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VALIDATION OF TRADITIONAL SIDDHA ANTHROPOMETRIC DIAGNOSTIC METHODOLOGY MAṆIKKAṬAI-NŪL- AN OBSERVATIONAL FIELD STUDY

S. Vinayak [*1], N. P. Vinod [1], M. S. Shreedevi [1], R. Gayatri [2], B. K. Priya [1] and P. Sathyarajeswaran [1]

Siddha Central Research Institute (Central Council for Research in Siddha) [1], Chennai - 600106, Tamil Nadu, India.
National Institute of Siddha [2], Chennai - 600047, Tamil Nadu, India.

Keywords:

Maṇikkaṭai-nūl, Siddha anthropometry, Antebrachial circumference, Finger breadths, Prediction accuracy, Tool validity

Correspondence to Author:
Dr. S. Vinayak

Research Officer,
Siddha Central Research Institute (Central Council for Research in Siddha), Chennai - 600106, Tamil Nadu, India.

E-mail: monowar250@gmail.com

ABSTRACT: Maṇikkaṭai-nūl (MK) is an exclusive diagnostic method particular to Siddha Medicine, where the subject's Finger breadths (FB) calculated from the Antebrachial circumference (ABC) is accessed for predicting the symptom, disease, or the pathological sequence. The present observational field studies (Study 1 & 2) aim to validate the clinical significance of MK as a reliable diagnostic tool. True positive (T+), False positive (F+) and False negative (F-) predictions were evaluated in study 1 (n=116). Three divisional trials were done in study 2 that assessed the correlation of MK readings with Antebrachial circumference (ABC) (n_1=117), ABC, total fingerbreadth (TFB) (n_2=27), and Body Mass Index (BMI), and ABC. (n3=23). Pearson correlation analysis was used to determine the association between different parameters based on a 95% confidence interval. The differences were considered significant at a P-value of <0.05. A Scatter plot was used to study the pattern of association. From the study (n =116), the T+ cases were 97 (83.62 %) and 16 cases (13.79%) were not relevant (F+ & F-). For the second study (n=167), based on Pearson Correlation, there was statistically significant linear relationship between ABC and MK (n_1=117) and moderate (.5 < | r | < .7) association between TFB & ABC. In study (n_3=23), a statistically significant linear relationship in the three combinations, i.e., between BMI & ABC (r =0.690, P<0.001), BMI& MK (r=0.742, P<0.001) and ABC & MK (r=.666, P=0.001) were observed. The studies validated the clinical reliability of MK.

INTRODUCTION: The treatise of Maṇikkaṭai-nūl (MK) is an exclusive diagnostic entity particular to Traditional Siddha Medicine (TSM), where the subject's Finger breadths (FB) are accessed for predicting the disease, symptoms, or the pathological sequence [1].

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In MK, the four fingers' total mediolateral (ML) length is measured using a standard inelastic thread. The length obtained is pointed backward from the wrist line to reach the focus, where the antebrachial circumference (ABC) is measured with the same thread.

The thread length obtained from ABC is then converted into the number of FB, specifying certain signs particular to the subject. Each finger unit pattern reveals a set of clinical symptoms described in the scripts, which help reach a diagnosis [2-4]. It is a very common tool used in Siddha medical practices and there is a lot of discrepancy in the

procedures. Mostly inaccurate methods are routinely followed, resulting in bias generation and indefinite assumptions. The most common error is the diagnostic error, *i.e.,* due to inadequate knowledge, faulty reading and data gathering or interpretation [5]. Tool errors occur due to using inappropriate thread for measurement [6]. Standardization of common protocol for precise measuring and reading has been tried in a few of the earlier studies [6, 7].

The Anthropometric significance of the tool correlated with other variables like Body mass index (BMI), finger breadths (FB) and Antebrachial circumference (ABC), is vaguely understood [8]. Many of the previous studies on MK were based on its clinical outcome in predicting diseases mentioned in specific FB signs. Still, the other vital aspects, like the accuracy of the tool, its limitations, and its validity as an anthropometric measure, have not been established [9-11].

This work aims to validate MK's clinical significance as a reliable tool for disease prediction. Two subsets of studies were conducted among the study participants to evaluate the accuracy (tool sensitivity), reliability, and scientific validity of this ancient diagnostic anthropometric approach.

Aim & Objectives:

Objective 1: The first objective was based on the Hypothetical deliberation that the traditional diagnostic tool MK could be efficiently used for disease diagnosis and prognosis or prediction with limited error generation.

The participants who reported positive symptoms correlated with the findings of the MK measurement are considered True positive (T+), and those with zero relevance to the findings of the MK measurement are considered False positive (F+) and negative (F-). T+ reflects the successful predictions that help in the part of diagnosis and vice versa [12]. Accordingly, the first study was purposed to evaluate the prediction accuracy of the tool among the study participants. Here the prediction accuracy (Tool sensitivity /true positive rate) depends on the extent of unbiased measurement and the information collected by ensuing stringent SOP, and logical diagnostic reasoning [12, 13].

Disease	Manikkadai reading describing the symptoms/signs	Clinical History / sign/symptom present
True positive (T+)	Yes	Yes
False positive (F+)	Yes	No
False positive (F-)	No	Yes

Objective 2: The second objective was based on the Hypothetical deliberation, that the readings obtained from MK measurement could be correlated with standard Anthropometric variables like BMI, Antebrachial circumference and total fingerbreadth. Accordingly, the second study was purposed to determine the correlation of MK readings with Anthropometric measurements amongst the study participants.

