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Section II – Exercise Physiology and Sports Medicine

Association Between the rs4680 Polymorphism of the COMT Gene and Personality Traits among Combat Sports Athletes

by
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Physical performance has been the focus of studies examining genetic influences in martial arts. There has been little quantitative analysis of the interaction between psychological traits and gene variants in athletes. This study aimed to determine whether the rs4680 polymorphism of the COMT gene (catechol-O-methyltransferase) was linked to other sports phenotypes such as temperament, mental toughness, and stress tolerance. In our study, we concentrated on the case-control analysis of athletes in the aspect of their personality traits in association with the COMT gene polymorphism. Participants comprised 258 combat sports athletes and 278 healthy male individuals as a control group. Psychometric properties were assessed-with the Revised Temperament and Character Inventory (TCI-R). COMT polymorphism testing was performed using real-time PCR. We found a statistically significant effect of a complex factor COMT rs4680 genotype with combat athletes/controls and novelty seeking ($F_{2,530} = 5.958$, $p = 0.0028$, $\eta^2 = 0.022$), self-management ($F_{2,530} = 6.772$, $p = 0.0012$, $\eta^2 = 0.025$), and with self-transcendence skills ($F_{2,530} = 9.387$, $p = 0.00009$, $\eta^2 = 0.034$). The results are important for encouraging further studies on the genetic makeup of athletes in conjunction with personality traits. Due to the multigene and multifactorial nature of determinants of sports predispositions, we propose to take into account also other features, especially when studying genes related to cerebral neurotransmission. It is a holistic departure, and it clearly illustrates the relationship between the given characteristics of an athlete.

Keywords: *catecholamine neurotransmitters; mentality; genetic predispositions; sport*

Introduction

Some athletes exhibit exceptional achievements in certain sports, with equal and/or similar training and physical conditions. Importantly, among the most crucial elements of success is an athlete's natural talent. However, every person may achieve a certain degree of physical fitness differently due to genetic diversity. Furthermore, a large number of a specific abilities and characteristics are genetically predetermined. Motor coordination processes occur mainly through neurophysiological mechanisms of control and regulation of sensorimotor, perceptual, intellectual, proprioceptive, and kinesiological functions. They rely on the central nervous system, the sensory organs (receptors), and the muscular system (effectors), all of which are influenced by genetic and environmental factors (Kochanowicz et al., 2015). Developments in DNA sequencing technology have led to a better understanding of the role of genetic variants in athletic performance, resulting in the development of "sports genomics". Over the past 20 years, intensive research has

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identified as many as 185 genetic markers that can be linked to an athlete's elite status (Maciejewska-Skrendo et al., 2019; Youn et al., 2021).

One of the best known genes involved in the metabolism of catecholamine neurotransmitters (e.g., adrenaline, noradrenaline, or dopamine) is the *COMT* gene (catechol-O-methyltransferase) (Bastos et al., 2017; Craddock et al., 2006; Perkovic et al., 2018). *COMT* is located at "22q11.1 – q11.2" and has a size of approximately 27 Kbp, with 345 polymorphisms identified (Chen et al., 2021; Harrison and Tunbridge, 2008). The magnesium enzyme ($Mg2^{+}$) transfers the COMT methyl group from S-adenosyl-L-methionine (SAM) to one of the catechol hydroxyl groups. The O-methylation is important in the inactivation of catecholamine neurotransmitters and catechol hormones such as dopamine (DA) and norepinephrine (NA) (Bastos et al., 2017). In humans, there are two isoforms of COMT, expressed from different promoters: the membrane-bound form (MB-COMT) and the soluble form (S-COMT). The first isoform controls extracellular DA levels in the prefrontal cortex and is mostly expressed in brain neurons. Its function was revealed in the late 1950s, yet researchers have been also interested in the role of the COMT enzyme in additional pathways and illnesses. COMT has been studied from the perspective of neuropsychiatric conditions and the neural underpinnings of cognitive functions, emotion, behavior, sleep and pain mechanisms, as well as addictive behavior and neurodegeneration (Bastos et al., 2017; Machoy-Mokrzyńska et al., 2019). It has been stated that athletic talent may be significantly influenced by the COMT enzyme activity (Zmijewski et al., 2021).

