# *The Effect of Blood Sugar Control and Association Among Elderly Patients With Type 2 Diabetes in Kantang District Southern Thailand*

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**Abstract**
The number of elderly patients with type 2 diabetes mellitus increases every year. This study aimed to compare the effect of blood sugar control and determine factors associated with blood sugar levels in patients with type 2 diabetes aged 60 years and over living in subdistrict health-promoting hospital (SHPH) and community hospital in Kantang District, southern Thailand. A retrospective comparative study was conducted using a database from the hospital and SHPH from January to December 2022. The data were analyzed by the Chi-square test, Fisher's Exact Test, Independent t-test, Wilcoxon rank sum test, and Spearman's rank correlation coefficient. It found that 222 patients received treatment from SHPH and 208 patients attended healthcare at community hospitals. Those patients who received treatment at community hospitals had lower hemoglobin A1C (HbA1c) ($p<0.001$) and Fasting Blood Sugar (FBS)($p=0.0251$) than those patients who received treatment at SHPH. Factors associated with HbA1C of patients who received treatment at SHPH included total cholesterol ($p=0.0308$), triglycerides ($p=0.0017$), estimated glomerular filtration rate (eGFR) ($p=0.0002$), and FBS ($p<0.001$). Patients who received treatment at community hospitals found that total cholesterol ($p=0.0388$), eGFR ($p=0.0101$), and FBS ($p<0.001$) had correlated with HbA1C. The study emphasizes the necessity for customized interventions in subdistrict health-promoting hospitals (SHPH) to effectively manage blood sugar levels in older adult patients with type 2 diabetes. Improving treatment protocols can enhance quality care.

Keywords: Type 2 Diabetes, Subdistrict Health Promoting Hospitals, Community Hospital

## Introduction

Diabetes mellitus (DM) is one of the chronic non-communicable diseases caused by high blood sugar levels because of abnormalities in insulin secretion (American Diabetes Association, 2022). Insulin is a synthetic hormone secreted from beta cells in the islet cells of Langerhans of the pancreas. Its role is to help maintain the balance of sugar levels in the bloodstream(Roden & Shulman, 2019). Insulin deficiency or abnormalities in insulin secretion result in high blood sugar levels. Such insulin imbalances also result in abnormalities in the metabolism of carbohydrates, proteins, and fats (Zheng et al., 2018).

The International Diabetes Federation found that in 2021, there were approximately 537 million people with diabetes worldwide and it is estimated that by 2045, the number of people with diabetes worldwide will increase to 783 million people (Magliano & Boyko, 2021). The United Nations has declared diabetes to be a public health problem that all countries around the world must cooperate to strictly control. Diabetes has an increasing number of patients every year. It is a silent danger that affects health, causing illness, disability, loss of health, and quality of life, and is one of the ten deaths of people worldwide. It affects the burden of medical care and costs for families, communities, and the nation. Diabetes is responsible for the deaths of up to 6.7 million people, or 1 death every 5 seconds and the prevalence of type 2 diabetes among the elderly continues to rise annually (International Diabetes Federation, 2021).

Effective management of diabetes requires continuous and systematic care, especially having a network that connects health facilities to the community to collaboratively improve patient health, reduce hospitalization rates, improve clinical outcomes, and reduce the incidence of complications (American Diabetes Association, 2021). To alleviate this strain, Thailand has established a primary medical system aimed at managing diabetic patients through Subdistrict Health Promoting Hospitals (SDHPH) and community hospitals. The studies demonstrating effective blood sugar control and identifying factors associated with blood sugar levels in secondary care settings (Dauod, 2018), remains unclear whether similar outcomes can be achieved in type 2 diabetic patients between SDHPH and community hospitals.

## Objective

This study aimed to compare blood sugar control outcomes and identify factors related to blood sugar levels in patients aged 60 and over with type 2 diabetes at SDHPH and Community Hospital in Kantang District.

## Materials and Methods

The institutional database and patients' files were retrospectively analyzed as soon as approval from the local ethics committee was obtained (approval date: 20-10-2023, approval number: 0528). Patients with type 2 diabetes mellitus over 60 years of age were selected from patients receiving treatment at the subdistrict health-promoting hospital (SHPH) and community hospital in Kantang District, Trang Province, Thailand. between January and December 2022. Patients with incomplete data were not included in the study. The sample group used in this study was 430 people. The chi-square test was used for data analysis. Fisher's exact test Independent t-test Wilcoxon rank sum test and Spearman's rank correlation coefficient.

