FLIGHT SAFETY FOUNDATION
HUMAN FACTORS & AVIATION MEDICINE
Vol. 52 No. 1 *For Everyone Concerned With the Safety of Flight* January–February 2005

Diabetes Presents Pilots With Range of Risks

Diabetes can lead to heart disease, nerve damage and related problems that may endanger medical certification. Nevertheless, if diabetes is diagnosed early and is controlled, pilots can continue their flying careers.

FSF Editorial Staff

Diabetes mellitus, the eighth-leading cause of death in developed regions of the world,[1] is a disorder in which the level of glucose (sugar) in the blood is higher than normal because the body does not properly use insulin, a hormone secreted by the pancreas to regulate blood sugar levels.

If blood sugar levels remain elevated, the small blood vessels that carry blood to body tissues are weakened; the results can include a variety of problems — including blindness, kidney failure, heart disease and nerve damage.

Nevertheless, diabetes is treatable, and civil aviation regulations have evolved in recent years to allow for continued medical certification of many pilots who are able to control the disease — in some cases, even if they require medication.

The International Diabetes Federation estimates that nearly 194 million people worldwide have diabetes, compared with 30 million in 1985; in 25 years, the number could reach 330 million.[2] The United Nations World Health Organization (WHO) says that the increasing prevalence of diabetes — associated in part with the increasing prevalence of an overweight and obese population — constitutes an epidemic. (There are several formulas for evaluating weight, including the body mass index [BMI], which calculates the relationship between an individual's height and weight; in general, people are considered overweight if they exceed their ideal weight by more than 20 percent and obese if they exceed the ideal weight by more than 30 percent [see "Continuing Increase Forecast in World's Diabetic Population," page 2]).[3] Diabetes is projected to become one of the world's main disablers and killers within the next 25 years," WHO says. "Because of its chronic nature, the severity of its complications and the means required to control them, diabetes is a costly disease, not only for the affected individual and his/her family but also for the health authorities."

For example, WHO cites studies that show that in India, as much as 25 percent of a family's income may be spent on treating a family member with diabetes, and that in the United States, the total health care cost incurred by a person with diabetes is at least twice the cost incurred by a person without the disease.

In a person without diabetes, blood sugar levels are relatively constant — usually between 70 milligrams per deciliter and 110 milligrams per deciliter of blood (between 3.9 millimoles per liter and 6.0 millimoles per liter of blood)[4] — and are maintained by insulin and glucagon, another hormone produced by the pancreas, and by hormones secreted by the adrenal glands and the pituitary gland. The sugar in the blood is transported to cells throughout the body; the cells use insulin to convert the sugar to energy. When blood sugar levels increase as a result of food consumption, the pancreas releases insulin to prevent too great an increase; when blood sugar levels decrease as a result of missed meals or consumption of additional sugar, glucagon and other hormones are released to prevent too great a decrease.

In someone with diabetes, either the body's insulin production is not sufficient to prevent blood sugar from increasing out of control or the cells are unable to use insulin properly to convert the sugar to energy. (This is known as insulin resistance.)

Continuing Increase Forecast in World's Diabetic Population

The United Nations World Health Organization (WHO) characterizes the increasing prevalence of diabetes as an epidemic.[1] Among the data cited by WHO and the International Diabetes Federation are the following:

- About 194 million people worldwide have diabetes mellitus; in 25 years, that number may reach 330 million or more;[2]
- The highest prevalence of diabetes in the adult population worldwide occurs in Nauru, where 30.2 percent of adults have the disease, according to 2003 data. Nauru is followed by the United Arab Emirates (20.1 percent), Qatar (16.0 percent), Bahrain (14.9 percent) and Kuwait (12.8 percent);[3]
- The countries with the largest numbers of people with diabetes are India (35.5 million), China (23.8 million), the United States (16.0 million), Russia (9.7 million) and Japan (6.7 million);
- By 2025, the number of people with diabetes is likely to more than double in Africa, the Eastern Mediterranean and the Middle East, and Southeast Asia. In developed countries worldwide, the increase is expected to be 42 percent; in developing countries, 170 percent; and,
- At least half of the people worldwide with diabetes do not know that they have the disease. In some countries, 80 percent have no knowledge of their condition.♦

— FSF Editorial Staff

Notes

1. United Nations World Health Organization. Fact Sheet No. 236, *Diabetes: The Cost of Diabetes.* Revised September 2002. <www.who.int>.
2. International Diabetes Federation (IDF). *Why You Should Care.* <www.idf.org>.
3. IDF. *Did You Know?* <www.idf.org>.

