



Research Article

Diagnosis of *Neerizhivu Mathumeham* (Diabetes Mellitus Type 2) using the Siddha and modern diagnostic methods - A cross-sectional observational study

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Abstract

Siddha Medicine, is an oldest traditional medical system, describes *Neerizhivu Madhumeham* (NM), is often compared with diabetes mellitus (DM). The Siddha system of medicine incorporates a unique set of diagnostic procedures. Modern medical practices have utilized biomedical knowledge to diagnose diseases. Yet comparative diagnostic analysis between both systems remains limited. The purpose of the study is to examine the connection between Siddha and modern diagnostic approaches for NM. A cross-sectional observational study was conducted at Government Siddha Medical College, Palayamkottai (GSMCP), Government District Headquarters Hospital, Thoothukudi, and Gopalsamudram village, India. Sixty patients diagnosed with DM, aged 18-64 years, were randomly selected based on selection criteria. Written informed consent was acquired from each participant, and the study received ethical approval from the GSMCP Ethics Committee. Patients underwent diagnostic assessments using Siddha (*neerkuri*, *neikuri*, *nadi*, and *manikkadai*), and modern (urine full report and fasting plasma glucose (FPG)) diagnostic techniques. Data analysis was employed using standard statistical methods. The findings revealed that the *Seerana pakuva neer* type of urine was associated with low FPG (199.6 ± 15.4 mg/dL). Lower FPG was observed in patients with *Vathapiththam* and *Piththavatham*. A significant correlation was detected between *neikuri* ($P=0.02$), *nadi* ($P=0.015$), with FPG. A movement 'Pendulum' of *nadi* was noted in all DM patient. Elevated *manikkadai nool* values may serve as an indicator of poor glycaemic control. The study suggests that *neikuri* and *nadi* could be serve as a diagnostic tool for DM. However, further comprehensive studies are necessary prior to clinical practice.

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Introduction

Siddha Medicine is acknowledged as an ancient system of traditional healthcare, globally. (1) According to Siddha medicine, the imbalance of *Trihumour* which is *Vatham*, *Piththam*, and *Kabham*, causes pathological states in the human body. The ancient Siddha literature *Thirumoolar Vaithiyam Karukkadai* 600 has documented that the imbalance between *Piththam* and *Vatham* causes a disease called *Neerizhivu Mathumegam* (NM), (2) in which the signs and symptoms as polyuria, glycosuria and polyphagia are related to diabetes mellitus (DM).

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DM is a prevailing metabolic non-communicable disease which devastate 422 million people globally. (3) It is one of the major causes for high rates of morbidity and mortality, and diminishes quality of life apart from an eye-catching economic burden on the health care system. The disease primarily characterized by hyperglycemia and impairments in secretion or action of insulin or both. (4) A previous study documented that, DM affected 463 million people worldwide in 2019, with a global prevalence of 9.3%. It is projected to rise to 10.2% (578 million) by 2030, rising further to 10.9% (700 million) by 2045.(5) The International Diabetes Federation (IDF) predicts that by 2045, DM will impact about 700 million individuals worldwide.(6) A previous study documented that the prevalence of DM will rise from 171 million (2.8%) to 366 million (4.4%) from 2000 to 2030.(7) Although the prevalence is high, the definition of the diagnostic threshold for DM is unresolved.

There are various screening methods and tools adopted to assess glucose levels in the blood. These are random plasma glucose (RPG) test, fasting plasma glucose (FPG) test, oral glucose

tolerance test (OGTT), (8) 2-hour post-load plasma glucose test, and glycated haemoglobin (HbA1c). (3) In addition to that Benedict's reagent test and dipstick methods are also used to examine the urine samples for DM. (9) Based on these screening methods several DM diagnostic criteria were established. The diagnostic criteria for DM endorsed by World Health Organization (WHO) and the American Diabetes Association (ADA) are, FPG ≥ 126 mg/dl (7.0 mmol/L), 2-hour post-load plasma glucose ≥ 200 mg/dl (11.1 mmol/L), HbA1c $\geq 6.5\%$ (48 mmol/mol), and random plasma glucose ≥ 200 mg/dl (11.1 mmol/L) with the occurrence of clinical features specific for DM. (3, 10) WHO has further recommended repeating the tests for the asymptomatic patients with elevated values to confirm DM. (3) However, these methods are invasive, and the recommended criteria are still under debate.

