Seasonal Changes in Preprandial Glucose, A1C, and Blood Pressure in Diabetic Patients

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The American Diabetes Association has recommended glycemic goals for nonpregnant diabetic individuals (1). These goals are aimed at controlling blood glucose levels, blood pressure, and lipid profiles. In addition, seasonal variation of blood pressure has been recognized and found to exist in both normotensive subjects and hypertensive patients (2). However, the relation between blood pressure patterns, as well as blood glucose levels and lipid profiles, in diabetic patients and seasonal cycles remains unclear.

RESEARCH DESIGN AND METHODS

We collected data from all patients who received treatment at the endocrinology and metabolism clinic at Da Chien Hospital (Miaoli, Taiwan) at least two times per year from 2003 to 2006. The clinic opened in May 2002, and data excluding personal information were retrieved from the hospital data bank; this procedure was approved by Da Chien Hospital. There were diabetic patients treated at the clinic in 2003 (n = 465), 2004 (n = 615), 2005 (n = 599), and 2006 (n = 662). Some patients (n = 212) were retained throughout the entire study period, while others only attended the clinic for a fraction of the 2003–2006 time frame. The mean diabetes duration in these patients was 7.89 years, and the mean age was 66.7 years. Laboratory tests were performed and drug therapy administered for hypertension, hyperglycemia, and hypercholesterolemia according to American Diabetes Association recommendations. Doses and regimens were adjusted for blood pressure, blood glucose level, A1C, and lipid profile. For each patient, blood pressure and plasma glucose (preprandial or postprandial) were measured during visits to the clinic. A1C levels were checked and data collected at intervals of 3–6 months. Lipid profiles were collected in annual examinations of every diabetic patient; thus, lipid profile data were available beginning October 2003. We analyzed the monthly mean values for blood pressure, A1C, and lipid profiles in relation to the monthly values for mean climate temperature. Systolic and diastolic blood pressure was measured with a fully automated sphygmomanometer (BP203RV-II).

The study area, Miaoli, is in Taiwan. Taiwan is located southeast of China and has a subtropical monsoon climate. The data on climate used in this study were obtained from the Central Weather Bureau of the Republic of China, Taiwan (3). The mean yearly temperature from 1971 to 2000 was 22.2°C. The highest mean monthly temperature, over this period, was in July (28.3°C), while the lowest was in January (15.1°C). Summers are generally very hot. The monthly means of the daily averages were used in this study.

Data were analyzed with Microsoft Excel 2003, and univariate correlations were assessed using Pearson's r test. We used linear regression to evaluate the relation between blood pressure, fasting glucose, A1C, and lipid profiles and the monthly average climate temperatures. All P values are two sided.

RESULTS

Average systolic and diastolic blood pressure was highest during the winter and lowest during the summer (Fig. 1). A seasonal pattern was evident throughout the 4-year period. Blood pressure was inversely correlated with the monthly mean temperature (r^2 = 0.44 and $P < 0.001$ for systolic and r^2 = 0.24 and $P < 0.001$ for diastolic blood pressure). Preprandial glucose was inversely correlated with the monthly mean climate temperature (r^2 = 0.12 and P = 0.018), and A1C was correlated with reversion of the tri-monthly mean climate temperature (r^2 = 0.09 and P = 0.042). There was a consistent cyclic variation in preprandial glucose and A1C during this 4-year study period. LDL cholesterol was inversely correlated with the monthly mean climate temperature (r^2 = 0.23 and P = 0.002). However, HDL cholesterol and triglycerides were not related to temperature (r^2 = 0.005 and P = 0.173 for HDL cholesterol and r^2 = 0.007 and P = 0.615 for triglycerides). In our study, we also found that the relation between blood pressure and monthly mean climate temperature was stronger when blood pressure was under better control. We compared patients from 2003 to 2004 and from 2005 to 2006 (the former for 2 years and the latter for 2 years) and found that the correlation of systolic blood pressure and monthly mean climate temperature in the years 2003–2004 was lower than in the years 2005–2006. We compared other factors in the two groups and found better blood pressure control in the years 2005–2006 (diastolic blood pressure 77.36 vs. 79.51 mmHg, $P < 0.001$, and systolic blood pressure 134.71 vs. 138.27 mmHg, $P < 0.001$). However, the monthly mean climate temperature did not show any significant change between the former and the later 2 years (22.52 vs. 22.68°C, P = 0.9124). Climate temperature changes showed similar patterns every year.

Furthermore, festivals may play a role in patient lifestyle. There are three main traditional festivals in the region, and their dates shift somewhat from year to year, as the traditional calendar is lunar. The Chinese New Year may be in January or February; the Dragon Festival may be in May, June, or July; and the Moon Festival may be in September or October.