There are two primary types of diabetes (Table 1, page 3). The most common is type 2 diabetes, which afflicts about 90 percent of those with the disease and which previously was called "adult-onset" diabetes because it is most common among people over age 50. Nevertheless, type 2 diabetes can occur at any age. Type 2 diabetes typically begins with "insulin resistance" — a condition in which muscle cells, liver cells and fat cells are unable to use insulin properly and require larger amounts; in response, the pancreas increases insulin production. Eventually, the pancreas is unable to manufacture enough insulin to satisfy the increased demand.

The other primary type of diabetes is type 1 diabetes, which previously was known as "juvenile" diabetes because the disease most frequently is diagnosed in children and young adults, although it can occur at any age. Type 1 diabetes is the most serious form of the disease and occurs when the body's immune system destroys the cells in the pancreas that manufacture insulin.[5]

A condition related to type 2 diabetes is pre-diabetes, in which blood sugar levels are higher than normal levels but not high enough to be classified as indicative of diabetes. People with pre-diabetes often develop type 2 diabetes within 10 years.

Another similar condition is hypoglycemia (low blood sugar), which is a side effect of diabetes but which also can affect people who are not diabetic. In both instances, hypoglycemia occurs when the blood sugar level is too low to provide energy for the body's activities; the body's reaction may include hunger; excess perspiration; shakiness, nervousness or feeling anxious; dizziness and/or light-headedness; sleepiness; confusion; difficulty speaking; and weakness. In its most extreme forms, hypoglycemia can lead to impaired brain function; civil aviation authorities consider hypoglycemia one of the greatest risks for pilots with diabetes.[7]

Pilots Typically Have No Symptoms

Some people with diabetes have no symptoms and are unaware that they have the disease. For example, in the United Kingdom, 1.8 million people are known to have diabetes and an additional 1 million people are thought to have the disease but not know it.[8] The International Civil Aviation Organization (ICAO) says in its *Manual of Civil Aviation Medicine* that middle-aged pilots with mild diabetes typically have no symptoms; their disease often is detected during a routine aeromedical examination — or during a routine physical examination by a personal physician.[9]

In other cases, symptoms may include increased thirst, increased urination, unexplained weight loss, fatigue or — rarely, in severe cases of type 1 diabetes — unconsciousness or coma.

Risk factors for type 2 diabetes include obesity, increasing age and insufficient physical activity. Members of some ethnic groups — aboriginal, Hispanic, Asian, South Asian and African — are considered to be at high risk of developing type 2 diabetes.

Medical specialists recommend that people older than 45 years should at least consider being tested for diabetes, especially if they are overweight; people younger than 45 who are overweight and have at least one additional risk factor also should consider being tested.[10] A diagnosis is made after one or more blood tests, including the following:[11]

- Fasting plasma glucose tests (also called fasting blood sugar tests) measure blood sugar levels after at least eight hours without food. This test also detects pre-diabetes;

Table 1
Types of Diabetes

	Type 1 Diabetes	Type 2 Diabetes
Other names	Insulin-dependent, immune-mediated, juvenile	Non-insulin-dependent, adult-onset
Number of People Affected	17 million	140 million
Causes	Pancreas does not produce insulin	Body does not properly use insulin produced by pancreas
Symptoms	Excessive urination, excessive thirst, weight loss, fatigue	Often asymptomatic; in some cases, excessive urination, excessive thirst, weight loss, fatigue
Method of Treatment	Insulin	Diet and exercise, oral medication, and/or insulin
Deaths	808,000 worldwide in 2001 (type 1 and type 2, combined)	

Source: International Diabetes Federation, United Nations World Health Organization

- Oral glucose tolerance tests measure blood sugar levels two hours after drinking a solution that contains glucose (and after eight hours without food). This test also detects pre-diabetes; and,

- Random plasma glucose tests can be administered to check blood sugar levels at any time. The results can be used in combination with a medical evaluation of symptoms to diagnose diabetes. This test does not detect pre-diabetes.