## Results

Those patients who received treatment at the community hospital had lower HbA1c ($p<0.001$) and FBS ($p=0.0251$) than those patients who received treatment at SDHPH as shown in Table 1and 2. Factors associated with HbA1C of patients who received treatment at SDHPH included total cholesterol ($p=0.0308$), triglycerides ($p=0.0017$), estimated glomerular filtration rate (eGFR) ($p=0.0002$), and FBS ($p<0.001$) as shown in Table 3. Patients who received treatment at community hospitals found total cholesterol ($p=0.0388$), eGFR ($p=0.0101$), and FBS ($p<0.001$) correlated with HbA1C as shown in Table 4.

Table 1. Socio-demographic characteristics of the population

| Variables | Total (n = 430) | SDHPH (n = 222) | Community Hospital (n = 208) | p-value |
|---|---|---|---|---|
| **Gender n (%)** | | | | |
| Male | 153 (35.58) | 71 (31.98) | 82 (39.42) | |
| Female | 277 (64.42) | 151 (68.02) | 126 (60.58) | 0.107[C] |
| **Age (years)** | | | | |
| 60 - 69 | 284 (66.05) | 147 (66.22) | 137(65.87) | |
| 70 - 79 | 120 (27.91) | 65 (29.28) | 55 (26.44) | |
| ≥ 80 | 26 (6.05) | 10 (4.50) | 16 (7.69) | 0.347[C] |
| **Religion n (%)** | | | | |
| Buddhism | 317 (73.72) | 162 (72.97) | 155 (74.52) | |
| Islam | 109 (25.35) | 56 (25.23) | 53 (25.48) | |
| Christianity | 4 (0.93) | 4 (1.80) | 0 (0.00) | 0.206[F] |
| **Hemoglobin A1c (mg%)** | | | | |
| <7 | 174 (40.47) | 68 (30.63) | 106 (50.96) | |
| ≥ 7 | 256 (59.53) | 154 (69.37) | 102 (49.04) | <0.001[C]* |
| **Cholesterol (mg/dL)** | | | | |
| < 200 | 321 (74.65) | 167 (75.23) | 154 (74.04) | |
| 200 - 239 | 77 (17.91) | 41 (18.47) | 36 (17.31) | |
| ≥ 240 | 32 (7.44) | 14 (6.31) | 18 (8.65) | 0.639[C] |
| **High-density lipoprotein; HDL (mg/dL)** | | | | |
| < 40 | 98 (22.79) | 50 (22.52) | 48 (23.08) | |
| 40 - 59 | 223 (51.86) | 112 (50.45) | 111 (53.37) | |
| ≥ 60 | 109 (25.35) | 60 (27.03) | 49 (23.56) | 0.705[C] |
| **Low-density lipoprotein; LDL (mg/dL)** | | | | |
| < 100 | 256 (59.53) | 135 (60.81) | 121 (58.17) | |
| 100 – 129 | 94 (21.86) | 48 (21.62) | 46 (22.12) | |
| 130 – 159 | 50 (11.63) | 27 (12.16) | 23 (11.06) | |
| 160 – 189 | 19 (4.42) | 8 (3.60) | 11 (5.29) | |
| ≥ 190 | 11 (2.56) | 4 (1.80) | 7 (3.37) | 0.742[C] |
| **Triglyceride (mg/dL)** | | | | |
| < 150 | 285 (66.28) | 155 (69.82) | 130 (62.50) | |
| 150 – 199 | 79 (18.37) | 34 (15.32) | 45 (21.63) | |
| 200 – 499 | 66 (15.35) | 33 (14.86) | 33 (15.87) | |
| ≥ 500 | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0.195[C] |
| **Fasting Blood Sugar (mg/dL)** | | | | |
| < 100 | 41 (9.53) | 18 (8.11) | 23 (11.06) | |

| Variables | Total (n = 430) | SDHPH (n = 222) | Community Hospital (n = 208) | p-value |
|---|---|---|---|---|
| 100 -125 | 389 (90.47) | 204 (91.89) | 185 (88.94) | |
| ≥126 | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0.298[C] |
| **estimated Glomerular Filtration Rate (mL/min/1.73m$^2$)** | | | | |
| Stage 1 (≥ 90) | 216 (50.23) | 109 (49.10) | 107 (51.44) | |
| Stage 2 (60-89) | 175 (40.70) | 91 (40.99) | 84 (40.38) | |
| Stage 3A (45-59) | 28 (6.51) | 13 (5.86) | 15 (7.21) | |
| Stage 3B (30-44) | 7 (1.63) | 6 (2.70) | 1 (0.48) | |
| Stage 4 (15-29) | 3 (0.70) | 3 (1.35) | 0 (0.00) | |
| Stage 5 (<15) | 1 (0.23) | 0 (0.00) | 1 (0.48) | 0.178[F] |