The rs4680 *COMT* single nucleotide polymorphism (SNP) is one of the most frequently analyzed variants of exon 4, as rs4680 takes an active part in the prefrontal cortex's enzymatic activity and cognitive function (Haraldsson et al., 2010). SNP rs4680, due to a functional change from G to A nucleotide, can cause a valine (Val) to methionine (Met) substitution at codon 158 (in membrane-bound COMT) or codon 108 (insoluble COMT), thereby generating changes in the enzyme's capacity (Craddock et al., 2006; Harrison and Tunbridge, 2008). The Val variant has almost two- to four-times higher enzymatic activity than the Met variant (Chen et al., 2021; Haraldsson et al., 2010). A polymorphism that causes the amino acid encoded by codon 158 of the *COMT* gene, substituted from valine to methionine (*COMT* Val158Met), has been shown to reduce the enzyme's activity by one-third to one-quarter of that of valine-type *COMT* (Savitz et al., 2006), therefore enhancing extracellular DA levels. It has been proposed that the *COMT* Val158Met SNP may be related to individual differences in emotional reactions, motivation, and executive control ability (Jaspar et al., 2014).

It is generally agreed that athletes' personality traits, including emotional resilience, persistence and stress management, are qualities enabling them to succeed in sports (Youn et al., 2021). However, research on psychogenetic factors affecting elite martial arts athletes' mental or emotional strength has been scarce. Nevertheless, previous studies on genetic factors of emotional and psychological traits suggest that genetic variants may influence various phenotypic traits associated with elite athletic performance (Youn et al., 2021; Humińska-Lisowska et al., 2022).

Most research in martial arts has emphasized that genetics contribute to athletic or physical performance (Cieszczyk et al., 2011; Guilherme et al., 2019, 2021; Ribas et al., 2017; Ruzic et al., 2023). Future investigations should search for DNA sequences related to other sporting phenotypes, i.e., the ability to cope with stress, mental strength, and attitude. Our study focused on the case-control analysis of athletes in terms of personality traits associated with the *COMT* gene polymorphism.

Methods

Participants

A total of 536 Caucasian men from the same area of Poland were examined. The study group consisted of 258 combat sports athletes (mixed martial arts (MMA), n = 85; judo, n = 53; boxing, n = 51; karate, n = 21; kickboxing, n = 34; wrestling, n = 14) with no previous history of addiction or psychosis. The control group included 278 healthy volunteers who were not competitive athletes (Table 1). The study group was considered "sub-elite" (participants of international or national sports competitions with a minimum of five years of training). Various methods were used to obtain the study sample, including targeting national teams and providing information to national coaching personnel and athletes attending training

camps. All study participants were of the Caucasian origin to avoid differences in allele frequencies due to systematic differences in ancestry arising from population stratification.

Psychometric Tests

Psychometric tests such as the Revised Temperament and Character Inventory (TCI-R) were conducted. Temperament refers to individual differences in perceptual and skill-based habits that are regulated by the limbic system and measured by independently inherited dimensions which are moderately stable throughout life. The TCI-R is a self-administered survey that assesses the four dimensions of temperament (novelty seeking (NS), the tendency to react and depend on reinforcements (reward dependence—RD), pain avoidance (harm avoidance—HA), and perseverance (PS)) and the three components of the higher-order character (cooperation, self-direction, and transcendence) as previously described (Harrison and Tunbridge, 2008; Zmijewski et al., 2021). The licensed TCI-R test, Polish version from 2018, was performed and interpreted by a trained psychologist (Niewczas et al., 2021).