Complications Include Damage to Blood Vessels, Nerves

Increased sugar levels in the blood can lead to damage of many of the body's systems, especially blood vessels and nerves. Diabetes-related damage to small blood vessels can narrow the vessels, impeding the flow of blood to various body organs and causing damage to those organs.

Among the serious complications associated with diabetes are the following:[12]

- Diabetic neuropathy (abnormality in the nerves or the nervous system) is the most common complication of diabetes, affecting as many as half of all diabetics. Neuropathy can result in diminished sensation, shooting pains or tingling in the hands, arms, feet and legs; changes in the shape of the feet; nausea, vomiting, constipation or diarrhea; sexual impotence in men and vaginal dryness in women; an irregular heartbeat or faster-than-normal heartbeat; sudden changes in blood pressure; double vision; and diminished sensation in the bladder;[13]

- Heart disease is cited as the cause of death of about half of all people with diabetes in industrialized countries. Diabetes is among the factors that can increase the level of cholesterol (a waxy substance found in the cells and among fats in the body) in the bloodstream. When cholesterol accumulates on the walls of the coronary arteries, the arteries are narrowed and the flow of blood to the heart is reduced; this can result in angina (chest pain), heart attack or stroke;

- Diabetic retinopathy occurs when the small blood vessels in the retina (the light-sensitive lining at the back of the eye) are damaged. These blood vessels swell and are weakened, and some become clogged. New blood vessels grow to replace them, but the replacements break easily, and can leak blood into the vitreous (the jellylike fluid at the back of the eye); the leaking blood blocks light from reaching the retina. Eventually, scar tissue forms, and the retina may be pulled away from the back of the eye, causing loss of sight. People with diabetes also may be more likely than others to develop cataracts (cloudiness in the normally clear lens of the eye that obstructs vision) or glaucoma (a condition in which pressure inside the eye increases, damages the optic nerve and — if untreated — may lead to vision loss).[14] WHO estimates that after 15 years with the disease, about 2 percent of diabetics become blind and about 10 percent develop serious visual handicaps;[15]

- Kidney failure occurs when the kidneys are unable to eliminate bodily wastes. The most common cause of kidney failure is diabetes. Diabetic kidney disease develops gradually, usually over many years, beginning when small amounts of protein in the blood leak into the urine. Eventually, the kidneys' filtering function deteriorates. Individuals with kidney failure sometimes undergo dialysis, in which a machine takes over some of the filtering function, or transplantation;[16]

- Diabetic foot disease, caused by changes in blood vessels and nerves in the feet, can lead to ulcers on the feet and eventually to amputation of limbs. Diabetes is the most common cause of non-traumatic amputations of the lower limbs; and,

- Diabetes is associated with a variety of other ailments, including gastroparesis, in which the stomach processes food too slowly and the food remains in the stomach too long; and an increased accumulation of plaque on the teeth.

Treatment Often Based on Healthy Diet, Exercise

There is no cure for diabetes, but the disease can be controlled through diet, exercise and/or medication.

Medical specialists, including Diabetes Australia, say that, for people with diabetes to remain healthy, they must maintain blood sugar levels as close as possible to normal.[17]

"The basis of traditional food habits for different cultures is suitable for people with diabetes, as they are based on plenty of whole grains, vegetables, fruit and nuts, seafood, and only small amounts of meat and meat products," Diabetes Australia says. "It is low in saturated fat, moderate in protein and high in carbohydrate. It does not need to be sugar-free, but concentrated sources like soft drinks, cordials … and sweets should be limited. The use of processed and convenience food is limited, and so maintaining traditional food habits can help manage diabetes."

Dietary recommendations call for consumption of healthy carbohydrates, including whole grains, legumes, vegetables and fruit; moderate amounts of protein, including lean meat, skinless chicken, fish and eggs; and high-fiber foods, including whole grains, fruit and vegetables. Foods to be avoided include saturated fats, such as meat fats, butter, cream, cheese, palm oil, coconut milk and processed snack foods; and foods that are high in sugar.

