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RESEARCH ARTICLE

DIGITAL DERMATOGLYPHICS STUDY OF CHEHA GURAGE, ETHIOPIA:PATTERN TYPE FREQUENCY AND INTERGROUP DIVERSITY

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ABSTRACT

Objective of the paper is to report genetic diversity study using digital dermatoglyphics traits as genetic markers among Cheha Gurage of Ethiopia and compare the results with available data from world population studies. Digital fingerprints of 322 healthy unrelated subjects (168 Male and 154 Female) with age of 30 and above were included in the present cross-sectional study. Data drawn from 10 villages of the district was pooled into 5 cluster groups, each cluster containing 2 villages. Percent frequency distribution of digital pattern types in each hand and both hands total, bimanual differences for digital pattern type frequencies and pattern intensity index were studied. Inter-group pattern frequency differences for Gender, Religion, Clan groups, Altitude and ABO/Rh blood groups were compared. Data was processed using Microsoft excel (2007) program to sort out the data into groups and apply statistical tests. Percent pattern type frequencies, pattern intensity index and Chi-square test of independence were used to compare Inter-group differences. The results revealed that among Cheha Gurage of Ethiopia there exists significant differences in digital pattern type frequencies for Inter-clan groups comparison ($\chi^2 = 18.8688$, d.f = 4, $p < 0.001$), ABO blood groups comparison ($\chi^2 = 25$, d.f = 12, $p < 0.05$) and bimanual differences comparison in female gender ($\chi^2 = 15.6498$, d.f = 4, $p < 0.01$).

INTRODUCTION

Ethiopia is one of Ancient countries located in the horn of Africa (East Africa). Based on May 2007 Census, projected population size of Ethiopia, for the year 2013, is 86,613,986, of which, 43,715,971 is male and 42,898,015 is female, CSA (2013). The country is known for bearing various hominid fossil records of the early and late Paleocene, including the famous "Lucy" (*Australopithecus afarensis*). For the reason of its contribution to supply various fossils related to hominid evolution, Ethiopia is usually referred to as "a cradle of human kind". Ethiopia is a home of more than 80 ethnic groups with more than 80 spoken languages. Associated with altitudinal variations and physical land features, the climate and agro-ecological zones of Ethiopia are highly diversified. Altitude ranges from about 115 m below sea level in Afar depression (Danakil Depression) of the East African rift valley to about 4620m above sea level at Mount Ras Dashen. Ethiopia is a home to members of three branches of the Afro-Asiatic language family (Cushitic, Omotic, and Ethiopic Semitic) as well as a number of non-Afro-Asiatic languages (Thomason, 2001). About eighty-two languages are spoken in Ethiopia, Crass and Mayer (2008). Based on a wide accepted view, Semitic-speaking peoples arrived in the Horn of Africa at the end of the first millennium BC by crossing the red Sea after having left their homeland on the Arabian Peninsula. They migrated into the area of today's Ethiopia and Eritrea and underwent extensive Linguistic and extra linguistic influence by Cushitic-speaking peoples (Ullendorff, 1955). A contradicting view considers Ethiopia to be the original homeland of Semitic-speaking people (Hudson, 1977; Murtonen, 1967). The second view is based on the assumption that the linguistic diversity among Semitic languages in Ethiopia is much greater than elsewhere (Crass and Meyer, 2008).

Gurage is one of Ethiopian Ethnic groups located at the very center of the country in the northern part of the south nations, nationalities and people's regional (SNNPR) state. The language of Gurage is Guragigna which is grouped under Ethiopic-Semitic. There are about 55 Ethnic groups in SNNPR and the figure is subject under changes because of identity issues related to Ethnicity based federal democratic governance system implemented in the country. On the basis of linguistic studies, the Gurage has generally been classified into three categories: the Western (i.e. Sebat Bet), the Northern (i.e. Kestane) and the Eastern (the Selte-speaking cluster). In spite of the strong tradition of their common identity, these three groups are mutually unintelligible categories (Bahiru Zewde, 2002). Cheha district is located at the center of south-western Gurage, commonly named as "Sebat-bet Gurage". More than 100 Clan groups (locally termed as 'Gosa' in Amharic and 'Tib' in native's Gurage language) have been identified to exist

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within Cheha District (Dinberu *et al.,* 1996/1988 E.C.). Studies on Gurage language diversity are relatively well documented but there is no research work published and documented (as to Author's understanding to this date) on the genetic structure of the people. Thus, the present study was initiated to understand and fill the gap about genetic information on Gurage people and Ethiopia in general, and compare it to world population studies from available data.