Statistical Analysis

The distribution of *COMT* rs4680 genotype frequencies was tested for the Hardy-Weinberg equilibrium (HWE) using HWE software (https://wpcalc.com/en/equilibrium-hardy-weinberg/; access date: 15 June 2021). The examined variables were not normally distributed. The Mann-Whitney U-tests were used to evaluate variations in the studied characteristics: novelty seeking, reward dependence, cooperative ability, self-transcendence ability, harm avoidance, and self-management. Not all conditions needed for ANOVA were met. For some dependent variables, the normal distribution assumption was not met. Nevertheless, the variance remained constant (Levene's test, $p > 0.05$). Because of the large sample size, a multivariate 2 × 3 factor ANOVA was used. The relationship between novelty seeking, harm avoidance, reward addiction, self-management, cooperation abilities, and self-transcendence skills results and combat athletes and the control group, and the *COMT* rs4680 polymorphism (personality traits x control and combat athletes subjects x genetic feature) was examined. For statistically significant ANOVA results, the post hoc least significant difference (LSD) test was used.

The chi-square and Cochran-Armitage trend tests were applied to determine associations of *COMT* rs4680 with combat athletes. Statistical analyses were conducted using STATISTICA 13 (Tibco Software Inc., Palo Alto, CA, USA) for Windows (Microsoft Corporation, Redmond, WA, USA) and the CATT package in R to conduct the Cochran-Armitage trend test.

Results

Genotype association analysis of *COMT* rs4680 polymorphisms in combat sports athletes and controls indicated statistically significant differences in the co-dominant model in frequencies of genotypes for *COMT* rs4680 (G/G 24.42% vs. G/G 21.58%; G/A 53.49% vs. G/A 44.96%; A/A 22.09% vs. A/A 33.45%; $\chi^2 = 8.621$; $p = 0.0134$, Table 2). Combat sports athletes and controls showed statistically significant differences in the frequency of alleles for the *COMT* rs4680 (G 51.16% vs. G 44.06%, A 48.84% vs. A 55.94%, $\chi^2 = 5.410$, $p = 0.0201$, Table 2).

Table 3 displays mean and standard deviation data for cooperation abilities, self-transcendence skills, novelty seeking, harm avoidance, reward dependence, and self-management skills in a group of combat athletes and controls. Compared to the control group, athletes had considerably higher scores in self-management (M 26.10 vs. M 23.73, $Z = 5.715$, $p < 0.0001$) and lower results considering harm avoidance (M 9.64 vs. M 11.46, $Z = -4.513$, $p = 0.019$, Table 3).

Novelty Seeking

The 2 × 3 factorial ANOVA showed a statistically significant effect of the complex factor *COMT* rs4680 genotype with combat sports athletes/controls and with novelty seeking ($F_{2,530} = 5.958$, $p = 0.0028$, $\eta^2 = 0.022$) (Table 4, Figure 1). Power calculation assessment revealed that the sample size in the present study had more than 87% power to detect the complex factor of combat athletes/controls x *COMT* rs4680 and their interaction effect (about 2% of the phenotype variance).

Post hoc LSD analysis showed a significantly lower novelty seeking score in combat sports athletes for the *COMT* rs4680 polymorphic variant (G/G M = 19.159) compared to controls

(G/G M = 21.383 $p = 0.0067$) (Table 5, Figure 1).

Self-Management

The results of 2 × 3 factorial ANOVA of combat sports athletes and control subjects were significant for self-management ($F_{1,530} = 44.61$, $p < 0.0001$, $\eta^2 = 0.078$). Our sample had 99% power to detect the effects of the studied self-management and the interaction effect (approximately 8% of the phenotype variance). Additionally, we observed a statistically significant effect of the complex factor *COMT* rs4680 genotype with combat sports athletes/controls and with self-management ($F_{2,530} = 6.772$, $p = 0.0012$, $\eta^2 = 0.025$) (Table 4, Figure 1). Our sample had more than 92% power to discern the complex factor of combat sports athletes/controls x *COMT* rs4680 and the interaction effect (around 2% of the phenotype variance).

Post hoc LSD analysis revealed that the *COMT* rs4680 polymorphic variant G/G M = 26.270 had a significantly lower self-management score in combat sports athletes than in controls G/G M = 23.283 ($p = 0.0003$) and A/A M = 23.075 ($p = 0.0001$). The same was true for self-management in combat sports athletes regarding variant G/A M = 25.449 compared to controls for A/A M = 23.075 ($p = 0.0001$) variants. Additionally, lower scores of self-management in combat sports athletes regarding A/A variant M = 27.509 versus controls A/A M = 23.075 ($p < 0.0001$) were detected (Table 5, Figure 1).