Physical activity also can help reduce blood sugar levels and improve the body's ability to use insulin.[18] Nevertheless — because exercise can cause an increase in blood sugar — exercise sessions should be scheduled at times when the blood sugar level is relatively low. Individuals should have a physician's approval before beginning an exercise program. (Conversely, physical activity can result in hypoglycemia in people whose diabetes is controlled with insulin or some oral medications. In these cases, the individual should check his or her blood sugar before exercising, and if the level is below 100 milligrams per deciliter, a snack is recommended. During exercise, food or glucose tablets should be available in case hypoglycemia develops. After exercise, blood sugar should be checked again, and if the level is 70 milligrams per deciliter or less, a snack or glucose tablets are recommended.)

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), part of the U.S. National Institutes of Health, recommends a combination of:[19]

- Aerobic exercise, including walking briskly, swimming, bicycling or other sports, to increase the heart rate and respiratory rate. The NIDDK recommends at least 30 minutes of aerobic exercise on most days, or about 150 minutes to 200 minutes a week;
- Strength training, including exercises with hand weights, elastic bands and/or weight machines, builds muscle and helps burn fat. The NIDDK recommends strength training two or three times a week; and,
- Stretching exercises increase flexibility, reduce stress and reduce muscle soreness caused by other exercise.

(Some types of exercise can aggravate problems related to diabetes and should be avoided. For example, weight lifting can increase pressure within the blood vessels in the eyes and can lead to a worsening of diabetes-related eye problems. In some cases, the feet become numb because of nerve damage; this may mean that walking should be avoided as a form of aerobic exercise.)

Dr. Claus Curdt-Christiansen, chief of the Aviation Medicine Section at ICAO, says that if pilots can control their diabetes through diet alone, without medication, then "of course they can fly. Certain types of oral anti-diabetic drugs are also compatible with safe flying, and pilots who need such medication usually can continue flying."[20]

ICAO's recommendations are outlined more fully in a revision, expected to be printed and distributed in 2006, of the diabetes section of the *Manual of Civil Aviation Medicine.*[21]

"When the diagnosis of diabetes is made, the license holder will have to be removed from aviation duties and other safety-critical functions for a suitable period of time," the unedited revision says. "The situation should then be reassessed after appropriate control has been achieved and a decision [has been] made based on relevant reports from the treating diabetologist/physician. …

"It is essential that aircrew have satisfactory control before being returned to the operational environment. They should be free from diabetic symptoms and [should] maintain good nutrition."

Many civil aviation authorities already issue unrestricted medical certificates to pilots who can control type 2 diabetes without the use of medication.

For example, the European Joint Aviation Authorities (JAA) *Manual of Civil Aviation Medicine* provides for unrestricted class 1 medical certificates (for professional pilots) and class 2 medical certificates (for private pilots) "for type 2 diabetics fully controlled on diet alone … subject to detailed follow-up at periodic medical examinations, or at least annually."[22]

For Some, Oral Medications Help Control Diabetes

About 40 percent of people with type 2 diabetes require medication taken by mouth to control blood sugar levels.[23] There are many types of medications to help lower blood sugar levels, including:[24]

- Sulfonylureas, which stimulate the pancreas, causing it to produce more insulin;
- Biguanides, which decrease the amount of glucose produced by the liver;
- Alpha-glycosidase inhibitors, which slow absorption of carbohydrates;
- Thiazolidinediones, which increase the body's sensitivity to insulin;
- D-phenylalanine derivatives, which stimulate the pancreas to produce insulin more quickly; and,
- Combination oral medicines, which combine different types of medications.

In recent years, civil aviation authorities have become increasingly likely to issue medical certificates to applicants whose diabetes is controlled with medication.

