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Original Research Article

DIGITOPALMAR DERMATOGLYPHIC PATTERNS AND ACADEMIC ACHIEVEMENT

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ABSTRACT

Background: The present study aimed at determining the association between dermatoglyphic patterns and academic achievement.

Material and Methods: The study involved the evaluation of dermatoglyphic patterns of 200 participants [100 individuals with second and/or tertiary degrees (HAA) and 100 with maximum of primary or secondary education (LAA)] selected by convenience sampling from Kwame Nkrumah University of Science and Technology, Kumasi, and University of Energy and Natural Resources, Sunyani after an informed consent and ethical approval. Hand prints were analysed for fingerprint patterns (FPP), finger ridge count (FRC), total finger ridge count (TFRC), atd angle, number of Primary creases, Intersections of primary crease and Complete transverse crease (PIC) and PIC symmetry.

Results: The study showed that individuals with symmetrical PIC patterns were likely to achieve higher in academia compared with those with asymmetrical palm prints ($p > 0.000$). Participants with PIC patterns of 300, 310 and 311 on the left hand were more likely to achieve lower academic status compared with other PIC patterns on the left hand ($p > 0.05$). There was an association between digitopalmar dermatoglyphic patterns and academic achievement. PIC profiles of 100, 200, 210 and 211 were not observed in Higher Academic Achievers compared to Lower Academic Achievers.

Conclusion: The results confirm an association of digitopalmar dermatoglyphic patterns with academic achievement. Further work needs to be done on 201 PIC that is associated with learning difficulties but was found in 2 % HAA.

KEY WORDS: Academic Achievers, Digitopalmar, Dermatoglyphic.

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INTRODUCTION

Dermatoglyphics concerns with the study of epidermal ridge patterns on the fingers, palms and the sole of the feet and has a very long history [1]. The nature of the epidermal ridges is determined mainly by genetic makeup; however, it can be influenced by environmental factors such as radiation, microbial infection (viruses), and drug (including alcohol) abuse that can affect the development of the brain [2,3]. According earlier studies, the nature of the ridges as well as their manner of appearance in

the digits and palms is distinct, unique and permanent [4,5].

Series of studies conducted by experts correlate palmar and finger prints to psychological characteristics and certain mental illnesses [6]. Owing to this fact dermatoglyphics is seen as a non-invasive tool for diagnosing psychogenetic disorders, person's identification and morphological research [7]. Perfect examples include Down syndrome, schizophrenia and hardened criminals that have been linked with certain fingerprint type [8,9]. Consequently, the human brain and the hand prints are found to develop during the same embryonic period and arise from the same ectodermal tissue therefore, the ridges are reflections of the gyri and sulci found in the cortex of the brain [10]. Since they both originate from the same ectodermal tissue, it is thought that any early disturbance of the epidermal ridges may reflect brain disturbance [11]. This is the more reason why several congenital problems such as Down syndrome, Rubinstein-Taybi syndrome and mental retardation have left indelible marks on both the brain and the hand. These disorders are presented with Simian crease, Sydney crease and other peculiar dermatoglyphic patterns [12,13,14,6].

A single transverse palmar crease is reported in children with Edward's syndrome and Patau's syndrome. These children usually have delayed developmental milestone, learning difficulties and minor behavioural problems [15,7,16]. Hand prints are found to correlate to a person's psychological characteristics [6]. In forensics, fingerprint features are used in crime investigations and commercial transactions [17]. Previous studies observed that students with central pocket loop whorl performed better academically than those having other fingerprint patterns [16]. All these studies have proven that the hand research is worth doing and could reveal not only vital genetics and medical information about individuals but also something about the psychological uniqueness of each person [18].

From personal observation certain individuals excel in the academia and end up as Lecturers in the universities and other institutions of higher learning. Since the minimum entry requirement to becoming a lecturer in the studied universities is a second and or tertiary degree, it was considered as academic achievement. Others struggle and may drop out of school due to non-performance. Though several other factors may contribute to higher academic achievement, the genotype of one's mind is very critical and the digitopalmar print seems to be the window.