In human population genetics study (Anthropological genetics) we can use different approaches that can utilize the direct and indirect products of genes or the DNA base sequences of genes that can act as genetic markers. Dermatoglyphics, the study of dermal ridges configuration on digits, palms and soles (Cummins and Midlo, 1926; Cummins and Midlo, 1961; Penrose, 1968), is an excellent example for polygenic traits (that are affected by many genes) used as genetic markers (Rife, 1990). Dermatoglyphics has wide applications in solving human social problems including: personal identification (Kumbnani, 2007), diagnosis of medical disorders (Preus and Fraser, 1972; Naffah, 1977; Ramani *et al.,* 2011; Kaur and Batra, 2013), disputed paternity (Kumbnani, 2007), Twins study (Kumbnani, 2007) and Anthropological significance in understanding human micro-evolutionary processes and tracing migration history/marriage contacts among peoples (Galton, 1892; Thoma, 1974; Naffah, 1977; Mavalwala *et al.,* 1990; Reddy *et al.,* 2001; Bhasin, 2007; Sagura-Wang and Barrantes, 2009; Cheng *et al.* (2009); Zhang *et al.,* 2010; Namouchi, 2011). World population studies for digital pattern type frequencies show great variations; Cummins and midlo (1961), Tiwari and Chattopadhyay (1967), Meier (1975), Naffah et al (1977), Bonne-Tamir *et al.* (1982), Hurvey and Suter (1983), Karmakar et al (2002), Choudhury (2005), Bhasin (2007), Li *et al.* (2006), Banik *et al.* (2009), Anibor *et al.* (2011). From available published data, the distribution of Whorls is highest (79.65%) around the peoples of Maupiti Islanders (Shima, 1963; c.f Meier, 1975) and lowest (16.1%) around the peoples of Kun in South Africa (Cummins, 1955). Loops are highest (73.05%) around the peoples of Faroe Islands (Hurvey and Suter, 1983) and lowest (20.35%), around the peoples of Maupiti Islanders (Shima, 1963; c.f Meier, 1975). Arches are highest (16.2%) around the peoples of Kun in South Africa (Cummins, 1955) and lowest (0%) around the peoples of Maupiti Islanders (Shima, 1963; c.f Meier, 1975).

This paper presents digital pattern type frequency study of Gurage Ethnic group of Ethiopia from Cheha district sample study. A total of 322 subjects (168 male and 154 Female) drawn from 10 villages has been included in the study and collected data was pooled into five clustered village groups, each group containing 2 villages. The traits studied include percent frequency of digital pattern types in each hand and both hands total, bimanual differences for digital pattern type frequencies and pattern intensity index (PII). Inter-group pattern frequency differences for Gender, Religion, Clan groups, Altitude and ABO/Rh blood groups were compared for the traits studied. Percent pattern type frequencies and Chi-square test of independence was applied to compare Inter-group differences for different variables. PII was calculated and mean values were compared. The results revealed that among Cheha Gurage of Ethiopia there exists significant differences in digital pattern type frequencies for Inter-clan groups comparison (χ^2 = 18.8688, d.f = 4, $p < 0.001$), ABO blood groups comparison (χ^2 = 25, d.f = 12, $p < 0.05$) and bimanual differences comparison in female gender (χ^2 = 15.6498, d.f = 4, $p < 0.01$).

MATERIALS AND METHODS

The study was approved by the institutional health research ethics review board at School of Medicine, Hawassa University, Hawassa, Ethiopia, and by National health research ethics review Committee at Ministry of Science and Technology, Addis Ababa, Ethiopia. A total of 322 healthy and unrelated subjects (168 male and 154 female) aged 30 and over from 10 villages were participated in the study and data was pooled into 5 cluster groups. Grouping was based on geographical distances, historical relationships, geographical barriers like rivers, and convenience in compiling group's data for further analysis (Table 1). All subjects gave written informed consent to participate in the study. Local administrative bodies and health officers at district and village level facilitated the process of selecting unrelated healthy participants aged 30 year and above. They also participated in discussions with participants about research process and purpose. Blood typing was assisted by the local health center laboratory experts (for safety reasons) at Emdibir Health Center, Aftir Health Center, Atat Hospital and Yeshere Health Center based on selected villages in their catchment areas.

Fingerprints were taken using a standard method described by Cummins and Midlo (1961) with finger printing Ink, Roller and Slab obtained from Zonal police office, Gurage Zone, Ethiopia. Prints were read with 75mm (D) magnifying lens. The scoring of the fingerprints and processing data was done by a single person (the principal Author) to reduce possible errors. Dermatoglyphic patterns were classified as Plain arches (AP), Tented Arches (AT), radial loops (LR), ulnar loops (LU) and whorls (W) according to the number of deltas (tri-radii) based on standard procedure. For comparative analysis purpose (with world population studies) both plain arches and tented arches have been pooled together to Arches (A). Similarly, radial and ulnar loops have been pooled together into loops (L). Variables considered in the present study as a possible factors for variability in pattern type frequencies and pattern intensity index are Gender, Religion, Clan Group, Bimanual differences, Altitude differences, ABO blood types, Rh blood types, and localities (Clustered groups of Villages).

