Prevalence and Management of Diabetes and Associated Risk Factors by Regions of Thailand

Third National Health Examination Survey 2004

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OBJECTIVE — The aim of this study was to determine the prevalence of diabetes and impaired fasting glucose (IFG) and their association with cardiovascular risk factors and to evaluate the management of blood glucose, blood pressure, and cholesterol in individuals with diabetes by geographical regions of Thailand.

RESEARCH DESIGN AND METHODS — With the use of a stratified, multistage sampling design, data from a nationally representative sample of 37,138 individuals aged ≥15 years were collected using questionnaires, physical examination, and blood samples.

RESULTS — The prevalence of diabetes and IFG weighted to the national 2004 population was 6.7% (6.0% in men and 7.4% in women) and 12.5% (14.7% in men and 10.4% in women), respectively. Diabetes was more common in urban than in rural men but otherwise prevalence was relatively uniform across geographical regions. In more than one-half of those with diabetes, the disease had not been previously diagnosed, although the majority of those with diabetes were treated with oral antiglycemic agents or insulin. The prevalence of associated risk factors was high among individuals with diabetes as well as those with IFG. Two-thirds of those with diabetes and concomitant high blood pressure (≥130/80 mmHg) were not aware that they had high blood pressure, and >70% of those with diabetes and concomitant high cholesterol (total cholesterol ≥6.2 mmol/l) were not aware that they had high cholesterol.

CONCLUSIONS — The prevalences of diabetes and IFG were uniformly high in all regions. Improvements in prevention, diagnosis, and treatment of diabetes and associated risk factors are required if the health burden of diabetes in Thailand is to be averted.

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Diabetes and its associated complications are a major health and economic burden worldwide (1,2), and the burden is expected to continue to increase (3). This problem is particularly relevant to the Asia-Pacific region, where lifestyle changes associated with rapid economic development, improved survival from communicable diseases, and genetic susceptibility have led to rising diabetes prevalence (4,5).

Thailand provides a prime example of this trend (6). A survey in 1999 estimated that 9.6% of Thai adults aged ≥35 years had diabetes with 5.4% having impaired fasting glucose (IFG) (fasting plasma glucose [FPG] ≥6.1 mmol/l and <7.0 mmol/l) (7). In half of those with diabetes, the disease had not been previously diagnosed, whereas of those with diagnosed diabetes, 18% were not receiving oral antiglycemic agents. Among those with diagnosed diabetes and concomitant hypertension, one-third were not receiving blood pressure–lowering medication. These individuals represent lost opportunities for reducing the risks of the macro- and microvascular diseases associated with diabetes.

To monitor the effectiveness of the health system response, routine measurement of the prevalence and management of diabetes is crucial. In Thailand, subnational monitoring is also essential, given health administration decentralization, as well as differences in economic development and lifestyle between geographical regions (8). In this article, we describe the prevalence of diabetes and IFG as well as the diagnosis, treatment, and control of blood glucose, blood pressure, and cholesterol in those with diabetes in five geographic regions of Thailand. We used data from the 2004 Third National Health Examination Survey (NHESIII) of >37,000 fasting individuals aged ≥15 years, which, to date, is the single largest survey of FPG in an adult population.

RESEARCH DESIGN AND METHODS

— The NHESIII was conducted between January and May 2004 by the Health Systems Research Institute (see ACKNOWLEDGMENTS). The study was approved by the Ethical Review Committee for Research in Human Subjects, Ministry of Public Health. All participants provided written informed consent.

A multistage sampling frame based on

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Abbreviations: FPG, fasting plasma glucose; IFG, impaired fasting glucose; NHESIII, Third National Health Examination Survey; PPS, probability proportional to size.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Prevalence of IFG and diabetes by age and sex, Thailand 2004*

