and temperament. The differences between elite athletes, football players, and the control sample will also be examined.

Methods: Participants in the case-control study were 73 people, aged between 16 and 30 years old ($M = 21.29$, $SD = 2.47$), including 59% of men. Three samples of participants consisted of Elite Athletes (AE, $n = 17$, 23.29%) of the Polish National Team; Football Players (FP, $n = 32$, 43.84%); and Control Sample (CS, $n = 24$, 32.88%). Postural control was assessed on a force platform (Type 9286AA, Kistler Instrument AG, Winterthur, Switzerland) with a sampling frequency of 100 Hz. The center of pressure (COP) parameters was measured during 20 seconds in both conditions eye open, and eye closed, in both directions anterior-posterior (AP) and medial-lateral (ML). The COP parameters include standard deviation (SD), mean range (RA), mean velocity (MV), and entropy (SE). The NEO-FFI questionnaire was used to assess Big-Five personality traits, whereas the FCB-TI was used to measure temperament traits.

Results: One-way ANOVA revealed that the EA and CS groups were more stable in ML direction than the FP group. In the AP direction, the athletes from the EA group were more stable than the CS group. Nor personality, neither temperament did not differentiate the three groups of participants, beside agreeableness, which was significantly lower in both EA and FP groups. Openness to experiences is positively associated with COP parameters, as it was shown in regression analysis. All COP parameters can explain for about 40% of openness variability.

Conclusions: The results of this study showed that EA and CS have better stability than footballers in both ML and AP direction. Openness seems to be related to postural balance skills.

Keywords: COP parameters; Elite athletes; FCB-TI; Football players; NEO-FFI

Background

Maintaining body equilibrium is of multiple sensory complex processes involving coordinated actions of sensory, motor, and biomechanical systems [1]. A stable standing position is fundamental for most other motor activities. Postural control is a complex motor skill derived from the interaction of multiple sensorimotor processes [2] and combines regulation of stability and orientation to the environment. Proper control of vertical posture is necessary for everyday life as well as in sports activity.

In athletic training, special attention is paid to improving the ability to maintain and control body balance. Balance is one of the components of coordination skills. Postural stability has been examined in such sports as gymnastics [3], judo [4], rifle shooting [5], skiing [6], volleyball [7], and football [8, 9]. The body balance skills were explored in athletes at various levels of specialist training [10, 11].

The results of the study indicate that athletes perceive the verticality of the body better than non-trained athletes [12]. However, there is much controversy about body balance. Many years of sports training may significantly modify the redundancy of the postural control system and lead to the discipline-oriented optimal use of sensorimotor modalities responsible for body balance [13]. The center of pressure (COP) analysis is most commonly used to assess postural sway. The COP is the most widely measured parameter from which various variables can be calculated to assess postural function [14]. Although various parameters that quantify postural control have been reviewed, no consensus was assigned in the issue, which variable most accurately represents changes in postural control. Further research is necessary to identify what aspects of posture is representing the best in a set of various parameters [1]. The analysis of the components contributing to postural behavior may be subject to future research about postural function [14].

Personality and temperamental traits are basic psychological constructs that can explain and predict human behavior in a sports activity. Personality is aimed at describing, explaining, and predicting the way human beings and function in various aspects of life. The five-factor model of personality [15] is the most frequently used to describe the basic traits, such as neuroticism, extroversion, openness to experience, agreeableness, and conscientiousness. Most studies indicate that participation in physical activity and sport is related to higher extroversion and conscientiousness, and lower levels of neuroticism [16, 17, 18]. Success in sport (in football, in particular) is associated with higher conscientiousness and lover neuroticism [19, 20, 21]. Undergraduate athletes scored higher in extroversion, agreeableness, and conscientiousness, and lower in neuroticism, compared to non-athletes [22]. A recent study showed that Polish students of physical education (PE) faculty scored lower in neuroticism, openness, and agreeableness than students of other faculties as a control sample [18]. Also, team sport athletes scored higher in extroversion than Physical Education non-athlete students.