The current study is therefore conducted to determine the digitopalmar dermatoglyphic patterns and academic achievement.

MATERIALS AND METHODS

The study involved the evaluation of dermatoglyphic patterns of 200 participants [100 individuals with second and/or tertiary degrees (HAA) and 100 with maximum of primary or secondary education (LAA)]. Study design was by convenience sampling from workers of Kwame Nkrumah University of Science and Technology (KNUST) and University of Energy and Natural Resources (UENR), Ghana, West Africa. Study participants gave an informed consent and ethical approval was obtained from KNUST institutional research review board. Bilateral images of the fingers and palms of each participants were captured using HP Scanjet digital scanner, Scanjet G3110 (Hewlett Packard, USA) connected to a laptop computer. Participant hands were clean, dried and gently placed on the scanner with the pads of all five fingers touching the surface of the scanner. Palm prints were analyzed using the number of Primary creases, Intersection of primary creases and Complete transverse crease (PIC) criteria. If both palms have same PIC profile, it was termed symmetry otherwise it was labeled asymmetry. The *a, t,* and *d* triradii were located on both palms and lines drawn with the aid of CorelDraw software from triradii a and d to meet at triradius *t*. The angle formed at t was then measured with CorelDraw and recorded accordingly [19]. Scanned thumb images were obtained separately due to the opposing orientation of the thumb. The palm/ finger prints were analyzed using Microsoft Photo Viewer according to the standard classification criteria used by US Federal Bureau of Investigation [20].

The data was entered into MS Excel (2013 Version) and analyzed with Statistical Package

for Social Sciences (SPSS 21.0 Inc., Chicago, IL). The results of the higher academic achievers were compared with lower academic achievers using Student's t-test and Chi-Square Analysis. The critical value for statistical significance was set at 0.05.

RESULTS

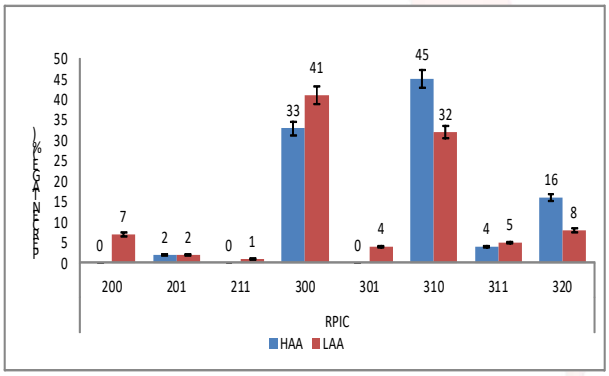
Palmprint patterns: The right palmar *atd* angle for higher academic achievers showed a mean of 39.49 ± 4.57 ° (range: 14 – 50 °) whereas that of lower academic achievers was 42.15 ± 4.70 ° (range: 25 – 57 °). The left palmar *atd* angle for higher academic achievers revealed a mean of 39.73 ± 3.81° (range: 28 – 50 °) whilst that of lower academic achievers was 42.35 ± 5.20 ° (range: 31 – 69 °) (Table 1).

Table 1: Descriptive and Comparative Statistics of Palmar *'atd'* Angles.

	Atd angle (°)	Mean ± SD (degree)	Range (degree)	t	p
Right	HAA	39.49 ± 4.57	14.00-50.00	-4.qqq057	0
	LAA	42.15 ± 4.70	25.00-57.00		
Left	HAA	39.73 ± 3.81	28.00-50.00	-4.063	0
	LAA	42.35 ± 5.20	31.00-69.00		

Data are expressed in Mean ± standard deviation (SD) and Range with minimum and maximum limits.
HAA = Higher Academic Achiever; **LAA** = Lower Academic Achievers.