	IFG	Diagnosed diabetes	Undiagnosed diabetes	All diabetes
Males				
15–24 years	6.7 (4.4–10.0)	N/A	2.2 (1.1–4.4)	2.2 (1.1–4.4)
25–34 years	11.8 (9.7–14.4)	0.0 (0.0–0.2)	1.8 (1.1–2.9)	1.8 (1.1–3.0)
35–44 years	15.9 (13.5–18.6)	2.1 (1.4–3.0)	3.8 (2.7–5.3)	5.9 (4.5–7.5)
45–54 years	21.1 (18.6–23.9)	3.8 (3.0–4.8)	5.8 (4.7–7.2)	9.6 (8.1–11.3)
55–64 years	20.8 (18.1–23.8)	7.2 (6.2–8.3)	6.4 (5.2–7.9)	13.6 (12.0–15.4)
65–74 years	21.7 (19.6–23.9)	7.4 (6.5–8.4)	6.7 (5.6–8.0)	14.1 (12.5–15.9)
≥75 years	20.6 (17.4–24.2)	4.7 (3.7–6.0)	5.2 (3.9–6.9)	9.9 (8.3–11.9)
All ages	14.7 (12.9–16.8)	2.2 (2.0–2.6)	3.7 (2.9–4.8)	6.0 (5.1–7.1)
Females				
15–24 years	4.0 (2.7–5.9)	0.2 (0.0–0.9)	1.1 (0.5–2.8)	1.3 (0.6–3.0)
25–34 years	5.1 (3.6–7.2)	0.7 (0.3–1.5)	1.7 (1.1–2.6)	2.4 (1.7–3.4)
35–44 years	9.7 (8.0–11.8)	2.7 (2.0–3.6)	3.7 (2.7–4.9)	6.4 (5.2–7.8)
45–54 years	16.4 (14.1–19.0)	6.2 (5.0–7.6)	4.6 (3.6–5.9)	10.8 (9.4–12.3)
55–64 years	17.8 (15.5–20.4)	12.8 (10.9–14.9)	6.8 (5.7–8.1)	19.6 (17.6–21.7)
65–74 years	18.8 (16.6–21.1)	11.6 (10.3–13.0)	6.4 (5.4–7.7)	18.0 (16.5–19.6)
≥75 years	20.9 (17.9–24.2)	6.3 (5.1–7.7)	5.4 (4.3–6.9)	11.7 (10.1–13.7)
All ages	10.4 (9.1–12.0)	4.0 (3.6–4.4)	3.4 (2.8–4.2)	7.4 (6.6–8.2)
Both sexes				
15–24 years	5.4 (3.9–7.3)	0.1 (0.0–0.5)	1.7 (0.8–3.4)	1.8 (0.9–3.5)
25–34 years	8.5 (7.0–10.3)	0.4 (0.2–0.8)	1.7 (1.2–2.5)	2.1 (1.5–3.0)
35–44 years	12.8 (10.9–14.8)	2.4 (1.9–3.0)	3.7 (2.8–4.9)	6.1 (5.1–7.3)
45–54 years	18.7 (16.6–20.9)	5.0 (4.3–5.8)	5.2 (4.4–6.2)	10.2 (9.2–11.3)
55–64 years	19.2 (17.1–21.6)	10.1 (9.0–11.4)	6.6 (5.7–7.6)	16.7 (15.4–18.2)
65–74 years	20.1 (18.2–22.1)	9.7 (8.8–10.7)	6.5 (5.6–7.6)	16.2 (14.9–17.7)
≥75 years	20.7 (18.1–23.7)	5.6 (4.8–6.6)	5.3 (4.5–6.4)	11.0 (9.8–12.3)
All ages	12.5 (11.0–14.2)	3.1 (2.8–3.5)	3.6 (2.9–4.4)	6.7 (5.9–7.6)

Data are % (95% CI).

government registers was used. For areas except for Bangkok, three provinces were chosen by probability proportional to size (PPS) for each of the 12 health administration areas. At the second stage, nine electoral units or villages were selected by PPS from both urban and rural areas for each province. At the final stage, 15 individuals were selected by simple random sampling with replacement from four broad groups (male or female sex and 15–59 or ≥60 years of age) for each electoral unit/village. Replacements within a 5-year age range and of the same sex and electoral unit/village were randomly sampled. For Bangkok, nine electoral units were selected PPS from six geographical zones. The final stage sampling was identical to that for the other provinces. The final collected sample, after selection of replacement individuals, was 39,290 individuals of a target sample size of 42,120 (93.3%). The final collected sample as a percentage of the target sample size, after selection of replacement individuals, by geographic region was as follows: Central, 99.1%; Northeast, 96.5%; North, 92.0%; South, 89.2%; and Bangkok, 72.2%. The proportion of the Thai population that is urban by geographic region is as follows: Central, 32.3%; Northeast, 15.0%; North, 20.1%; South, 23.5%; and Bangkok 100.0%.