The Regulative Theory of Temperament (RTT) assumes that people modify their behavior according to the needs of stimulation [23]. The structure of temperament consists of the six following traits: Briskness (BR), Perseveration (PE), Sensory Sensitivity (SS), Emotional Reactivity (ER), Endurance (EN), and Activity (AC) [24]. Athletes demonstrate a usually low level of ER and high levels of AC and EN [25, 26, 27]. Also, a positive association between the activity facet trait of extroversion and physical activity was found in a meta-analytic Review [16, 28]. Besides AC, temperamental traits seem not to be related strongly with physical activity, since research showed ambiguous connections in particular studies [29, 30, 31].

Purpose

Athletes experience numerous injuries [32, 33], which can be related to poor balance skills [34], as well as to selected psychological factors [35, 36, 37]. Understanding

injury risk factors is necessary to identify the injury-prone athletes and to develop appropriate injury prevention plans. It was found that personality and temperament may be related to balance skills [8, 9]. However, research on the relationship between personality and balance skills is scarce. This study aims to compare balance skills, personality, and temperament traits between elite sports athletes, football players, and physiotherapy students as a control sample. The association between all variables will be examined, as well.

Hypotheses

On the base of previous research [38, 39], it is hypothesized that elite sports athletes will differ in postural balance from football players and also from the control group of non-athletes. Overall, athletes and football players should demonstrate better balance skills that the control sample [40, 41]. Consistent with previous studies, we also assume that postural balance is related to conscientiousness as a personality trait [8] and sensory sensitivity as a temperament trait [9].

Methods

Study design

Specialized sports training starts early in childhood or adolescence. The case-control study recruited to samples of athletes that represent different patterns of long-term sports training, that may affect posture stability. The samples differ in the sport's level, which is related to intensity, frequency and strength of the training. Elite athletes (EA) represent a professional individual sports engagement, with everyday cyclical training for many hours and frequent participation in competitions at the highest sports performance level. The second comparative sample consisted of the Football Players (FP). Football is a team and contact sport related to the highest injury risk. The FP were undergraduate students of physical education faculty and members of the Academic Sports Association, in the football section. They took everyday (for a few hours) sports training focused mainly on speed, energy, reaction, and coordination. They also participated in competitions on the academic level. The third, control sample (CS) included undergraduate students of physiotherapy faculty, that matched EA and FB groups in age. However, students of the CS were not engaged in a sports activity. The inclusion criteria for all participants in the study were: written informed consent of the participant, the level of engagement in sports (professional, academic, none at all), and young adulthood as an age. The exclusion criteria were: no upper or lower limb injuries, dizziness, or disease.

The research was conducted from October 28, 2010, to April 26, 2011. Samples FB and CS were examined at the biomechanics workshop of the Faculty of Physical Education and Physiotherapy at the Opole University of Technology, Poland. The CS sample participated in the study during biomechanics classes that were part of the course credit. The FB sample was examined after classes at university. The EA sample was examined with the consent of the Polish Athletic Association on April 26, 2011, during a sports grouping at the Central Sports Centre in Spala, Poland.

Before the test, the participants were acquainted with the purpose, methodology, and procedures of the examination. In order to take part in the test, they voluntary signed a written consent to participate in the test. The subjects were standing on

the platform for 20 seconds twice, with their eyes open, and with their eyes closed. According to the methodology used, the participants were requested to stand barefoot, with a 14-degree angle between the feet, and a distance of 17 cm between the heels, with their arms at sides. The test was invalid if the participant moved his leg or used arm. Subjects rested in for approximately one minute between trials. Then, they completed the "paper and pencil" questionnaires (the NEO-FFI and FCB-TI). All recruited participants have completed postural tests and questionnaires to measure personality and temperament. Institutional Review Board approval was obtained for the study procedures for recruitment, data collection, and analysis. Experiments were conducted following the Helsinki Declaration.