Here the rationality (Tool validity) is dependent on the extent to which it is associated with the anthropometric variables.

MATERIALS AND METHODS:

Type of Study: Diagnostic Accuracy Study (Observation Field Study):

Study Participants: Study participants (both male and female) who attended the different medical camps conducted by the doctor's community program for 3 months (January 2019 to April 2019), in Kerala were selected for the observational field study (Non-interventional) [14, 15]. Study participants from age 12 to 70, with the willingness to participate, were recruited after getting verbal consent.

Those with any history of arm, forearm, wrist and fingers fracture, nerve injury, or surgical history of upper limb were excluded from the study [15].

Sample size and type of Studies: The recruited study participants (n-283) were allocated into two subsets of studies. In the study's first phase, the total number of participants observed was 116 (n=116). An SOP has been followed for taking the MK readings (3 repetitions) for all the participants, and the no: of T+ predictions that helped in diagnosis and F+, F- predictions that were not

relevant (Zero relevance) in diagnosis, were evaluated in **Table 1.**

The complete case history for each of the participants was recorded in a clinical record form. In the second phase of studies (n=167), the correlation of MK readings with different anthropometric variables was assessed in 3 subsets of studies. The measurements, along with MK readings, were made on the same day, namely Antebrachial circumference (ABC) (n_1=117), ABC and total fingerbreadth (TFB) (n_2=27), BMI, and ABC. (n_3=23) **Table 1.**

TABLE 1: OBJECTIVE AND STUDY PARTICIPANTS IN EACH STUDY

	Study-2 (n=167)			
	Study-1 (n=116)	**Sub study A (n_1=117)**	**Sub study B (n_2=27)**	**Sub study C (n_3=23)**
Objective	Evaluating T+, F+, F- predictions	Correlation of MK readings with ABC.	Correlation of MK readings with ABC + TFB	Corelation of MK readings with ABC + BMI

T+= True positive predictions, F+ = False positive predictions, F- = False negative predictions, MK = Maṇikkaṭaireadings, ABC = Antebrachial circumference, TFB = Total finger breadth of four fingers, BMI= Body Mass Index.

Statistical Analysis: Statistical analysis was performed using IBM SPSS software version 26.0. Descriptive statistics in frequency and percentage were used to present the predictions.

Pearson correlation analysis was used to determine the association between different parameters based on a 95% confidence interval [16].

The differences were considered significant at a P-value of <0.05. A Scatter plot was used to study the pattern of association [17].

Components of Diagnostic Study:

1. A non-elastic toin of a standard length of 30 cm **Fig. 1.**

2. Weighing scale.

3. Stadiometer.

4. Clinical from.

Standard Operating Procedure for Manikkadai Reading (MK):

1. The study participant was asked to sit comfortably in the chair, keeping the hand fingers intact and straight.

2. The participant should hold the anterior wrist surface and place it on the examination table for easy measuring by the investigators **Fig. 2.**

3. A standard in-elastic thread of a length of 30cm was used to take the measurement.

4. The total perpendicular length of 4 fingers is measured from the middle part by using the to in **Fig. 3** & **4.**

5. The total length obtained is measured back towards the antebrachial part of the arm by keeping the to in the middle of the wrist crease **Fig. 5.**

6. Reach the point where the total length is met in the antebrachium, point out and measure the Antebrachial circumference (ABC) by using the same to in **Fig. 6.**

7. The length obtained, i.e., ABC, is converted into total no fingerbreadths and recorded in **Fig. 7.**

8. Repeat the process twice again for maximum accuracy of the reading.

9. The reading obtained in no: of fingerbreadths (FB) is interpreted with clinical description from the script.

One full breadth of the finger is taken into consideration for Fb, and the readings of each Fb are divided into 4 units, quarter measurement ($1/4^{th}$), half (1/2), three quarters ($3/4^{th}$), and full breadth **Fig. 8**.

There are definite findings for each unit that should be interpreted with the clinical presentations of the study participants [1-3].

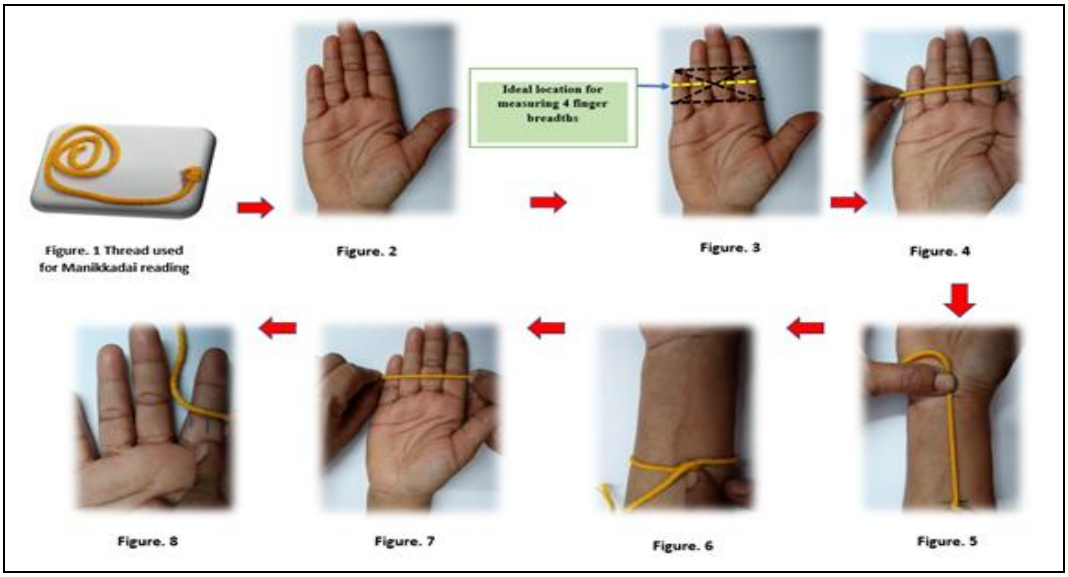


FIG. 1-8: STANDARD OPERATING PROCEDURE OF MANIKADAI-NUL READING

Standard Operating Procedure for Measuring FB, Antebrachial Circumference, Height, Weight and BMI:

