Research article

Association of 2D:4D finger length ratio of People Working in different professions with personality traits

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ABSTRACT

Background: The ratio of the index finger (2nd finger) to the ring finger (4th finger) (2D:4D) can give information about harmony between personality and career of individuals. The developing technology makes it difficult to choose a profession.
Aim: This study aims to contribute to the career choice of individuals by analyzing the relationship between the 2D:4D finger digit ratio and personality traits of individuals working in different professions (Educator, Worker, Housewife, Civil servant, Healthcare professional/ EWHCH).
Method: The participants were three hundred twenty-five individuals living in the province of Malatya. The SPSS 26.0 software was utilized in the data analysis. The p value of 0.05 was accepted as significance level in comparison tests.
Results: A statistically significant difference was determined between the participants, who had the 2D shorter than the 4D in right hand, in terms of professional groups ($p < 0.05$). In healthcare workers, a low level ($r = 0.305$) positive correlation was found between right hand 2D4D and both control ($r = 0.264$) and curiosity and left hand 2D:4D, and a low level ($r = 0.255$) negative correlation was found between Conscientiousness and right hand 2D:4D in housewives. There was a statistically significant difference between the groups (educator, worker, housewife, civil servant, healthcare professional) in terms of total score of the Five-Factor Personality Inventory (FFPI) and scores of extroversion, agreeableness, conscientiousness, neuroticism, and openness to experience subscales ($p < 0.05$). A weak positive statistically significant correlation was detected between the healthcare professionals' score of Career Adapt-abilities Scale (CAAS) control subscale and the right-hand 2D:4D ratio. **Conclusions**: It is suggested to investigate the 2D:4D ratio over different professional groups. The present study is important since it gives information about personality and associates such information with the 2D:4D ratio, the

1. Introduction

The career choice is one of the most important decisions that an individual has to make in his or her life. One of the most important criteria for the individual to decide on a suitable career for himself or herself in this process is awareness of his or her own personal traits and evaluation of his or her career choice in accordance with those traits accordingly [1]. Genetic factors are also effective in the choice of a profession. Since the genetics are known to be encoded to individuals in their formation stages from the mother's womb, the

potential talents that can be developed also form in the person at this time [2]. One of the methods used to reveal talents is anthropometric measurements: examination of hand and foot dimensions; studies on the estimation of hand fingerprints, their lengths and ratios to each other based on race, gender, age and height [3]. The levels of sex hormones in the body is associated with the ratio of the second (2D) (index finger) and fourth (4D) (ring finger) fingers. The 2D:4D ratio refers to the ratio of the length of the index finger to the length of the ring finger [4–9]. During the prenatal period, the hormones estrogen and testosterone promote the growths of the 2nd finger (2D) and the 4th finger (4D), respectively. Therefore, a low 2D:4D ratio indicates masculinity characterized by a high testosterone-low estrogen level during this period, while a high 2D:4D ratio indicates femininity characterized by a low testosterone-high estrogen level [10]. Evidence prove that the 2D:4D ratio is relatively fixed at the first trimester of gestation in terms of development and remains significantly the same with increasing age [11]. The length of the index finger on the human hand is divided into three groups: index finger shorter than the ring finger (2D < 4D), index finger equal to the ring finger (2D = 4D), and index finger longer than the ring finger (2D > 4D). The group 2 is sometimes seen. While the group 1 (2D < 4D) is predominately seen in males, the group 3 (2D > 4D) is predominately seen in females. This means that the gene for short index finger is dominant in males and recessive in females [9,12]. The index finger is generally shorter than the ring finger in males, while this is opposite in females [13]. Left-handed individuals have a low 2D:4D ratio, left hand preference is correlated with elevated levels of fetal testosterone, and testosterone levels in adulthood are associated with testosterone levels in fetal life [14]. While there is a decline in the 2D:4D ratio in the presence of traits such as left-hand preference, good visuospatial skills, autism, Asperger's disorder, attentive decision-making, organization, responsibility/decisiveness, and analytical thinking, 2D:4D ratio increases in cases such as fluent language and a high level of emotional expression [15,16]. A correlation between attention deficit/hyperactivity syndrome and low hand-finger ratios has also been reported [17]. Studies on personality have reported that the 2D:4D ratio is correlated with schizotypal personality trait and depression scores are higher in the group exhibiting feminine traits in men, similar to women [18,19]. It has also been reported that finger length ratios are more strongly correlated with personality traits in females compared to males [20]. The 2D:4D ratio is a reliable indicator of androgen sensitivity and can be used as a criterion in determining individuals' cognitive abilities, emotional intelligence, learning styles, personality traits, and occupational fields to which they are predisposed [8]. Different models have been proposed for the classification of personality, and the most preferred and powerful one is the "Five Factor Personality" (FFPI) model [21]. FFPI Model has shown that the 2D:4D ratio is correlated weakly and positively with extroversion, positively with uncertainty avoidance, negatively with dominance, assertiveness, openness, and sincerity, and negatively with thrill seeking and aggression in both gender groups [13,22]. Many studies have grouped the terms related to personality with factor analysis methods. Studies have resulted in a consensual FFPI model consisting of neuroticism, extroversion, openness to experience, conscientiousness, and agreeableness factors. The FFPI is the most preferred and practiced model [23]. Individuals with high levels of neuroticism are more likely to experience fear of failure, work stress, and anxiety in business life. Extroverted individuals are friendly and sociable. Responsible individuals are hardworking, reliable, cautious, and organized. Well-adjusted individuals are respectful, reliable, tolerant, and well-meaning [24]. Stronger personality trait correlations were observed in females than males in terms of finger length ratios, and age and gender norm differences were found in personality tests in accordance with age and gender differences for personality traits [20]. Lippa (2006) measured the hand 2D:4D ratio of 2000 university students and applied the FFPI [25]. Although studies with finger length ratios (2D:4D) have been carried out on talent and personality in students and athletes [6,26–28], how the 2D:4D ratio is correlated with FFPI and **Career Adapt-Abilities Scale** has not been revealed separately among professions. The importance of talent and personality in career choice and the lack of the 2D:4D ratio in the current literature have led to an idea for the present study. The conscious career choice by individuals makes it very important not only for the individual's own future but also for the future of the countries [29]. Given this significance, this study aims to determine how the 2D:4D ratios of individuals is correlated with their career and personality, and based on this information, to identify the correlation between individuals' digit ratio and predisposition to a particular profession, and to create an insight for the individuals who will choose a career. We believe that the present study would contribute to those who choose a career, to the literature, and to the researchers who study accordingly.

1.1. Theoretical framework

2D:4D ratio is more sensitive in spite of other digit ratios (3D:5D) displaying sexual dimorphism and relationship to various human phenotypic traits [30,31].

Numerous studies have investigated 2D:4D finger length ratio [6,32–36,36,37]. However, there has been no study in the literature examining the correlation between finger length ratio and FFPI and CAAS of different professions.