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

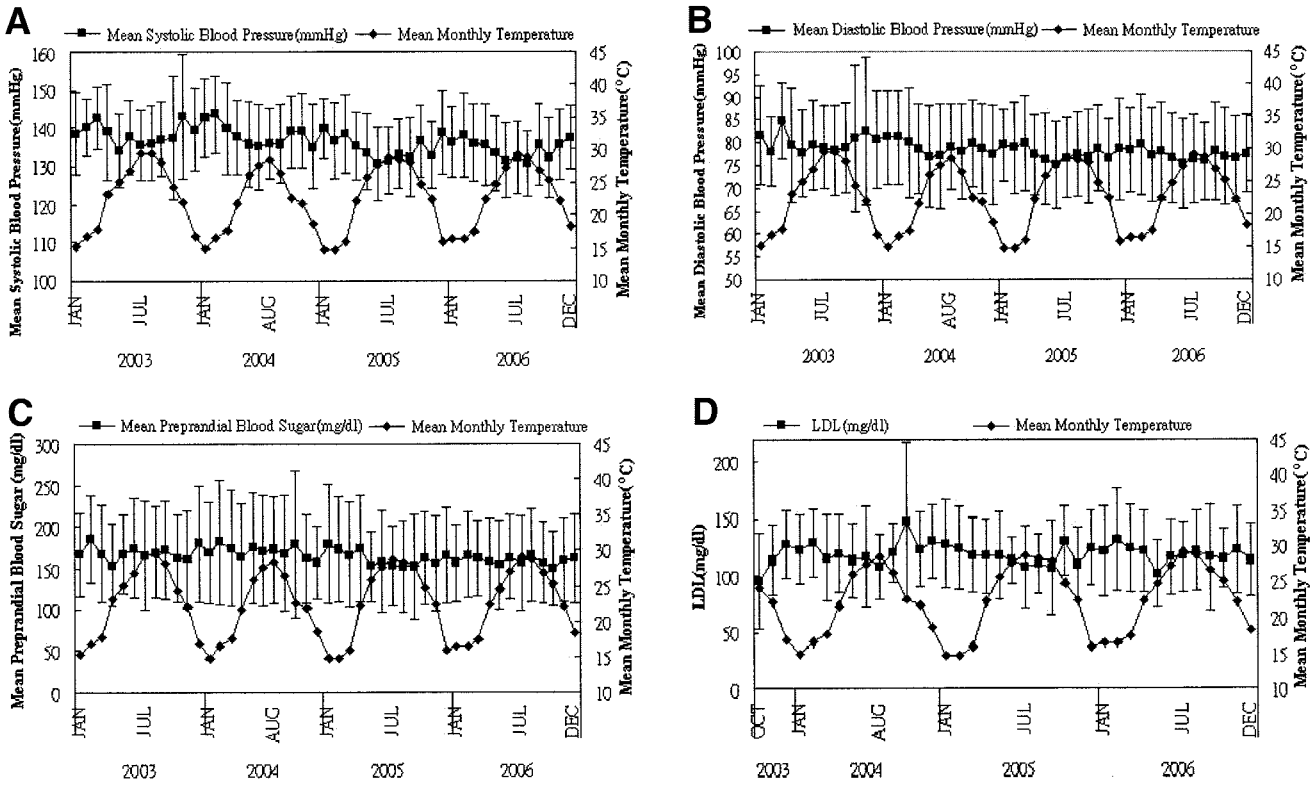

Figure 1—*Systolic blood pressure* (A)*, diastolic blood pressure* (B)*, preprandial blood glucose* (C)*, and LDL cholesterol* (D) *according to calendar month in diabetic patients. Data are means ± SE.*

Festivals, however, do not seem to play a role in the results of our study.

CONCLUSIONS — In patients with diabetes receiving treatment at the endocrinology and metabolism clinic, blood pressure, preprandial glucose, A1C, and LDL cholesterol varied seasonally, with higher values in the winter and lower values in the summer.

References

1. American Diabetes Association: Standards of medical care in diabetes—2007 (Position Statement). *Diabetes Care* 30 (Suppl. 1):S4–S41, 2007
2. Brennan PJ, Greenberg G, Miall WE, Thompson SG: Seasonal variation in arterial blood pressure. *Br Med J (Clin Res Ed)* 285:919–923, 1982
3. Central Weather Bureau of the Republic of China, Taiwan: The monthly mean climate table for Taiwan [Internet]. Available from http://www.cwb.gov.tw/V5e/climate/statistic/monthlydata.htm. Accessed 10 January 2007