Inter-group differences were considered at Clustered group level for Gender differences and Clan group differences. A total of 81 Clan and sub-Clan names have been identified for the participants in the sample study. The major Clan group in the district is "Mogemene" and 23 sub-Clan names have been identified within Mogemene clan group. The total number of participants in Mogemene major Clan group was 162 and the number was 160 for non-Mogemene (other) Clan group participants. Thus, for the purpose of convenience in statistical analysis, the sample was analyzed by grouping into two (Mogemene and Others). Altitude differences were set in relative terms. Thus, high Altitude groups refer in relative terms to colder areas with about 2000m above sea level and low Altitude refers to hotter areas with under about 2000m above sea level. Historically, the low land areas have been

Table 1. Percent distribution of subjects by Cluster Groups, Villages, Gender and Total

S.No.	Cluster Group	Included Villages	N	Male	Female	Total	Locality
1	Group A (AF-MG)	Afttir (AF) and Megenase (MG)	65	52.3	47.7	100	High Land
2	Group B (MC-GR)	Moche (MC) and Grar (GR)	67	50.7	49.3	100	High Land
3	Group C (YF-DA)	Yefek Terek (YF) and Dagag (DA)	58	56.9	43.1	100	Transitional
4	Group D (AZ-GA)	Azer (AZ) and Gasore (GA)	70	52.9	47.1	100	Low Land
5	Group E (BR-YE)	Bora (BR) and Yeshere (YE)	62	48.4	51.6	100	Low Land
	Sample Total		322	52.2	47.78	100	

Table 2. Percent Digital pattern type frequency by Cluster group, Gender and Total

S-N	Group	Gender	N	AP	AT	LR	LU	W	Total	PII
1	AF-MG	Male	34	4.1	2.1	1.2	58.8	33.8	100	12.76
		Female	31	3.5	1.6	1.6	62.6	30.7	100	12.56
		Mean		3.8	1.85	1.4	60.7	32.25	100	12.66
2	MC-GR	Male	34	6.5	2.4	0.6	62.9	27.6	100	11.87
		Female	33	3.3	1.2	0.9	62.4	32.1	99.9	12.75
		Mean		4.9	1.8	0.75	62.65	29.85	99.95	12.31
3	YF-DA	Male	33	2.1	0.6	0.6	72.4	24.2	99.9	12.14
		Female	25	1.2	0	1.6	61.2	36	100	13.48
		Mean		1.65	0.3	1.1	66.8	30.1	99.95	12.81
4	AZ-GA	Male	37	4.6	3.8	3.2	57.3	31.1	100	12.27
		Female	33	3.9	3.6	1.5	66.7	24.3	100	11.68
		Mean		4.25	3.7	2.35	62	27.7	100	11.98
5	BR-YE	Male	30	2.7	2	1.7	63.3	30.3	100	12.56
		Female	32	4.7	0.6	2.5	62.2	30	100	12.47
		Mean		3.7	1.3	2.1	62.75	30.15	100	12.52
	Total	Male	168	4	2.2	1.5	62.8	29.5	100	12.33
		Female	154	3.4	1.5	1.6	63.3	30.3	100.1	12.55
		Mean		3.7	1.85	1.55	63.05	29.9	100.05	12.44

Table 3. Percent Digital pattern type frequency by Cluster group, Clan groups and Total

S. No.	Group	Clan Group	N	AP	AT	LR	LU	W	Total	PII
1	AF-MG	Mogemene	33	6.1	1.5	2.1	60	30.3	100	12.27
		Others	32	1.6	2.2	0.6	61.3	34.4	100.1	13.07
		Mean		3.85	1.85	1.35	60.65	32.35	100.05	12.67
2	MC-GR	Mogemene	44	5.7	1.6	0.7	57.7	34.3	100	12.70
		Others	23	3.5	2.2	0.9	72.2	21.3	100.1	11.57
		Mean		4.6	1.9	0.8	64.95	27.8	100.05	12.14
3	YF-DA	Mogemene	27	1.9	0	1.5	68.9	27.8	100.1	12.60
		Others	31	1.6	0.6	0.6	66.5	30.6	99.9	12.83
		Mean		1.75	0.3	1.05	67.7	29.2	100	12.72
4	AZ-GA	Mogemene	31	7.4	4.2	0.6	60	27.7	99.9	11.60
		Others	39	1.8	3.3	3.8	63.1	27.9	99.9	12.27
		Mean		4.6	3.75	2.2	61.55	27.8	99.9	11.94
5	BR-YE	Mogemene	27	3	0	1.5	54.4	41.1	100	13.81
		Others	35	4.3	2.3	2.6	69.1	21.7	100	11.50
		Mean		3.65	1.15	2.05	61.75	31.4	100	12.66
	Total	Mogemene	162	5	1.5	1.2	59.9	32.3	99.9	12.57
		Others	160	2.5	2.2	1.9	66	27.4	100	12.27
		Mean		3.75	1.85	1.55	62.95	29.85	99.95	12.42