The Siddha system of medicine also recommended various diagnostic methods to diagnose the diseases including *envagaithervu* (eight types of diagnostic methods), and *manikkadai nool* (circumference of the wrist). (11) *Envagaithervu* consists of *nadi* (vital vibrant), *sparisam* (palpation), *naa* (tongue examination), *niram* (colour of the skin and its appendages), *mozhi* (speech and language), *vizhi* (test related to eyes), *malam* (test related to stool), and *siruneer* (test related to urine). The Siddha literature *Pathinen Siddhar nadi saasthiram* (11) and *Theraiyar Neerkuri Vaitthiyam - Neerkuri nool - Neikuri nool Moolamum Uraiyum* (12) documented *nadi* and the urine examination are crucial methods among the *envagaithervu* for the diagnostic of diseases. The urine examination consists of *neerkuri* (physical test of urine) and *neikuri* (oil drop test of urine). (12,13) *Neerkuri* assay determines the physical characteristics of the urine such as colour, froth, sediment, weight, and smell. *Neikuri* assay exhibits various spreading patterns of oil in the urine while dropping a drop of sesame oil on the surface of the urine. The spreading patterns indicate the healthy and pathological condition of humans and forecast the curable possibilities of the disease. *Manikkadai nool* (wrist circumference) is one of the diagnostic and prognostic parameters, which gives the progress of the disease by calculating the four-finger breadths above the wrist crease are taken as the measuring points in the forearm and the length of the circumference is measured by a thread. Following that, the thread's length is measured by placing four fingers together, excluding the thumb. The total breadth of the fingers (counted numerically) indicates the body's health status. Generally, the thread ranges from four to eleven finger breadths in length. (11, 14)

The above-described Siddha diagnostic methods are non-invasive and cost-effective while providing an early diagnosis and prognosis of diseases including NM (DM). These diagnostic methods have been practiced in a little community and are non-familiar among health care, medical, and scientific sectors. Furthermore, only a marginal data is available on Siddha diagnostic methods for NM. Hence, it is crucial to identify the associations between Siddha diagnostic criteria with modern diagnostic criteria, to promote the practical application of Siddha diagnostic techniques in clinical settings. Hence, this study focused on comparing methods such as *neerkuri* and *neikuri*, *nadi*, and *manikkadai* with the WHO-recommended criteria for diagnosing DM.

Subjects and Methods

Study design and its setting

A comparative investigation was conducted to the current study with accordance with the STROBE guidelines. The study involved

newly diagnosed diabetes mellitus (DM) patients who had not yet begun any form of medication. A stratified random sampling technique was utilized to enrol DM patients, resulting a total of sixty patients ($n = 60$), comprising 31 males and 29 females, aged between 18 and 64 years as the adults exhibit physiological and cognitive maturity.

Patients' recruitment primarily screened at the outpatient and inpatient department (IPD) of the Government Siddha Medical College, Palayamkottai, (GSMCP) Tirunelveli, as well as at General Hospital Thoothukudi and in the village of Gobalasamuththiram, India. Eligible patients were identified based on an FPG level of ≥ 126 mg/dL (7 mmol/L) (3) along with symptoms such as increased urination (polyuria), significant weight fluctuations, and increased appetite (polyphagia). However, pregnant and breastfeeding mothers, individuals with other health issues, and those currently undergoing treatment with anti-diabetic medications or other therapies were excluded from the study.

All patient-related procedures were conducted in accordance with the ethical guidelines set forth in the Declaration of Helsinki. Before commencing the study, informed written consent was secured from each patient, after providing sufficient information regarding the study. Ethical approval was granted by the Institutional Ethics Committee (IEC), GSMCP (reference No. GSMC/5676/P&D/Res/IEC/2014). The trial was registered with India's Clinical Trials Registry (CTRI) under reference No. REF/2018/01/016691.

Data and sample collection

An interviewer-administered questionnaire was utilized to gather socio-demographic information along with a comprehensive medical history. Patients were scheduled to return the following day after fasting for eight hours (to investigate FPG), while blood samples were collected in a sterile environment. Additionally, spot urine samples were obtained using sterilized containers provided to the patients. Anthropometric data, including weight and height, were recorded, and thorough physical and systemic examinations were conducted to each patient.

Laboratory analysis

Blood investigation

Blood samples were collected to evaluate various parameters including FPG, aspartate aminotransferase (AST), alanine aminotransferase (ALT), and serum creatinine levels. FPG levels were determined by the enzymatic colorimetric method (GOD-PAP) (Biosystems, Australia). For AST and ALT measurements, a modified International Federation of Clinical Chemistry (IFCC) (Dialab, Australia) was employed. Serum creatinine was assessed using an enzymatic technique (Biosystems Creatinine Enzymatic, Spain). All tests including FPG were conducted with the Indiko Plus Analyzer (Turkey) at GSMCP.

