Is Sports Choice and Participation Related to 2D:4D? A Study Among Adult Male Students in Wrocław, Poland

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ABSTRACT

Psychology and personality of individuals may have implications for choice of, and performance in sports disciplines. Individual- and group sports differ in psychological requirements, such as, competitiveness, sensation seeking and risk taking attitude, often required in sports. There is sex difference in human in these qualities, which also show association with prenatal testosterone exposures. Second-to-fourth digit lengths ratio (2D:4D) is an indicator of prenatal testosterone exposure. Lower 2D:4D indicates higher prenatal testosterone exposure and vice versa. Males generally have lower 2D:4D than females. This study cross-sectional study investigated the relationship of 2D:4D with team based- or individual sports. The participants were 421 Polish male students with a mean (±SD) age of 19.78 (±0.79) years. Among them, 139 were engaged in sports and 282 were not. Mean 2D:4D in each hand of individual sporting group was significantly lower than the team sports- and no sports groups. Participants not involved in any sports had the highest mean 2D:4D value. However, the team sportsmen's 2D:4D did not differ from the non-sporting group. Prenatal testosterone exposure might have implication in sports choice and participation.

Key words: sports, preference, 2D:4D, digit ratio, testosterone, male, Poland

Introduction

The ratio of second- to fourth digit lengths (2D:4D) has been in use in scientific literature for quite some time as a morphological indicator of fetal intrauterine prenatal testosterone (PT) exposure, particularly, in humans[1]. A relatively lower 2D:4D is indicative of higher PT exposure[2]. Recent experimental studies with animal model also strongly supported this fact[3,4]. PT seems to elongate the ring finger, whereas prenatal estrogen lengthens the index finger. Males tend to have lower 2D:4D than do females[1]. This ratio is determined by the proportion of PT and PE in a narrow window period of fetal development[3]. This sex difference was evident at the end of first trimester[5,6]. Although 2D:4D could increase slightly with growth, the change was small and was little affected by puberty[7,8].

Role of androgens was also implicated for competitive behaviours[9]. As androgens differentially function in two sexes, these psychological attributes therefore have a sexual dimorphism. The factors that determine sex, such as, prenatal testosterone, might also have a role in modifying these attributes. It was suggested that PT has an 'organizational' effect on brain during its prenatal development and thus could determine behavior in later life[2,3]. Psychological aspects could also have a major effect on sports performance[10,11]. In solo sporting activities, such as long-distance running or martial art, the performer is responsible for the training and efficiency required for personal success, whereas in a group sport like football, team members must accomplish mutual cooperation and teamwork for a success. Athletes who were involved in individual sports were indeed reported to experience greater feelings of autonomy than their team-based counterparts[12]. On the other hand, group cohesiveness is related to individual adherence behaviour across different sporting activities including fitness classes, recreational team

sports, and elite team sports[13]. Besides, variation in participation in a sport or other regular physical training not only depends on differences in physical ability but also mental traits of the participants, such as, levels of competitiveness[14] and sensation seeking (SS)[15]. Furthermore, these personality measures were also reported to be higher in males than in females[16,17] and in females with higher testosterone level[18]. On the other hand, various sporting activities do differ in terms of physical risk involved[19]. Decision to participate in a high risk sport could also be guided by higher SS attitude, which was found more in men[20,21] and was associated with higher testosterone level[22]. These findings indicate that sex differentiating factors, such as, androgens, may have a link with choice of sporting activities by an individual.

Most of the studies with 2D:4D dealt with its associations with physical ability, endurance and sporting prowess, e.g., running, fencing, skiing, surfing, rowing, sumo wrestling, rugby, football and gymnastics[23]. However, all these studies compared 2D:4D, either between performers and non-performers or between high and low ranking performers within specific sport discipline. However, the extent of the association may also vary across sports disciplines. In a recent meta-analysis, medium- and long duration running showed the strongest relationships between 2D:4D and physical performance, whereas, team-based field sports (e.g., rugby and football) and other individual sports (e.g., skiing, fencing)[24] did exhibit relatively smaller associations. There is, however, no other study to demonstrate variation in 2D:4D values across different sports disciplines, more particularly, between individual and group sports.

The objective of this study was to compare 2D:4D between two groups of adult male Polish students who were engaged either in team based or in individual sports, respectively. We therefore hypothesized that there could be significant difference in 2D:4D between individuals participating in team sports and those in individual sports. Further, we also observed 2D:4D differences between martial art (judo / boxing) and other individual athletics, viz., running and swimming, since these two groups do differ in personal risk profile of a participant.