Table 4. χ^2 - Values for digital pattern type frequencies (AT, AP, LR, LU and W) of selected variables

S.No.	Test Group	χ^2 Value	d.f.	Probability∗	Remarks
1	Difference by Gender: Male X Female	0.68669	4	0.95296	Not significant
2	Bimanual Differences				
	Males: Right Hand X Left Hand	0.22609	4	0.994072	Not significant
	Females: Right Hand X Left Hand	15.6498	4	0.003527	Significant∗∗
3	Differences by Religion				
	Christian (ORT), Christian (CAT+PRO) and Muslim	9.33687	8	0.31468	Not significant
4	Differences by Clan Group: Mogemene X Others	18.8688	4	0.000834	Significant∗∗∗
5	Differences by Altitude: High Alt. X Low Alt.	5.17621	4	0.26969	Not significant
6	Differences by ABO Blood types				
	(Contingency table used)	25.0006	12	0.014	Significant∗
7	Differences by Rh Blood: Rh+ X Rh-	8.40086	4	0.07795	Not significant
8	Inter-Group differences by Gender (Contingency table used)				
	Differences by Male Gender and Villages	31.9207	16	0.01024	Significant∗
	Differences by Female Gender and Villages	22.1603	16	0.13809	Not significant
9	Inter-Group differences by Clan groups (Contingency table used)				
	Differences by Mogemene Clan group and Villages	43.3207	16	0.00025	Significant∗∗∗
	Differences by Other Clan group and Villages	35.5028	16	0.00339	Significant∗∗

∗Significance level: ∗ at $P<0.05$, ∗∗ at $P<0.01$, and ∗∗∗ at $P<0.001$

inhabited in the later times when population density increased in the high land areas, and malaria and trypanosome varieties of domestic animals has been known to limit settlements in the low land areas until current times.

Statistical analysis

Collected data was analyzed using Microsoft Excel 2007 program. Pattern types were identified and registered on formats, and transferred to excel sheets. Different variables studied were sorted out to obtain their respective pattern frequencies and pattern intensity indices. Percent frequencies, pattern intensity indices and expected values for processing χ^2 test analyses were calculated following standard procedures. The level of statistical significance was set at $P < 0.05$ to reach at conclusion. The result was compared with available published data from world population studies.

RESULTS

Gender differences in pattern type frequencies

Frequency of ulnar loop (LU) is highest in both males and females with a total mean percent frequency of 63.05 followed by whorls (W), plain arches (AP), tented arches (AT) and radial loops (LR) with percent frequency of 29.9, 3.7, 1.85 and 1.55, respectively. The mean percent frequency of AP and AT are little higher in males (4 and 2.2, respectively) compared to females (3.4 and 1.5, respectively). The percent frequency of LR, LU, and W is little higher in females (1.6, 63.3 and 30.3, respectively) compared to males (1.5, 62.8 and 29.5, respectively). The highest percent frequency of LU in cluster groups is 72.4 in males and the lowest value is 57.3 in males. Mean pattern intensity index is little higher in females (12.55) compared to males (12.33) (Table 2). χ^2 test of independence shows that gender differences for sample total is statistically not significant (χ^2 = 0.68669, d.f. = 4, P < 0.96). But the test statistics value is significant (χ^2 = 31.9207, d.f. = 16, P < 0.02) for intergroup differences by clustered groups in males. Intergroup differences by cluster groups in females is statistically not significant (χ^2 = 22.1606, d.f. = 16, P < 0.2).

Bimanual differences in pattern type frequencies

Mean percent frequency of LU is higher in right hands (65.5) compared to the left hands (60.2). Percent frequency of AP is the same (3.7) in both the right and left hands. Percent frequency of AT, LR and W are higher in left hands (23, 2.2 and 31.5, respectively) compared to right hands (1.5, 0.9 and 28.4, respectively). χ^2 test of independence shows that bimanual differences in pattern type frequencies in females is statistically significant ($\chi^{2\,=}$ 15.6498, d.f. = 4, P < 0.01) and not significant in males (χ^2 = 0.22609, d.f. = 4, P < 1).