Participants

Seventy three people participated in the study, aged between 16 and 30 years old ($M = 21.29$, $SD = 2.47$), with the prevalence of men ($n = 43$, 58.90%). The mean height of the study sample was 176 cm, while the mean weight equals 72 kg. The participants were grouped in the following three samples: 1) Elite Athletes (AE, $n = 17$, 23.29%) of the Polish National Team; 2) Football Players (FP, $n = 32$, 43.84%); and 3) Control Sample (CS, $n = 24$, 32.88%). The demographic data, such as age, height, and weight in particular samples, are included in Table 1. Both FP and CS samples consisted of undergraduate students of a large university in the south of Poland. Among the EA sample, participants represented athletics and were members of the Polish National Team. The FP sample included Physical Education faculty, and CS sample comprised students of physiotherapy faculty.

Table 1 Demographic data in the particular groups of participants.

	Elite Athletes		Football Players		Control Sample		Total sample	
Demographics	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age [years]	20.12	3.85	22.66	1.60	20.29	0.86	21.29	2.47
Hight [cm]	179.29	6.29	176.78	9.14	172.81	8.65	176.20	8.63
Weight [kg]	71.84	7.61	72.76	12.87	70.47	10.14	71.79	10.86

Measures

Postural balance

The posturographic examination was performed on a force platform (Type 9286AA, Kistler Instrument AG, Winterthur, Switzerland) with a sampling frequency of 100 Hz. Based on the recorded signal COP, average values for the amplitude parameters of the stabilograph in the anterior-posterior (AP) and medial-lateral (ML) directions of the movement were calculated. Linear parameters included the standard deviation (SD), range (RA) of the time series, and the mean velocity (MV). Sample entropy (SE) as a nonlinear parameter was measured to assess the irregularity or unpredictability of a time series [42, 43]. Overall, lower values for these parameters indicated a more efficient postural balance control.

Personality

Personality traits were assessed by the NEO Five-Factor Inventory (NEO-FFI). The NEO-FFI comprises 60 items in five subscales: Neuroticism, Extroversion, Openness to Experience, Agreeableness, and Conscientiousness. To answer the questions,

Table 2 Descriptive statistics for the total sample.

Variables	*Min.*	*Max*	*M*	95% *CI*	*SD*	*SE*
COP Parameters - Eyes Open						
SD ML	1.13	5.17	2.4	[2.22, 2.58]	0.79	0.09
SD AP	1.76	8.78	3.87	[3.51, 4.23]	1.55	0.18
RA ML	4.55	24.39	12.56	[11.55, 13.58]	4.35	0.51
RA AP	8.26	42.42	18.31	[16.82, 19.8]	6.39	0.75
MV ML	4.08	10.18	6.74	[6.4, 7.09]	1.48	0.17
MV AP	5.34	14.01	9.56	[9.14, 9.99]	1.81	0.21
SE ML	0.4	1.42	0.89	[0.83, 0.95]	0.25	0.03
SE AP	0.26	1.55	0.87	[0.81, 0.94]	0.28	0.03
COP Parameters - Eyes Closed						
SD MI	1.22	6.02	2.95	[1.22, 6.02]	1.14	0.13
SD AP	2.16	11.41	4.8	[2.16, 11.41]	1.66	0.19
RA ML	5.73	34.52	15.4	[5.73, 34.52]	6.03	0.71
RA AP	10.78	52.69	23.65	[10.78, 52.69]	7.36	0.86
MV ML	4.21	28.55	9.12	[4.21, 28.55]	3.41	0.4
MV AP	6.54	48.94	14.59	[6.54, 48.94]	5.47	0.64
SE ML	0.48	1.43	0.96	[0.48, 1.43]	0.25	0.03
SE AP	0.46	1.42	0.92	[0.46, 1.42]	0.2	0.02
Personality traits						
Neuroticism	1	38	17.37	[15.48, 19.26]	8.11	0.95
Extraversion	20	44	32.14	[30.69, 33.58]	6.18	0.72
Openness	15	39	25.3	[24.06, 26.54]	5.33	0.62
Agreeableness	17	40	29.33	[27.86, 30.8]	6.31	0.74
Conscientiousness	14	45	33.82	[32.34, 35.3]	6.34	0.74
Temperament traits						
Sensory Sensitivity	8	20	14.6	[13.95, 15.26]	2.8	0.33
Activity	4	19	12.89	[12.02, 13.76]	3.71	0.43
Perseveration	0	19	12.16	[11.19, 13.14]	4.17	0.49
Briskness	9	20	15.88	[15.31, 16.44]	2.41	0.28
Endurance	2	19	12.16	[11.12, 13.21]	4.5	0.53
Emotional Reactivity	1	19	7.52	[6.43, 8.61]	4.68	0.55