For example, in Australia, the *Designated Aviation Medical Examiners Handbook* says that a class 1 medical certificate (for airline transport pilots and commercial pilots) may be issued, with an "as or with co-pilot" restriction, to an applicant who has no unacceptable side effects from the medication, can show that blood sugar levels are under control and has no complications that "could result in sudden or unpredictable incapacitation when exercising the privileges of a license." Unrestricted class 2 medical certificates (for private pilots, student pilots and cabin crew) and class 3 medical certificates (for air traffic controllers) are issued to applicants to meet the same criteria.[25]

40 Percent of Diabetics Require Insulin Treatment

About 40 percent of people with diabetes (all type 1 diabetics and about one-third of type 2 diabetics) require treatment with insulin, which can quickly reduce blood sugar levels by moving sugar from the blood into the body's cells. If insulin is administered in inappropriately high doses, if meals and/or exercise do not occur on schedule or if exercise is more vigorous than expected, the result may be hypoglycemia.

Insulin is administered through injections using a needle and syringe or, if the user prefers, by other methods intended to simplify the injection process, including the following.[26,27]

- Injection aids, such as spring-loaded syringe holders or stabilizing guides, some of which allow the injection to be administered by pushing a button;
- Insulin pens, which resemble ink pens but which contain cartridges of insulin. Users select a dial setting for the appropriate dosage and depress a plunger to administer an injection beneath the skin;
- Insulin jet injectors, which use a high-pressure air mechanism to deliver a spray of insulin through the skin;
- Subcutaneous infusion sets (insulin infusers), in which a catheter (flexible hollow tube) is inserted under the skin and insulin is injected into the infuser rather than into the skin; and,
- External insulin pumps, which are the size of a deck of playing cards, weigh about three ounces (85 grams) and can be carried in a pocket or on a belt. The pump can be adjusted to deliver insulin throughout the day through a flexible plastic tube with a needle at the tip that is inserted under the skin near the abdomen.

Other methods of administering insulin are being developed, including insulin pills, some of which have been tested in clinical trials; surgically implanted insulin pumps; an insulin patch to be placed on the skin to provide a continuous low dose of insulin to be absorbed through the skin; inhalers to allow an insulin spray or insulin powder to be inhaled through the mouth or nose into the lungs and on to the bloodstream; and a surgically implanted artificial pancreas to sense blood sugar levels and release the required amount of insulin. Another development is pancreatic islet transplantation, an experimental procedure in which clusters of pancreatic cells that manufacture insulin are transplanted from a donor pancreas into the pancreas of a type 1 diabetic; the transplanted cells then produce insulin.[28]

ICAO says that use of insulin to control diabetes is "an absolute disqualification" for medical certification, and only a few countries issue medical certificates to insulin-treated diabetics.

Nevertheless, in recent years, civil aviation authorities in several countries have begun allowing some pilots with insulin-treated diabetes to receive medical certification, with requirements for frequent monitoring of their blood sugar levels and with conditions that limit their flight operations.

For example, Transport Canada changed its medical certification guidelines in 1992 to provide for pilots with insulin-treated diabetes to be evaluated according to their individual abilities to control the disease.

"Control of [diabetes] has improved dramatically," Transport Canada says in its *Handbook for Civil Aviation Medical Examiners*. "This enormous progress in the management of the disease, together with an increase in the number of insulin[-treated diabetics] and oral-hypoglycemic-treated diabetics prompted Transport Canada's Civil Aviation Medicine Branch to re-examine its policies on diabetes mellitus."[29]

To receive medical certification, an applicant must have had "no recurring hypoglycemic episodes requiring the intervention of another party during the past five years"; stable control of blood sugar levels for the previous year; "good diabetes education and understanding and … a positive attitude towards monitoring and self-control"; "no evidence of hypoglycemia unawareness"; and medical reports from an ophthalmologist, a

cardiologist, a neurologist and a nephrologist — all of whom have found no significant complications related to diabetes, the handbook says. In addition, an applicant must undergo medical evaluation by a specialist in diabetes every three months and must maintain a log of blood sugar levels.

Those pilots are subject to continued monitoring of their health, with special attention from cardiologists and eye care specialists, and are required to check their blood sugar levels before takeoff, during the flight and before landing and to eat a snack containing a specified amount of glucose if the test indicates that blood sugar is below the required level.

The pilots are required to operate only in multi-crew situations and only in Canadian airspace.