Self-Transcendence

The results of 2 × 3 factorial ANOVA of the *COMT* rs4680 genotype were found significant for self-transcendence skills ($F_{2,530} = 3.035$, $p = 0.0489$, $\eta^2 = 0.011$). Power calculation showed that our sample had 59% power to detect the influence of the studied self-transcendence skills and their interaction effect (about 1% of the phenotype variance) in the *COMT* rs4680 genotype. Moreover, we noticed a statistically significant relationship of the complex factor *COMT* rs4680 genotype with combat athletes/control and self-transcendence skills ($F_{2,530} = 9.387$, $p = 0.00009$, $\eta^2 = 0.034$) (Table 4). Our sample had more than 98% power to detect the complex factor of combat sports athletes/controls x *COMT* rs4680 and their interaction effect (about 3.4% of the phenotype variance).

Post hoc LSD analysis showed a significantly lower score of self-transcendence skills in combat sports athletes for the *COMT* rs4680 polymorphic variant G/G M = 6.650 compared to controls for G/G M = 8.600 variants ($p = 0.0014$). The same was true for self-transcendence skills in combat sports athletes regarding variant G/A M = 6.9783 compared to controls for G/G M = 8.6000 variants ($p = 0.0019$). In addition, A/A variant M = 7.982 had lower self-transcendence scores in combat sports athletes than in controls (A/A M = 6.419, $p = 0.0001$, and G/G M = 8.600, $p = 0.0001$; Table 5).

Table 1. Anthropometric characteristics of the study participants.

	Combat sports athletes n = 258	**Controls n = 278**
Age	26.01 ± 8.30	22.93 ± 4.81
Body mass	79.67 ± 13.68	81.28 ± 10.69
Body height	178.46 ± 7.31	181.73 ± 6.07
BMI	24.57 ± 4.18	24.28 ± 3.93

Table 2. The frequency of genotypes and alleles of *COMT* rs4680 in combat sports athletes and controls.

	Combat sports athletes	Controls	Co-dominant model χ^2 (p value)	OR (95% Confidence, p value)	Additive model Cochran-Armitage trend test Z (p value)
			COMT rs4680		
	n = 258	n = 278			
G/G	63 (24.42%)	60 (21.58%)	8.621 (0.0134)*		−2.307 (0.0211)
G/A	138 (53.49%)	125 (44.96%)		1.05 (0.68–1.61, p = 0.4093)	
A/A	57 (22.09%)	93 (33.45%)		0.58 (0.36–0.94, p = 0.0145)*	
G	264 (51.16%)	245 (44.06%)	5.410 (0.0201)		
A	252 (48.84%)	311 (55.94%)			

*p: statistical significance, χ^2: Chi² test result, n: number of subjects, * significant statistical difference, OR: Odds Ratio, G/G and A/A: genotypes (homozygotes), G/A: genotype (heterozygote), G and A: alleles*

Table 3. Analysis of novelty seeking, harm avoidance, reward dependence, self-management, ability to cooperate, and self-transcendence results in combat sports athletes and controls.

	Combat sports athletes	**Controls**	**U Mann-Whitney Z**	***p* value**
	(n = 258) M ± SD	(n = 278) M ± SD		
Novelty Seeking	20.20 ± 4.79	19.92 ± 4.34	0.667	0.5045
Harm Avoidance	9.64 ± 4.83	11.46 ± 4.63	−4.513	0.0000*
Reward Dependence	10.03 ± 3.03	10.47 ± 2.87	−1.449	0.1471
Self-Management	26.10 ± 4.40	23.73 ± 4.81	5.715	0.0000*
Cooperative Abilities	20.59 ± 4.54	19.92 ± 4.60	1.834	0.0667
Self-Transcendence Skills	7.12 ± 3.47	6.92 ± 3.39	0.484	0.6286

*M: mean, SD: standard deviation, U Mann-Whitney Z-test. * statistically significant between-group difference*

Table 4. The results of 2 × 3 factorial ANOVA (interaction) for combat sports athletes and controls, incorporating novelty seeking, harm avoidance, reward dependence, self-management, ability to cooperate, self-transcendence skills results and *COMT* rs4680.