Studies have reported that a lower 2D:4D ratio is correlated with physical fitness, better performance in competitive sports, and better levels of spatial cognition [38,39]. It has been shown that this ratio is related to various psychological characteristics [18]. Manning and colleagues found significant correlations between success, skill, and speed with more masculine (smaller) digit ratios in various sports and visuospatial ability [10,13,40]. In their meta-analysis including over 2010 samples representing over 2500 participants, Hönekopp and Schuster showed that sports/athletic performance was weakly and negatively correlated with 2D:4D in both hands in men and women [41]. Tester and Campbell found that 2D:4D was negatively correlated with performance in both male and female amateur football, rugby and basketball players. Therefore, a similar study reported that the 2D:4D ratio is correlated with performance in many sports branches [42]. Tatar et al., found in their study that there is a connection between FFPI and finger length. In line with these studies, we think that looking at finger length ratio will provide information about personality and profession [20,39, 39,43,44,44]. In the light of the studies, we reached out to individuals in different professional groups and investigated whether or not their finger length ratios were correlated with FFPI and CAAS test results. It is thought that the present study will contribute both to the literature and to researchers who study finger length.

2. Material-method

The present study was conducted individuals who were from 5 professional groups (EWHCH) and voluntarily participated in the study. Totally 325 people including 65 people in each group participated in the study. Individuals who had deformity in their hands, deformed fingers, and the history of trauma and fracture in their fingers, were excluded from the study.

2.1. Sample size

Upon power analysis made through G*power 3.1 program at an effect size of 0.242, a margin of error of 0.05, a confidence level of 0.95, and a population representativeness of 0.95, the sample size was calculated to be 325 (65 per group) based on previous studies (Faul, Erdfelder, Burchner, & Lang, 2009) [45].

2.2. Ethical Considerations

Approval was obtained from the non-invasive ethics committee of Malatya Turgut Özal University (2022/46) to conduct the study. The volunteers signed the informed consent form. 2D:4D ratios of the participants were measured using a 0.01-mm digital caliper.

2.3. Data collection tools

The participants' social-demographic characteristics were determined [36]. The "FFPI" and the "CAAS" were also used to collect data.

Five-Factor Personality Inventory; This scale was developed by John Donahue and Kentle in 1991 and its Turkish validity and reliability study was conducted by Alkan in 2007 [46,47]. The inventory has 44 items under 5 factors. The extroversion subscale is assessed with items 1, 6, 11, 16, 21, 26, 31, and 36; the agreeableness subscale is assessed with items 2, 7, 12, 17, 22, 27, 32, 37, and 42; the conscientiousness subscale is assessed with items 3, 8, 13, 18, 23, 28, 33, and 38; the neuroticism subscale is assessed with items 4, 9, 14, 19, 24, 29, 34, and 39 and openness to experience subscale is assessed with items 5, 10, 15, 20, 25, 35, 40, 41, and 44. Items are rated using a 5-point Likert scale ranging from '1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, to 5: Strongly agree' [5,8,20,23,46–48].

Career Adapt-Abilities Scale; The scale was developed by Savickas and Profeli (2012) and its Turkish validity and reliability study was conducted by Kanten in 2012. It has 19 items and 4 subscales (concern, control, curiosity, and confidence). The Cronbach's alpha values of its subscales were calculated as 0.61 for the concern subscale, 0.77 for the control subscale, 0.79 for the curiosity subscale, and 0.81 for the confidence subscale [49–51].

2.4. Process

After the participants placed both hands on a hard surface, the proximal fold on the volar side of the metacarpophalangeal joint was measured to the fingertip through a digital caliper. In order to prevent any confusion between the participants and to perform the
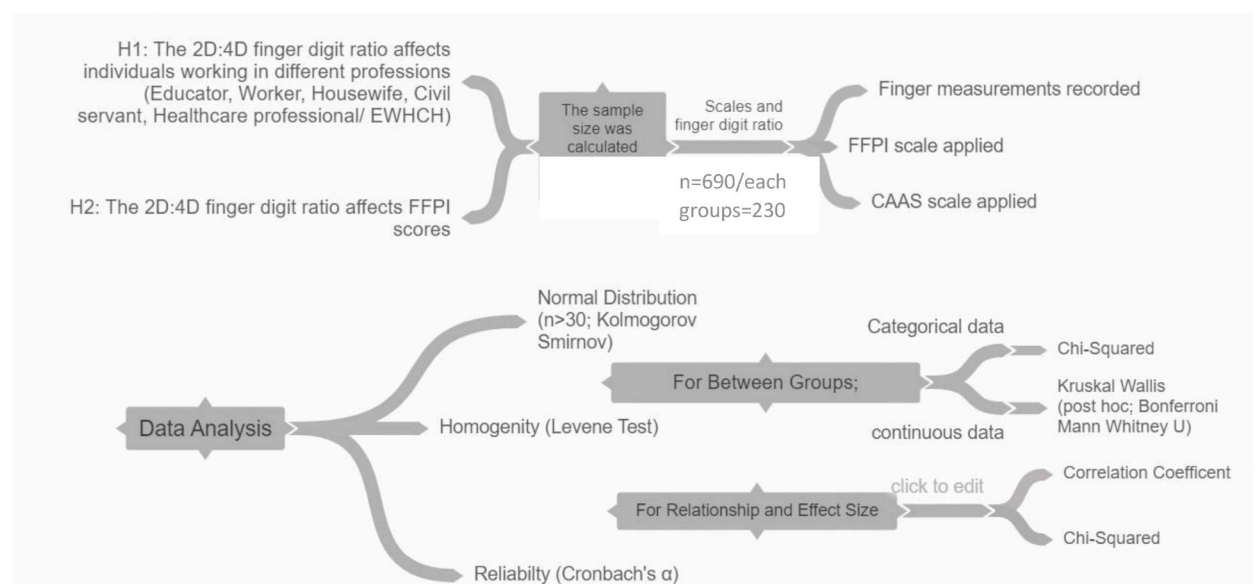

Fig. 1. The flow chart of the design of our study.

measurement with the same method and precision, each person was photographed from a height of 50 cm, and the people whose measurements were completed were separated. Measurements were made separately for right and left hands and their 2D:4D (2D < 4D, 2D = 4D, 2D > 4D) values were found.

Bias: In order to prevent bias in the answers of all participants, information about the questions and the purpose of the study was given to them. The researcher avoided misleading-directive comments and responses.

Data collection.

Each participant was informed about data collection tools separately, and those who agreed to participate in the study were asked to fill out a google form, including an informed consent form. It took approximately 35 min to collect data. An explanation was made to the participants on the questions that they asked while filling out the questionnaire. Each participant was included individually, based on confidentiality.

2.5. Hypotheses

The hypotheses determined for this descriptive cross-sectional study are given below.