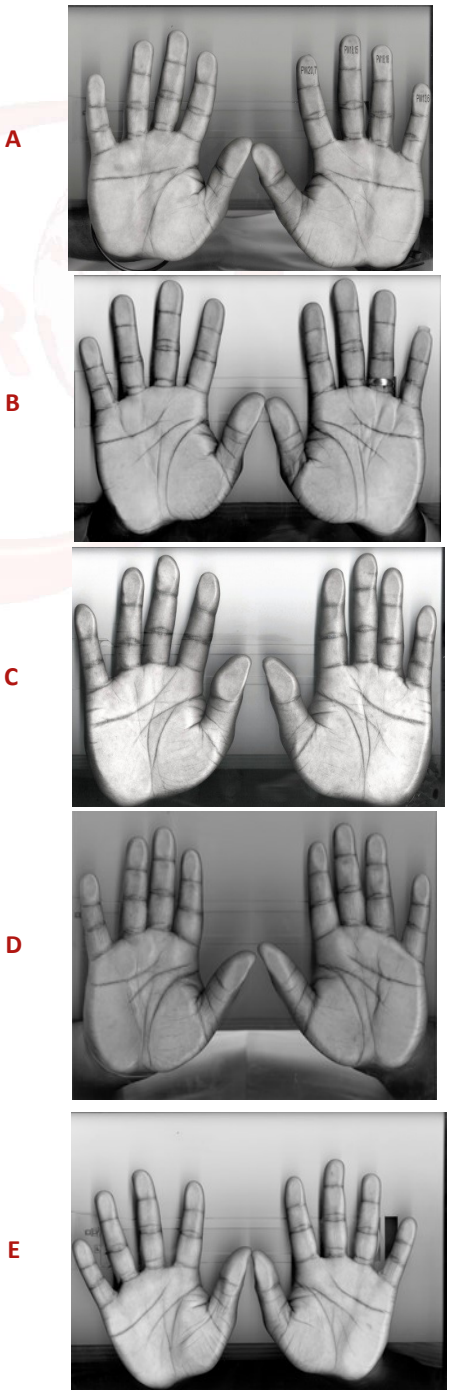
Fig. 1: A clustered bar chart showing the distribution of right PIC patterns amongst higher and lower academic achievers.



RPIC= Right palm number of primary crease, intersection of primary creases and complete transverse crease (PIC); **HAA** = Higher Academic Achievement; **LAA** = Lower Academic Achievement.

Right PIC profile and academic achievement: As shown in figure 1, the predominant PIC profile on the right palm of higher academic achievers was 310 PIC (45%) with the 210 PIC as the least occurring profile (2%). PIC profiles of 100, 200, 211, 301, 311 were absent on the right palm of higher academic achievers. Amongst, lower academic achievers, the predominant and least occurring PIC profile were 300 PIC (41%) and 211 PIC (1%) respectively. The 100 PIC pattern was absent on the right palms of lower academic achievers. Chi square analysis revealed a statistically significant and a moderate relationship between right PIC profile and academic achievement (L.R = 22.537, p = 0.002, Cramer's V = 0.299).

Fig. 2: Photographs of Symmetrical (left column) and Asymmetrical (Right column) palmar PIC patterns in participants. A; (PIC 200 and 200) B; (PIC 300 and 300) C; (PIC 320 and 320) D; (PIC300 and 310) E; (PIC 320 and 310) (X 0.2)



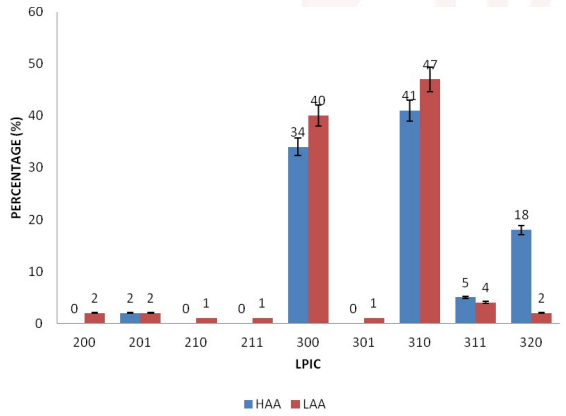
A further binary logistic regression analysis on RPIC indicated that none of the print patterns observed on the right hands of the study participants had any statistically significant association with academic status (Table 11).