Clan group differences in pattern type frequencies

Mean percent frequency of AP and W is higher in Mogemene clan group (5 and 32.3, respectively) compared to other non-Mogemene clan groups pooled together (2.5 and 27.4, respectively). The percent frequency of AT, LR and Lu is higher in other clan groups pooled together (2.2, 19 and 66, respectively) compared to Mogemene major clan group (1.5, 1.2 and 59.9, respectively). The highest LU percent frequency is obtained in other clan groups pooled together (72.2) and the lowest LU percent frequency is obtained in Mogemene major clan group cluster (54.4). The highest W percent frequency is obtained in Mogemene major clan group cluster (41.1) and the lowest W percent frequency is obtained in other clan groups pooled together (21.3) (Table 3). χ^2 test of independence shows that clan group difference by clustered groups total for the sample is statistically significant (χ^2 = 18.8688, d.f. = 4, P < 0.001). Similarly, χ^2 test of independence for intergroup differences within Mogemene major clan group among clustered groups (χ^2 = 43.3207, d.f. = 16, P < 0.001) and other clan groups pooled together among clustered groups (χ^2 = 35.5028, d.f. = 16, P < 0.005) are statistically significant.

Religion differences in pattern type frequencies

Mean percent frequency of AT, LR and Lu is higher in Muslims (2.05, 2.3 and 63.4, respectively) compared to Orthodox Christians (1.8, 1.25 and 63.2, respectively) and Catholic/Protestant Christians (1.6, 0.9 and 62.2, respectively). Percent frequency of AP is little higher in Catholic/Protestant Christians (4.65) compared to Muslims (4.35) and Orthodox Christians (2.75). Percent frequency of W is higher in Orhtodox Christians (31.1) compared to Catholic/Protestant Christians (30.7) and Muslims (27.9). Mean frequency of Lu is highest in all religions with the highest in Muslims (63.4), followed by Orthodox Christians (63.2) and Catholic/Protestant Christians (62.2). χ^2 test of independence shows that religion difference in pattern type frequency is statistically not significant (χ^2 = 9.33687, d.f. = 8, P < 0.4).

ABO blood type differences in pattern type frequencies

Mean percent frequency of Lu pattern types is highest in all 4 ABO blood types with highest percent frequency in blood type B individuals (67) followed by AB (65), A (62.3) and O (58.1). The mean percent frequency of W is highest in blood type O individuals (34.1) followed by Type A (31.9), Type AB (29.1) and type B (24.1). The mean percent frequency of both AP and AT is highest in blood type B individuals (5.5 and 2.3, respectively) followed by type O individuals (4.4 and 1.9, respectively), type AB individuals (3.6 and 1.4, respectively) and type A individuals (2.6 and 1.2, respectively). χ^2 test of independence shows that ABO blood type difference in pattern type frequency is statistically significant (χ^2 = 25, d.f. = 12, P < 0.02).

Rh blood type differences in pattern type frequencies

Mean percent frequency of LU pattern type is highest in both Rh-positive (Rh+ve) and Rh-negative (Rh-ve) individuals (62.5 and 54.5, respectively). There is greater difference between the Rh+ve and Rh-ve individuals in mean percent frequency of both Lu and W pattern types. Mean frequency of W is higher in Rh-ve individuals (42) compared to Rh+ve individuals (30). Mean percent frequency of AP, AT, LR and Lu is higher in Rh+ve individuals (4.2, 1.7, 1.6 and 62.5, respectively) compared to Rh-ve individuals (1.5, 1.5, 0.5 and 54.5, respectively). χ^2 test of independence shows that Rh blood type difference in pattern type frequency is statistically not significant (χ^2 = 8.4, d.f. = 4, P < 0.1).

Altitude differences in pattern type frequencies

Mean percent frequency of AP, AT, LR and Lu is higher in the low land (low Altitude) group (3.8, 2.3, 2.1 and 63.35, respectively) compared to high land group (3.75, 1.45, 1 and 62.7, respectively). The mean percent frequency of W is higher in high land group (31.1) compared to low land group (28.5). χ^2 test of independence shows that Altitude difference in pattern type frequency is statistically not significant (χ^2 = 5.17621, d.f. = 4, P < 0.3).

Pattern intensity variation within sample population

The highest pattern intensity index (PII) is obtained among Mogemene major clan group (13.81) in Bora and Yeshere cluster villages and it is lowest (11.5) in the same clustered Villages among other clan groups. In females PII is highest in Yefek-Terek Dagag cluster group (13.48) compared to lowest value (11.68) in Azer Gasore cluster group. Mean value of PII for total sample population is 12.44

DISCUSSION

Within African populations, from available data published, the mean percent frequency of Loops is highest (67.75) in the people of Kun (South Africa), Cummins (1955), and it is lowest (54.7) in Egypt, Naffah *et al*. (1977). Within Europe and the Middle East, mean percent frequency of loops is highest (73.05) in the peoples of Faroe Islanders, Harvey and Suter (1983), followed by (67.70) in the peoples of England, Roberts and Muir (1978), and it is lowest (41.1) in the peoples of Iraq (Alanga kindred), Abdulah (1978). Within Asia and pacific

Table 5. Comparison of available data from African population studies - Percent digital pattern type frequencies and PII for both hands and all digits