Data collection and measurement

Demographic characteristics, previous diagnosis of diabetes, high blood pressure, or high cholesterol and corresponding medication use, and smoking habits were determined on the basis of an interview. Three serial measurements of blood pressure, 1 min apart, were made using a mercury sphygmomanometer. Weight, height, and waist circumference were directly measured using standard techniques (9). Participants were asked to fast for 12 h overnight before the venous blood sample was obtained. Sera were frozen and transferred to a regional university laboratory for analysis of plasma glucose using a hexokinase enzyme method. Serum total cholesterol was measured using enzymatic methods. All regional laboratories were standardized by a central laboratory at the Ministry of Public Health.

Definition

Diabetes was defined as FPG ≥7.0 mmol/l, use of medication (oral antiglycemic agents or insulin) for the treatment of diabetes during the previous 2 weeks, or a report of a previous diagnosis of diabetes by a medical doctor. Diagnosed diabetes was defined as meeting the criteria for diabetes and having a previous diagnosis of diabetes by a medical doctor. As A1C measurements were not obtained in the survey, control of plasma glucose was defined as FPG <7.8 mmol/l (10). IFG was defined as FPG ≥5.6 and <7.0 mmol/l. High blood pressure was defined as systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥80 mmHg (average of the two measurements with the lowest variability) or use of blood pressure–lowering medication during the previous 2 weeks (11). High cholesterol was defined as total serum cholesterol ≥6.2 mmol/l or cholesterol-lowering drug use during the previous 2 weeks. Central obesity was defined as a waist circumference of ≥90 cm in men and ≥80 cm in women (12). Overweight was defined as BMI of ≥25 kg/m^2 (12,13).

Statistical methods

The analysis was restricted to respondents who had fasted over the previous 12 h before blood collection (94.5% of respondents) with the sample weighted against the registered 2004 population by public health administration area, area of residence (urban/rural or geographical zone for Bangkok), sex, and 5-year age-groups up to 80+ years. All comparisons by sex, area of residence, geographic region, and fasting plasma glucose status were age- and sex-standardized to the national population. Adjusted Wald tests were used to determine statistical significance with $P < 0.05$ considered statistically significant. Robust methods of variance estimation were used to take into account the complex survey design using Stata 9.2 (StataCorp, College Station, TX).

RESULTS — FPG was 5.2 ± 0.04 mmol/l (mean ± SE), 5.3 ± 0.04 mmol/l in men, and 5.2 ± 0.04 mmol/l in women. Prevalences of diabetes and IFG in Thais aged ≥15 years were 6.7% (95% CI 5.9–7.6%) and 12.5% (11.0–14.2%), respectively. Diabetes prevalence in men was lower than that in women (6.0 vs. 7.4%; $P < 0.05$ for the age-standardized comparison), whereas prevalence of IFG was higher in men than in women (14.7 vs. 10.4%; $P < 0.001$ for the age-standardized comparison) These figures equate to an estimated 3.0 million Thais with diabetes (1.3 million men and 1.7 million women), and 5.6 million with IFG (3.2 million men and 2.4 million women). Diabetes prevalence was notably higher among women aged 55–74 years than among men of the same age (Table 1) ($P < 0.001$), whereas IFG prevalence was higher among men aged 25–54 years than among women of the same age (Table 1) ($P < 0.001$). Diabetes was more common in urban men than in rural men (Fig. 1) ($P < 0.01$) but was similar in urban and rural women ($P > 0.05$). Male prevalence was higher in Bangkok than in the urban North (Fig. 1) ($P < 0.01$). Bangkok and the urban and rural Northeast had the highest female prevalence of diabetes, which was higher than that in the urban North and rural South (Fig. 1) ($P < 0.05$ for all comparisons).

Cardiovascular risk factors among those with IFG and diabetes

Individuals with diabetes have high levels of concomitant cardiovascular risk factors (Table 2), except for smoking, with 72.7% (95% CI 68.7–76.4%) having high blood pressure (≥130/80 mmHg or receiving medication), 33.0% (28.6–37.8%) having high total cholesterol (≥6.2 mmol/l or receiving medication), 48.8% (43.6–54.1%) being overweight (BMI ≥25 kg/m^2), and 53.5% (48.3–58.6%) having central obesity (waist circumference ≥90 cm in men and ≥80 cm in women). Those with diagnosed diabetes tended to have a higher prevalence of high blood pressure, high cholesterol, and overweight but a lower prevalence of smoking than those in whom diabetes had not been previously diagnosed (Table 2). Individuals with IFG had more concomitant cardiovascular risk factors, except for smoking, than those with normal FPG (Table 2).