1. An Inch of tape was used to measure the total length of four fingers and antebrachial perimeter. ABC is (cm/inch) noted in the tape, with three repetitions during the time of MK reading [15].
2. Height was measured using a stadiometer.
3. Weight was measured by using a weighing scale.
4. Body Mass Index (BMI) was calculated as weight (kg)/height squared ($m^{2)}$ [18].

RESULTS:

Study 1: The prediction accuracy of MK in 116 study participants was evaluated in which the readings were cross-matched with the clinical history. A total of 21 different FB patterns were recorded among the participants out of the 57 cases (49.14%) fall under the 10 FB category, followed by 9 cases in 9.5 FB (7.76%), 8 cases in 9 FB (6.9%), 7 cases in 9.75fb (6 %), 3 cases in 9.5 FB (2.59%), 1 case each in 8.25, 8.5 and 8.75 FB respectively. Three cases showed 12 FB as the reading, and 2 of them were healthy **Table 2**.

The mainstream study participants who showed the 10 FB measures had presented the complaints as illustrated in **Table 2** & **Fig. 9**. All of them presented with a history of gastric complaints, which correlates with the MK reading descriptions and Siddha medicines provisional diagnosis **Table 3** [19, 20]. The outcome of MK readings is depicted in **Fig. 10.**

TABLE 2: DISTRIBUTION OF MK READINGS, FREQUENCY, TRUE POSITIVE PREDICTIONS AND FALSE-NEGATIVE PREDICTIONS, MISCELLANEOUS READINGS (N=116)

				True positive predictions (T+)		F+ & F-	Miscellaneous
S. no.	Readings	Total No: cases	Freq *	No: of cases that reported more than 3 features (symptoms) of the reading & its %	No: cases that reported than 2 or fewer features (symptoms) of the reading & its %	Total zero relevance	Healthy
1	10	57	49.14	30 (52.63)	20 (35.09)	7 (12.28)	0(0)
2	10.5	2	1.72	0(0)	0(0)	2 (100)	0(0)
3	11	7	6.03	0(0)	5 (71.43)	2 (28.57)	0(0)
4	11,10	1	0.86	0(0)	1 (100)	0(0)	0(0)
5	11.5	2	1.72	0(0)	0(0)	1 (50)	1 (50)
6	12	3	2.59	0(0)	0(0)	1 (33.33)	2 (66.67)
7	8.25	1	0.86	0(0)	0(0)	1 (100)	0(0)
8	8.5	1	0.86	0(0)	1 (100)	0(0)	0(0)

9	8.75	1	0.86	1 (100)	0(0)	0(0)	0(0)
10	8.75,9	1	0.86	0(0)	1 (100)	0(0)	0(0)
11	8.75,9,9	1	0.86	0(0)	1 (100)	0(0)	0(0)
12	9	8	6.9	2 (25)	5 (62.5)	1 (12.5)	0(0)
13	9,9.25,1	1	0.86	0(0)	1 (100)	0(0)	0(0)
14	9,9.25,9	3	2.59	3 (100)	0(0)	0(0)	0(0)
15	9.25	3	2.59	1 (33.33)	2 (66.67)	0(0)	0(0)
16	9.25,9.5	5	4.31	4 (80)	1 (20)	0(0)	0(0)
17	9.45,9.5	1	0.86	1 (100)	0(0)	0(0)	0(0)
18	9.5	9	7.76	7 (77.78)	1 (11.11)	1 (11.11)	0(0)
19	9.5,9.75	1	0.86	1 (100)	0(0)	0(0)	0(0)
20	9.75	7	6.03	0(0)	7(100)	0(0)	0(0)
21	9.75,10	1	0.86	1(100)	0(0)	0(0)	0(0)

*Frequency = (total no: cases of individual FB /n*100) 0.25 = quarter FB, 0.5 = half FB, 0.75 = 3/4thFB, F+ = False positive predictions, F- = False negative predictions

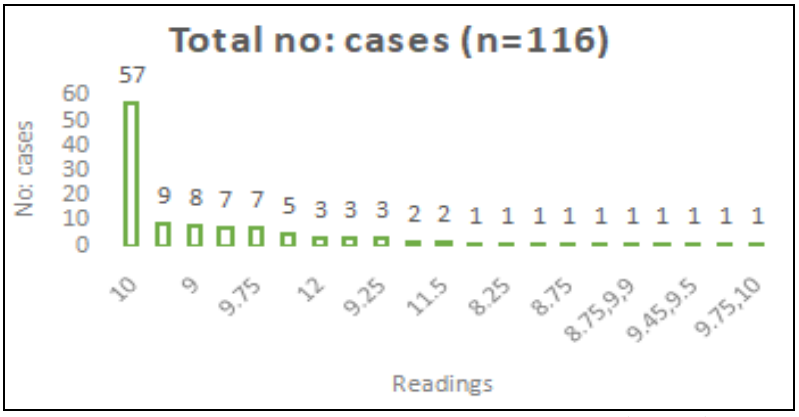


FIG. 9: DISTRIBUTION OF MK READINGS (N=116)