		***COMT* rs4680**			**ANOVA (interaction)**		
STAI /NEO Five Factor Inventory	**Group**	**G/G (n = 123) M ± SD**	**G/A (n = 263) M ± SD**	**A/A (n = 150) M ± SD**	**Combat athletes /controls x *COMT* rs4680 F (*p* value)**	**η^2**	**Power (alfa = 0.05)**
Novelty Seeking	Combat sports athletes; n = 258	19.15 ± 4.20	20.62 ± 4.87	20.37 ± 5.13	$F_{2,530} = 5.958$ ($p = 0.0028$)*	0.022	0.8789
	Controls; n = 278	21.38 ± 4.25	19.62 ± 4.39	19.37 ± 4.17			
Harm Avoidance	Combat sports athletes; n = 258	9.69 ± 5.01	9.65 ± 4.84	9.56 ± 4.70	$F_{2,530} = 0.065$ ($p = 0.9373$)	0.0002	0.059
	Controls; n = 278	11.43 ± 4.77	11.36 ± 4.53	11.61 ± 4.71			
Reward Dependence	Combat sports athletes; n = 258	9.92 ± 2.77	10.02±3.20	10.16 ± 2.85	$F_{2,530} = 0.450$ ($p = 0.6377$)	0.002	0.123
	Controls; n = 278	10.72 ± 2.84	10.22 ± 3.16	10.64 ± 2.46			
Self-Management	Combat sports athletes; n= 258	26.27 ± 4.21	25.45 ± 4.75	27.51 ± 3.33	$F_{2,530} = 6.772$ ($p = 0.0012$)*	0.025	0.918
	Controls; n = 278	23.28 ± 4.37	24.44 ± 4.84	23.07 ± 4.95			
Cooperative Abilities	Combat sports athletes; n = 258	20.11 ± 4.52	20.62 ± 4.71	21.07 ± 4.14	$F_{2,530} = 0.743$ ($p = 0.4762$)	0.003	0.176
	Controls; n = 278	20.27 ± 4.54	19.73 ± 4.40	19.94 ± 4.92			
Self-Transcendence Skills	Combat sports athletes; n = 258	6.65 ± 3.34	6.98 ± 3.31	7.98 ± 3.88	$F_{2,530} = 9.387$* ($p = 0.00009$)	0.034	0.979
	Controls; n = 278	8.60 ± 4.06	6.50 ± 3.08	6.42 ± 2.96			

*M: mean, SD: standard deviation, * statistically significant differences, G/G and A/A: genotypes (homozygotes), G/A: genotype (heterozygote)*