Seventy-five insulin-treated pilots and air traffic controllers currently have medical certificates from Transport Canada, including 13 pilots with air transport pilot licenses, says Dr. James Wallace, senior consultant for operations, policy and standards at the Civil Aviation Medicine Branch of Transport Canada.[30]

"We're quite comfortable with them being in a multi-crew situation where the other members of the flight crew do not have any medical restriction," Wallace says. "It hasn't been a problem for us. All of these pilots are very compliant; many of them send me their blood sugar logs by e-mail attachment.

"We've had very good results with this policy. It has enabled [trained and experienced] people … to continue in their profession."

Among the airline pilots who have received medical certification under the new policy is Capt. Stephen C. Steele, who lost his medical certificate when he was diagnosed with type 1 diabetes in 1986, was issued a medical certificate with restrictions in 2001 and resumed his airline flying career in 2002.

"The safety regulations regarding pilots with diabetes were put in place when diabetes management was far less precise than it is today," Steele says. "However, over the past 20 years, huge advances have been made in the development of new medical technologies, such as home blood sugar testing and the new, versatile, more precise insulins. These developments have revolutionized the management of diabetes. But while medical technology has advanced … outdated regulations remain in place which unfairly discriminate against the pilot with diabetes."[31]

In addition to Transport Canada, civil aviation authorities in several countries, including Australia, the United Kingdom and the United States, have made policy changes to allow some insulin-treated private pilots or recreational pilots to receive medical certification.

Similar requirements apply for medical certification, for follow-up monitoring of their health and for checks of blood sugar levels before takeoff, during the flight and before landing.

Regular Monitoring of Blood Sugar Required

People with diabetes should monitor their blood sugar levels regularly — sometimes as often as several times a day, although the frequency of monitoring depends on the method used to control the diabetes. Monitoring typically requires a diabetic individual to prick a finger to obtain a drop of blood and then to use a glucose meter to measure the amount of glucose in the blood.

Glucose meters measure sugar in whole blood or in plasma (a component of whole blood; this is the type of measurement obtained in a medical laboratory), or they provide a "plasma equivalent" to allow comparison between sugar levels in blood obtained through the home monitor and in blood that has been analyzed in medical laboratories.

Newer meters allow blood to be taken from sites other than the fingertips, including the upper arm, forearm, base of the thumb and thigh. Nevertheless, the U.S. Food and Drug Administration (FDA), which has responsibility for approving medical devices that are offered for sale in the United States, says that blood in the fingertips shows changes in sugar levels more quickly than blood from other sites.[32] Other new meters function without pricking the skin, either by using small electric currents to pull body fluid from the skin or using a laser beam to prick the skin.

Researchers are working to develop other methods of testing without pricking the skin, including use of light beams, energy waves emitted by the body, radio waves and ultrasound.[33]

In addition to monitoring their own blood sugar levels, people with diabetes should be tested at least twice a year with a hemoglobin A1C test administered by health care providers to assess their blood sugar levels during the previous three months, medical specialists say. If the result of the test is less than 7 percent, this indicates that the diabetes-treatment plan probably is effective; a result of more than 8 percent means that the person has an increased risk of developing diabetes-related problems involving the eyes, kidneys or nerve damage.[34]

Diet, Exercise Remain Primary Elements of Diabetes Prevention

Medical specialists recommend a healthy diet — such as the diet recommended for control of diabetes — and exercise as essential in helping to prevent diabetes (see "Diabetes Prevention Guidelines," page 7).

"Healthy dietary patterns need to be encouraged at an early age," the International Diabetes Federation (IDF) says in a position statement about controlling diabetes and obesity. "Physical activity should form a central part of both childhood and adult lifestyles. Clear food labeling and a reduction in portion size are crucial factors."[35]

Diabetes Prevention Guidelines

Medical specialists recommend the following actions to minimize the risk of developing diabetes:

- **Maintain a healthy weight.** If overweight, even a relatively small weight loss helps reduce the risk of diabetes. Diabetes New Zealand estimates that at least half of all cases of type 2 diabetes could be avoided if excess weight gain in adults were prevented;[1]
- **Eat a healthy, low-fat, low-calorie diet.** In addition to promoting weight loss, this diet also will help reduce blood pressure and blood cholesterol;[2]
- **Exercise.** Thirty minutes a day (or 2 1/2 hours a week) of walking can help prevent or delay the onset of type 2 diabetes;[3]
- **Medication sometimes is effective in preventing diabetes.** In a study of people with pre-diabetes and others at high risk of developing the disease, those treated with the drug metformin reduced their risk of diabetes by 31 percent over three years. Metformin was more effective among people between ages 25 and 40 who were 50 pounds (23 kilograms) to 80 pounds (36 kilograms) overweight. In another study of people with pre-diabetes, the drug acarbose reduced the risk of developing diabetes by 25 percent over three years;[4]
- **Some studies indicate that people who smoke cigarettes are more likely than nonsmokers to develop diabetes.** Among people who have diabetes, smoking can increase the incidence of heart attack and stroke, diabetic foot problems, diabetic eye disease and diabetic kidney disease.[5]♦

Notes

1. Diabetes New Zealand. *The Link Between Obesity and Type 2 Diabetes.* Oct, 20, 2004.
2. U.S. National Institute of Diabetes and Digestive and Kidney Diseases. *Insulin Resistance and Pre-diabetes.* <http://diabetes.niddk.nih.gov/>.
3. American Diabetes Association. *National Diabetes Fact Sheet.* <www.diabetes.org>.
4. Ibid.
5. International Diabetes Federation. *Diabetes and Tobacco Use*: *A Harmful Combination.* <www.idf.org>.

The IDF also recommended regular diabetes screenings for anyone who is overweight, has a first-degree relative (a parent or a sibling) who has diabetes, is older than 65 or is a member of an ethnic group that is considered to be at high risk of developing diabetes.

Although diabetes presents risks of major health problems that can endanger medical certification, early diagnosis and consistent compliance with prescribed changes in diet and exercise can keep the disease under control. In most cases, pilots who can control their diabetes through diet and exercise can continue their flying careers; in some cases — depending on civil aviation regulations — pilots who require medication for diabetes control also can retain their medical certification.♦

Notes

1. United Nations World Health Organization (WHO). *World Health Report* 2003. "Causes of Death." Geneva, Switzerland, 2003.
2. International Diabetes Federation (IDF). *Why You Should Care*. <www.idf.org>.
3. WHO. *Diabetes: The Cost of Diabetes,* Fact Sheet No. 236, Revised September 2002. <www.who.int>.

   (See "Sedentary Lifestyles and High-fat, High-calorie Diets Blamed for Worldwide Increases in Overweight, Obesity," *Human Factors & Aviation Medicine* Volume 48 [March–April 2001]).
4. IDF. *Who Gets Diabetes?* <www.idf.org>.
5. A third form of diabetes is gestational diabetes, which develops among some women during the latter months of pregnancy because of the effects of hormones produced by the body during pregnancy or because the body is not producing sufficient insulin. Gestational diabetes typically ends after the baby's birth, but women who have had gestational diabetes are more likely than other women to later develop type 2 diabetes.
6. U.S. National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). *Hypoglycemia*. <http://diabetes.niddk.nih.gov>.

   Among non-diabetics, hypoglycemia can be either reactive (occurring after meals and usually not associated with any disease) or fasting (occurring hours after eating and often related to an underlying disease).

   The causes of reactive hypoglycemia are unknown, but some researchers believe that the causes may involve sensitivity to the body's secretion of the hormone epinephrine or to insufficient secretion of the hormone glucagon. Reactive hypoglycemia can be relieved by consuming small meals or snacks every three hours, limiting foods with high sugar content and exercising regularly.

   The causes of fasting hypoglycemia include medications such as those used to treat diabetes, large doses of salicylates (pain relievers, including aspirin) and sulfa medicines used to treat infection; excessive consumption of alcoholic beverages; some illnesses involving the heart, kidneys or liver; serious infections; and insulin-producing tumors. Treatment typically includes stopping use of a medication that has been identified as the cause of hypoglycemia or changing the dosage, or treating underlying illnesses.
7. International Civil Aviation Organization (ICAO). Planned revision (unedited) to *Manual of Civil Aviation Medicine.* Part III, Chapter 4, "Metabolic, Nutritional and Endocrine Diseases." Publication expected in 2006.
8. Diabetes UK. *Who Gets Diabetes and What Causes It?* <www.diabetes.org.uk>.
9. ICAO. *Manual of Civil Aviation Medicine*. Part III, Chapter 4, "Metabolic, Nutritional and Endocrine Diseases." Second edition, 1985.