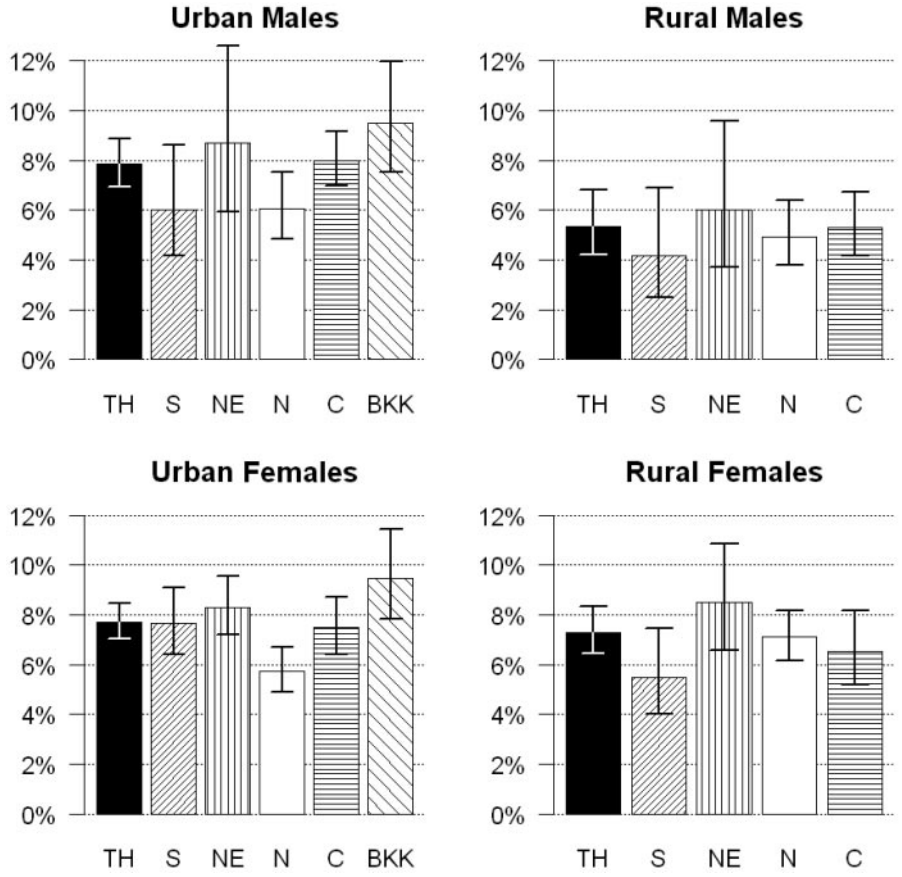

Figure 1—*Age-standardized prevalence of diabetes (diagnosed and undiagnosed) by sex, area of residence (urban/rural), and geographic region, Thailand 2004.* Top*: Men.* Bottom*: Women. BKK, Bangkok; C, Central; N, North; NE, Northeast; S, South; TH, Thailand.*

Diagnosis of diabetes and treatment and control of blood glucose, blood pressure, and cholesterol in individuals with diabetes

Of those identified as having diabetes in the survey, 53.3% (95% CI 47.8–58.8%) had not previously had the diagnosis of diabetes. Nondiagnosis was higher in men (62.6%) than in women (62.6 vs. 46.2%, respectively; $P < 0.001$ for the age-standardized comparison). This equates to an estimated 1.6 million (0.8 million men and 0.8 million women) Thais aged ≥15 years with undiagnosed diabetes. Although diagnosis rates increased with age, 48.1% of men and 36.7% of women aged ≥55 years had diabetes that remained undiagnosed. Of those in whom diabetes was previously diagnosed, 90.7% (95% CI 87.7–92.9%) were receiving either oral antiglycemic agents or insulin, and of those receiving treatment, 41.6% (37.8–45.5%) had FPG controlled to <7.8 mmol/l. Glycemic control was higher in women than in men (44.6 vs. 35.8%; $P < 0.01$). Of those in whom diabetes had been diagnosed, 71.1% had received advice from health personnel to reduce their weight, 90.3% to increase their physical activity levels, and 92.5% to consume a healthier diet. Diagnosis rates tended to be higher in urban than in rural men, but the difference was not significant (42.2 vs. 34.6% diagnosed, respectively; $P = 0.057$). Rates of