Table 2: Binary logistic regression of RPIC against academic status.

	B	S.E.	Wald	p	Exp(B)
RPIC			5.018	0.658	
200PIC	21.896	15191.515	0	0.999	3230949686
201PIC	0.693	1.09	0.405	0.525	2
211PIC	21.896	40192.969	0	1	3230949686
300PIC	0.91	0.492	3.421	0.064	2.485
301PIC	21.896	20096.485	0	0.999	3230949686
310PIC	0.352	0.491	0.515	0.473	1.422
311PIC	0.916	0.798	1.317	0.251	2.5
Constant	-0.693	0.433	2.562	0.109	0.5

RPIC = Right palm number of primary creases, intersection of primary creases and complete **transverse crease (PIC)**; **B** = Beta-coefficient; **S.E.** = Standard error; **Wald** = Wald statistic; **p** = Probability; **Exp(B)** = Odds ratio, **320PIC**= reference point for the other PICs

Fig. 3: A clustered bar chart showing the distribution of left PIC patterns amongst higher and lower academic achievers.



LPIC= Left palm number of bi crease (PIC). **HAA**=Higher Academic Achievement; **LAA**=Lower Academic Achievement.

Left PIC profile and academic achievement: From figure 3, the predominant PIC profile on the left palm of higher academic achievers was 310 PIC (41%) with the 210 PIC as the least occurring profile (2%). PIC profiles of 100, 200, 211, 301, 311 were again absent on the left palm of higher academic achievers. Amongst, lower academic achievers, the predominant PIC profile observed was 300 PIC (47%) and the least occurring were 210 PIC (1%), 211 PIC (1%) and 301 PIC (1%). The 100 PIC pattern was absent on the right palms of lower academic achievers. Chi square analysis revealed a statistically significant and a moderate relationship between left PIC profile and academic achievement (L.R = 22.662, p = 0.004, Cramer's V = 0.307).

Table 3 shows a binary logistic regression analysis of LPIC. It reveals that PIC patterns 300, 310 and 311 had statistically significant influence on the variability in academic status in the present study. Participants with PIC 300 were more likely to be lower academic achievers (Odds ratio = 10.588, 95% CI = 2.291 – 48.935). Likewise, participants with PIC 310 (Odds ratio = 10.317, 95% CI = 2.257 – 47.159) and PIC 311 (Odds ratio = 7.2, 95% CI = 1.009 – 51.392).

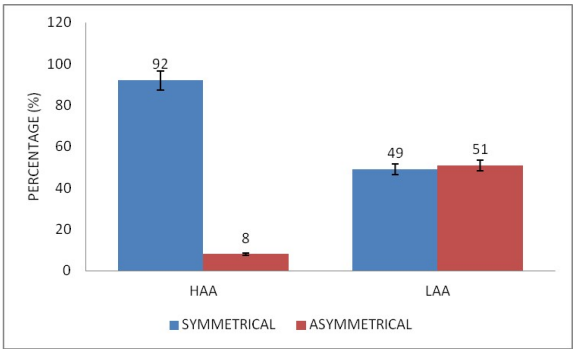
The left PIC thus predicted academic status with an accuracy of 58.5% (23% for high academic achievers and 94% for lower academic achievers).

Table 3: Binary logistic regression of LPIC against academic status.