SDHPH = SubDistrict Health Promoting Hospital

[F] = Fisher's exact test, [C] = Chi-Square Test

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

Table 2. Socio-demographic characteristics of the population

| Variables | Total (n = 430) | SDHPH (n = 222) | Community Hospital (n = 208) | p-value |
|---|---|---|---|---|
| **Age (years) n (%)** | | | | |
| $\bar{\chi}$ ± S.D. | 67.92 ± 6.59 | 67.86 ± 6.30 | 68.00 ± 6.91 | 0.7764[W] |
| Median (25th-75th percentile) | 67.00 (71-63) | 66.00 (74-64) | 67.00 (73-63) | |
| Min-Max | 60.00-95.00 | 60.00-95.00 | 60.00-93.00 | |
| **HbA1C (mg%)** | | | | |
| $\bar{\chi}$ ± S.D. | 7.67 ± 1.79 | 7.94 ± 1.70 | 7.39 ± 1.85 | <0.001[W]* |
| Median (25th-75th percentile) | 7.3 (8.5-6.4) | 7.5 (8.9-6.8) | 6.9 (7.9-6.15) | |
| Min-Max | 4.4-16.4 | 4.9-14.3 | 4.4-16.4 | |
| **Cholesterol (mg/dL)** | | | | |
| $\bar{\chi}$ ± S.D. | 175.12 ± 40.54 | 173.98 ± 38.01 | 176.33 ± 43.14 | 0.8041[W] |
| Median (25th-75th percentile) | 169 (200-146) | 169 (199-147) | 169 (145-201.5) | |
| Min-Max | 76-337 | 83-337 | 76-335 | |
| **High-density lipoprotein; HDL (mg/dL)** | | | | |
| $\bar{\chi}$ ± S.D. | 50.12 ± 14.41 | 50.79 ± 14.16 | 49.41 ± 14.68 | 0.3202[T] |
| Median (25th-75th percentile) | 48.5 (60-40) | 49 (61-41) | 48 (58-40) | |
| Min-Max | 17-95 | 61-41 | 17-88 | |
| **Low-density lipoprotein; LDL (mg/dL)** | | | | |
| $\bar{\chi}$ ± S.D. | 97.80 ± 38.79 | 96.42 ± 35.90 | 99.26 ± 41.11 | 0.7487[W] |
| Median (25th-75th percentile) | 90 (120-70) | 90 (118-71) | 90 (121-70) | |
| Min-Max | 23-264 | 28-264 | 23-260 | |
| **Triglyceride (mg/dL)** | | | | |
| $\bar{\chi}$ ± S.D. | 136.57 ± 65.78 | 134.24 ± 65.60 | 139.06 ± 66.04 | 0.3296[W] |
| Median (25th-75th percentile) | 119 (167-89) | 119 (162-88) | 122 (172.5-91.5) | |
| Min-Max | 29-448 | 29-396 | 31-448 | |
| **Fasting Blood Sugar (mg/dL)** | | | | |
| $\bar{\chi}$ ± S.D. | 149.34 ± 50.24 | 154.26 ± 53.24 | 144.101 ± 46.38 | 0.0251[W]* |
| Median (25th-75th percentile) | 136 (167-115) | 141 (179-120) | 133.5 (160.5-110.5) | |
| Min-Max | 62-417 | 62-417 | 77-358 | |
| **estimated Glomerular Filtration Rate (mL/min/1.73m2)** | | | | |
| $\bar{\chi}$ ± S.D. | 86.23 ± 17.19 | 84.93 ± 17.99 | 87.62 ± 16.21 | 0.2830[W] |

| Variables | Total (n = 430) | SDHPH (n = 222) | Community Hospital (n = 208) | p-value |
|---|---|---|---|---|
| Median (25th-75th percentile) | 90.19 (97.96-77.81) | 89.56 (97.32-73.89) | 90.52 (98.385-82.06) | |
| Min-Max | 5.13-120.66 | 28.08-115.51 | 5.13-120.66 | |

SDHPH = SubDistrict Health Promoting Hospital
$^{T}$ = t-test, $^{W}$ = Wilcoxon rank sum test
* Correlation is significant at the 0.05 level (2-tailed).