SN	Population	Ge	N	A	L	W	Total	PII	Reference
1	Egypt	M		3.2	55.9	40.9	100	13.8	(c.f.) Naffah *et al*. (1977)
2	Algeria	M		3.9	59	36.8	99.7	13.3	(c.f.) Naffah *et al*. (1977)
3	Ibo (Nigeria)	M	250	12.9	64.35	23.25	101	11.09	Igbigbi *et al*. (1994)*
		F	140	12.5	59.6	28.2	100	11.6	
4	Ogoni (Nigeria)	M	203	8.95	56.05	34.95	100	12.6	Igbigbi *et al*. (1996)*
		F	203	13.8	58.7	27.5	100	11.37	
5	Hausa (Nigeria)	M	300	8.3	56.2	35.55	100	12.33	Igbigbi *et al*. (1994)*
		F	305	14.9	54.4	30.7	100	11.58	
6	Yoruba (Nigeria)	M	250	10.2	62.25	27.6	100	11.75	Igbigbi *et al*. (1994)*
		F	133	10.9	67.65	24.5	104	11.67	
7	Yurhobo (Nigeria)	M	250	13.2	54.4	32.4	100	11.9	Igbigbi *et al*. (1994)*
		F	140	13	54.95	32.1	100	11.92	
8	Kun (South Africa)	M	164	13	71.9	15.1	100	10.21	Cummins (1955)
		F	181	19.4	63.6	17.1	100	9.78	
9	Barakwengo (South Africa)	M	44	5.2	64.1	30.7	100	12.55	Cummins (1955)
		F	61	9.6	64.6	25.9	100	11.64	
10	Kanikwe (South Africa)	M	23	7	54.3	38.7	100	13.17	Cummins (1955)
		F	34	6.2	61.7	32.2	100	12.59	
11	Haikom (South Africa)	M	17	2.4	67	30.6	100	12.82	Cummins (1955)
		F	20	10.5	65	24.5	100	11.4	
12	Cheha Gurage (Ethiopia)	M	168	6.3	64.3	29.5	100	12.32	Present Study
		F	154	4.9	64.9	30.3	100	12.56	

* Original data source and citation from Anibor et al (2011); the values are calculated from bimanual distributions obtained in the document.

Table 6. Comparison of available data from Europe and Middle East population studies

SN	Population	Ge	N	A	L	W	Total	PII	Reference
1	Faroe Islander	M	446	7.4	73.4	18.9	100	11.2	Hurvey and Suter (1983)
		F	463	11.8	72.7	15.4	100	10.4	
2	Denmark	M	8960	6.5	65.1	28.4	100	12.2	Anderson (1969)*
		F	8990	9.6	65.7	24.7	100	11.5	
3	Norway	M	24518	7.4	66.9	25.7	100	11.8	Bonevie (1924)*
4	Scotland (North)	M	225	5.9	69.7	24.4	100	12.3	
		F	119	8.5	65.1	26.4	100	11.8	Suter (Unpublished)*
5	England (Cumbria)	M	407	4.3	68.2	27.5	100	12.3	Roberts and Muir (1978)*
		F	595	7	67.2	25.8	100	11.9	
6	Samaritans (Israeli)	M	60	0.83	67.83	31.33	100	13.05	
		F	49	2.24	66.53	31.22	100	12.9	Bonne-Tamir et al (1982)
7	Habanites	M	278	2.57	63.53	33.9	100	13.13	Bonne-Tamir (1971)**
		F	298	2.6	61.72	35.68	100	13.31	
8	Ashkenazi Israeli	M	100	3.2	57.5	39.2	99.9	13.59	Katznelson and Ashbel (1973)**
		F	100	7.1	60.7	32.2	100	12.51	
9	Israeli	M	234	2.2	59.7	38.1	100	13.59	Dar and Winter (1970)**
		F	217	4	63.4	32.6	100	12.86	
10	Rwala Bedouin	M	200	3.8	57.2	39.1	100	13.54	Shanklin and Cummins (1937)**
11	Lebanese	M	106	2.5	52.2	45.4	100	14.3	Shanklin and Cummins (1937)**
12	Mitwali	M+F	138	2.7	55.1	42.2	100	13.95	Shanklin and Cummins (1937)**
13	Iraq, Unrelated	M	71	1.83	58.59	39.58	100	13.78	Abdulah (1978)**
		F	36	6.11	64.72	29.17	100	12.31	
14	Iraq, Alanga Kindred	M	52	1.73	38.85	59.42	100	15.77	Abdulah (1978) **
		F	42	0.24	43.33	56.43	100	15.62	
15	Parsi	M	200	5	59.2	35.8	100	13.08	Mavalwala (1963) **
		F	200	4.35	60.9	33.55	98.8	12.8	

* Original data source and citation from Hurvey and Suter (1983)
** Original data source and citation from Bonne-Tamir et al (1982)