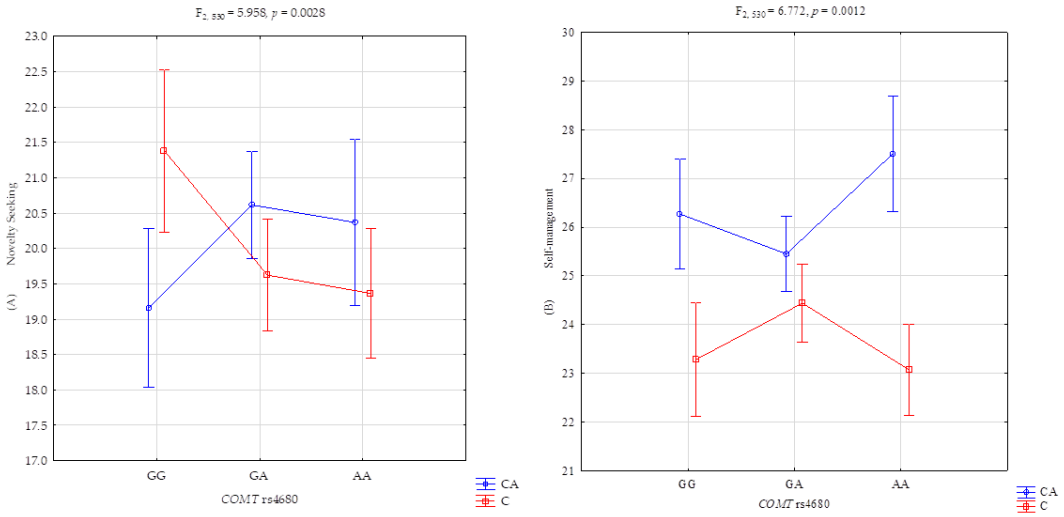

Figure 1. Interaction between combat sports athletes (CA)/controls (C), *COMT* rs4680 and (A) the novelty seeking scale, and (B) self-management scale.
GG and AA: genotypes (homozygotes), GA: genotype (heterozygote)

Table 5. Post hoc LSD test of interactions between combat sports athletes/controls, *COMT* rs4680 and the novelty seeking scale, self-management and self-transcendence skills.

Novelty Seeking scale						
***COMT* rs4680**	{1} 19.159	{2} 21.383	{3} 20.616	{4} 19.624	{5} 20.368	{6} 19.366
GG Combat sports athletes {1}		0.0067*	0.0348*	0.5063	0.1445	0.7796
GG Controls{2}			0.2736	0.0137*	0.226137	0.0073*
GA Combat sports athletes {3}				0.0766	0.7286	0.0401*
GA Controls {4}					0.3041	0.6770
AA Combat sports athletes {5}						0.1886
AA Controls {6}						
Self-Management						
***COMT* rs4680**	{1} 26.270	{2} 23.283	{3} 25.449	{4} 24.440	{5} 27.509	{6} 23.075
GG Combat sports athletes {1}		0.0003*	0.2388	0.0099*	0.1391	0.00002*
GG Controls{2}			0.0023*	0.1081	0.000001*	0.7837
GA Combat sports athletes {3}				0.0746	0.0044*	0.0001*
GA Controls{4}					0.00003*	0.0298*
AA Combat sports athletes {5}						0.000000*
AA Controls {6}						
Self-Transcendence Skills						
***COMT* rs4680**	{1} 6.6508	{2} 8.6000	{3} 6.9783	{4} 6.5040	{5} 7.9825	{6} 6.4194
GG Combat sports athletes {1}		0.0014*	0.5224	0.7778	0.0308*	0.6735
GG Controls{2}			0.0019*	0.0001*	0.3215	0.0001*
GA Combat sports athletes {3}				0.2542	0.0586	0.2162
GA Controls {4}					0.0062*	0.8543
AA Combat sports athletes {5}						0.0059*
AA Controls {6}						

** statistically significant differences, M: mean, GG and AA: genotypes (homozygotes), GA: genotype (heterozygote)*

Discussion

Our study focused on a case-control analysis of martial arts athletes with personality traits associated with the *COMT* gene rs4680 polymorphism. The current study found a significant association between the *COMT* rs4680 polymorphism and the psychological profile in combat athletes. We discovered a significant effect of a complex factor *COMT* rs4680 genotype on combat sports athletes/controls and novelty seeking, self-management, and self-transcendence skills. The *COMT* gene is responsible for the degradation of catecholamines. This has been linked to genotypes associated with dopamine availability in the brain. *COMT* gene variants are engaged in a number of psychological roles, e.g. cognition, anxiety, and stress response (Nogueira et al., 2019). However, *COMT* gene results are controversial. According to Leźnicka et al. (2017, 2018), no significant relationship ($p = 0.286$ and $p = 0.43$) between the *COMT* rs4680 GG genotype and elite martial arts athletes exists. This implies that the perception of pain is the same in both the martial arts athletes and non-athletes. In contrast, Tatar et al. (2020) demonstrated a significantly higher frequency of the GG (fighter) phenotype in combat sports athletes compared to the control group ($p = 0.003$). This suggests that in combat sports, a fighter's genotype may be important. In our research, we observed a statistically significant effect of a complex factor of rs4680 of the *COMT* genotype on combat sports athletes/controls regarding novelty seeking ($F_{2,530} = 5.958$, $p = 0.0028$, $\eta^2 = 0.022$), self-management ($F_{2,530} = 6.772$, $p = 0.0012$, $\eta^2 = 0.025$), and self-transcendence skills ($F_{2,530} = 9.387$, $p = 0.00009$, $\eta^2 = 0.034$). Our genotype association analysis of *COMT* rs4680 polymorphisms in combat sports athletes and controls indicated statistically significant differences in the co-dominant model in frequencies of genotypes for *COMT* rs4680 (G/G 24.42% vs. G/G 21.58%; G/A 53.49% vs. G/A 44.96%; A/A 22.09% vs. A/A 33.45%; $\chi^2 = 8.621$; $p = 0.0134$). Combat sports athletes and controls showed statistically significant differences in the frequency of alleles for the *COMT* rs4680 (G 51.16% vs. G 44.06%, A 48.84% vs. A 55.94%, $\chi^2 = 5.410$, $p = 0.0201$).