H1. The 2D:4D ratio affects individuals working in different professions (Educator, Worker, Housewife, Civil servant, Healthcare professional/ EWHCH),

H2. The 2D:4D ratio affects FFPI scores (Fig. 1)

2.6. Statistical analysis

The SPSS (Statistical Program in Social Sciences) 26.0 software was used in the data analysis. The Kolmogorov Smirnov Test was run to determine whether or not the data were normally distributed [52]. The p value of 0.05 was accepted as significance level in comparison tests. In non-normally distributed variables, non-parametric tests were used. Independent multiple groups were compared by the Kruskal Wallis test. Due to the fact that the p-value will increase depending on the increase in the number of comparisons for variables in which a difference was determined, Bonferroni corrected p value was used and calculated through "(0.05/pairwise comparison)" [53]. The p-value to be used for pairwise comparisons was calculated as $\binom{5}{2} = 10$, $\alpha_{BD} = 0.05/10 = 0,005$ since the number of groups was 5 (EWHCH) and the number of comparisons was 2. After the Kruskal-Wallis test, the p values obtained with the Mann-Whitney test were compared with the 0.005 value, and the result was decided. In categorical data, chi-square (χ^2) analysis was applied over crosstabs (Fig. 2).
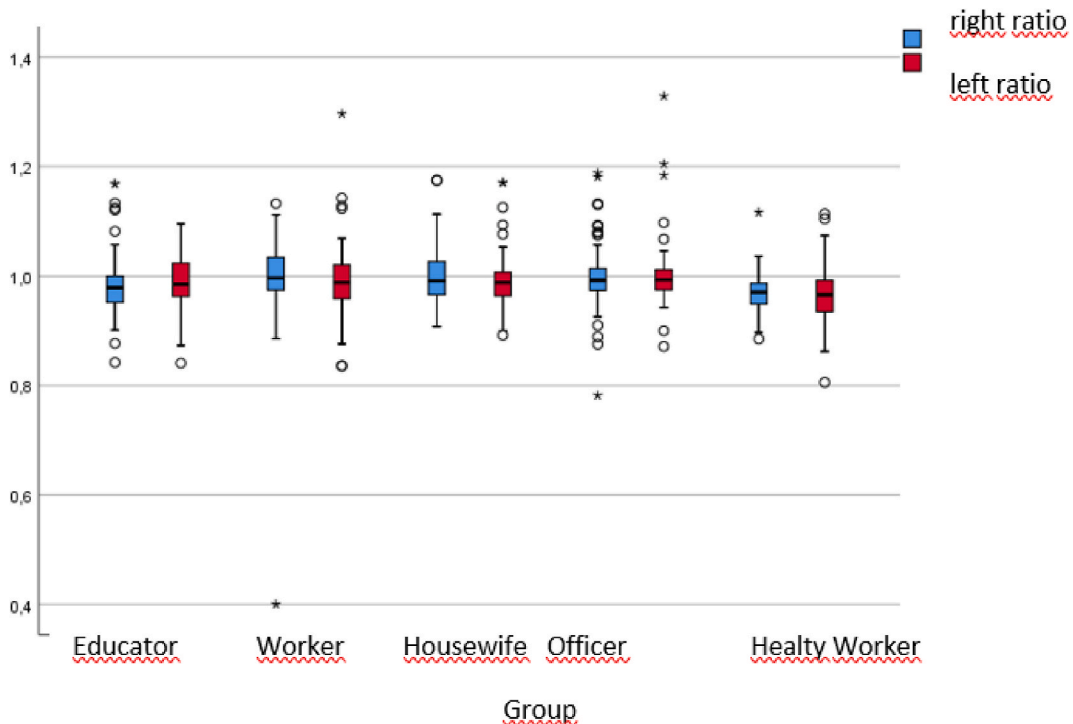

Fig. 2. Box-plot graph of 2D:4D ratios of Professional Groups.

3. Results

3.1. Reliability of the scales

Table 1 shows the Cronbach's α coefficient results for the reliability of the scales.

The Cronbach's α coefficient for CAAS was calculated as 0.927 for educators, 0.780 for workers, 0.910 for housewives, 0.771 for civil servants, and 0.944 for healthcare professionals. Cronbach's α coefficient for FFPI was calculated as 0.743 for educators, 0.766 for workers, 0.706 for housewives, 0.714 for civil servants, and 0.758 for healthcare professionals.

Scales can be used in a format suitable for statistical calculations without repeating analyses in scales whose validity and reliability studies were conducted before. Therefore, the validity analyses of the scales were not repeated. Since the Cronbach's alpha coefficient of the scales was above 0.70, it was detected that they can be used [54].

3.2. Socio-demographic characteristics of the participants

It was tested whether or not the socio-demographic characteristics of the participants differed in terms of the groups (EWHCH).

There was a statistically significant difference among the groups in terms of gender ($p = 0.001$, Table 1), educational level ($p = 0.001$, Table 1), marital status ($p = 0.002$, Table 2) and mother's educational level ($p = 0.001$, Table 1). Any statistically significant difference was not found among the groups in terms of father's educational level ($p = 0.117$, Table 1), income level ($p = 0.863$, Table 2), age ($p = 0.618$, Table 2), and BMI ($p = 0.783$, Table 1).

3.3. Comparison of the scale scores and 2D:4D ratios in terms of professional groups

Table 2 shows the results of the comparison of the scale scores of the groups with right-hand and left-hand 2D:4D ratios.

There was a statistically significant difference among the groups in terms of total score of CAAS ($p = 0.001$) and scores of its concern ($p = 0.010$), control ($p = 0.016$), curiosity ($p = 0.001$), and confidence subscales ($p = 0.001$). Scores of educator, worker, and housewife groups on the concern subscale differed ($p = 0.001$). The concern scores of educator and housewife groups ($p = 0.001$) and of educator and healthcare professional groups differed. The curiosity scores of housewife and worker groups differed ($p = 0.002$). The confidence scores of housewife, educator, and civil servant groups differed ($p = 0.001$), A difference was determined between housewife group and educator, worker, civil servant, and healthcare professional groups in terms of CAAS total score ($p = 0.001$) (Table 2).

A statistically significant difference was detected among the groups in terms of total score of FFPI ($p = 0.001$) and scores of its extroversion ($p = 0.001$), agreeableness ($p = 0.002$), conscientiousness ($p = 0.003$), neuroticism ($p = 0.003$) and openness to experience ($p = 0.001$) subscales ($p < 0.05$). The extroversion scores of healthcare professional group and educator, housewife, and civil servant groups differed ($p < 0.005$). There was a difference between housewife and educator and civil servant groups in agreeableness score ($p = 0.001$), between housewife and civil servant groups in conscientiousness score ($p = 0.003$), and between housewives and educators and workers in neuroticism score ($p = 0.001$). In the openness to experience score, there was a difference between housewives and educators and civil servants and between workers and educators and civil servants ($p = 0.001$). There was a difference between civil servants and workers, between housewives and healthcare professionals, and between educators and housewives in terms of FFPI total score ($p = 0.001$) (Table 2).

There was a statistically significant difference among the groups in terms of right-hand ($p = 0.001$) and left-hand 2D:4D digit ratios ($p = 0.002$) and between healthcare professionals and workers, housewives and civil servants in terms of right-hand and left-hand 2D:4D digit ratio ($p < 0.002$) (Fig. 2, Table 2).

3.4. Comparison of 2D:4D ratios of professional groups

The 2D:4D ratios of the participants were classified as small, equal, and large and it was tested whether or not this classification

Table 1
Reliability of the scales.

Scale	Groups	Cronbach's α
CASS	**Educator**	0.927
	Worker	0.780
	Housewife	0.970
	Civil Servant	0.771
	Healthcare professional	0.944
FFPI	**Educator**	0.743
	Worker	0.766
	Housewife	0.706
	Civil Servant	0.714
	Healthcare professional	0.758

FFPI: Five-Factor Personality Inventory; CAAS: Career Adapt-abilities Scale.

Table 2
Comparison of the groups in terms of demographic variable.