COP: center of pressure; SD: standard deviation; RA: range; MV: mean velocity; SE: entropy; AP: anterior-posterior; ML: medial-lateral.

participants use a 5-point Likert scale, ranging from 0 = strongly disagree, to 4 = strongly agree. The reliability of the NEO-FFI indicated an acceptable internal consistency (Cronbach's α) in the previous research [15], as well as in the Polish version of the questionnaire [44], for the following scales: Neuroticism ($\alpha = .80$), Extraversion ($\alpha = .77$), Openness ($\alpha = .68$), Agreeableness ($\alpha = .68$) and Conscientiousness ($\alpha = .82$). The Cronbach's alpha for the scales of Neuroticism, Extroversion, Openness to Experience, Agreeableness, and Conscientiousness, in the present study were .85, .80, .55, .76, and .81, respectively.

Temperament

A standard self-reported questionnaire was used to measure temperament traits, according to the Regulative Theory of Temperament (RTT), developed by Strelau [45, 46]. Each of the six scales (Activity, Briskness, Emotional Reactivity, Endurance, Perseveration, and Sensory Sensitivity) comprises 20 items, with "yes" or "no" answers. The FCB–TI in its Polish version [47] has revealed sufficient reliability for the following scales: Briskness ($\alpha = .77$), Perseveration ($\alpha = .79$), Sensory Sensitivity ($\alpha = .73$), Emotional Reactivity ($\alpha = .83$), Endurance ($\alpha = .85$) and Activity ($\alpha = .83$). In the present study ($N = 73$), the internal reliability (Cronbach's α) equals .54, .78, .63, .85, .82, and .73, for BR, PE, SS, ER ($\alpha = .85$), EN, and AC scales, respectively.

Table 3 Sample table title. This is where the description of the table should go.

	EA		FB		CS				
Variables	*M*	*SD*	*M*	*SD*	*M*	*SD*	$F(2, 70)$	*p*	LSD post-hoc
COP Parameters - Eyes Open									
SD ML	1.95	0.63	2.76	0.75	2.24	0.75	7.86	0.00	FB>EA***, FB>CS**
SD AP	3.66	1.15	4.26	1.79	3.48	1.38	1.98	0.15	
RA ML	10.26	3.56	14.57	4.23	11.52	3.95	7.70	0.00	FB>EA***, FB>CS**
RA AP	17.15	4.41	19.91	7.81	17.00	5.06	1.83	0.17	
MV ML	6.68	1.34	6.89	1.47	6.59	1.62	0.31	0.74	
MV AP	9.62	1.97	9.02	1.83	10.25	1.46	3.35	0.04	FB>CS*
SE ML	0.90	0.23	0.75	0.18	1.08	0.22	17.99	0.00	CS>EA**,CS>FB***, EA>FB*
SE AP	1.03	0.27	0.80	0.29	0.85	0.24	4.21	0.02	EA>CS*, EA>FB**
COP Parameters - Eyes Closed									
SD MI	2.12	0.69	2.98	1.18	2.70	1.21	3.38	0.04	FB>EA*
SD AP	5.19	2.11	4.44	1.73	3.81	0.83	3.68	0.03	EA>CS**
RA ML	11.48	3.94	15.93	6.62	13.18	5.79	3.59	0.03	FB>EA*
RA AP	25.33	9.00	22.13	7.50	19.26	4.64	3.65	0.03	EA>CS**
MV ML	8.77	2.07	8.69	4.50	7.51	2.26	1.01	0.37	
MV AP	14.51	4.25	12.74	7.33	13.24	2.68	0.58	0.56	
SE ML	0.97	0.18	0.80	0.22	0.99	0.27	5.31	0.01	CS>FB**, EA>FB*
SE AP	0.96	0.23	0.83	0.21	0.87	0.17	2.20	0.12	
Personality									
N	18.35	9.06	16.63	7.10	17.67	8.89	0.27	0.76	
E	33.00	6.02	32.41	5.83	31.17	6.85	0.48	0.62	
O	26.06	5.36	24.34	5.09	26.04	5.64	0.92	0.40	
A	26.53	6.06	28.63	6.49	32.25	5.19	4.93	0.01	CS>EA***, CS>FB*
C	34.29	7.17	33.59	6.13	33.79	6.26	0.07	0.94	
TEmperament									
SS	14.12	2.60	15.16	3.01	14.21	2.62	1.12	0.33	
AC	13.18	3.49	13.22	2.84	12.25	4.81	0.53	0.59	
PE	11.65	4.81	11.94	3.53	12.83	4.56	0.48	0.62	
BR	15.24	2.11	16.28	2.58	15.79	2.36	1.07	0.35	
EN	13.12	4.69	10.75	4.66	13.38	3.70	2.99	0.06	
ER	7.53	4.43	6.84	4.55	8.42	5.06	0.77	0.47	