Urine analysis

The urine sample was separated into two containers, one with 10 mL and the other with 50 mL.

Modern approach of urine analysis

A urinalysis was performed using a 10 mL portion of the sample, utilizing a urinalysis reagent strip (Mission URS7010029). Various parameters evaluated, including specific gravity (SG), the potential of hydrogen (pH) level, presence of protein, glucose,

urobilinogen, ketones, bile pigments, leucocytes, nitrate, and blood.

Siddha approach of Urine analysis - *neerkuri* and *neikuri*

Urine samples were collected in the early morning after an overnight fast. The samples were initially examined for *Neerkuri* by assessing physical characteristics such as colour, froth, odour, and the presence of sediment. (13) For *Neikuri* analysis, 50 mL of urine was transferred into a clean glass petri dish (3.5 inch /9 cm diameter). A single drop (0.05 μ L) of black sesame oil, extracted from sesame seeds, was gently released onto the urine surface from a height of less than 2 mm to minimize surface disturbance. (15) The observation will be made following order after application of oil; formation of shape (pattern) formed by the oil drop, following by the time taken for the appearance of the first dot (indicating the initial onset of the first hole appears on the oil surface after the oil application), and the duration until the dispersed oil pattern fully disappeared. All observations were recorded. Both *neerkuri* and *neikuri* analyses were conducted within one hour of time from the collection of urine.

Nadi

The physician rubbed the patient's palm with mild pressure. The physician then holds the patient's hand with their left hand. The index finger of the right side was positioned approximately an inch below the crease of the wrist on the radial side of the forearm, with the other fingers placed alongside it, ensuring the hand was in proper anatomical orientation. The physician used the three fingers to assess *Vatham*, *Piththam*, and *Kabham nadi*. For female patients, the assessment was conducted with the left hand, while for male patients, the right hand was used. (13)

Manikkadai

To determine the *manikkadai*, a thread was used to measure the forearm's girth at a location approximately four finger-breadths from the wrist. Following this, the length of the circumference was assessed by placing the thread on the four fingers of the patient, excluding the thumb. (11)

Statistical analysis

Data were entered and analyzed using SPSS version 18.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was determined at a 95% confidence level, with a *P* value < 0.05. Descriptive statistics were reported as means, and standard error of the mean (SEM). Frequencies with percentages were used to summarize categorical variables such as urine report, *neerkuri*, *neikuri*, *nadi*, and *manikkadai* alongside the number of patients. The inferential statistics were conducted using a One-way ANOVA and independence sample t-test to evaluate association of FPG with *neerkuri*, *neikuri*, *nadi*, and *manikkadai*. Additionally, the chi-squared test was used to compare the association between the categorical variables *neikuri*, and *nadi*.

Results

The study included sixty patients with DM initially. However, fifty-one patients adhered to the 8-hour fast (to measure FPG levels and diagnose DM in accordance with the criteria set by the WHO and the ADA), (3, 10) while the remaining nine patients cited their busy schedules and dietary habits as reasons for not adhering to the fast. Hence, data from these 51 patients were collected and analysed for the study. The study population's mean age was 48.1 ± 1.4 (mean $\pm$ SEM) years. At baseline, weight loss, excessive urination, excessive hunger (polyphagia), and excessive thirst (polydipsia) were experienced by 82.4%, 84.3%, 70.6%, and

74.5% of patients respectively. Tiredness/exhaustion was felt by 66.7%. Further, body ache, giddiness, and numbness/tingling sensation were noted in < 50% of patients. At the baseline, the mean FPG was 262.3 ± 13.0 mg/dL.

Physicochemical and biochemical parameters of the urine sample and FPG

Table 1: Physicochemical parameters of the urine sample and FPG

Physicochemical parameters	Number of patients (%)	FPG (mg/dL) (mean ± SEM)	P value
pH			
5.0	80.4	267.7 ± 14.7	F _{3,47} = 0.815, P=0.492
6.0	11.8	212.3 ± 37.8	
6.5	3.9	312.0 ± 88.0	
7.0	3.9	250.5 ± 0.5	
Specific gravity (SG)			
1.010	7.8	237.3 ± 54.3	F _{4,46} = 1.109, P=0.364
1.015	3.9	142.0 ± 1.0	
1.020	23.5	274.3 ± 39.8	
1.025	2.0	208.0 ± 0	
1.030	62.8	270.1 ± 12.3	
*FPG, Fasting plasma glucose; %, percentage; SEM, Standard error of the mean. One-way ANOVA was performed to compare the mean concentration of FPG with the physicochemical parameters of urine sample.			