Material and Methods

Participants

This cross-sectional study included 430 male students from the 1st year course of General Kuściuszko Military Academy of Land Forces in Wroclaw (GKMALF), Poland, during two academic sessions October–November 2012–13 and 2013–14. Written consent from the Chancellor of GKMALF and informed consent from the participants were obtained. Ethical standards as per Helsinki Declaration[25] were adhered to. The participants were asked to fill up questionnaire about their participations in organized sports performance, i.e., their affiliation to sport clubs, taking part in regular trainings and sports games before beginning the study at GKMALF. Each participant was given option to mention the kind of primary sports discipline in which he underwent regular training, participation and performance. They also had option to choose none if they were not engaged in any. For the purpose of the study, the reportedly healthy male students without any chronic or acute illness were approached for voluntary participation. A total of 421 students were agreed upon and participated. Among them 139 were engaged in different kinds of sports and 282 did not report any previous sporting activity. General information such as residential address, age and type of course, type of sports they are engaged in were asked and recorded accordingly.

Measurements

Height was measured by stadiometer to the nearest 1 mm. Weight was measured by digital scale to the nearest 0.1 kg following a standard protocol[26]. During measurement subjects wore light garments. The lengths of the second and fourth digits of each hand were measured to the nearest 0.1 mm by a trained physical anthropologist (MK) using a digital caliper (TESA SHOP-CAL). The finger lengths were recorded on the ventral surface of the hand, from the mid-point of the basal crease (most proximal to palm) to the tip of the digit[1]. The intra-observer error of measurement varied from 0.165 mm for second digit of left hand to 0.208 mm for 4th digit of right hand. The length of the 2D was then divided by the length of the 4D for each hand to derive Digit ratios (2D:4D).

Statistics

Mean and standard deviation of mean values (SD) were calculated to describe the quantitative measurements including the digit lengths and 2D:4D. Percentage was calculated to show the distribution of the participants across different sports groups. Differences in mean digit ratio between the groups (team sports/individual sports/no sports group) were assessed for significance by one way analysis of variance (ANOVA)and NIR post-hoc test were applied to evaluate the significance of inter group differences. Analysis of covariance (ANCOVA), using the Generalized Linear Model, were also performed to assess the significance of impact of the sports groups on 2D:4D (separately for both hands) after allowing for the covariates (age, height, BMI). Bar diagram were also produced to demonstrate these inter group differences in mean ($\pm$ 95% CI) 2D:4D for each hand. All calculations were done using Statistica 10.0.

Results

Mean (SD) age of all participants was 19.78 (0.79) years. The mean (SD), height and weight were 179.58 (6.00) cm and 74.46 (7.99) kg, respectively and the mean (SD) BMI was 23.06 (1.87) kg/m^2. There were no significant differences between groups (team and individual sports) in mean age (t=0.76, p>0.05), weight (t=0.42,

p>0.05), height (t=1.15, p>0.05) and BMI (t=0.57, p>0.05). (results not shown).

Table 1 shows the results of analyses of covariance for 2D:4D in right and left hand (separately), where 2D:4D was dependent variable and the covariates were age, height and BMI. No covariate showed significant impact on 2D:4D for any hand except for height in case of right hand (Wald's χ^2=3.956, p=0.0467). However, sporting group (team/individual/no sports) had a significant impact on 2D:4D for both hands after allowing for the covariates (right hand Wald's χ^2=10.650, p=0.0049; left hand χ^2=9.843, p=0.0073).

TABLE 1
RESULTS OF ANALYSIS OF COVARIANCE (ANCOVA) FOR 2D:4D IN RIGHT AND LEFT HAND

Factors	2D:4D Right hand		2D: 4D Left hand	
	Wald's χ^2	p	Wald's χ^2	p
Height	3.956	0.0467	1.564	0.2111
BMI	1.431	0.2316	0.154	0.6946
Age	0.001	0.9889	0.012	0.9142
Engagement in sport	10.650	0.0049	9.843	0.0073

(Dependent: 2D:4D; covariates: age, height and BMI)

Table 2 shows the numeric and percentage distribution of subjects according to sports disciplines and also for the control group (no sports). The study participants included 68 (16.15%) engaged in team sports and 71 (19.86%) in