COP: center of pressure; SD: standard deviation; RA: range; MV: mean velocity; SE: entropy; AP: anterior-posterior;ML: medial-lateral; N: Neuroticism, E: Extroversion, O: Openness, A: Agreeableness, C: Conscientiousness, SS:Sensory Sensitivity, AC: Activity, PE: Perseveration, BR: Briskness, EN: Endurance, ER: Emotional Reactivity. $p^* < .05$, $p^{**} < .01$, $p^{***} < .001$.

Statistical analysis

The reliability (Cronbach's α) of the FCB-TI scales and descriptive statistics (range, mean, 95% confidence interval, standard deviation, and standard error) were performed at the first step of statistical analysis. The differences in postural balance, personality, and temperament traits, between the EA, FP, and CS samples, were assessed using a one-way ANOVA, with a p-value of .05 (5%) as an acceptable level of validity. Fisher's Least Significant Difference (LSD) posthoc test was performed to asses significant differences between samples. Finally, a series of Pearson's correlation and regression analyses were conducted to clarify the relationship between personality and temperament traits as a dependent variable and COP parameters as an independent variable. Missing data in the questionnaires was replaced by the sample average. There was one participant with two missing data (one in the NEO-FFI and one in the FBC-TI). All statistical analysis was performed by using the STATISTICA 13.1 software.

Results

The descriptive statistics for the COP parameters, personality, and temperament traits in the total sample ($N = 73$) are shown in Table 2. Because the Kolmogorov-Smirnov d test showed the normal distribution in all variables, parametric tests

Table 4 Correlation between COP parameters and temperament traits.

Variable	SS	AC	PE	BR	EN	ER
COP Eyes Open						
SD Ml	0.08	0.04	0.11	0.01	-0.03	0.05
SD AP	-0.15	-0.02	-0.21	-0.06	-0.07	-0.14
RA ML	0.07	0.15	-0.04	0.06	0.07	-0.08
RA AP	-0.13	0.01	-0.22	0.02	-0.06	-0.20
MV ML	-0.03	-0.10	0.11	-0.01	0.07	0.08
MV AP	0.06	0.02	0.18	0.01	0.19	0.12
SE ML	-0.08	-0.18	0.06	0.01	0.13	0.13
SE AP	0.07	-0.07	0.27*	-0.03	0.05	0.27*
COP Eyes Closed						
SD Ml	0.00	-0.05	0.08	0.02	-0.07	-0.05
SD AP	-0.01	-0.06	0.03	-0.16	-0.14	0.03
RA ML	0.07	-0.06	0.05	0.02	-0.10	-0.05
RA AP	0.05	-0.04	0.06	-0.06	-0.17	0.04
MV ML	0.00	-0.03	0.14	0.04	0.00	0.08
MV AP	0.06	0.02	0.16	0.03	-0.01	0.09
SE ML	-0.01	-0.02	0.06	0.00	0.14	0.25*
SE AP	0.07	0.08	0.16	0.02	0.08	0.18