Variable	Groups	n/%	Groups					Total	Chi-square (χ2)	Sig. (p)
			Educator	worker	housewife	civil servant	healthcare professional			
Gender	**Female**	**n**	41	28	62	35	41	207	***51.740***	***0.001***
		%	63.1 %	43.1 %	95.4 %	53.8 %	63.1 %	63.7 %		
	Male	**n**	24	37	0	33	24	118		
		%	36.9 %	56.9 %	0	46.2 %	36.9 %	36.3 %		
Education level	**Literate**	**n**	1	1	6	7	1	16	***64.249***	***0.001***
		%	1.5 %	1.5 %	9.2 %	10.8 %	1.5 %	4.9 %		
	Primary education	**n**	2	10	20	7	6	45		
		%	3.1 %	15.4 %	30.8 %	10.8 %	9.2 %	13.8 %		
	High school	**n**	9	26	22	15	15	87		
		%	13.8 %	40.0 %	33.8 %	23.1 %	23.1 %	26.8 %		
	University and Higher	**n**	53	28	17	36	43	177		
		%	81.5 %	43.1 %	26.2 %	55.4 %	66.2 %	54.5 %		
Marital Status	**Married**	**n**	20	22	7	19	26	94	***17.053***	***0.002***
		%	30.8 %	33.8 %	10.8 %	29.2 %	40.0 %	28.9 %		
	Single	**n**	45	43	58	46	39	231		
		%	69.2 %	66.2 %	89.2 %	70.8 %	60.0 %	71.1 %		
Mother's education level	**Illiterate**	**n**	13	14	22	25	15	89	***34.247***	***0.001***
		%	20.0 %	21.5 %	33.8 %	38.5 %	23.1 %	27.4 %		
	Primary school	**n**	31	37	37	23	35	163		
		%	47.7 %	56.9 %	56.9 %	35.4 %	53.8 %	50.2 %		
	High school	**n**	13	12	4	15	5	49		
		%	20.0 %	18.5 %	6.2 %	23.1 %	7.7 %	15.1 %		
	University and Higher	**n**	8	2	2	2	10	24		
		%	12.3 %	3.1 %	3.1 %	3.1 %	15.4 %	7.4 %		
Father's education level	**Illiterate**	**n**	12	13	17	16	12	70	17.969	0.117
		%	18.5 %	20.0 %	26.2 %	24.6 %	18.5 %	21.5 %		
	Primary school	**n**	20	33	35	28	28	144		
		%	30.8 %	50.8 %	53.8 %	43.1 %	43.1 %	44.3 %		
	High school	**n**	16	12	7	13	13	61		
		%	24.6 %	18.5 %	10.8 %	20.0 %	20.0 %	18.8 %		
	University and Higher	**n**	17	7	6	8	12	50		
		%	26.2 %	10.8 %	9.2 %	12.3 %	18.5 %	15.4 %		
Income level	**Income Less Than Expenses**	**n**	3	2	7	3	4	19	3.940	0.863
		%	4.6 %	3.1 %	10.8 %	4.6 %	6.2 %	5.8 %		
	Income Equalling to Expense	**n**	46	46	44	46	45	227		
		%	70.8 %	70.8 %	67.7 %	70.8 %	69.2 %	69.8 %		
	Income Higher Than Expense	**n**	16	17	14	16	16	79		
		%	24.6 %	26.2 %	21.5 %	24.6 %	24.6 %	24.3 %		

Variables	Groups	Mean ± sd	M (Min - Max)	Kruskal Wallis	Sig. (p)
Age	**Educator**	36.65 ± 8.2	38 (19–59)	1.298	0.618
	Worker	35.63 ± 9.85	36 (19–63)		
	Housewife	41.74 ± 11.06	41 (22–67)		
	Civil Servant	39.42 ± 9.61	39 (24–60)		
	Healthcare Professional	37.57 ± 11.85	35 (20–67)		
BMI	**Educator**	28.7 ± 7.1	28.1 (16.7–53.7)	1.745	0.783
	Worker	27.31 ± 8.13	27.5 (9.1–53.7)		
	Housewife	27 ± 5.27	27.7 (11.9–41.6)		
	Civil Servant	28.28 ± 9.09	28.2 (9.9–53.7)		
	Healthcare Professional	28.19 ± 7.73	27.3 (9.1–53.7)		

Table 3
Comparison of scale scores and 2D:4D ratio by the professional groups.

Factors	Groups	Mean ± sd	M (Min - Max)	Kruskal Wallis	Sig. (p)	Groups with a difference
Concern	Educator[1]	11.69 ± 2.46	12 (3–15)	**13.278**	*0.010[a]*	**1–3, 2–3**
	Worker[2]	11.6 ± 2.04	12 (5–15)			
	House wifwe[3]	10.78 ± 2.01	12 (3–15)			
	Civil servant[4]	11.68 ± 1.72	12 (8–15)			
	Healthcare professional[5]	11.25 ± 2.45	12 (3–15)			
Control	Educator[1]	20.68 ± 3.13	20 (5–25)	**12.167**	*0.016[a]*	**1–3**
	Worker[2]	20.2 ± 2.96	20 (6–25)			
	House wifwe[3]	19.18 ± 2.88	20 (5–25)			
	Civil servant[4]	20.34 ± 2.55	20 (15–25)			
	Healthcare professional[5]	19.65 ± 3.79	20 (5–25)			
Curiosity	Educator[1]	20.2 ± 3.34	20 (5–25)	**19.07**	*0.001[a]*	**1–3, 3–4**
	Worker[2]	19.92 ± 2.43	20 (15–25)			
	House wifwe[3]	17.46 ± 4.71	20 (5–25)			
	Civil servant[4]	20.4 ± 2.63	20 (12–25)			
	Healthcare professional[5]	19.51 ± 3.75	20 (5–25)			
Confidence	Educator[1]	25.18 ± 3.88	25 (6–30)	**22.003**	*<0.001[a]*	**1–3, 3–4**
	Worker[2]	25.05 ± 2.73	24 (18–30)			
	House wifwe[3]	23.45 ± 3.31	24 (6–30)			
	Civil servant[4]	25.68 ± 2.4	26 (20–30)			
	Healthcare professional[5]	24.31 ± 4.71	25 (6–30)			
CAAS	Educator[1]	77.75 ± 11.01	76 (20–95)	**20.953**	*<0.001[a]*	**1–3, 2–3, 3–4**
	Worker[2]	76.77 ± 6.61	76 (56–95)			
	House wifwe[3]	70.88 ± 10.8	74 (19–95)			
	Civil servant[4]	78.09 ± 6.97	76 (65–95)			
	Healthcare professional[5]	74.71 ± 13.62	76 (19–95)			
Extraversion	Educator[1]	27.46 ± 4.61	28 (17–40)	**18.29**	*0.001[a]*	**1-5, 3–5, 4-5**
	Worker[2]	26.66 ± 4.24	27 (18–36)			
	House wifwe[3]	26.94 ± 3.98	27 (14–35)			
	Civil servant[4]	28.15 ± 4.14	28 (19–36)			
	Healthcare professional[5]	25.03 ± 4.16	25 (17–34)			
Agreeableness	Educator[1]	34.95 ± 4.08	35 (23–43)	**17.021**	*0.002[a]*	**1-3, 3-4**
	Worker[2]	32.71 ± 5.01	33 (21–44)			
	House wifwe[3]	32.37 ± 4.6	33 (20–42)			
	Civil servant[4]	34.83 ± 4.97	35 (15–45)			
	Healthcare professional[5]	33.54 ± 4.38	33 (21–42)			
Conscientiousness	Educator[1]	32.6 ± 4	32 (24–43)	**15.76**	*0.003[a]*	**3–4**
	Worker[2]	31.83 ± 3.85	32 (23–40)			
	House wifwe[3]	31.34 ± 3.56	31 (21–40)			
	Civil servant[4]	33.82 ± 3.54	34 (27–44)			
	Healthcare professional[5]	32.2 ± 4.51	32 (22–43)			
Neuroticism	Educator[1]	23.77 ± 3.47	24 (14–32)	**16.092**	*0.003[a]*	**1-3, 2-3**
	Worker[2]	23.94 ± 3.44	24 (16–33)			
	House wifwe[3]	25.85 ± 3.3	26 (17–32)			
	Civil servant[4]	24.77 ± 2.91	25 (18–33)			
	Healthcare professional[5]	24.37 ± 3.43	24 (18–31)			
Openness	Educator[1]	34.11 ± 4.57	34 (16–45)	**28.937**	*<0.001[a]*	**1-2, 1–3, 2–4, 3-4**
	Worker[2]	30.4 ± 6.49	32 (10–41)			
	House wifwe[3]	30.23 ± 5.54	31 (13–41)			
	Civil servant[4]	34 ± 4.25	34 (20–43)			
	Healthcare professional[5]	32.25 ± 4.84	33 (12–41)			
Total	Educator[1]	152.89 ± 12.41	153 (104–184)	**23.162**	*<0.001[a]*	**1-3, 2–4, 3–4, 4-5**
	Worker[2]	145.54 ± 16.46	150 (100–173)			
	House wifwe[3]	146.72 ± 11.19	147 (100–172)			
	Civil servant[4]	155.57 ± 11.44	152 (137–186)			
	Healthcare professional[5]	147.38 ± 13.93	147 (96–180)			
Right Ratio	Educator[1]	0.98 ± 0.06	0.98 (0.84–1.17)	**25.059**	*<0.001[a]*	**2-5, 3–5, 4-5**
	Worker[2]	0.99 ± 0.09	1 (0.4–1.13)			
	House wifwe[3]	1.01 ± 0.05	0.99 (0.91–1.17)			
	Civil servant[4]	1.02 ± 0.06	0.99 (0.78–1.19)			
	Healthcare professional[5]	0.97 ± 0.03	0.97 (0.89–1.12)			
Left Ratio	Educator[1]	0.97 ± 0.05	0.98 (0.84–1.1)	**17.522**	*0.002**	**2-5, 3–5, 4-5**
	Worker[2]	0.99 ± 0.07	0.99 (0.84–1.3)			
	House wifwe[3]	0.98 ± 0.05	0.99 (0.89–1.17)			
	Civil servant[4]	1.02 ± 0.04	0.99 (0.87–1.33)			
	Healthcare professional[5]	0.96 ± 0.05	0.97 (0.81–1.11)			