	B	S.E.	Wald	p	EXP(B)
LPIC			9.643	0.291	
200PIC	23.4	28420.721	0	0.999	14539273586
201PIC	2.197	1.247	3.104	0.078	9
210PIC	23.4	40192.969	0	1	14539273586
211PIC	23.4	40192.969	0	1	14539273586
300PIC	2.36	0.781	9.129	0.003**	10.588
301PIC	23.4	40192.969	0	1	14539273586
310PIC	2.334	0.775	9.059	0.003**	10.317
311PIC	1.974	1.003	3.875	0.049*	7.2
Constant	-2.197	0.745	8.69	0.003	0.111

LPIC= Left number of Primary crease, Intersections of primary crease and Complete transverse Crease (PIC**),** **B** = Beta-coefficient; S.E. = Standard error; **Wald** = Wald statistic; **p** = Probability; **Exp(B)** = Odds ratio; **CI** = Confidence interval;). **320PIC**= reference point for the other PICs

Fig. 4: A bar chart showing the distribution of PIC symmetry amongst higher and lower academic achievers.



HAA = Higher Academic Achievement; **LAA** = Lower Academic Achievement.

PIC symmetry and academic achievement: From figure 4, 92% of higher academic achievers in the present study had symmetrical PIC

patterns whilst 8% had asymmetrical patterns. Amongst lower academic achievers, 49% had symmetrical PIC patterns whilst 51% had asymmetrical patterns. Chi square analysis revealed a statistically significant and moderately strong relationship between academic status and PIC symmetry (χ^2 = 44.452, p = 0.000, phi = 0.471).

As shown in table 4, PIC symmetry had a statistically significant association with academic status amongst the study participants. Participants with symmetrical PIC patterns were less likely to be lower academic achievers (Odds ratio = 0.084, 95% CI = 0.037 – 0.190).

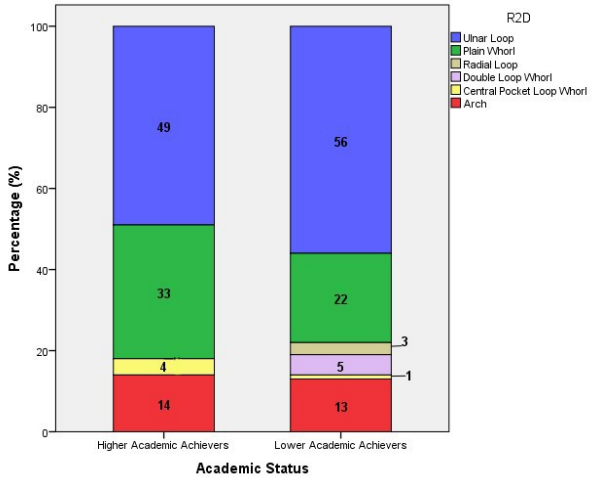
PIC symmetry predicted academic status with an accuracy of 71.5% (92% for higher academic achievers and 51% for lower academic achievers).

Table 4: Binary logistic regression of PIC symmetry against academic status.

	B	S.E.	Wald	p	Exp(B)
SYM(1)	-2.482	0.419	35.035	0	0.084
Constant	1.852	0.38	23.728	0	6.375

SYM = Symmetry; **B** = Beta-coefficient; **S.E.** = Standard error; **Wald** = Wald statistic; **p** = Probability; **Exp(B)** = Odds ratio; **CI** = Confidence interval.

Fig. 5: A stacked bar chart showing the distribution of R2D patterns amongst higher and lower academic achievers.



R2D patterns and academic achievement: As indicated in figure 5, the predominant pattern on the right second digit (R2D) of higher academic achievers was the ulnar loop (49%) with the central pocket loop whorl as the least occurring (4%). Radial loop and double loop whorl patterns were absent on the R2D of higher academic achievers. Amongst, lower academic achievers, the predominant and least occurring patterns were ulnar loops (56%) and central pocket loop whorls (1%) respectively. Chi square analysis revealed a statistically significant and moderately strong relationship between R2D pattern and academic status (L.R = 15.737, p = 0.008, Cramer's V = 0.25).