COP: center of pressure; SD: standard deviation; RA: range; MV: mean velocity; SE: entropy; AP: anterior-posterior; ML: medial-lateral; SS:Sensory Sensitivity, AC: Activity, PE: Perseveration, BR: Briskness, EN: Endurance, ER: Emotional Reactivity. $p^* < .05$.

were performed for further statistical analyses. A series of one-way ANOVA was performed for COP parameters, personality, and temperament as a dependent variable and group (EA, FB, and CS) as an independent sample. Numerous group differences in postural balance were found, which is shown in Table 3. Among personality traits, the only CS sample differed in higher AC form EA and FP groups. No significant differences between the three groups were noted in temperament traits.

As it is shown in Tables 4 and 5, a significant correlation was found between selected COP parameters and traits of personality and temperament. PE and ER are positively related to SE AP EO, and also SE ML EC is related positively to ER. Among personality traits, N is positively related to MV ML EO, and MV ML EO is negatively related to MV ML EO, and A is related positively to SE ML EO.

A series of regression analysis was performer for particular temperament and personality traits as an explained variable, and all COP parameters in both EO and EC conditions, as an independent variable. This model explain 37% of Openness variance $[R^2 = .37, F(16, 56) = 2.09, p < .05]$. Openness may be predicted by RA ML EO $[\beta = 1.29, SE = .30,\ t(56) = 4.33, p < .001]$, and MV ML EO $[\beta = -0.80, SE = .22, t(56) = -3.62, p < .001]$. Beside Openness, nor the other personality traits, neither temperament traits, showed sufficient significance for the regression model.

Discussion

Group differences in postural balance skills

The present study indicates that there are significant differences in the COP parameters between the three following samples: athletes (EA), football players (FP), and control sample (CS). The FP group demonstrate significantly higher body variability in the ML direction under visual control conditions than the EA and CS. Entropy in this direction was significantly higher in the CS group, in comparison

Table 5 Correlation between COP parameters and personality traits

COP Eyes Open					
Variable	N	E	O	A	S
SD MI	0.10	-0.04	-0.02	-0.17	-0.18
SD AP	0.08	0.07	-0.19	-0.04	0.06
RA ML	0.06	0.00	0.08	-0.18	-0.12
RA AP	0.02	0.10	-0.15	-0.06	0.02
MV ML	0.25*	-0.17	-0.27*	-0.12	-0.04
MV AP	0.00	-0.03	-0.03	0.03	0.05
SE ML	0.04	-0.13	-0.04	0.27*	0.15
SE AP	0.01	-0.10	0.16	-0.03	0.00
COP Eyes Closed					
SD MI	0.10	-0.09	-0.15	-0.10	-0.06
SD AP	0.07	0.04	-0.03	-0.20	-0.07
RA ML	0.18	-0.13	-0.15	-0.12	-0.05
RA AP	0.12	-0.05	-0.01	-0.17	-0.09
MV ML	0.26*	-0.23	-0.17	-0.16	-0.17
MV AP	0.20	-0.18	-0.05	-0.07	-0.18
SE ML	0.06	-0.17	0.05	0.18	0.05
SE AP	0.09	-0.16	0.01	0.05	0.09

COP: center of pressure; SD: standard deviation; RA: range; MV: mean velocity; SE: entropy; AP: anterior-posterior;ML: medial-lateral; N: Neuroticism, E: Extroversion, O: Openness, A: Agreeableness, C: Conscientiousness. $p^* < .05$.

to EA and FP, and also in the AE group as compared to FP. However, in the AP direction, the FP showed a higher speed of body sway than persons from the CS group. Analysis of changes in COP without visual inspection showed that the body sway of the FP group was higher than in the EA sample, with regards to the variability of COP. In contrast, entropy was significantly higher in the CS and AE group, as compared to FP.