Table 7. Comparison of available data from Asia and Pacific population studies

SN	Population	Ge	N	A	L	W	Total	PII	Reference
1	Kkazakhs	M	85	2.7	45.1	52.5	100	15.01	Heet (1964)*
2	Kirghiz	M	100	2.5	51.2	46.3	100	14.38	Heet (1964)*
3	Uzbeks	M	100	3.1	47.5	49.4	100	14.63	Heet (1964)*
4	Turkmans	M	100	4.2	49.2	46.6	100	14.24	Heet (1964)*
5	Tadjiks	M	100	3	59.2	37.8	100	13.48	Heet (1964)*
6	Bhutanese	M	69	0.7	45.6	53.6	99.9	15.29	Bhasin (1966) *
		F	16	1.3	51.3	47.4	100	14.6	
7	Tibetans	M	156	0.76	38.99	60.24	100	15.95	Tiwari and Chattopadhyay (1967)
		F	150	2.2	49.13	48.67	100	14.65	
8	Rengma Naga (India)	M	104	0.11	47.7	52.19	100	15.21	Banik et al (2009)
		F	103	1.5	42.81	55.69	100	15.42	
9	Kutia Kondh (India)	M	115	1.75	53.83	44.42	100	14.27	Choudhury (2005)
		F	43	3.49	61.64	34.88	100	13.14	
10	Dongoria Kond (India)	M	90	2.11	55.51	42.38	100	14.03	Choudhury (2005)
		F	45	1.78	58.34	39.87	100	13.81	
11	Kuvi Kondh (India)	M	185	3.74	58.16	38.1	100	13.44	Choudhury (2005)
		F	185	5.04	62.2	32.78	100	12.78	
12	Japanese	M	268	3.4	56.6	40	100	13.66	Maoka (1938) *
		F	233	3.7	54.7	41.6	100	13.79	
13	Koreans	M	2677	2.1	49.8	48.1	100	14.6	Tanaka (1937) *
		F	517	4.1	49.3	46.6	100	14.25	
14	Javanese	M	1000	2.7	61.3	35.9	99.9	13.31	Dankmeijer (1938) *
		F	1000	3.3	64	32.7	100	12.94	
15	Thai	M	316	1.9	49	49.1	100	14.71	Rife (1958) ; *
		F	126	1.2	50.6	48.2	100	14.7	
16	Australian Aborigins	M	114	0.8	42.6	56.7	100	15.6	Cho (2000)
		F	90	1.7	47	51.2	99.9	14.94	
17	Polynesian	M	145	0.6	46.4	53	100	15.24	Meier (1975)
		F	149	2.7	43.6	53.8	100	15.12	
18	Maupiti Islanders	M	25	0	17.6	82.4	100	18.2	Shima (1963)**
		F	13	0	23.1	76.9	100	17.7	
19	Tahoe Mauris	M	65	0.3	22.6	77.1	100	17.7	Veale and Adams (1965)**
		F	86	0.5	30.9	68.6	100	16.8	
20	Samoans	M	157	0.8	40.8	58.3	99.9	15.7	Shima (1963)**
		F	153	1.4	42	56.6	100	15.5	
21	Peruvian	M	68	8.68	57.65	33.7	100	12.51	Baca et al (2001)
		F	52	11.5	55.77	32.7	100	12.12	

* Original data source and citation from Tiwari and Chattopadhyay (1967) ** Original data source and citation from Meier (1975)

countries the mean percent frequency of loops is highest (62.65) in the peoples of Java, Maoka (1938), and it is lowest (20.35) in the peoples of Maupiti Islanders (South pacific), Shima (1963). From the world population studies available data, the highest mean percent frequency of Loops seems highest (73.05) around the peoples of Faroe Islanders and lowest around the peoples of Maupiti Islanders (Table 5, 6 and 7. In the present study mean percent frequency of loops is highest (72.2) in non-Mogemene clan groups within Moche Grar clustered villages, and it is lowest (54.4) in Mogemene clan group within Bora Yeshere clustered villages. The mean value is 64.6 and it is comparable to the mean values obtained in the populations of Ibo, Yoruba, Kun, Barakwengo, and Haikom in Africa (Table 5); Habanites, Israeli, Denmark, Norway, Scotland and England in Europe and the Middle East (Table 6); and Javanese in Asia and the pacific (Table 7). This great variation in digital pattern frequency within the study sample shows the presence of population admixture effect in the area.