While inherited genetic elements can significantly affect an athlete's character or potential, athletic success may also be affected by factors arising from the environment. It would be preferable to use genetic information to build tailored training methods that boost athletes' talent or attributes and prevent potential injuries rather than focus on the abilities of only elite athletes because many factors affect athletic performance (Youn et al., 2021). Numerous attempts to determine the potential implications of the *COMT* rs4680 polymorphism for neuropsychiatric disorders have been made because of the polymorphism's relatively high frequency and critical function in regulating catechol-amine catabolism (Bilder et al., 2004; Srivastava et al., 2021). The rs4680 polymorphism of the *COMT* gene leads to a substitution of Val with Met at codon 158. This in turn leads to the fact that the enzyme is prone to conformational changes at the active site and clustering of the polypeptide at physiological temperature. This results in decreased enzymatic activity in Met allele carriers, while higher activity is observed in Val allele carriers (Bilder et al., 2004). Met/Met homozygotes are responsible for a 3–4-fold decrease in COMT activity in Val/Val carriers (Weinshilboum et al., 1999), and higher baseline fat levels, compared to Val/Val carriers, with heterozygotes showing an average activity (Switala et al., 2022). The frequency of the Met allele varies by ethnicity, ranging from 0.01 to 0.62, e.g., 0.49–0.54 in Caucasians, 0.49 in Southwest Asia, 0.18–0.3 in East Asians and 0.03–0.04 in African Americans and Africans (Bastos et al., 2017). The Met genotype, according to Bilder et al. (2004), is associated with higher tonic dopamine levels, reciprocal dopamine phase reductions in the subcortical areas, and increased D1 receptor transmission in the cortex. As a result, the activation levels of brain networks that underpin critical components of working memory and executive processes may be more stable, but less flexible. Depending on the phenotype and many endogenous and environmental factors, these impacts can be positive or negative (Bilder et al., 2004). Some authors have speculated that chronic physical exertion, as observed in ultra-endurance athletes, manifests in Met/Met homozygotes exhibiting greater novelty seeking traits, corroborating the hypothesis of a relationship between personality traits and *COMT* Val158Met heterozygotes (rs4680) (van Breda et al., 2015; Zmijewski et al.,

2021). In a study conducted by Leźnicka et al. (2018), the relationship between genetic diversity and temperamental features was also established. Notably, associations between the functional polymorphism of the *COMT* gene and the Formal Characteristics of Behavior—Temperament Inventory scores for temperamental traits were revealed. Furthermore, lower sensitivity was seen in (Val/Val) homozygous combat athletes compared to (Met/Met or Met/Val) individuals who carried the Met allele (Leźnicka et al., 2018).

Conclusions

The present study was designed to determine the effects of the *COMT* gene rs4680 polymorphism on the psychological profile of athletes. Studying genetic associations with psychological phenotypes presents a promising avenue of inquiry regarding an athlete's success. Due to the multi-gene and multifactorial nature of the determinants of sports predispositions, we propose to take into account also other features, especially when studying genes related to cerebral neurotransmission. It is a holistic departure, and it clearly illustrates the relationship between particular characteristics of an athlete. The limitation of our research is that personality traits are not only genetically determined, but are also conditioned by the developmental environment of the athlete.

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