TABLE 3: COMMON CLINICAL PRESENTATIONS OF 10 FB READINGS, ITS CORRELATION IN THE SCRIPT, AND PROVISIONAL MODERN DIAGNOSIS

Common symptoms presented MK 10 FB readings	Symptoms correlated with / Siddha provisional diagnosis of MK 10 FB reading	Modern provisional diagnosis
Abdominal distension Acidity Anorexia Back pain Burning sensation inthe abdomen Constipation Diarrhoea/dysentery Extreme Tiredness and body pain Flatulence Gastric discomfort Giddiness Low backache Nausea Pain in the lower abdomen Pricking sensation all over the body Retrosternal pain and burning sensation Weight loss	Vāyu kuṉmam: marked by dyspepsia, anorexia, abdominal bloating, exhaustion, and loss of strength; epigastric discomfort makes the patient bent like a bow. Vāta kuṉmam: Constipation, reduced mobility, extreme body pain, heaviness of the body, reduced appetite, loss of strength, tiredness of extremities Pitta kuṉmam: Nausea, vomiting, giddiness, tiredness of extremities Eri kuṉmam:the burning sensation of epigastrium, nausea, hypersalivation, headache, bloating of the abdomen, sour belching, giddiness, diarrhoea, emaciation Vali kuṉmam: Abdominal distension, sleep disturbances, pain in the chest and intercostal or flanks, back pain / vertebral pain, low backache/ lumbosacral pain, body pain Veṇ piṇi: Diseases associated with the pallor of the body, tentatively caused due to deficient Senneer thathu (blood elements)	Acid peptic diseases Gastritis with dyspepsia Gastro-Oesophageal Reflux Diseases Gastro-duodenitis Gastrointestinal diseases Peptic ulcer Gastritis with the clinical association with Anaemia

Some reported positive readings from multiple FB descriptions, which was observed as the pattern that showed the sequence of symptoms and disease progression in the same patient. One of the previous studies recognized MK's scope in identifying progressing FB patterns in inpatients. The progression is noted by the change in FB readings in the same patient, and they clinically

present the symptoms of consecutive advancement in FB measure [6]. In the present study, fifteen cases (12.93 %) had positive symptoms from multiple reading descriptions. The readings helped to sort out the preliminary phase of the complaint, the sequence of events developing to the present condition, and how it might present or progress in the future. From the study (n =116), cases that reported matching findings of MK reading and clinical presentation (T+) were 97 (83.62 %). The findings helped in reaching the diagnosis of the study participants. There were 16 cases (13.79%) of F+ and F-, which was not relevant, as neither of the readings matched the complaints presented by the study participants or vice versa. Apart from the two categories of predictions, three study participants who shown 11.5 and 12 FB and were healthy. The distribution of MK readings, frequency, true positive predictions, and false-negative predictions, miscellaneous readings are illustrated in **Table 4** and **Fig. 10.**

TABLE 4: FREQUENCY & PERCENTAGE OF FINAL OUTCOME OF MK STUDIES (N= 116)

1	True Positive predictions (T+)	No. of cases	Percentage (%)
a	Cases that reported more than 3 features (symptoms) of the reading and helped in complete prediction)	51	43.97
b	Cases which reported 1 or 2 features (symptoms) of the reading and helped in Partial prediction)	46	39.66
c	Cases that reported features of multiple positive readings that helped in diagnosis	15	12.93
	True Positive predictions (T+) = 1+2	97	83.62
2	False Positive (F+) and False Negative predictions (F-) Predictions	16	13.79
	True Negative cases (Tn) /Total zero relevance: Readings that helped in neither diagnosis nor prediction)		
3	Miscellaneous		
	Healthy subjects	3	2.59

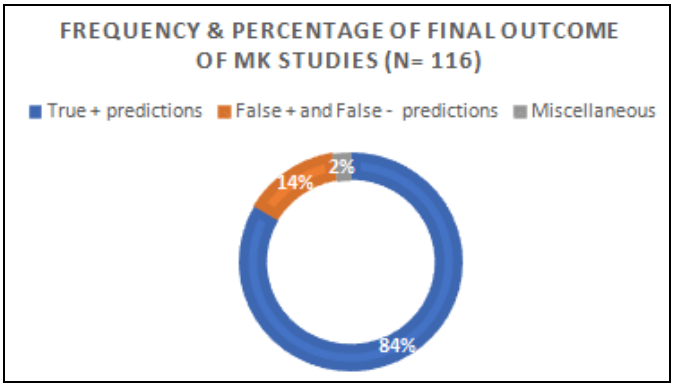


FIG. 10: FINAL OUTCOME OF MK STUDIES (N=116)

Study 2: In study 2, readings of MK were taken from 167 study participants (n=167) which were divided into sub-studies n_1, n_2, n_3.