Table 2—*Age-standardized cardiovascular risk factors among those with normal fasting plasma glucose, IFG, and undiagnosed and diagnosed diabetes, Thailand 2004*

	Normal FPG	IFG	Undiagnosed diabetes	Diagnosed diabetes
Men				
Systolic BP (mmHg)	119.0 ± 0.5	123.4 ± 0.8	124.7 ± 1.1	126.0 ± 2.3
Diastolic BP (mmHg)	77.0 ± 0.4	79.6 ± 0.5	79.7 ± 0.7	84.5 ± 2.4
BP ≥130/80 mmHg or receiving medication (%)	51.3 ± 1.3	61.1 ± 2.1	62.7% ± 4.2	68.9 ± 7.8
TCh (mmol/l)	4.8 ± 0.03	5.1 ± 0.05	4.9 ± 0.31	5.7 ± 0.22
TCh ≥6.2 mmol/l or receiving medication (%)	12.0 ± 0.6	20.1 ± 1.4	21.5 ± 3.0	35.2 ± 9.1
Current smoker (%)	50.7 ± 0.8	43.8 ± 1.7	54.9 ± 3.1	32.2 ± 8.3
BMI (kg/m^2)	22.3 ± 0.1	23.5 ± 0.2	24.1 ± 0.5	28.3 ± 1.5
BMI ≥25 kg/m^2 (%)	19.8 ± 0.7	31.8 ± 1.9	35.2 ± 4.7	59.6 ± 8.1
Waist circumference (cm)	77.6 ± 0.3	81.6 ± 0.5	83.0 ± 1.0	94.1 ± 3.3
Central obesity (%)	12.7 ± 0.6	22.4 ± 1.6	29.2 ± 4.1	53.5 ± 8.9
Women				
Systolic BP (mmHg)	115.9 ± 0.4	120.7 ± 0.8	121.4 ± 1.1	130.6 ± 1.8
Diastolic BP (mmHg)	74.5 ± 0.3	78.1 ± 0.5	78.0 ± 0.8	82.0 ± 1.1
BP ≥130/80 mmHg or receiving medication (%)	41.8 ± 1.2	56.5 ± 2.5	55.8 ± 3.7	79.0 ± 4.3
TCh (mmol/l)	5.1 ± 0.03	5.2 ± 0.06	5.0 ± 0.30	5.6 ± 0.07
TCh ≥6.2 mmol/l or receiving medication (%)	15.4 ± 0.7	19.5 ± 1.5	27.0 ± 4.8	39.0 ± 3.7
Current smoker (%)	2.8 ± 0.3	2.7 ± 0.4	3.0 ± 1.1	1.1 ± 0.4
BMI (kg/m^2)	23.5 ± 0.1	25.3 ± 0.3	26.1 ± 0.6	28.0 ± 0.3
BMI ≥25 kg/m^2 (%)	31.7 ± 0.7	46.9 ± 2.4	50.0 ± 4.4	60.8 ± 2.9
Waist circumference (cm)	75.6 ± 0.3	79.9 ± 0.7	83.3 ± 1.4	89.1 ± 0.9
Central obesity (%)	32.6 ± 0.9	48.1 ± 2.5	55.3 ± 4.1	76.2 ± 3.0

Data are means ±SEM, age-standardized to the total population. Central obesity is waist circumference ≥90cm in men and ≥80 cm in women. BP, blood pressure; TCh, total cholesterol.

diagnosis were similar for urban and rural females (55.0 vs. 52.7%). Rates of glycemic control were higher in rural than in urban women receiving treatment (47.3 vs. 38.3%; $P < 0.05$). Both Bangkok and the South had higher rates of diagnosis than the Central and Northeast regions (Fig. 2) ($P < 0.01$ for both compared with Bangkok; $P < 0.05$ compared with the South). The fraction of treated individuals achieving glycemic control was lower in Bangkok than in the Central and North regions ($P < 0.01$ for both comparisons) and higher in the North compared with the South and Northeast ($P < 0.05$ for both).