Table 1 indicates, at baseline, 80.4% had a pH of 5 and 62.8% of patients had high SG (1.030) in their urine samples. The patient's urine with pH of 5 and high SG (1.030) had higher concentrations of FPG (> 265 mg/dL) when compared to those with pH > 5 and low SG (<1.030) (FPG < 250 mg/dL). Furthermore, a significant association was observed between FPG and SG ($t_{49} = -0.779$, $P < 0.001$), while no significant association was observed with pH ($t_{49} = -0.846$, $P=0.784$).

Table 2: Biochemical parameters of the urine sample and FPG

Biochemical parameters	Number of patients %	FPG (mg/dL) (mean ±SEM)	P value
Protein			
Negative	72.6	240.8 ± 13.4	F _{3,47} = 2.945, P=0.042
Trace (15 ± 0.15 mg/dL)	5.9	339.0 ± 49.9	
+ (30 ± 0.3 mg/dL)	13.7	329.4 ± 44.4	
++ (100 ± 1.0 mg/dL)	7.8	285.8 ± 48.4	
Urine glucose			
Negative	3.9	142.0 ± 1.0	F _{4,46} = 7.804, P<0.001
+ (250 ± 15 mg/dL)	31.4	196.6 ± 11.3	
++ (500 ± 30 mg/dL)	21.6	269.2 ± 21.2	
+++ (1000 ± 60 mg/dL)	29.4	303.3 ± 24.1	
++++ (≥ 2000 ± 110 mg/dL)	13.7	347.9 ± 36.2	
*FPG, Fasting plasma glucose; %, percentage; SEM, Standard error of the mean; One-way ANOVA was employed to assess the mean concentration of FPG in relation to the biochemical markers of the urine			

As presented in Table 2, 72.6% of patients had no detectable protein in their urine at baseline. The absence of urine protein correlated with lower FPG level ($< 240.8 \pm 13.4$ mg/dL). This result reached statistical significance ($P=0.042$). The patients with high urine glucose level of +++ or $\geq 2000 \pm 110$ mg/dL, exhibited a significant higher concentration of FPG (347.9 ± 36.2 mg/d)

($F_{4,46} = 7.804$, $P < 0.001$) than the patients with negative urine glucose (142.0 ± 1.0 mg/dL). No participants exhibited elevated serum creatinine levels, ALT, and AST in blood and urine ketones, urobilinogen, bile pigments, nitrate, or leucocytes in urine at baseline.

Characteristics of the urine samples based on Siddha aspect; neerkuri, neikuri, nadi, and manikkadai and their association with FPG

Examination of neerkuri

As shown in Table 3, the patient with *Seerana pakuva neer* (colour of urine like as fruit of *Citrus medica* L.) had a lower concentration of FPG (199.6 ± 15.4 mg/dL), when compared to the others ($t_{49} = 2.497$, $P = 0.016$). No significant association of FPG was found with other characteristics of urine samples including froth, and sedimentation. However, a statistically significant relationship was noted with the odour and FPG ($t_{49} = -0.22$, $P = 0.008$).

Table 3: Characteristics of urine (neerkuri) samples and FPG

Characteristics of the urine samples	No. of patients %	FPG (mg/dL) (mean $\pm$ SEM)	P value
Urine colour			
Colour of wet straw water - <i>Seerana apakuva neer</i>	52.9	269.2 ± 20.3	$F_{4,46} = 1.656$, $P = 0.117$
Colour of <i>Citrus medica</i> L. fruit - <i>Seerana pakuva neer</i>	19.6	199.6 ± 15.4	
Colour of <i>Atalandia monophylla</i> (Roxb.) A. DC. fruit - <i>Soottai tharakoodiya neer</i>	15.7	291.6 ± 24.3	
Clear urine - <i>Thelintha neer</i>	7.8	294.5 ± 54.6	
Colour of flame - <i>Athiuttina neer</i>	3.9	300.0 ± 0.0	
Odour			
Odourless urine samples	86.3	262.2 ± 15.0	$t_{49} = -0.22$, $P = 0.008$
Odorous urine samples	13.7	263.0 ± 12.0	
Sedimentation			
Urine samples without sediment	100	262.3 ± 13.0	$t_{49} = -0.005$, $P = 0.079$
Urine samples with sediment	0.0	-	
Froth			
Urine samples without foam	88.2	262.4 ± 9.0	$t_{49} = -0.005$, $P = 0.079$
Urine samples with foam	11.8	251.8 ± 8.5	

*FPG, Fasting plasma glucose; %; percentage; SEM, Standard error of the mean. Independent Sample T test and One-way ANOVA were used to compare the mean concentration of FPG with the characteristics of urine sample.