Table 3. Spearman's rho correlation coefficients between selected metabolic variables for SubDistrict Health Promoting Hospital

| Variables | Age | TC | HDL | LDL | TG | eGFR | FBS | HbA1c |
|---|---|---|---|---|---|---|---|---|
| **Age** | 1.0000 | | | | | | | |
| **TC** | -0.0012 | 1.0000 | | | | | | |
| **HDL** | -0.0506 | 0.0519 | 1.0000 | | | | | |
| **LDL** | 0.0430 | 0.9170** | -0.1509* | 1.0000 | | | | |
| **TG** | -0.0022 | 0.2923** | -0.5177** | 0.1912** | 1.0000 | | | |
| **eGFR** | -0.5231** | 0.0708 | 0.1460* | 0.0241 | -0.0406 | 1.0000 | | |
| **FBS** | -0.0869 | 0.2041** | 0.0186 | 0.1443* | 0.1557* | 0.1931** | 1.0000 | |
| **HbA1c** | -0.0911 | 0.1450* | -0.0481 | 0.1012 | 0.2096** | 0.2454** | 0.6406** | 1.0000 |

TC = Total Cholesterol, HDL =High density lipoprotein, LDL = Low-density lipoprotein, TG =Triglycerides, eGFR = estimated Glomerular Filtration Rate, FBS = Fasting Blood Sugar, HbA1c = Hemoglobin A1c
** Correlation is significant at the 0.01 level (2-tailed)., * Correlation is significant at the 0.05 level (2-tailed).

Table 4. Spearman's rho correlation coefficients between selected metabolic variables for Community Hospital

| Variables | Age | TC | HDL | LDL | TG | eGFR | FBS | HbA1c |
|---|---|---|---|---|---|---|---|---|
| **Age** | 1.0000 | | | | | | | |
| **TC** | -0.1099 | 1.0000 | | | | | | |
| **HDL** | 0.0126 | 0.0327 | 1.0000 | | | | | |
| **LDL** | -0.1453* | 0.9292** | -0.1704* | 1.0000 | | | | |
| **TG** | 0.0275 | 0.2958** | -0.5044** | 0.1855** | 1.0000 | | | |
| **eGFR** | -0.4336** | 0.0345 | 0.0502 | 0.0707 | -0.1578* | 1.0000 | | |
| **FBS** | -0.1426* | 0.2174** | 0.0048 | 0.1806** | 0.1259 | 0.2002** | 1.0000 | |
| **HbA1c** | -0.1299 | 0.1434* | 0.0360 | 0.0869 | 0.1274 | 0.1781* | 0.7082** | 1.0000 |

TC = Total Cholesterol, HDL =High density lipoprotein, LDL = Low-density lipoprotein, TG =Triglycerides, eGFR = estimated Glomerular Filtration Rate, FBS = Fasting Blood Sugar, HbA1c = Hemoglobin A1c
** Correlation is significant at the 0.01 level (2-tailed)., * Correlation is significant at the 0.05 level (2-tailed).

## Discussion and Conclusion

The study compared patients with type 2 diabetes treated at SDHPH and Community Hospitals in Kantang District. The results showed significant differences in mean of HbA1C and FBS between the two groups ($p<0.001$, $p=0.0251$, respectively). The results indicated that patients who were treated at Community Hospitals had lower levels of HbA1C and FBS

than those who received care at SDHPH which is contrary to previous findings; emphasizing the role of primary health care in diabetes management (Dauod, 2018). This disparity may reflect shortcomings in the SDHPH system. Challenges in empowering DM patients were evident, with factors like total cholesterol, triglycerides, eGFR, and FBS, significantly associated with HbA1C in both settings. Previous studies also highlighted lipid profile, FBS, and eGFR as key factors in diabetes control (Sanal et al., 2011). Understanding these factors can inform Public Health Officers about treatment decisions and address patient-specific issues. Future research should explore effective strategies for DM care, including medication adherence and dietary control.

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