Of those individuals with diabetes and concomitant high blood pressure, 65.9% were not previously aware that they had high blood pressure. Of those who were aware, 82.2% were taking blood pressure–lowering medication, and of those taking medication, 14.9% had blood pressure controlled to <130/80 mmHg. Rates of awareness were lower in rural than in urban areas for both men (26.3 vs. 37.0%; $P < 0.01$) and women (34.9 vs. 43.5%; $P < 0.05$). The Northeast region had the lowest rates of awareness (Fig. 2) ($P < 0.01$ for all comparisons), whereas Bangkok had the highest ($P < 0.05$ for all comparisons). The fraction of those receiving blood pressure–lowering medication who had blood pressure <130/80 mmHg was universally low but higher in Bangkok than in other regions (Fig. 2) ($P < 0.01$ for all comparisons).

Diagnosis, treatment, and control levels of high cholesterol were low. Of individuals with diabetes and high cholesterol, high cholesterol had not been previously diagnosed in 72.0%. Of those in whom it had been diagnosed, 80.7% were receiving cholesterol-lowering medication, and of those receiving medication, 63.1% had total cholesterol controlled to <6.2 mmol/l. Rates of diagnosis were lower in rural than in urban women (21.0 vs. 36.3%; $P < 0.001$) but similar in rural and urban men (30.2 vs. 32.2%). The Northeast had the lowest rates of diagnosis (Fig. 2) ($P < 0.05$ compared with the North and South and $P < 0.01$ compared with Bangkok and Central). The fraction of those taking cholesterol-lowering drugs who achieved total cholesterol <6.2 mmol/l was lower in Bangkok and the South than in other regions (Fig. 2) ($P < 0.01$ for all comparisons).

CONCLUSIONS — This study demonstrates a continued high prevalence of diabetes and IFG in Thailand consistent with a previous survey (7). These rates are similar to those in the U.S. (14) and higher than those of China (15). A higher prevalence of diabetes was found in middle to older aged women compared with men of the same age, whereas the prevalence of IFG was higher among younger to middle aged men compared with women of the same age. This pattern is similar to that of a recent Korean survey (16). Urban men were more likely to have diabetes than rural men, whereas the prevalence of diabetes was similar in rural and urban women. This finding may be related to the shift in obesity from high to low socioeconomic groups occurring earlier in women, as has been noted in other populations (17). Despite these differentials, diabetes prevalence is relatively uniform throughout Thailand.

In two-thirds of individuals with diabetes in the current survey (1.6 million individuals), the disease had not been previously diagnosed. Subsequently,