Examination of neikuri

Table 4 indicates that four types of *neikuri* that were identified based on the *neikuri* testing of the urine sample. The patients with *Kabhavatha neikuri* had a significantly higher FPG (322.7 ± 43.4 mg/dL) when compared to other types of *neikuri* ($F_{3,47} = 3.595$, $P = 0.02$). The lowest concentration of FPG was noted in patients

with *Vathakabham* (179.0 ± 28.0 mg/dL). Further, the total time taken to scatter the oil drop was less in the patient with *Vathapiththam* and *Piththavatham neikuri* when compared to *Kabhavatham* and *Vathakabha neikuri*.

Table 4: Characteristics of neikuri and FPG

Neikuri (type)	Number of patients %	FPG (mg/dL) (mean $\pm$ SEM)	Timing of the first dot appearance in neikuri (minutes)	Total duration of neikuri scatter (minutes)
<i>Vathakabham</i>	5.9	179.0 ± 28.0	188.7 ± 85.3	971.3 ± 327.7
<i>Piththavatham</i>	45.1	255.5 ± 20.2	118.9 ± 16.3	669.7 ± 83.3
<i>Vathapiththam</i>	39.2	272.5 ± 19.4	135.8 ± 21.2	767.5 ± 112.0
<i>Kabhavatham</i>	9.8	322.7 ± 43.4	342.3 ± 90.3	1449.3 ± 607.8

*FPG, Fasting plasma glucose; %; percentage; SEM, Standard error of the mean. The model was significant ($F_{3,47} = 3.595$, $P = 0.02$). One-way ANOVA was used to assess variations in the mean concentration of FPG with the characteristics of *neikuri*.

Furthermore, 43 (84.3%) patients were noted with irregular (did not exhibit a well-defined margin or a recognizable geometric pattern - indicating *Vatham*), while 08 patients (15.7%) had a round shape of oil drop (indicating *Piththam*) in their urine samples when comparing the shape of the oil drops. Patients whose urine samples exhibited an irregular *neikuri* shape had marginally higher FPG levels (269.3 ± 14.7 mg/dL) compared to those with a round *neikuri* shape (FPG: 224.5 ± 22.5 mg/dL) ($t_{49} = 0.178$, $P = 0.053$). No participants displayed a pearl-shaped form (indicative of *Kabham*) in their urine.

Examination of nadi (vital vibrant)

A special rhythm of movement called the 'Pendulum movement' of *nadi* was noted in all the DM (NM) patients. As exhibited in Table 5 substantial correlation was observed between FPG and *nadi* ($F_{3,47} = 3.875$, $P = 0.015$). Patients with *Kabhavatha nadi* demonstrated notably higher FPG levels (390.3 ± 39.8 mg/dL) than those with other *nadi* types (254.3 ± 12.7 mg/dL) ($F_{1,49} = 6.731$, $P = 0.012$). FPG concentrations were lower (166.8 ± 23.9 mg/dL) in participants with *Vathakabha nadi* compared to other *nadi* types.

Table 5: FPG and Nadi (n = 51)

Nadi	No. of patients %	FPG (mg/dL) (mean $\pm$ SEM)
<i>Vathapiththam</i>	43.1	263.9 ± 17.0
<i>Piththavatham</i>	43.1	260.6 ± 20.7
<i>Vathakabham</i>	7.8	166.8 ± 23.9
<i>Kabhavatham</i>	5.9	390.3 ± 39.8

*%; percentage. The model was significant ($F_{3,47} = 3.875$, $P = 0.015$). One-way ANOVA was applied to evaluate differences in mean FPG levels across different *nadi* types.

Furthermore, the relationship between *neikuri* and *nadi* was examined to validate the diagnosis (Table 6). More than 80% of *Vathapiththam* and *Piththavatham* patients identified by the

neikuri that they already identified by *nadi*. Out of three *Kabhavatham* patients diagnosed via *nadi*, two (66.7%) were correctly recognized using the *neikuri* method. This finding indicated a statistically significant correlation between *nadi* and *neikuri* ($P < 0.001$).

Table 6: Correlation of *neikuri* with *nadi* (n = 51)

		<i>Neikuri</i>			
		VK (03)	KV (03)	PV (23)	VP (22)
<i>Nadi</i>	VK (04)	03 (75%)	-	-	01 (25%)
	KV (03)	-	02 (66.7%)	-	01 (33.3%)
	PV (22)	-	01 (4.5%)	19 (86.4%)	02 (9.1%)
	VP (22)	-	-	04 (18.2%)	18 (81.8%)

%; percentage; VP - *Vathapiththam*, PV - *Piththavatham*, KV - *Kabhavatham*, VK - *Vathakabham*. Crosstab analysis with the chi-square test was conducted to examine the relationship between *nadi* and *neikuri* and the model was significant ($P < 0.001$).