Following binary logistic regression analysis, none of the categories of fingerprint patterns on the right second digit had any statistically significant influence on the variation in academic status amongst the study participants (Table 5).

Table 5: Binary logistic regression of R2D print against academic status.

	B	S.E.	Wald	p	Exp(B)
R2D			3.954	0.556	
UL	0.208	0.432	0.231	0.631	1.231
PW	-0.331	0.473	0.49	0.484	0.718
RL	21.277	23205.4	0	0.999	1739742138
DLW	21.277	17974.8	0	0.999	1739742138
CPLW	-1.312	1.183	1.231	0.267	0.269
Constant	-0.074	0.385	0.037	0.847	0.929

R2D = Right second digit; **UL**=ulnar loop, **PW**=plain whorl, **RL**=radial loop, **DLW**=double loop whorl, **CPLW**=central pocket loop whorl, **B** = Beta-coefficient; **S.E.** = Standard error; **Wald** = Wald statistic; **p** = Probability; **Exp(B)** = Odds ratio

DISCUSSION

Palmar ATD angle and academic achievement: The epidermal ridges are related to foetal development which in part includes the development of the central nervous system. Deviation from normal pattern is normally a strong indication of certain anomaly in dermatoglyphics [21]. In this study, the right and left palmar atd angles for the Higher Academic Achievers were significantly ($p < 0.05$) smaller than the Lower Academic Achievers. This finding is similar to Cesarik et al. [22] who reported smaller atd angles on both hands in individuals with superior intelligence (40.49 ± 5.84 o) compared to control (47.86 ±7.70 o). It also agrees with Shao (1992) [23] who reported smaller atd angles of exceptional athletes to be less than 41- 42° compared with the general population. This study could not establish association between atd angles of both hands and academic achievement. This finding is similar to a study by Rishi and Sharma [24] who concluded that there is no direct relationship between atd angle and academic performances.

It was observed in the present work that both the Higher Academic Achievers and Lower Academic Achievers were found in each range of *atd* angle. It may be speculated that environmental factors such as access to good primary education, educational level of family and parents, time spent in studying play a greater role in predicting success in academics than the atd angle. An earlier study by Vahist et al [25] on mental retardation showed a statistically significant variation in *atd* angles between mentally retarded and normal individuals with an observation of < 30o to > 65o and 30o to 65o respectively. This increased atd angle may be attributable to a shifted triradius 't' distally which is reported in clients with delayed developmental milestone [25].

Singh [26] could not demonstrate any statistically significant difference in the atd angle between schizophrenics and control but only observed an increase in their atd angles compared to the control. The present study could not also demonstrate any statistically significant difference in the atd angles between the HAA and LAA but realised that the atd angles of the HAA were comparatively smaller than those of the LAA. As revealed in most of earlier studies on medical conditions the experimental participants tend to have an increased atd angles compared to the control group. This is because most medical condition with an early onset alters dermatoglyphic patterns including the atd angles at the formative period [8].

PIC Profile And Academic Achievement: The different palm print patterns observed in this study were 200PIC, 201PIC, 211 PIC, 300 PIC, 301 PIC, 310 PIC, 200 PIC, 311 PIC and 320 PIC. The dominant PIC in both the HAA and LAA were 300 PIC, 310 PIC. The finding agrees with Wu et al. [27]; Fang et al. [28] in China and Offei et al. [16] in Ghana suggesting the prevalence of 300 PIC and 310 PICs in the Ghanaian population. Another group of PIC pattern observed in the present study in the Ghanaian population is the 320 PIC pattern but has not been reported in earlier published works. The present work showed a statistically significant ($p < 0.05$) difference in PIC profile between higher and lower academic achievement on both the left and right hands. This however did not show any statistically significant ($p > 0.05$) association between right PIC profile and participants' academic achievement.