sd; standard deviation, M; Median.

[a] $p < 0.05$; There is a statistically significant difference among the groups.

showed a difference in terms of distribution of professional groups. Table 3 shows the results.

A statistically significant difference was found among the groups based on 2D < 4D in right hand (p = 0.001). The pairwise comparison indicated a statistically significant difference between healthcare professionals and workers, civil servants, and house-wives (p = 0.001), between the professional groups based on 2D > 4D in right hand (p = 0.001). The pairwise comparison indicated a statistically significant difference between healthcare professionals and workers, civil servants and housewives (p = 0.001) (Table 3).

A statistically significant difference was found between the professional groups based on 2D < 4D in left hand (p = 0.019). The pairwise comparison indicated a statistically significant difference between healthcare professionals and workers (p = 0.019) (Table 3).

The analysis of right-hand 2D:4D ratios demonstrated that while 2D > 4D was observed mostly (222), 2D = 4D was observed the least (6). While 2D = 4D was not observed in civil servants and housewives (0), healthcare professionals had the highest rate of 2D > 4D (58). The professional group with the lowest rate of 2D > 4D was workers (36). While 2D < 4D had the same rate in civil servants, housewives, and workers (25) and did not have a distinctive feature, 2D > 4D was observed mostly in healthcare professionals (58) and was a distinctive feature for professional groups (Fig. 3, Table 3).

When examining left-hand 2D: 4D ratios, it was determined that 2D > 4D was observed at the highest rate (220); whereas 2D = 4D was observed at the lowest rate (5). While 2D = 4D was not observed in healthcare professionals and educators (0), healthcare professionals had the highest rate of 2D > 4D (54). The professional group having the lowest rate of 2D > 4D was workers (36). 2D < 4D was observed at least in healthcare professionals (11) and mostly in workers (25). Left-hand 2D < 4D and 2D > 4D were distinctive features in professional groups (Fig. 4, Table 3).

No difference was determined among the groups' right-hand 2D:4D ratios (2D < 4D, 2D = 4D, 2D > 4D) in terms of CAAS total score (p = 0.525) and scores of concern (p = 0.975), control (p = 0.385), curiosity (p = 0.513) and confidence subscales (p = 0.185) and FFPI total score (p = 0.051) and scores of extroversion (p = 0.082), agreeableness (p = 0.052), conscientiousness (p = 0.081), neuroticism (p = 0.549) and openness to experience subscales (p = 0.114) (Table 4).

Any difference was not determined among the groups' left-hand 2D:4D ratios (2D < 4D, 2D = 4D, 2D > 4D) in terms of CAAS total score (p = 0.623) and scores of concern (p = 0.874), control (p = 0.422), curiosity (p = 0.260) and confidence subscales (p = 0.806) and FFPI total score (p = 0.052) and scores of extroversion (p = 0.056), agreeableness (p = 0.061), conscientiousness (p = 0.143), neuroticism (p = 0.076), and openness to experience subscales (p = 0.199) (Table 4).

Healthcare professionals: A weak positive statistically significant correlation was determined between the score of CAAS control subscale, and the right-hand 2D:4D ratio (r = 0.263, p = 0.033). A weak positive statistically significant correlation was also found between the score of CAAS curiosity subscale and the left-hand 2D:4D ratio (r = 0.361, p = 0.003) (Table 4).

There was a weak positive statistically significant correlation between CAAS score and the left-hand 2D:4D ratio (r = 0.305, p = 0.014) (Table 4).