Examination of *manikkadai*

Nearly 26 (54.9 %) patients had $8\frac{1}{4}$ finger breadths, with a mean FPG of 258.5 ± 19.0 mg/dL. There was no significant association ($F_{2,48}=0.362$, $P=0.698$) found between *manikkadai* with FPG.

However, the high (279.6 ± 27.2 mg/dL) and low (249.3 ± 22.6 mg/dL) mean of FPG were observed when the *manikkadai* above and below $8\frac{1}{4}$ finger breadths respectively and this difference was statistically significant ($F_{17,33}=2.972$ $P=0.01$).

Discussion

The present study assessed Siddha diagnostic practices, specifically *neerkuri*, *neikuri*, *nadi*, and *manikkadai*, in comparison with modern diagnostic criteria for NM (DM). Specifically, this study found a correlation between FPG and *neerkuri*, *neikuri*, *nadi*, and *manikkadai*. Furthermore, a collaboration was noted between the *neikuri* and *nadi*. Limited literature exists on the overall effectiveness of traditional medicine for specific diseases. (16) However, there has been little research comparing Siddha diagnostic techniques, particularly *neerkuri*, *neikuri*, *nadi*, and *manikkadai*, with modern diagnostic methods for DM. One earlier study by Ekka Ranjita et al. (2013) explored the prognostic value of *taila bindu pariksha* in *prameha*. (17) In this context, the present study represents a novel and innovative approach.

In current study, the majority of patients (80.4%) had a pH of 5 in their urine and had higher FPG (267.7 ± 14.7 mg/dL) than the others with pH > 5. This may due to diabetes, and starvation which influence the acidity in urine. (18) In addition, fermentation of sugar in urine by microorganisms may be a reason for acidic urine. Most patients (62.8%) were observed with high specific gravity of urine (SG 1.030) and high FPG, albeit these differences were statistically significant. The specific gravity of urine is mainly influenced by factors such as fluid intake, profuse sweating, and diuretic-induced urine output. (18) High urine volume along with glucose in the urine could be responsible for an elevated specific gravity. The current study documented the substantial relationship between FPG and urine glucose levels. A previous study also documented the correlation between FPG and urine glucose levels. (19) There was a considerable interaction

between FPG and urine protein. Negative urine protein was detected in 72.6% of patients. In comparison to positive urine protein samples, negative urine protein samples exhibited a lower FPG. The positive urine protein findings may indicate that the patients had been suffering from renal pathology for a long period due to the silent DM. (20)

The color of urine can reflect the dosha influencing the patient. *Seerana pakkuva neer*, *seerana apakkuva neer*, *soottai tharakkoodiya neer*, and *athiuttina neer* suggest a predominance of *Piththam*, while *thelintha neer* indicates that *Vatham* is primarily involved. (13) According to *Thirumoolar Vaithiyam Karukkadai* 600, (2) *Piththam* and *Vatham* are the main doshas responsible for NM. Moreover, evidence suggests that when complications arise in patients with NM, the dosha shifts towards *Kabham*. Urine color may help identify the type of NM in patients already diagnosed with the condition. It indicated that it is not possible to diagnose the NM by the colour of urine in all circumstances.

Froth urine was observed in 11.8% of patients, and the readings of the *neikuri* and *nadi* were interpreted as *Kabhavatham*. Furthermore, *Seerana pakkuva neer* (colour of *Citrus medica*. L. fruit) was observed in 19.6% of patients with low FPG (199.6 ± 15.4 mg/dL). The terms '*Seeranam*' and '*pakkuvam*' refer to digestion and the perfect state of the soul respectively. (21, 22) Hence, it indicates that the patient's digestion was normal, and the body was not affected by the disease (maybe in the initial stage of the disease).

Among the patients, 84.3% displayed irregular *neikuri* shapes, while 15.7% showed round shapes. According to *Noi Naadal Noi Muthal Naadal Thirattu*, *neikuri* can appear in irregular, round, and pearl forms, corresponding to *Vatham*, *Piththam*, and *Kabham*, respectively. (13) Based on the literature, 84.3% and 15.7% of the patients were affected by *Vatham* and *Piththam* respectively. Contrarily, the current study establishes that the affected doshas (*Vathapiththam*, *Piththavatham*, *Vathakabham*, and *Kabhavatham* NM) can be determined by examining the *neikuri*'s shape, along with the time until the first dot appears and the duration for the oil drop to fully disperse. When comparing *neikuri* with *nadi*, the diagnostic accuracy improves by considering both the pattern of the *neikuri* and the duration from the initial appearance of the first dot to the complete dispersal of the oil drop (total time of scattered). Furthermore, the study documented that the FPG levels of the *Vathapiththam* and *Piththavatham* patients were lower when compared with the *Kabhavatham* patients.