Body posture control is an individual feature depending on body build, age, and level of training. Numerous studies show that balance-oriented exercises can improve adaptive posture control [10, 39, 48]. COP parameter values testify to global coordination abilities concerning the equilibrium system [49]. Higher COP variability may indicate various regulatory mechanisms manifesting in the ability to maintain balance by triggering random movements. Test results of Yamada et al. [50], indicate that in football players, along with the increase of sports advancement, the instability in the AP plane increases. Other studies [51] indicate that specific training (with varying effort energy) contributes to a decrease in the variability of body excretions. COP parameter values testify to global coordination abilities related to the equilibrium system [49]. Higher COP variability may indicate various regulatory mechanisms manifesting in the ability to maintain balance by triggering random movements. Test results of Yamada et al. [50], indicate that in football players, along with the increase of sports advancement, the instability in the AP plane increases. Other studies [51] indicate that specific training (with varying effort energy) contributes to a decrease in the variability of body excretions.

Our findings differ from Bieć and Kuczyński [13], who said that footballers have better body balance control compared to non-athletes. The difference found in our results may mean that the age of the respondents, and thus the level of training, can explain the differences and dependencies in the changes in COP values. Our research is consistent and supports those presented in the paper Wojciechowska-Maszkowska et al. [9]. The other studies indicate that football and gymnasts are not different from static or dynamic control [52].

Group differences in personality and temperament

Surprisingly, neither personality nor temperament traits do not differ significantly between EA, FP, and CS samples in this study, beside agreeableness. A recent study [18] indicates that academic's team sport players scored significantly lower in neuroticism, openness, and agreeableness, and also they scored higher in extraversion than students of Physical Education faculty. This study seems partially consistent since agreeableness was significantly lower in both EA and FP samples when compared to the CS group (which include Physiotherapy students). The other study [53] have compared personality traits between individual and team sport athletes. Higher agreeableness in team sports players was found when compared to individual sports samples. Similar to the present study, no other the two groups of athletes did not differ in neuroticism, extraversion, conscientiousness, and openness.

On the other hand, Talyabee et al. [22] showed that non-athletes scored lower than an academic sample of athletes in agreeableness, extroversion, and conscientiousness, and higher in neuroticism. Agreeableness seems to be a very valuable trait in team sports. A systematic review [16] indicates that those sport participants with high levels of agreeableness report more favorable relationships with their teammates and coaches. Highly agreeable athletes also demonstrate less team-related conflicts and better cooperation and relationship with other team members [54] The role in the team (i.e., leader, team star) may also determine the usefulness of higher or lower agreeableness, as indicates Kim et al. [55]. It should be said, that high inconsistency exists between particular studies, which may be determined cultural differences, or maybe specific sport discipline.

Nevertheless, the present study indicates that an essential trait that differs from physical education students from professional athletes is agreeableness level. People who score high on agreeableness are perceived as empathetic and altruistic, while a low agreeableness score relates to selfish behavior and tendency to competing with others rather than cooperating [56]. Because sports activity is fundamentally related to competition, a lower level of agreeableness may be a beneficial trait in sport achievement [57]. Thus, lower agreeableness may be related to frequent participation in the competition and a high level of aspiration and need for achievement.

Association of postural balance with traits of personality and temperament

The main goal of the study was to look for relationships between COP indicators and temperament and personality traits. The novelty of this study is the combination of biomechanical and psychological data in understanding postural behavior. Although a series of correlation was found between selected COP parameters and traits of personality and temperament, the association is weak in the present study and may not be considered as sufficient, given multiple comparisons. Indeed, a series of regression analyses did not confirm the previous association. Surprisingly, among all temperament and personality traits, openness solely demonstrated a significant relationship with COP parameters, such as RA ML EO and MV ML EO. Open people actively seek out new and varied experiences and are apt to be particularly reflective and thoughtful about the ideas they encounter. The trait openness involves motivation, needs for variety cognition sentience, and need for deep understanding, which may lead to higher academic performance in undergraduates [58]. Research

indicates that openness is related to physiological responses to chronic social stress [59]. Herzhoff and Tackett [60] found three facets of openness in children: Intellect, Imagination, and Sensitivity. Openness is the one personality trait that is the most strongly related to creativity and intelligence.