MK readings with ABC were measured in 117 study participants, MK readings with ABC and TFB were measured in 27 study participants and MK readings with ABC and BMI were measured in 23 study participants. The correlation between the Fb measurements and the other variables was evaluated **Table 5-10**, **Fig. 11-16.**

TABLE 5: RESULTS OF STUDY-2

Study- $n_{1=}$ = 117	**Range**	**Mean ±SD**
ABC (in cm)	14-24	19.10 ± 2.07
MK (in FB)	$8^{1/4}$ -12	-
Study- $n_{2=}$ = 27	**Range**	**Mean ±SD**
TFB (in cm)	6-8.5	7.65 ± 0.62
ABC (in cm)	17-24	19.69 ± 2.09
MK (in FB)	9-12	-
Study- $n_{3=}$ = 23	**Range**	**Mean ±SD**
Height (in cm)	134-178	158.51 ± 10.94
Weight (in kg)	39-110	64.30 ± 16.48
BMI ($kg/m^{2)}$	18.10-37.50	25.27 ± 5.47
ABC (in cm)	14-22	18.59 ± 1.97
MK (in FB)	$8^{1/4}$ -12	-

ABC = Antebrachial circumference (in cm), MK=Manikkadai readings (in finger breadths), TFB= Total finger Breadth in cm, BMI=Body Mass Index, FB= Finger Breadth

Sub study -1 (n_1=117):

- The mean ABC for the study participants were 19.10 ± 2.07 and the range of MK readings obtained was from 8 ¼ to 12 FB.
- From the results illustrated in **Table 6** and **Fig. 10**, the hypothesis asserting the positive correlation of ABC and MK was cleared based on Pearson Correlation. There was a statistically significant linear relationship between the two measures (r=0.656, P<.001).
- The direction of the relationship is positive *(i.e.*, ABC and MK are positively correlated), meaning that these variables tend to increase together (*i.e.*, greater ABC measurements are associated with higher FB reading).
- The magnitude, or strength, of the association is approximately moderate (.5 < | *r* | < .7) **Table 6** & **Fig. 11.**

Sub Study -2 (n_2=27):

- For 19 male study participants, the mean TFB was 7.88 ± 0.41cm, and the mean ABC was 20.36 ± 2.052 and for 8 female study participants, the mean TFB was 7.05 ± 0.668, and mean ABC was 18.36 ± 1.394. Common MK readings obtained for each are tabulated. **Table 7.**
- From the results illustrated in **Table 8** and **Fig. 12** & **13**, the hypothesis asserting the positive correlation of TFB and ABC, TFB & MK were cleared based on Pearson Correlation.
- There was moderate (.5 < | r | < .7) association between TFB & ABC and negligible association between TFB & MK (0<|r|<0.3).
- There was a negligible negative correlation present between Age with TFB, ABC & MK that means as age increases TFB, ABC & MK are negligibly decreasing (0<|r|<0.3).

Sub study -3 (n_3=23):

- The study participants were categorized based on BMI, two cases fall in an underweight category with a mean BMI of 18.55 ± 0.63 kg/m2, eleven cases under the normal weight category with a mean BMI of 22±1.60 kg/m2, six cases under the overweight category with mean BMI 26.83 ±1.05 kg/m2, three cases fall under Class -I obesity with mean BMI (34.5±0.3 kg/m2), and one case under Class -II obesity with BMI 37.5 kg/m2.
- The mean ABC under each category and the MK readings obtained are illustrated in **Table 9** & **Fig.14.**
- For 12 male study participants, the mean BMI was 24.48 ±4.39 kg/m2, and the mean ABC was 19.08 ±1.59, and for 11 female study participants, BMI was 26.13 ± 6.55 kg/m2, and the mean ABC was 18.04 ± 2.13 **Table. 10.**
- From the results illustrated in **Table 11** and **Fig. 15, 16,** and **17** the hypothesis asserting the positive correlation of BMI, ABC and MK were cleared based on Pearson Correlation.
- There was correlation b/w BMI & ABC (r =0.690, P<0.001), BMI & MK (r=0.742, P<0.001) and ABC & MK (r=.666, P=0.001) based on 23 observations. A statistically significant linear relationship in these three combinations was observed.
- The direction of the relationship is positive (*i.e.*, BMI & MK, BMI & ABC and ABC & MK are positively correlated), meaning that these variables tend to increase together (i.e., greater ABC is associated with greater BMI). Towards the higher-end BMI category, higher values of MK are observed.
- The magnitude, or strength, of the association is approximately moderate (.5 < | r | < .7) in cases of BMI & ABC, ABC & MK. In the case of BMI & MK, the association is approximately high. (0.7<|r|<0.9)

As illustrated in tables 12 &13, there was a positive relationship between BMI-ABC, BMI-MK, and MK -ABC for both male and female study participants in **Tables 9** & **10**.

All relation except BMI-ABC (in the male) has approximately high association. (0.7<|r|<0.9) and for BMI-ABC (in male) is approximately moderate association (.5 < | r | < .7)

TABLE 6: CORRELATION BETWEEN ABC & MK (N_1=117)

Correlations			
		ABC	**MK**
ABC	Pear. Corre		
	Sig. (2-tailed)		
	N		
MK	Pear. Corre	1	**1**
	Sig. (2-tailed)		
	N	117	**117**
**. Correlation is significant at the 0.01 level (2-tailed)			