Within African populations, from available data published, the mean percent frequency of Whorls is highest (40.9) in the peoples of Egypt, Naffah (1977), and it is lowest (16.10) in Kun, Cummins (1955). Within Europe and the Middle East, mean percent frequency of Whorls is highest (57.90) in the peoples of Iraq (Alanga kindred), Abdulah (1978) and it is Suter (1983). Within Asia and pacific peoples of Iraq (Alanga kindred), Abdulah (1978) and it is lowest (25.40) in the peoples of Scotland (North), Harvey and Suter (1983). Within Asia and pacific countries, the mean percent frequency of Whorls is highest (79.65) in the peoples of Maupiti Islanders, Shima (1963), and it is lowest (33.00) in the peoples of Peruvian highlanders, Baca et al (2001). From the world population studies available data, the highest mean percent frequency of Whorls seems highest (79.65) around the peoples of Maupiti Islanders and lowest (16.10) around the peoples of Kun. In the present study mean percent frequency of Whorls is highest (41.10) in Mogemene major clan group within Bora Yeshere clustered villages, and it is lowest (21.30) in non-Mogemene clan groups within Moche Grar clustered villages. The mean value is 29.9 and it is comparable to the values obtained in the populations of Ogoni, Hausa, Yoruba, Yurhobo, Barakwengo and Haikom in Africa, Samaritans, Habanites, England, Denmark and Parci in Europe and the Middle East, and Javanese and Peruvian high landers in Asia and the pacific. Thus, percent frequency of Whorl patterns in the present sample show great variability and may be an indication of admixture effect.

Within African populations, from available data published, the mean percent frequency of Arches is highest (16.20) in the people of Kun (South Africa), Cummins (1955), and it is lowest (3.2) in Egypt, Naffah (1977). Within Europe and the Middle East, mean percent frequency of Arches is highest (8.05) in the peoples of Denmark, Anderson (1969) and it is lowest (1.00) in the peoples of Iraq (Alanga kindred), Abdulah (1978). Within Asia and pacific countries the mean percent frequency of Arches is highest (10.1) in the peoples of Peruvian high landers, Baca *et al.* (2001), and it is lowest (0.00) in the peoples of Maupiti Islanders, Shima (1963). From the world population studies available data, the highest mean percent frequency of Arches seems highest (16.20) around the peoples of Kun and lowest (0.00) around the peoples of Maupiti Islanders.

In the present study mean percent frequency of Arches is highest (7.60) in Mogemene major clan group within Aftir Megenase clustered villages, and it is lowest (1.90) in Mogemene major clan group within Yefek-Terek Dagag clustered villages. The mean value is 5.60 and it is comparable to the values obtained in the populations of Egypt and Algeria in Africa, Ashkanazi Israeli, Rwala Bedouin, England, Scotland, and Norway in Europe and the Middle East, and Kuvi Kondh, Japanese and Korea in Asia and the pacific. Hence, Arches also show great variations within the sample area and suggest possible admixture effect. In African population studies data, included under the present study, Pattern intensity index is highest (13.80) in the peoples of Egypt and lowest (10.00) in the peoples of Kun. In Europe and Middle East population studies data, it is highest (15.7) in the peoples of Iraq (Alanga kindred) and lowest (11.85) in the peoples of Denmark. In Asia and Pacific population studies data, it is highest (17.95) in the peoples of Maupiti Islanders and lowest (12.32) in the peoples of Peruvian high Landers. In the present study, PII is highest (13.81) in Mogemene major clan group within Bora Yeshere clustered villages and lowest (11.50) in non-Mogemene clan groups within the same clustered villages (Bora Yeshere). The mean PII index for the sample total is 12.44.

Summary and Conclusion

From the present digital pattern frequency study of Cheha Gurage (Ethiopia) we have seen great variations among different clan groups and localities. Pattern frequency was affected by clan group differences, blood type differences, Gender differences and locality differences. Thus, there exists statistically significant differences in digital pattern type frequencies for Inter-clan groups comparison ($\chi^2 = 18.8688$, d.f = 4, $p < 0.001$), ABO blood groups comparison ($\chi^2 = 25$, d.f = 12, $p < 0.05$) and bimanual differences comparison in female gender ($\chi^2 = 15.6498$, d.f = 4, $p < 0.01$). We also observed statistically significant differences within Mogemene major clan group inter-cluster comparisons ($\chi^2 = 43.3207$, d.f = 16, $p < 0.001$), and within other clan groups inter-cluster comparisons ($\chi^2 = 35.5028$, d.f = 16, $p < 0.01$). Religion differences do not show significant effect on digital pattern frequencies; indicating its relatively current occurrence within the community and/or existence of inter-religious marriages existing within the community. Digital pattern frequencies are affected by admixture populations (Meier, 1975; Cheng et al, 2009). Based on observed pattern frequency distributions and comparison with data from different world population studies it can be concluded that in Cheha Gurage of Ethiopia percent digital pattern frequencies are affected by population admixture. The nature and source of admixture effect and the extent of genetic diversity existing within the sample area can be better understood if more genetic data (molecular, physiological and anatomical) from the same sample area and related populations is available. The present preliminary study confirms the effect of admixture population on the digital pattern frequency of sample population studied.

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