The *nadi* exhibited a pendulum-like movement in each individual diagnosed with DM in the present study. The Siddha literature *Nadi Vaagadam* (2014) documents, the movement resembled the vibration of a Veena string, which is characteristic of *Piththavatha* disorders. (23) Four subtypes of NM (*Vathapiththam*, *Piththavatham*, *Vathakabham*, and *Kabhavatham*) were identified through *nadi* examination in this study. Although Ramachandran (2000) classified twenty-four forms of *neerizhivu* under seven categories. (24) The present investigation further demonstrated that variations in plasma glucose levels could be reflected through *nadi* assessment. Patients diagnosed with *Vathapiththa* and *Piththavatha* NM showed comparatively lower FPG levels than those with *Kabhavatha* NM. These findings suggest that *nadi* examination may serve as a potential diagnostic indicator for DM. Moreover, a statistically significant association ($P < 0.001$) was found between *nadi* and *neikuri* readings, confirming that both parameters align in diagnostic interpretation.

In the current study, 54.9% of the patients had an 8 ¼ finger breadths of *manikkadai nool*. According to *Panthinen Siddhar arulichcheitha nadi sasthiram*, (11) the *manikkadai nool* measures 8¼ finger breadths, it signifies the presence of *Piththam* imbalances, fever, *kamiyam*, *piramiyam*, and head diseases. Additionally, *Mathu piramiyam* (a particular sort of *piramiyam*) was regarded as diabetes mellitus. (25) Furthermore, *Thirumoolar vaiththiyam karukkadai* 600 (2) explains that as *piththam* increases, it combines with *Vatham* to cause NM (DM). According to *Panthinen Siddhar arulichcheitha nadi sasthiram*, (11) the *Piththam* disorders also denote the *manikkadai nool* 8¼. This suggests that the primary cause of DM may be an imbalance of *Piththam*. Furthermore, patients with higher than 8¼ *manikkadai nool* had high FPG (279.6 ± 27.2 mg/dL). The lack of significance was evident with FPG and *manikkadai nool* in the current study ($P=0.698$). The *manikkadai nool* measurement varied from 7.5 to 10, indicating the presence of 10 different categories. However, the sample size was insufficient for each group. This might be the reason for the lack the significance.

Conclusion

The current study concluded that the Siddha diagnostic method of *neerkuri* and *neikuri* facilitate the assessment of the clinical states of DM patients. In addition, it could be used to find out the stages of DM based on *Vatham*, *Piththam*, and *Kabham*. The *nadi* may serve as a diagnostic parameter of DM, as specially pendulum movement of *nadi* has felt in DM patients. Moreover, elevated *manikkadai nool* values may serve as an indicator of poor glycemic control. In conclusion, the Siddha diagnostic techniques discussed above may serve as effective alternative tools to modern diagnostic methods for diagnosing DM.