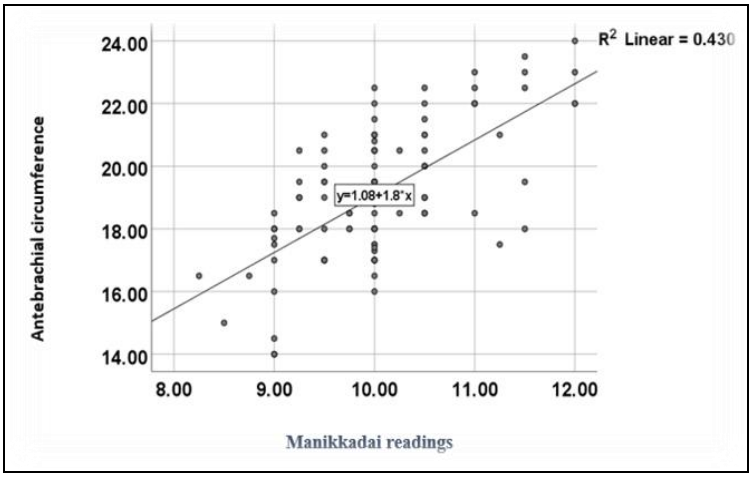


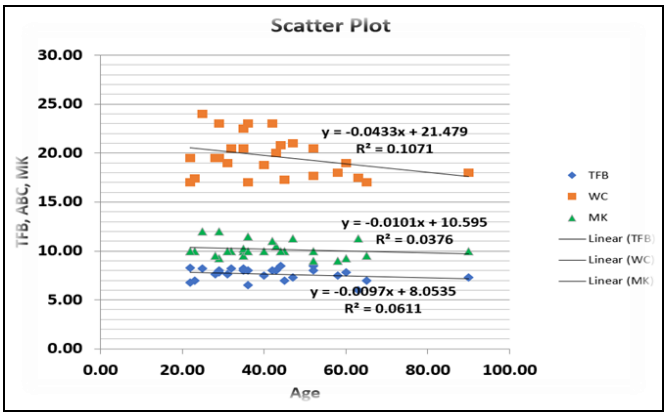
FIG. 11: SCATTER PLOT OF ABC & MK (N1=117)

TABLE 7: DISTRIBUTION OF CASES (N2=27)

Study participants	No. of cases	Age (Mean)	Total Medio lateral length of 4 fingers (range) in cm	Total Medio lateral length of 4 fingers (Mean ±SD) in cm	ABC (Range)	ABC (Mean ±SD)	Manikkadai measurements obtained for the study participants (in no. of FB)
Male	19 (70%)	40.21	7-8.5	7.88 ± 0.41	17-24	20.36 ± 2.052	9, $9^{1/4}$, $9^{1/2}$,10, $10^{1/4}$,11, $11^{1/2}$ 12
Female	8 (30%)	44.37	6-8	7.05 ± 0.668	17-21	18.36 ± 1.394	10, $10^{1/2}$, $11^{1/4}$

TABLE 8: CORRELATION BETWEEN AGE, TFB, ABC & MK (N2=27

Correlations					
		Age	**TFB**	**ABC**	**MK**
Age	Pear.Corre	1	-0.247	-0.327	-0.194
	Sig. (2-tailed)		0.214	0.096	0.333
	N	27	27	27	27
TFB	Pear.Corre	-0.247	1	.685**	0.017
	Sig. (2-tailed)	0.214		0	0.932
	N	27	27	27	27
ABC	Pear.Corre	-0.327	.685**	1	.627**
	Sig. (2-tailed)	0.096	0		0
	N	27	27	27	27
MK	Pear.Corre	-0.194	0.017	.627**	1
	Sig. (2-tailed)	0.333	0.932	0	
	N	27	27	27	27
**. Correlation is significant at the 0.01 level (2-tailed).					



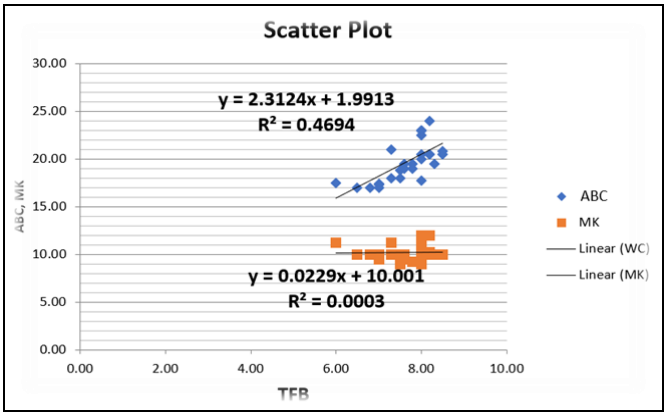


FIG. 12: SCATTER PLOT OF AGE, TFB, ABC & MK (N_2=27) FIG. 13: SCATTER PLOT OF TFB WITH ABC & MK (N2=27)

TABLE 9: DISTRIBUTION OF CASES BASED ON BMI & ABC AND THE MK READINGS OBTAINED UNDER EACH CATEGORY (N_3=23)

Category		No: cases	BMI (Mean) kg/m^2	ABC (Mean in cm)	MK readings obtained in study participants (in FB)
15-19.9	Under weight	2 (8.60%)	18.55 ± 0.63	15.75 ±2.47	9
20-24.9	Normal Weight	11 (47.82%)	22±1.60	17.95 ± 1.33	8.25, 9, 9.25,9.5,10,10.5
25-29.9	Over weight	6 (26%)	26.83 ±1.05	19.33 ±1.25	10
30-34.9	Class I - Obesity	3 (13%)	34.5±0.3	20.16±1.60	10,10.5,12
35-39.9	Class II - Obesity	1 (4.34%)	37.5	22	11
≥ 40	Class III - Obesity	-	-	-	-