TABLE 2
MEAN (SD) 2D:4D FOR RIGHT AND LEFT HAND IN PARTICIPANTS ACCORDING TO SPORTS GROUP

Sports groups	N (%)	Right 2D:4D*		Left 2D:4D**	
		$\overline{X}$	SD	$\overline{X}$	SD
Team Sports					
Football	35 (8.31)	0.967	0.033	0.977	0.032
Basketball	12 (2.85)	0.974	0.028	0.981	0.029
Handball	5 (1.18)	0.978	0.025	0.983	0.024
Volleyball	16 (3.80)	0.974	0.030	0.981	0.034
Total	68 (16.15)	0.971	0.031	0.979	0.031
Individual Sports					
Martial art	46 (10.92)	0.957	0.027	0.968	0.024
Running	15 (3.56)	0.953	0.022	0.958	0.019
Swimming	10 (2.33)	0.959	0.034	0.952	0.033
Running + Swimming	25 (5.94)	0.956	0.027	0.960	0.025
Total	71(16.86)	0.957	0.026	0.965	0.025
No sports	282 (66.98)	0.975	0.029	0.980	0.030
All groups	421	0.971	0.030	0.977	0.030

*F=7.090, p=0.000012; **F=5.565, p=0.00094

individual sports disciplines. The participants who were not engaged in any sporting activity comprised of 66.98% (N=282).

It was also interesting to note that for both right and left hands, when we arranged the mean digit ratio values in an ascending order, we found a more or less clear division between two groups of sports, one representing team based sports, and the other, individual performances (Table 2). The 2D:4D values ranged from 0.978 (handball) to 0.953 (running) for right hands and from 0.983 (handball) to 0.952 (swimming) for the left hands. The 2D:4D values for the non-participants (right 0.975, left 0.980) were similar with the performers in the team sports (right 0.971, left 0.979).

Table 2 also shows the mean 2D:4D values for the three different sporting groups derived from the one way ANOVA tests for both hands. Overall the results revealed significant differences in mean 2D:4D within the groups both for the right (7.090, p = 0.000012) and for the left hand (F=5.565, p=0.00094) as well. The participants without any sporting activity showed the highest mean values for the right (0.975) and the left hands (0.980). The participants who were engaged in individual sports showed the lowest values (right, 0.957; left, 0.965). The post-hoc comparison test (results not shown) revealed that the individual sporting group had significantly lower 2D:4D in both hands than the team sportsmen (Right p=0.0200; Left p=0.0107) and non-sportsmen (Right p=0.0003; left p=0.00004). The differences between the latter two groups were not significant for any hand at all. Figure 1 also demonstrates graphically the differences in mean (±95% CI) values between the sports groups.

The individual sports group was further subdivided into 1) martial art and 2) Running and swimming. Scheffe's post hoc comparison revealed that the difference in 2D:4D between these two groups of individual sport was not statistically significant in any hand (p=0.998). However, 2D:4D in both these groups differed from the group without sporting activity (p=0.00328 and 0.02399).

Discussion and Conclusion

The objective of this study was to detect if there were differences between team based- and individual sports participants in 2D:4D. We hypothesized that participation in either of those two kinds of sports might be associated with difference in 2D:4D since they demanded different psychological requirements. For instance, individual sports, in general depend more on personal competence, at least psychologically, rather than showing coordinated skills as in team based sports. Our results indeed showed that the mean 2D:4D in each hand of individual sporting group was significantly lower than the team sports- and non-sports groups. The non-sports group had the highest mean 2D:4D values. However, the difference in 2D:4D between the team sports and the non-sports groups was not statistically significant.

Different kinds of sports involve variable extents of relative risk, e.g., judo and boxing were listed highest among a number of sports[19,27]. Therefore, the choice or preference to participation in a sport, which directly involved higher relative probability of personal risk, could also be associated with a higher risk taking attitude. Personality dimensions that had evolutionary biological significance, such as aggression and risk taking, were thought to be influenced by androgens[17]. Aggression and risk-taking might have been adaptive in males, because of the greater involvement by males in warfare/protection and exploration of the physical environment. The 2D:4D may be a valid, though weak, predictor of selective sex-dependent traits that is sensitive to testosterone[17]. In some studies, 2D:4D also showed negative association with risk taking[28,29,30] and sensation- and/or thrill-seeking behaviors[17,21,31]. We propose that higher sensation-seeking and risk taking attitude among our participants involved with individual sports, e.g., judo/boxing, were associated with their lower mean 2D:4D relative to their team sportsmen counterparts.

Sex differences in cognition and personality were linked, speculatively, to early androgen exposure during intrauterine development[32]. Individual differences in sexually dimorphic traits within each sex could also arise from the differential level of foetal androgen exposure[33,34]. In a variety of sports, 2D:4D was suggested to be a performance indicator in men[35]. A number of psychological factors, such as masculine gender identity[36], aggression in men[37], high status in competitive sports[38] were associated with lower 2D:4D. As we have mentioned earlier that team sports like football and basketball requires more social skills like sharing the recognition with other people for a win, and less extraversion and egoism, than in individual sports[39]. There were evidence that pro-social behavior could have hormonal and biological basis[40,41]. The individual sport athletes showed scoring significantly higher on conscientiousness and autonomy than did team sport athletes, while the team sport athletes were higher on agreeableness and sociotropy than did the individual sport athletes[42]. On the other hand, a higher 2D:4D ratio has indeed been shown to be related to higher levels of (aggregate) pro-social behaviour and lower social cognition in girls[43]. The team sportsmen in our study also showed higher 2D:4D which might be indicative of their higher (social) collaborative skills in comparison with the individual sportsmen.