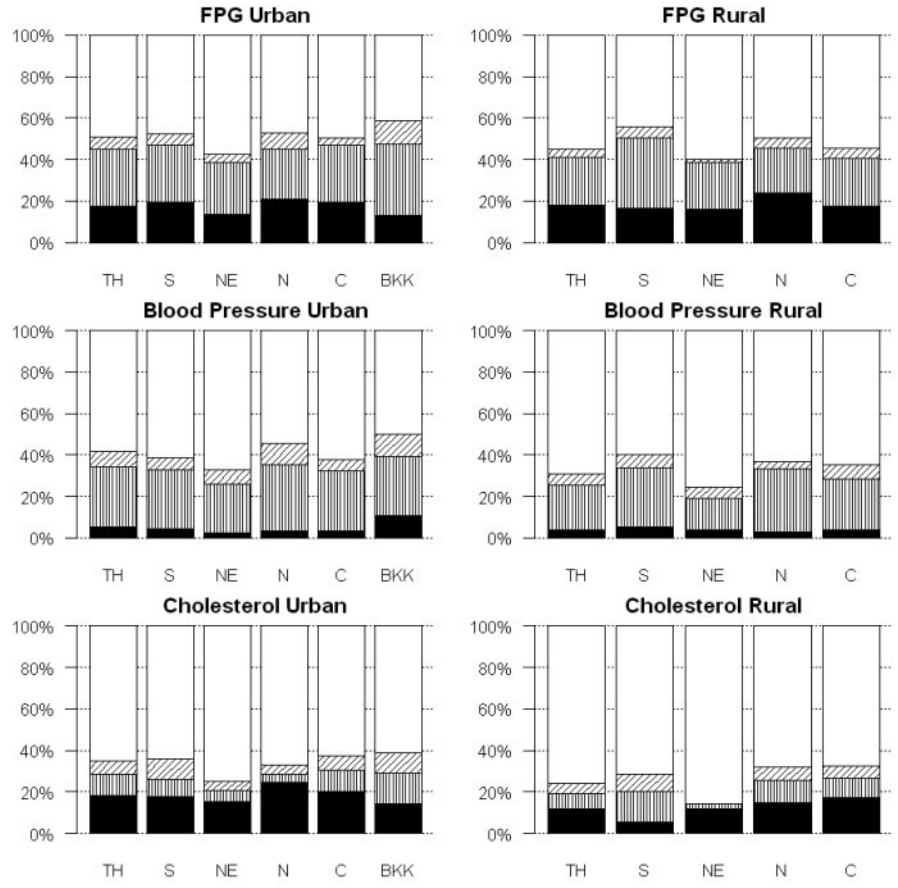

Figure 2—*Age- and sex-standardized proportions of diagnosis, pharmacological treatment, and control of* (A) *FPG (control target is <7.8 mmol/l) among individuals with diabetes,* (B) *blood pressure among individuals with diabetes and high blood pressure (≥130/80 mmHg), and* (C) *cholesterol among individuals with diabetes and high total cholesterol (≥6.2 mmol/l), by area of residence (urban/rural) and geographic region, Thailand 2004. "Diagnosed but not treated" (▨) are individuals in whom the relevant condition has been diagnosed by a medical doctor (or health personnel for high blood pressure) but who have not received pharmacological treatment in the past 2 weeks. "Treated but not controlled" (▥) are individuals who have received pharmacological treatment for the relevant condition in the past 2 weeks but have not achieved the relevant control target. "Treated and controlled" (■) are individuals who have received pharmacological treatment in the past 2 weeks and have met the control target for the relevant condition. □, undiagnosed; BKK, Bangkok; C, Central; N, North; NE, Northeast; S, South; TH, Thailand.*

there were low rates of treatment and control of plasma glucose with insulin or oral antiglycemic agents. Of further concern are the high levels of cardiovascular risk factors, such as high blood pressure and high cholesterol in those with diabetes. Diagnosis, treatment, and control rates of these risk factors among those with diabetes are also low. As diabetes itself is an independent risk factor for coronary heart disease, stroke, and renal disease (2,18), control of cholesterol and blood pressure is essential to reduce the risk of these events. The economic burden associated with these outcomes is highlighted by the potentially large financial burden of including renal dialysis on the Thai universal health insurance scheme (19). A crucial finding is that a large proportion of older individuals have undiagnosed diabetes, and these individuals have the greatest risk of macro- and microvascular diseases. When these findings are combined with the presence of an aging population and the 5.7 million individuals with IFG, it is clear that a scaled-up response is needed to better diagnose and treat diabetes and prevent progression to diabetes in those with IFG (20) if the health and economic burden of the condition is to be reduced.

Recognizing the growing burden of diabetes and other noncommunicable diseases and risk factors, the Ministry of Public Health launched a nationwide program, "Healthy Thailand," in 2004. This program includes components promoting healthier lifestyles (physical activity and diet) and set a target for 60% of Thai people aged ≥40 years to be screened for IFG and diabetes by the end of 2006. Surveys must continue to be routinely conducted to monitor the impact of these programs. Furthermore, the need for subnational assessment is highlighted by the lower rates of diagnosis for diabetes and associated risk factors in the Northeast and in rural compared with urban populations. The distribution of health resources, such as medical doctors, has historically been biased against both these populations (21).

Several limitations should be considered. Although replacements were made based on age, sex, and cluster, information to determine the response rate before replacement was not available. Differentials in the final collection rate may also obscure variation across geographic regions. Oral glucose tolerance tests were not conducted in the NHESIII, preventing an estimation of the exact prevalence of pre-diabetes. Long-term glycemic control could also not be assessed as A1C was not measured. Likewise, cholesterol fractions were not measured. Despite these limitations, a clear strength of the study is the large sample size and the ability to monitor diabetes prevalence and management at a subnational level.

This study demonstrates a high prevalence of diabetes and IFG across all regions of Thailand with low levels of diagnosis and appropriate management of blood glucose, blood pressure, and cholesterol among individuals with diabetes. These findings serve to emphasize to other countries undergoing similar epidemiological transitions the importance of establishing monitoring systems for diabetes built on valid and representative data. In Thailand, without increased efforts to prevent diabetes by promoting and facilitating healthier lifestyles along with improvements in the diagnosis and control of diabetes and associated risk factors, the health burden of diabetes has the potential to overwhelm the health care system.

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