References

1. Peris Urbana Ivy B, Rani Hema Malini R. Modern pulsometer for traditional Indian Medicine. *IJCA*. November,2010; 9(3); 19-23. doi: 10.5120/1366-1841.
2. Arumuka Suvamikal. *Thirumoolar Vaiththiyam Karukkadai* 600. 1st edition. Chennai; B. Raththina Nayakar and Sons; 2010. 15 p.
3. World Health Organization. Global report on diabetes. <https://www.who.int/publications/i/item/9789241565257> dated 13-07-2024 time 15:20 IST.
4. Ozougwu J.C, Obimba K.C, Belonwu C.D, Unakalamba C.B. The pathogenesis and pathophysiology of type 1 and type 2 diabetes mellitus. *J. Physiol. Pathophysiol*. September,2013; 4(4); 46-57.
5. Pouya Saeedi, Inga Petersohn, Paraskevi Salpea, Belma Malanda, Suvi Karuranga, Nigel Unwin, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9 edition. *Diabetes Res and Clin Pract*. September,2019; 157; 1-10.
6. World Bank Group. Diabetes prevalence (% of population ages 20 to 79) - Sri Lanka. International Diabetes Federation, Diabetes atlas. <https://data.worldbank.org/indicator/SH.STA.DIAB.ZS?locations=LK> dated 15-01-2024 time 14:50 IST.
7. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes care*. May,2004; 27(5); 1047-53. doi: 10.2337/diacare.27.5.1047.
8. U.S. Department of Health and Human Services Food and Drug Administration Center for Drug Evaluation and Research (CDER). Guidance for Industry, Diabetes Mellitus: Developing Drugs and Therapeutic Biologics for Treatment and Prevention. [file:///C:/Users/HP/Downloads/FDA-2008-D-0118-0003_attachment_1%20\(3\).pdf](file:///C:/Users/HP/Downloads/FDA-2008-D-0118-0003_attachment_1%20(3).pdf) dated 23-08-2024 time 10:30 IST.
9. Chaturvedi S, Jain N, Bhatia A. Evaluation of semi-quantitative methods for protein and sugar estimation in urine. *Indian J Pathol Microbiol*. October,2001; 44(4); 399-401.
10. American Diabetes Association. 2. Classification and diagnosis of diabetes: standards of medical care in diabetes – 2021. *Diabetes Care* 2021; 44(Suppl. 1): 15-33. <https://doi.org/10.2337/dc21-S002>.
11. Kalaththur Kanthasami Muthaliyar. *Pathnen Siddhar arulichcheitha nadi saasthiram*. 1st edition. Chennai; B. Raththina Nayakar and Sons; 2012. 36, 118-123 p.
12. Ramachandran S P. *Theraiyar Neerkuri Vaiththiyam - Neerkuri nool - Neikuri nool Moolamum Uraiyum*. 1st. Chennai; Thamarai library; 2015. 1-31 p.
13. Shanmugavelu M. *Noi naadal Noi muthal naadal thirattu*. 1st edition. Chennai; Department of Indian Medicine and Homeopathy; 1967. 129-131, 282-325 p.
14. Susila R, Arunadevi R, Christian G.J, Elansekaran S, Ramamurthy M, Logamaniyan M. Validation of Siddha Diagnostic Procedures for Madhu Piramiyam with the Aid of Conventional Diagnostic Procedures. *IJAAYUSH*. July,2014; 3(1); 197-208.
15. Vidya dharshini K, Victoria S, Krishnaveni M. Standardization of Neikuri (oil drop test of urine) - A Siddha diagnostic method. *Int. J. Ayur. Pharma Research*. September,2018; 6; 24-30.
16. Claudia M. Witt, Andreas Michalsen, Stephanie Roll, Antonio Morandi, Shivnarain Gupta, Mark Rosenberg, et al. Comparative effectiveness of a complex Ayurvedic treatment and conventional standard care in osteoarthritis of the knee - study protocol for a randomized controlled trail. *Biomed central*. May,2013; 14; 1-10.
17. Ekka Ranjita, Chadrakar Anukul, Upadhyay BN. Assessment of prognostic aspect of Prameha (Diabetes mellitus) by Taila bindu pariksha. *IAMJ*. March-April,2013; 1(2); 1-4.
18. Queremel Milani D.A, Jialal I. Urinalysis. *StatPearls*; 2023. <https://www.ncbi.nlm.nih.gov/books/NBK557685/> dated 15-09-2024 time 11:30 IST
19. Morris L.R, McGee J.A, Kitabchi A.E. Correlation between plasma and urine glucose in diabetes. *Ann Intern Med*. April,1981; 94(4 pt 1); 469-471.
20. Jeerasuwannakul B, Sawunyavisuth B, Khamsai S, Sawanyawisuth K. Prevalence and risk factors of proteinuria in patients with type 2 diabetes mellitus. *APST*. July,2021; 26(4); 26.
21. Sambasivam Pillai T.V. *Siddha Medical Dictionary Vol. IV – Part I (Tamil-English Dictionary)*. 2nd edition. Chennai; Department of Indian Medicine and Homoeopathy; 1998. 95 p.
22. Sambasivam Pillai T.V. *Tamil-English Dictionary of Medicine, Chemistry, Botany and Allied Sciences (Based on Indian Medical Science)*, Vol. V. 1st edition. Chennai; Government of Tamil Nadu; 1998. 14 p.
23. Sourirajan M. *Nadi Vaakadam*. 1st edition. Thanjavur; Director, Saraswathi Mahal Library; 2014. 55 p.
24. Ramachandran S.B. *Uyir kakkum Siddha maruththuvam*. 1st edition. Chennai; Thamarai library; 2000. 360-363 p.
25. World Health Organization. WHO international standard terminologies on Siddha Medicine. <https://www.who.int/publications/i/item/9789240064973> dated 16-09-2024 time 15:30 IST.