10. NIDDK. *Diagnosis of Diabetes*. <http://diabetes.niddk.nih.gov>.

11. Ibid.

12. WHO. *Diabetes Mellitus,* Fact Sheet 138. Revised April 2002. <www.who.int>.

13. NIDDK. *Prevent Diabetes Problems: Keep Your Nervous System Healthy.* <http://diabetes.niddk.nih.gov>.

14. NIDDK. *Prevent Diabetes Problems: Keep Your Eyes Healthy.* <http://diabetes.niddk.nih.gov>.

15. WHO. *Diabetes Mellitus*.

16. NIDDK. *Kidney Disease of Diabetes.* <http://kidney.niddk.nih.gov>.

17. Diabetes Australia. *Healthy Eating*. <www.diabetesaustralia.com.au>.

18. Physical activity also is associated with numerous other health benefits, including reductions in blood pressure, cholesterol and stress; a reduced risk for heart disease and stroke; weight loss and reduction of body fat; increased energy; and increased strength of the heart, bones and joints.

19. NIDDK. *What I Need to Know About Physical Activity and Diabetes*. <http://diabetes.niddk.nih.gov>.

20. Curdt-Christiansen, Claus. Telephone interview with Werfelman, Linda. Alexandria, Virginia, U.S., Feb. 10, 2005. Flight Safety Foundation, Alexandria, Virginia, U.S.

21. ICAO. Planned revision (unedited).

22. Joint Aviation Authorities. *Manual of Civil Aviation Medicine*. Chapter 5, "Metabolic, Nutritional and Endocrine Systems." Feb. 1, 2005.

23. WHO. *Diabetes Mellitus.*

24. NIDDK. *Medicines for People With Diabetes*. <http://diabetes.niddk.nih.gov>.

25. Civil Aviation Safety Authority of Australia. *Designated Aviation Medical Examiners Handbook*. Section 2.4.4 "Diabetes Mellitus and Impaired Glucose Tolerance." Version 3.0, December 2003.

26. WHO. *Diabetes Mellitus.*

27. NIDDK. *Alternative Devices for Taking Insulin*. <http://diabetes.niddk.nih.gov>.

28. NIDDK. *Pancreatic Islet Transplantation*. <http://diabetes.niddk.nih.gov>.

29. Transport Canada. "Canadian Guidelines for the Assessment of Medical Fitness in Pilots, Flight Engineers and Air Traffic Controllers With Diabetes Mellitus." *Handbook for Civil Aviation Medical Examiners*.

30. Wallace, James. Telephone interview by Werfelman, Linda. Alexandria, Virginia, U.S., Feb. 9, 2005. Flight Safety Foundation, Alexandria, Virginia, U.S.

31. Steele, Stephen C. "Discrimination on High: Flying on Insulin." *Diabetes Voice* Volume 48 (September 2003).

32. U.S. Food and Drug Administration. *Diabetes Information: Glucose Meters and Diabetes Management.* <www.fda.gov>.

33. NIDDK. *Noninvasive Blood Glucose Monitors*. <http://diabetes.niddk.nih.gov>.

34. University of Michigan Health Systems. *Hemoglobin A1C Test*. <www.med.umich.edu>.

35. IDF. *Diabetes and Obesity — A Global Problem*. <www.idf.org>.

Human Factors & Aviation Medicine

Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; Linda Werfelman, senior editor; Rick Darby, associate editor; Karen K. Ehrlich, web and print production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and Patricia Setze, librarian, Jerry Lederer Aviation Safety Library

Subscriptions: One year subscription for six issues includes postage and handling: US$160 for members/US$280 for nonmembers. Include old and new addresses when requesting address change. • Attention: Ahlam Wahdan, membership services coordinator, Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708.