Housewives; There was a weak negative statistically significant correlation between score of FFPI conscientiousness subscale and the right-hand 2D:4D ratio (r = −0.255, p = 0.041) (Table 4).
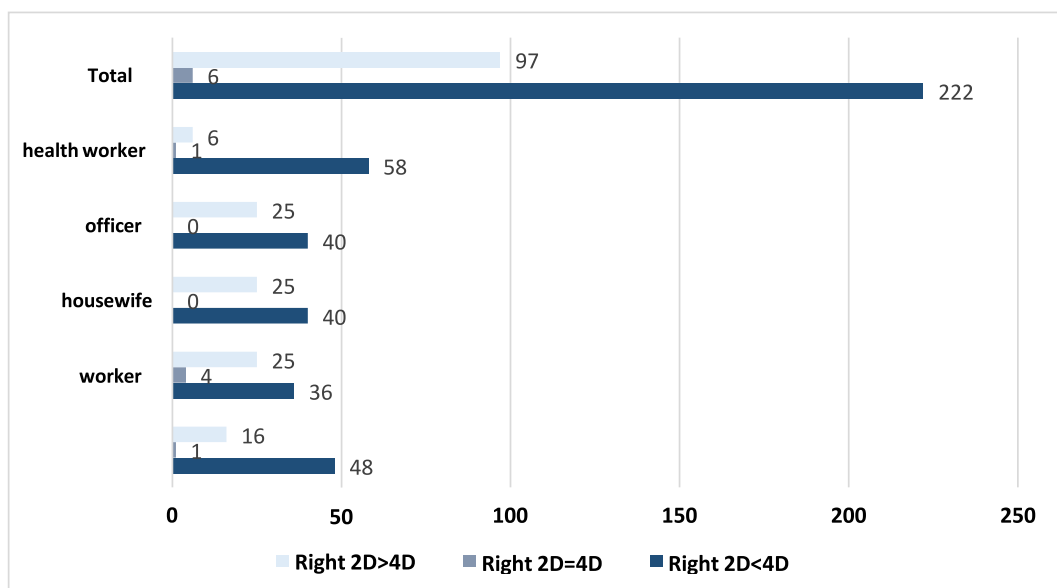

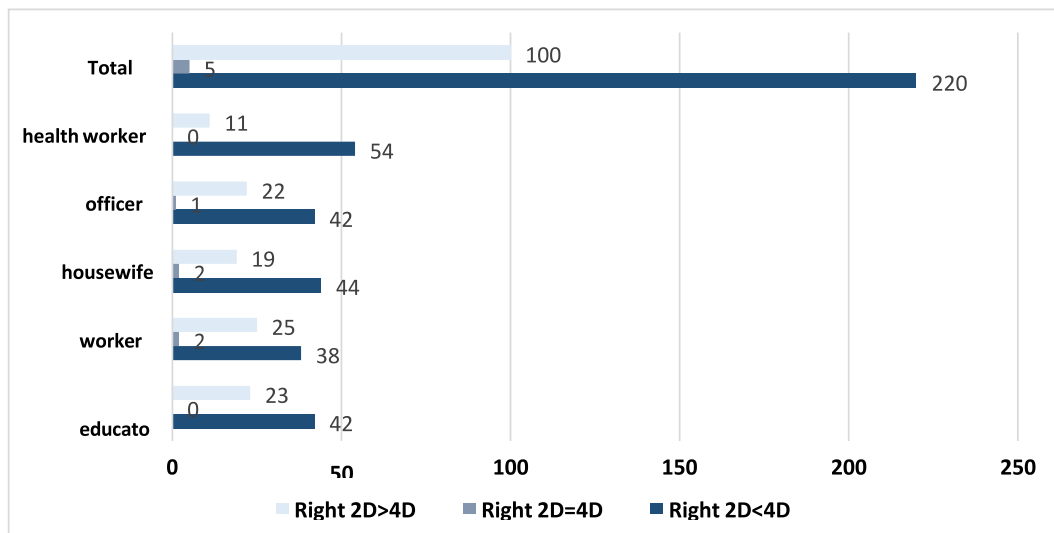**Fig. 3.** Distribution of right hand 2D:4D Classifications by professional group.

Fig. 4. Distribution of left hand 2D:4D Classifications by professional groups.

Table 4
Comparison of 2D:4D Classifications by the professional groups.

Variable	Groups	n/%	Educator	Worker	House wife	officer	Healthcare professional	Total	Chi- square (χ2)	Sig. (p)
	2D < 4D	n	48a. [b]	36b	40b	40b	58a	222		
		%	73.8 %	55.4 %	61.5 %	61.5 %	89.2 %	68.3 %		
Right	2D = 4D	n	1a	4a	0a	0a	1a	6	33.377	0.000
		%	1.5 %	6.2 %	0.0 %	0.0 %	1.5 %	1.8 %		
	2D > 4D	n	16a. [b]	25b	25b	25b	6a	97		
		%	24.6 %	38.5 %	38.5 %	38.5 %	9.2 %	29.8 %		
	2D < 4D	n	42a. [b]	38b	44a. [b]	42a. [b]	54a	220		
		%	64.6 %	58.5 %	67.7 %	64.6 %	83.1 %	67.7 %		
Lef t	2D = 4D	n	0a	2a	2a	1a	0a	5	5.469	0.019
		%	0.0 %	3.1 %	3.1 %	1.5 %	0.0 %	1.5 %		
	2D > 4D	n	23a	25a	19a	22a	11a	100		
		%	35.4 %	38.5 %	29.2 %	33.8 %	16.9 %	30.8 %		
Total		n	65	65	65	65		325		
		%	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %		

n; number of samples, %; percent, *p < 0.05; There is a statistically significant difference among the groups. While the different letters in the lines show the difference between the groups, the same letters show that there is no difference.

4. Discussion

The returns of changing technology and its effect on people's whole lives have been a subject of curiosity for researchers in their career choice [55,56]. The literature contains studies that investigate the correlation between 2D and 4D ratios, especially for athletes [26,57] [26,57–59]. Also, there are studies that investigate how personality traits, the ability, and the 2D–4D ratio are correlated [2,5, 6,8]. However, the present study is important since there has been no study investigating the correlation between personality traits and the 2D–4D ratio in different professions in the literature.

Sumo et al. stated that not only he is effective in choosing a career, but external factors are also important, and the family can also play an active role in this [56]. The study by Maksum and Indahwati highlighted the importance of the family atmosphere of the individual in reaching professional achievement. The present study revealed a statistically significant difference between the groups (educator, worker, housewife, civil servant, health worker) according to the variables of gender (female, male), educational background (literate, primary school, high school, university, and above), marital status (married, single), and mother's educational level (illiterate, primary school, high school, university, and above), confirming that there was no only one's own influence on the choice of career. This study also indicated a statistically significant difference between the CAAS total score and concern, control, curiosity, and confidence scores of the groups, which may be an indication of the difference between the professions.

There are many studies investigating differences in physiological, psychological, and behavioral characteristics of individuals according to the 2D–4D finger ratio [58,60–63]. In their study, Karacaoğlu and Acar reported that prenatal sex hormones were correlated with both personality traits and the length ratios of the index and ring (2D–4D) fingers [6]. The correlations between finger length ratios and personality traits are higher in females compared to their male counterparts, and males are more active than females

in the dimensions of assertiveness, self-esteem, open-mindedness, openness to experience, and thrill-seeking [8,20]. Lower right 2D:4D ratios are correlated with multiple non-normative personality traits and behaviors, including attention deficit disorder, aggression, risk-taking, recklessness, aggression, impulsivity, and criminality [64,65]. Furthermore, the study by Maksum and Indahwati indicated that personality was significant and has an essential role in professional achievement [66]. We have not found any studies that examined both personality tests and inter-professional differences in different professional groups and the present study is important thereof.

Goldberk and Lippa stated that the five-factor personality inventory test can be used [23,25]. Burton et al., stated that this test would differ in men and women [67]. The current study revealed a statistically significant difference between the groups in terms of FFPI total score and scores of its subscales. This result found in different professional groups may be indicative of the importance of personality in the career choice. It is thought that this difference would contribute to the existing literature and it would be better for future studies to analyze separately as men and women.