PIC patterns on the left hand showed statistically significant ($p < 0.05$) association with academic status in the present study. Participants with PIC 300, 310 and 311 were more likely to be lower academic achievers. The brain has a contralateral function with the left hemisphere controlling the right side and vice versa. The left hemisphere is associated with logical intelligence (Rakik, 1988) [29]. The varied PIC profile observed may be due to geographical difference and maternal stress level during pregnancy which is reported to have an effect on palm print pattern [19].

The 100 PIC, 200 PIC, and 210PIC patterns were not observed in higher academic achievers but in the lower academic achievers. These dermatoglyphic characteristics are found in individuals with a Simian or single transverse palmar crease, which joins the proximal and distal creases to produce a single horizontal crease across the width of the palm. Such persons have delayed developmental milestone; learning disabilities and/or behavioural disorders [30,16]. The presence of 200 PIC, 210 PIC and 201 PIC profiles in LAA may be true reflection since most of them had maximum of primary or secondary school qualification. What needs further investigation is the 201 PIC which though is thought to be associated with learning difficulties [16] was found in some individuals with higher academic achievement. This could stem from the fact that some individuals with higher academic achievement may have much external support and not by dint of their innate and cognitive abilities. The external supports include access to good primary education, educational level of family and parents, time spent in studying. In the same vein, it may be that the LAA were adversely affected by unfavourable external support such as educational level of parents and family [23].

PIC symmetry and academic achievement: The present study showed a statistically significant relation between academic achievement of participants' PIC symmetry ($p < 0.0001$). In this study, PIC symmetry predicted academic status with an accuracy of 71.5% with Higher Academic

Achievers having symmetrical PIC palmprints. This current finding agrees with Offei et al. who reported that students with symmetrical palm prints pattern performed better academically compared to the counterparts with asymmetrical palm prints patterns.

It is common belief that the genes which determine right side characteristics are the same as those which determine the left side [31].

Deviation from perfect symmetry is therefore interpreted as an effect of disturbances during the normal process of embryologic development; the greater the asymmetry, the greater the disturbance. It is well known that Higher Academic Achievers react better than Lower Academic Achievers to intellectual activities which happen during development of the brain [32]. The observation of more PIC asymmetry in Lower Academic Achievers in the present study may be due to the existence of some element of disturbance during the embryologic period [33].

There is evidence that PIC symmetry may be a reflection of decrease morphological and functional asymmetries of the cortical hemisphere that exist in certain individuals that gives them advantage to achieve higher in academia [16]. Alternatively, students with symmetrical palmprints may be associated with a large corpus callosum that allows better transfer and coordination of the two cerebral hemispheres. There is evidence suggesting that a better inter-hemispheric transfer of information is associated with larger corpus callosum. This might contribute to the higher academic achievement [34,16]. The present study has confirmed earlier report by Zhou et al. [35] who suggested that a measure of asymmetry in palmprint patterns could be a tool to identifying the clients with mental retardation from the normal participants. A study on schizophrenic clients by Wang et al. [36] showed that sample means of the proposed measures could identify client group as having a higher degree of asymmetry than the control group however, no significant relation was established.

CONCLUSION

In this study, it was observed that individuals with symmetrical PIC patterns were likely to achieve higher in academia compared to individuals with asymmetrical PIC palm prints. Participants with PIC patterns of 300, 310 and 311 on the left hand were more likely to achieve lower academic status compared with other PIC patterns on the same left hand. Individuals with a smaller mean *atd* angle on both palms were likely to achieve higher academic status It can be concluded that there was an association of digitopalmar dermatoglyphic patterns and academic achievement.

The results of the study could serve as an adjunct method in recruiting and training academic staff for the universities and other higher educational institutions in the country. Hence the decision to explore the dermatoglyphic patterns of individuals with higher academic achievement.

Further work needs to be done on 201 PIC palm print patterns in HAA which is known to be associated with individuals with learning difficulties.

Conflicts of Interests: **None**

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