Moreover, the heritability of openness is shared with a heritability of intelligence [15]. Conversely, low openness to experience was found as a pre-clinical marker of incipient cognitive decline in older adults [61]. Intelligence has a strong genetic base and manifests on the neuronal level in a shorter time and more accurate response for stimulus. Thus, both openness and balance skills may share a common neuronal mechanism responsible for adaptation to the environment. This speculation needs settlement in future research, since COP parameters may explain almost 40% of openness variance.

The present study is not consistent with previous research. Wojciechowska-Maszkowska et al. [9] found the relationship between body balance and conscientiousness among football players. The SD AP EC was significantly higher for more conscientious athletes, whereas less conscientious athletes showed higher SD AP EO. Previous research found an interaction effect between static balance and sensory sensitivity in a sample of football players [8]. Individuals with heightened sensory sensitivity showed lower SD ML EC and higher in the SD AP EC. There may be an infinitive number of variables that may mediate the relationship between postural balance and personality or temperament. Future research should be focused on further exploration of this association.

There is some limitation of the study. Firstly, the sample size was not large. Further study should consider a larger sample size and a more balanced gender distribution. Secondly, the age of the participants was limited to early adulthood. Further study should include people with a wide range of age and internship of sports training. The group of athletes consisted of two selected sports disciplines; thus, the results of this study may not be generalized to the other disciplines of individual and team sports. Further study may include other sports disciplines. Finally, personality and temperament traits were measured using a self-report survey. The other experimental methods for assessing behavior concerning personality and temperament traits maybe take into consideration in future research.

Conclusions

The results of this study indicate that people from the EA and CS groups were more stable in ML direction than the FP group. Changes in the AP direction of COP indicate that the athletes from the EA group were more stable than the CS group in terms of body change and variability. To sum up, the results of this study showed that EA and CS have better stability than footballers in both ML and AP direction. Among the personality and temperament traits, openness seems to only one trait that has a contribution to postural balance skills. Fluid intelligence and factor g should be examined in future research as a potential predictor of postural balance skills. It seems that the inclusion of such components as personality and temperament in the assessment of posture control may enrich knowledge about postural behavior. Sports psychologists and trainers might use the results of the present study to optimize the training process. The balance training with excluded

or limited sight control should be individualized and applied to a greater extent in individuals with extremely high and low conscientiousness.

Abbreviations
COP: center of pressure; SD: standard deviation; RA: range; MV: mean velocity; SE: entropy; AP: anterior-posterior; ML: medial-lateral; N: Neuroticism, E: Extroversion, O: Openness, A: Agreeableness, C: Conscientiousness, SS: Sensory Sensitivity, AC: Activity, PE: Perseveration, BR: Briskness, EN: Endurance, ER: Emotional Reactivity.

Ethics approval and consent to participate
The protocol and consent forms were approved by the Bioethics Committee of the District Medical Chamber in Opole (Resolution No. 151), in conformity with principles identified in the Declaration of Helsinki. All participants provided written informed consent.

Consent to publish
Not applicable.

Availability of data and materials
The data supporting the findings can be found at Mendeley Data, http://dx.doi.org/10.17632/pnc5kkv876.1/

Competing interests
The authors declare that they have no competing interests.

Funding
No funding was obtained for this study.

Author's contributions
B.W-M., D.B. and A.R. conceived and designed the experiments. A.R. performed the data analysis. B.W-M., D.B. and A.R. prepared the original manuscript. All authors contributed to the data collection and interpreted the experimental results. All authors edited and revised the manuscript, nad have read the final version of the manuscript.

Acknowledgements
We wish to thank all volunteer participants and participating athletes and the Polish Athletic Association provided the necessary location.

Author details
[1]Faculty of Physical Education and Physiotherapy, Opole University of Technology, Prószkowska 76, 45-758 Opole, Poland. [2]Institute of Psychology, University of Opole, Plac Staszica 1, 45-052 Opole, Poland.

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