In their study, Burton et al., examined personality and the 2D-4D ratio. They reported that the openness personality trait was statistically significantly higher in males compared to females and finger length ratios were positively correlated with openness to experience in the sample group; as the 2D:4D ratio increased, the level of openness to experience elevated and the 2D:4D ratio was negatively correlated with extroversion and *agreeableness* and was not correlated with neurotic personality [67]. Lippa (2006) stated that the estrogen dominant group had more sensitive traits than the other two groups, and the medium group had more sensitive traits than the small group, with a 2D:4D ratio in terms of the sensitivity sub-dimension as a subscale of the openness to experience factor [25]. In their study, Aksu et al. (2010) reported that the scores of attentive decision-making and openness to innovation were higher in the group with a low left-hand 2D:4D ratio, and the scores of evaluation of emotions, responsibility, and decisiveness were higher in the group with a low right-hand 2P:4P ratio compared to the estrogen-dominant group. They found that attentive decision-making, organization, responsibility, decisiveness, analytical thinking, and sensitivity scores were high in the group with a low 2D:4D ratio in both hands [16]. In the present study, the 2D:4D ratios of the participants were categorized as small, equal, and large and it was examined whether or not there was a difference in the distribution of this classification in professional groups. There was a statistically significant difference between the groups (educator, worker, housewife, civil servant, and healthcare professional) in the right-hand and left-hand 2D:4D ratios. In addition, when the left-hand 2D: 4D ratios were examined in the present study, it was observed that left-hand 2D:4D ratio and 2D > 4D were distinctive features by differentiating in professional groups. The present study reported that

Table 5
Comparison of right-hand 2D:4D ratio groups according to scores of the scales.

Factors	Groups	Mean ± sd	M (Min - Max)	Kruskal Wallis	Sig. (p)
Concern	index finger short	11.36 ± 2.2	12 (3–15)		
	equal lengths	11.5 ± 1.22	12 (9–12)	0.050	**0.975**
	index finger long	11.49 ± 2.17	12 (3–15)		
Control	index finger short	20.1 ± 3.03	20 (5–25)		
	equal lengths	19 ± 2	20 (15–20)	1.908	**0.385**
	index finger long	19.86 ± 3.37	20 (5–25)		
Curiosity	index finger short	19.44 ± 3.63	20 (5–25)		
	equal lengths	18.83 ± 2.04	20 (15–20)	1.334	**0.513**
	index finger long	19.68 ± 3.66	20 (6–25)		
Confidence	index finger short	24.73 ± 3.67	25 (6–30)		
	equal lengths	23 ± 2.53	24 (18–25)	3.375	**0.185**
	index finger long	24.84 ± 3.39	24 (6–30)		
CAAS	index finger short	75.63 ± 10.53	76 (19–95)	1.290	**0.525**
	equal lengths	72.33 ± 7.63	75.5 (57–77)		
	index finger long	75.87 ± 10.43	76 (20–95)		
Extraversion	index finger short	26.93 ± 4.49	27 (14–40)		
	equal lengths	23.17 ± 3.06	22.5 (20–28)	4.997	**0.082**
	index finger long	26.89 ± 3.94	27 (18–36)		
Agreeableness	index finger short	33.65 ± 4.56	34 (15–45)		
	equal lengths	29.5 ± 4.14	30 (25–35)	5.928	**0.052**
	index finger long	34 ± 5.02	35 (20–45)		
Conscientiousness	index finger short	32.6 ± 4.01	32 (21–44)		
	equal lengths	29.67 ± 3.01	31 (25–33)	5.033	**0.081**
	index finger long	31.97 ± 3.89	32 (22–43)		
Neuroticism	index finger short	24.46 ± 3.39	25 (14–33)		
	equal lengths	23.33 ± 4.46	22 (19–30)	1.201	**0.549**
	index finger long	24.79 ± 3.29	25 (16–33)		
Openness to experience	index finger short	32.4 ± 5.02	33 (12–43)		
	equal lengths	25.5 ± 8.6	25 (13–37)	4.345	**0.114**
	index finger long	32.14 ± 5.89	33 (10–45)		
FFPI	index finger short	150.05 ± 13.22	150 (96–184)		
	equal lengths	131.17 ± 19.71	130 (103–160)	5.193	**0.051**
	index finger long	**149.79 ± 13.81**	**151(100–186)**		

sd; standard deviation, M; Median, *p < 0.05; There is a statistically significant difference among the groups. FFPI: Five-Factor Personality Inventory; CAAS: Career Adapt-abilities Scale.

both finger lengths and ratios differed between professions, which is significant for contributing to the career choice. The data of the study showed that finger length and ratio in choosing a profession may differ between professions.

When the studies on the correlation between profession and 2D-4D ratio were analyzed, Tester et al., found in their study that a low 2D-4D ratio for both hands in university students in the north-eastern England was inversely proportional to sports ability and success level [68]. In their study, Eklund et al., reported that the right-hand 2D:4D ratio was significantly lower in female Olympic athletes than controls [57]. In their study, Paul et al., found that the 2D-4D ratio improved running performance in female athletes [69]. In their study on athletes, Nobari et al., found no correlation between the 2D:4D ratio and the total daily exercise load per week, or four-week cumulative load [59].

The present study examined the finger ratios of different professional groups and the correlation between scores of the control subscale of CAAS in healthcare professionals, and revealed a weakly positively statistically significant correlation between the right-hand 2D:4D ratios (p < 0.05, Table 5). A weak negative statistically significant correlation was detected between score of the conscientiousness subscale of FFPI, and the right-hand 2D:4D ratio in housewives (p < 0.05, Table 6). It is thought that the 2D-4D ratio can be considered in many professional branches (see Table 7).

5. Implications of findings

The important findings regarding the relationship between 2D:4D Finger Length Ratio and Personality Traits of People Working in Different Professions are listed below.

- **Accordingly**, the mean values of the right-hand 2D:4D ratios were the highest in civil servants (1.02 ± 0.06) and the lowest in healthcare professionals (0.97 ± 0.03). In this context, it was concluded that the profession of civil servant was correlated with right finger ratio. We think that there will be an occupational difference based on the finger ratio.
- The mean values of left-hand 2D:4D ratios were analyzed, and the highest value was reported in civil servants (1.02 ± 0.04) and the lowest value was reported in healthcare professionals (0.96 ± 0.05). In line with this result, there is a difference in finger ratio between professions. Our suggestion is that finger ratio can be examined in different professions and will guide new researchers.
- A statistically significant difference was found between the groups' FFPI total score and scores of its extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience subscales and a statistically significant correlation was found. In this context, our personality is effective among professions. Personality is important in choosing a profession.
- A weak positive statistically significant correlation was found score of the control **subscale of** CAAS and the right hand 2D:4D ratio in healthcare professionals while a weak positive statistically significant correlation was found between the curiosity score and the left-hand 2D:4D ratio. Moreover, there was a weak positive statistically significant correlation between the left-hand 2D:4D ratio. Results of the present study represent the first of their kind in the literature, which makes them more important. The results in healthcare professionals indicated that finger ratio was correlated with CAAS and suggested that such a study will also be conducted among healthcare professionals. It has been concluded that the length of the finger can be looked at the people who want to choose the health profession and the CAAS scale can be applied.