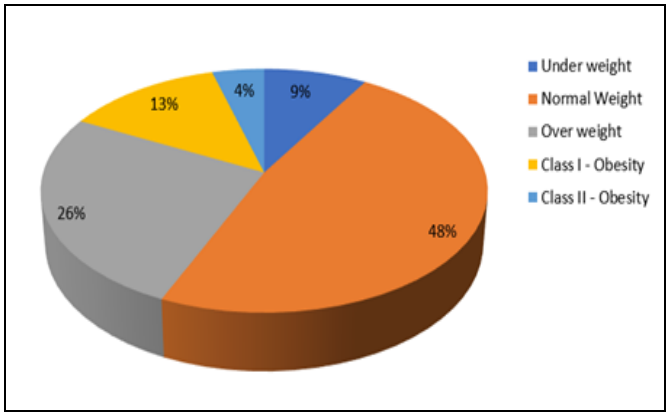


FIG. 14: DISTRIBUTION OF CASES BASED ON BMI (N_3=23)

TABLE 10: DISTRIBUTION OF STUDY PARTICIPANTS (N_3=23)

	No: cases	BMI (Mean) kg/m^2	ABC (Mean in cm)	MK readings obtained in study participants (in FB)
Male participants	12	24.48 ± 4.39	19.08 ±1.59	$9, 9^{1/4}, 9^{1/2}, 10, 10^{1/4}, 11, 11^{1/2}$
Female participants	11	26.13 ± 6.55	18.04 ± 2.13	$8^{1/4}, 9, 9^{1/4}, 9^{1/2}, 10, 10^{1/2}$

TABLE 11: CORRELATION B/W BMI, ABC & MK (N3=23)

Correlations				
		BMI	ABC	MK
BMI	Pear.Corre	1	.690**	.742**
	Sig. (2-tailed)		.000	.000
	N	23	23	23
ABC	Pear.Corre	.690**	1	.666**
	Sig. (2-tailed)	.000		.001
	N	23	23	23
MK	Pear.Corre	.742**	.666**	1
	Sig. (2-tailed)	.000	.001	
	N	23	23	23
**. Correlation is significant at the 0.01 level (2-tailed).				

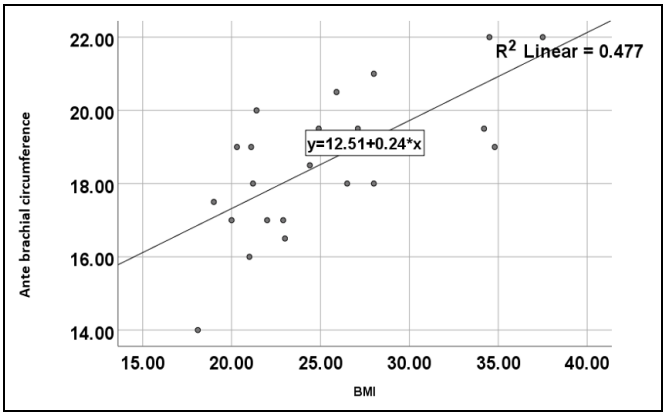


FIG. 15: SCATTER PLOT OF ABC & BMI (N3=23)

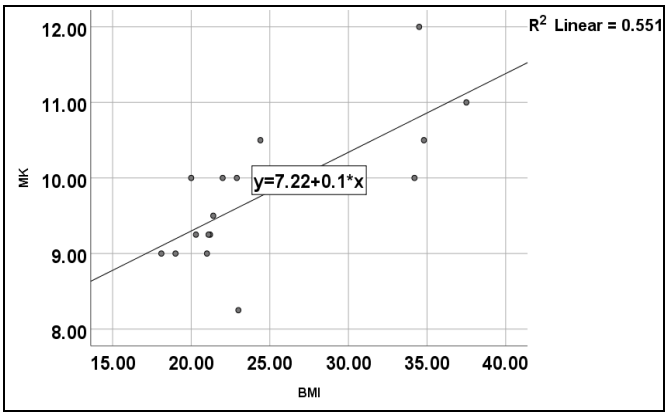


FIG. 16: SCATTER PLOT OF MK & BMI (N3=23)

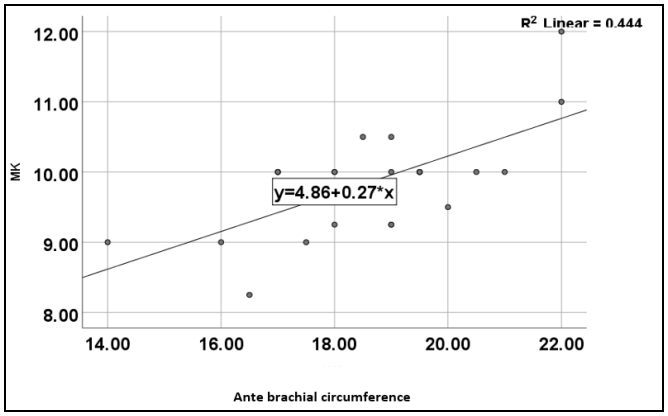


FIG. 17: SCATTER PLOT OF MK & ABC (N3=23)

TABLE 12: CORRELATION B/W BMI, ABC & MK IN 12 STUDY PARTICIPANTS (MALE)

Correlations – male				
		BMI	**ABC**	**MK**
BMI	Pear.Corre	1		
	Sig. (2-tailed)			
	N	12		
ABC	Pear.Corre	.597*	1	
	Sig. (2-tailed)	.040		
	N	12	12	
MK	Pear.Corre	.865**	.784**	1
	Sig. (2-tailed)	.000	.003	
	N	12	12	12

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

TABLE 13: CORRELATION B/W BMI, ABC & MK IN 11 STUDY PARTICIPANTS (FEMALE)