Lower 2D:4D was also found to be associated with occupational choice[44] among the female. A recent study revealed that the young Polish females in the military training course had lower 2D:4D than those females who were in civil courses in a same military academy[45]. Our present study might have hinted at a possibility that 2D:4D could be associated not only with the choice for an occupation, but also with smaller decisions, such as participating in a sport among young Polish men. In a study on sporting choice, female participants were significantly more interested in gymnastics and figure skating, whereas males were significantly more interested in hockey, football, baseball and basketball, golf, tennis, and boxing[16]. Our study indicated that even within one sex, more "masculine" digit ratio could also discriminate the sporting choices. In a study, the association of low 2D:4D with endurance was also observed[46]. We assume that the individual sports have a more reliance on personal endurance than on coordinated management of communication skills. This might be a reason why we observed a lower (more masculine) digit ratio among the individual sportsmen. Higher sensation seeking (SS) attitude could also be associated with choice and performance in individual sports. The high and low risk sports participants showed differences in total SS[47]. Women with a low 2D:4D ratio had significantly greater total SS and willingness to be engaged in physical risk in individual sports e.g., sky diving[17]. Austin et al.[21] found that higher 2D:4D ratios were associated with lower SS in women, whereas, in men, both right- and left-hand 2D:4D ratios were negatively associated with total SS scores. We therefore expect more SS attitude could be associated with lower 2D:4D[32]. In many studies, the observed correlations between personality and 2D:4D were stronger in women than in men[21,48,49,50]. Our study implicated that even among the males, the personality traits, as reflected by their sporting choice, could show association with 2D:4D. But to prove it, studies directly focussed on personality traits are necessary. The present study also had an inherent limitation of including one sex. Further studies would be necessary to see this relationship in both sexes.

The study showed that the mean 2D:4D in individual sporting group was significantly lower than the team sports- and no sports groups. Higher sensation-seeking and risk taking attitude among individual sports participants might be associated with their lower 2D:4D. The use of 2D:4D could be a simple morphological parameter to study the associations between psychological variables, such as personality orientation and choice, and to identify traits under hormonal influences during ontogenic processes. Our findings, to some extent, also had practical implication in selection of individuals for sports disciplines. As the use of height is a selective feature for the basketball players, the low value of DR can favour individuals who prefer individual sports. It could indicate their psychological inclination and higher psychical endurance and persistence. Since the DR does not change with age, it could be very useful, among other physical features, at the early stage of selection of children or youth for particular disciplines of sport.

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KAKO SE IZBOR I SUDJELOVANJE U SPORTU ODNOSE NA 2D: 4D? ISTRAŽIVANJE MEĐU MUŠKIM ODRASLIM STUDENTIMA U WROCLAWU U POLJSKOJ

S A Ž E T A K

Psihologija i osobnost pojedinca može imati utjecaj na izbor i uspješnost u sportskim disciplinama. Pojedinačni i grupni sportovi se razlikuju u psihološkim zahtjevima kao što su konkurentnost, senzacionalizam i stava prema riskiranju koji je često potreban u sportu. Postoji seksualna razlika kod čovjeka u tim osobinama, koje pokazuju korelaciju s prenatalnom izloženosti testosteronu. Omjer duljine drugog i trećeg prsta (2D: 4D) je pokazatelj prenatalnog izlaganja

testosteronu. Niži omjer 2D: 4D označava veću izloženost prenatalnom testosteronu i obrnuto. Muškarci općenito imaju nižu razinu 2D: 4D od ženki. Ova presječna studija istražuje odnos 2D: 4D sa timskim i pojedinačnim sportovima. Ispitano je 421 muški studenti iz Poljske s prosjekom (+ SD) godina od 19.78 (+0.79) godina. Među njima, 139 ih je sudjelovalo u sportu i 282 nije sudjelovalo. Medijan 2D: 4D u svakoj ruci kod pojedinačnih sportova je bio znatno niži nego kod timskih sportova i onih koji se ne bave sportom. Sudionici koji se nisu bavili sportom su imali najveću srednju razinu 2D: 4D. Međutim, nije pronađena značajna razlika između ispitanika u timskim sportovima i onih koji se ne bave sportovima. Prenatalna izloženost testosteronu mogla bi imati implikacije u izboru i sudjelovanju u sportovima.