In our study, 2D:4D ratio, CASS and FFPI scales show that it can be done across professions. Enriching the scales and looking at the 2D:4D finger ratio among all professions may be a preliminary idea for developing a software program or different scales in the future.

6. Conclusion

Personality is important in choosing a profession. Students seek to change technology to make the right choice of profession. We concluded that a person can have an idea about his/her own personality and 2D-4D finger ratio can be examined by applying FFPI and career adapt-abilities scale in choosing a profession. The present study will contribute to both researchers and literature.

Limitations

The limitations of the study, the length of our survey questions made it difficult for the volunteer individuals who participated in our study to answer them. It was difficult to find the occupational groups included in the hypothesis of our study. In our study, the housewife's group had difficulty in solving and understanding the questions. There were difficulties in obtaining permission from the working volunteer participants due to the time-consuming nature of the questionnaires. Volunteer participants who did not like their fingers were reluctant to take manual measurements.

Ethical approval

Approval was granted by the Non-Invasive Clinical Trials Ethics Committee of Malatya Turgut Özal University (Decision No: 2022/ 46).

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Table 6
Comparison of left-hand 2D:4D ratio groups according to scores of the scale.

Factors	Groups	Mean ± sd	M(Min-Max)	Kruskal Wallis	Sig. p)
Concern	index finger short	11.46 ± 1.95	12 (3–15)		
	equal lengths	12 ± 0	12 (12–12)	0.269	0.874
	index finger long	11.24 ± 2.65	12 (3–15)		
Control	index finger short	20 ± 2.69	20 (5–25)		
	equal lengths	20.6 ± 0.89	20 (20–22)	1.726	0.422
	index finger long	19.99 ± 3.97	20 (5–25)		
Curiosity	index finger short	19.49 ± 3.23	20 (5–25)		
	equal lengths	19.2 ± 1.1	20 (18–20)	2.693	0.260
	index finger long	19.54 ± 4.41	20 (5–25)		
Confidence	index finger short	24.8 ± 3.08	25 (6–30)		
	equal lengths	24.6 ± 1.95	24 (23–28)	0.431	0.806
	index finger long	24.6 ± 4.52	24 (6–30)		
CAAS	index finger short	75.75 ± 8.73	76 (19–95)		
	equal lengths	76.4 ± 3.36	76 (73–82)	0.947	0.623
	index finger long	75.37 ± 13.69	76 (19–95)		
Extraversion	index finger short	26.58 ± 4.17	26 (17–40)		
	equal lengths	29.8 ± 5.07	32 (21–33)	5.174	0.056
	index finger long	27.29 ± 4.59	28 (14–36)		
Agreeableness	index finger short	33.4 ± 4.66	34 (15–45)		
	equal lengths	31.2 ± 3.19	32 (27–35)	5.595	0.061
	index finger long	34.43 ± 4.82	35 (22–45)		
Conscientiousness	index finger short	32.1 ± 3.75	32 (23–44)		
	equal lengths	33.6 ± 3.13	32 (31–37)	3.897	0.143
	index finger long	32.85 ± 4.44	33 (21–43)		
Neuroticism	index finger short	24.51 ± 3.38	25 (14–33)		
	equal lengths	27.8 ± 2.59	28 (24–31)	5.157	0.076
	index finger long	24.44 ± 3.35	24 (17–33)		
Openness to Experience	index finger short	32.01 ± 5.17	33 (10–45)		
	equal lengths	32.4 ± 4.28	31 (28–39)	3.229	0.199
	index finger long	32.6 ± 6.04	34 (13–43)		
Total	index finger short	148.6 ± 12.81	149.5 (96–183)		
	equal lengths	154.8 ± 13.59	157 (136–172)	5.879	0.052
	index finger long	151.61 ± 15.42	152 (100–186)		

sd; standard deviation, M; Median, *p < 0.05; There is a statistically significant difference among the groups. FFPI: Five-Factor Personality Inventory; CAAS: Career Adapt-abilities Scale.

Table 7
Correlation analysis on the correlation between scale scores and finger lengths.

Variable		Educator		Worker		Housewife		Officer		Healthcare Professional	
		Right Ratio	Left Ratio	Right Ratio	Left Ratio	Right Ratio	Left Ratio	Right Ratio	Left Ratio	Right Ratio	Left Ratio
Concern	r	−0.045	0.070	0.018	−0.118	0.017	−0.232	0.102	0.023	−0.004	0.037
	p	0.723	0.577	0.884	0.348	0.894	0.062	0.420	0.854	0.977	0.768
Control	r	0.046	0.144	−0.022	0.050	−0.059	−0.016	−0.121	−0.047	*0.264*	0.132
	p	0.713	0.253	0.861	0.694	0.638	0.899	0.338	0.708	*0.033**	0.295
Curiosity	r	0.032	−0.113	−0.101	0.116	−0.062	−0.132	0.102	0.011	0.090	*0.361*
	p	0.801	0.372	0.424	0.358	0.624	0.294	0.419	0.928	0.474	*0.003**
Confidence	r	0.005	0.038	0.055	−0.008	−0.073	−0.116	0.102	−0.076	−0.040	0.168
	p	0.969	0.764	0.666	0.951	0.561	0.357	0.418	0.548	0.754	0.182
CAAS	r	0.046	0.095	0.028	−0.024	−0.066	−0.131	0.039	−0.070	0.156	*0.305*
	p	0.714	0.453	0.824	0.850	0.600	0.297	0.757	0.581	0.215	*0.014**
Extroversion	r	−0.162	−0.023	−0.140	0.240	−0.039	−0.032	−0.237	−0.177	0.023	0.103
	p	0.197	0.854	0.265	0.055	0.760	0.799	0.057	0.158	0.857	0.413
Agreeableness	r	0.099	0.070	0.053	0.129	0.011	0.073	−0.020	−0.016	−0.021	0.155
	p	0.430	0.580	0.674	0.307	0.933	0.565	0.873	0.899	0.866	0.218
Conscientiousness	r	−0.164	0.168	0.003	0.196	*−0.255*	−0.013	−0.114	0.088	0.196	0.145
	p	0.191	0.182	0.983	0.118	*0.041**	0.915	0.364	0.484	0.118	0.249
Neuroticism	r	−0.074	−0.139	0.172	0.082	0.032	−0.082	−0.083	0.186	0.019	0.061
	p	0.557	0.270	0.170	0.518	0.803	0.514	0.509	0.139	0.878	0.629
Openness to experience	r	0.022	0.094	−0.065	0.208	−0.130	−0.116	−0.038	0.066	0.090	−0.055
	p	0.862	0.458	0.605	0.097	0.302	0.359	0.767	0.603	0.478	0.664
Total	r	−0.036	0.086	0.046	0.210	−0.227	−0.066	−0.111	−0.062	0.115	0.205
	p	0.778	0.493	0.714	0.093	0.069	0.599	0.380	0.625	0.363	0.101

r; spearman correlation coefficient, *p < 0.05; there is a statistically significant correlation between the measurements.

Data availability

Data will be made available on request.

CRediT authorship contribution statement

Gökçe Bağci Uzun: Writing – review & editing, Writing – original draft, Investigation, Data curation, Conceptualization. **Feyza İnceoğlu:** Writing – review & editing, Writing – original draft, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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