Correlations – male				
		BMI	**ABC**	**MK**
BMI	Pear.Corre	1		
	Sig. (2-tailed)			
	N	11		
ABC	Pear.Corre	.871**	1	
	Sig. (2-tailed)	.000		
	N	11	11	
MK	Pear.Corre	.722*	.850**	1
	Sig. (2-tailed)	.012	.001	
	N	11	11	11

**. Correlation is significant at the 0.01 level (2

*. Correlation is significant at the 0.05 level (2

DISCUSSION: The treatise authored by Siddha sage Akattiyar, otherwise called Akattiyar Cūṭāmaṇi Kayiṟu Cūttiram (Maṇikkaṭai nūl) is an ancient diagnostic methodology based on specific anthropometric measures expressed in finger breadth units. Eight main FB units ranging from 4 - to 11 FB, along with subunits of 0.25, 0.5, and 0.75 FBs each (*e.g.,* 4, 4.25, 4.5, 4.75), comprise 26 patterns. The 26 patterns describe particular signs, symptoms, pathological sequences, or disease clusters predicted on the subject when the particular reading is shown [1]. The reading obtained is cross-matched with the clinical presentations for maximum accuracy of the predictions. Many of the studies explored its possibility as a diagnostic tool in the clinical platform, while there were a lot of conflicts in terms of its validity and reliability in precise estimations [2]. Since it is an Anthropometric approach, an effort was needed to evaluate its correlation with other variables. The observational studies on a total of 283 study participants were planned to access the hypothetical deliberations relating to the tool diagnostic accuracy and its rationality in practices.

The first study (n=116) took a greater time to evaluate, as it needed to carefully record all the findings of the study participants in a clinical research form (CRF). The readings were repeated 3 times in each participant by separate investigators to maintain the consistency of the reading. Then the presenting complaints and the history of illness were interrogated and recorded. The findings of the readings were cross-checked with the study participants before their confirmation. The perfect matching of readings with the clinical presentations was considered as T+ and for whom we were not able to find any relevance to the diagnosis were taken as F+ and F-. The success of the readings was based on the appropriate implementation of two aspects, analogical derivation and meta reasoning [14]. In analogical derivation, the physician after reading the measurement of MK uses a reasoning approach based on the matching patterns of the presenting complaints of the participants with the description in the literature. *E.g.,* If the measurement obtained is 10 and the presenting complaints are identical to the description of the particular reading that could be taken as a valid point for a diagnosis. The second meta-reasoning part is where the physician critically examines the assumptions from a particular complaint presented, and after measuring MK, the readings are correlated to reach an inference. The first study's findings were found to support its claim as a reliable tool with a significant diagnostic accuracy rate. The second study (n=167), explored its correlation with the measured anthropometric variables. Many epidemiological and observational studies affirmed the reliability of using BMI and ABC as important predictors of diseases or syndromes [18, 21].

The body mass index (BMI) is a common metric that describes relative weight for height and has significant value in population-based studies, owing to its strong correlation with total body fat. It has been widely accepted as a risk factor marker for many health issues associated with overweight and obesity, like diabetes, hypertension, and coronary heart diseases (CHD) [18, 21, 22]. The 3rd subset of Phase 2 studies (n_3=23) successfully found a positive correlation of MK with different variables like ABC and BMI. Both the variables reflect MK readings in such a way that the higher the BMI, followed by ABC, the subjects tend to show higher readings. There is an equal chance of obtaining lower readings in subjects with low BMI, as in malnutrition, emaciation, or severe debility in hospitalized conditions [23]. The lower MK readings 4-6FB is considered as complicated as it depicts the features of incurability and fatality [3]. Future studies on Mk may focus on such cases to improve the measure's reliability. Thus, the studies put on the hypothetic deliberations infer that this ancient practice of diagnosis based on the ABC conversion to FBs could be a valid measure for disease predictions.

Limitations of the Study:

Lack of Reference or Gold Standards: One of the study's main limitations is that we could not confirm the true positive findings from the readings with any reference standards apart from the clinical picture. Standard diagnosis tests (imaging and laboratory investigations) for the particular ailment were limitedly used to validate the clinical profile of the study participant and the Mk readings. This was due to limited facilities in the medical camp.

Lack of Information about Readings of Fb Beyond 10 (10.5, 11.5, 12): There is no textual

description of the above set of readings; hence, we were unable to conclude its diagnostic significance. The readings of the 3 Healthy participants, who reported none of the symptoms, were obtained as 12 Fb and whether the reading beyond 11 Fb might be taken as a healthy MK measure is yet to be explored.

Lack of Subsequent follow-up of Cases: The variation in readings with repeated visits and the prognosis of the disease was unable to record since it was a single-day camp setting.

CONCLUSION: This was the preliminary footstep to validate the traditional Siddha diagnostic concept based on anthropometry. Maṇikkaṭai nūl readings, when properly measured and interpreted, may help the physicians to appreciate the disease pattern, its premonitory symptoms, sequence of its progress, and could implement effective remedial measures. The fundamental concept of this diagnostic approach is easy to infer and apply, and it's inexpensive. The study explored prediction accuracy, the drawbacks and limitations of the tool, and its scientific reliability when used along with other anthropometric variables. Like any different traditional diagnostic approach used in Siddha medicine like Nāṭi (Pulse reading), this unexplored concept should be brought into research for its further authentication and clinical acceptance. Interdisciplinary concepts like Yākkai-Ilakkaṇam (body constitution), and Mukkurram (Three humoral concepts) should be merged in MK studies to reach accurate inferences.

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CONFLICTS OF INTEREST: None declared

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