EPIDEMIOLOGY

Type 2 Diabetes Mellitus Among Youth in Puerto Rico, 2003

ROSA PÉREZ-PERDOMO, MD, MPH, PhD*; CYNTHIA M. PÉREZ-CARDONA, MS, PhD*;
MYRIAM ALLENDE-VIGO, MD†; MARIAM I. RIVERA-RODRÍGUEZ, MA‡;
LUIS A. RODRÍGUEZ-LUGO, MS‡.

Aims. **To describe the clinical characteristics, and estimate the prevalence of type 2 diabetes mellitus among Puerto Rican youth, 1995-2003.**

Methods. **All patients aged less than 20 years with a confirmed diagnosis of type 2 diabetes were identified from pediatric endocrinologists' medical practices. Medical records of each patient were reviewed to confirm the diagnosis, classify the type of diabetes, and gather sociodemographic and clinical characteristics. From 1995 to 2003 a total of 32,444 records were reviewed. A total of 2,800 children with diabetes were identified, of which 2,702 were type 1 and 93 type 2; type1/type2 ratio was 29:1. Frequency distributions were obtained for categorical variables, and summary measures (mean ± standard deviation) for quantitative measure were computed.**

Results. **Mean age at first visit was 14 years. The majority of cases were females (69%), for a female/male ratio of 2.2:1. 78.5% had a family history of the disease, 74.2% were overweight, and 48% had acanthosis nigricans. 64.5% of the cases were receiving some type of hypoglycemic therapy. 18.5% of the cases had severe hypertension while 17.5% had cholesterol levels considered at increased risk (e"200). The overall prevalence was 13.5 per 100,000 population.**

Conclusions. **This study is the first that describes the frequency and clinical presentation of type 2 diabetes in children and adolescents in a sample of Puerto Ricans. Further investigations must be conducted to obtain a more precise estimate of the burden of type 2 diabetes in youth and to raise awareness of this condition among health care professionals.**

Key words: Youth, Diabetes mellitus, Type 2, Hispanics

New cases of children and adolescents with type 2 diabetes mellitus are being diagnosed at an amazing rate (1). However, few studies have investigated the prevalence of type 2 diabetes in Hispanic youth (2-3); primarily among Mexicans. It was observed that type 2 diabetes disproportionately affects individuals of Hispanic ethnicity (83%), mostly females (75%) and with a significant family history of the disease (2-4).

Recent epidemiological studies in Puerto Rico have demonstrated a high prevalence of type 2 diabetes, particularly, in the older population. Indeed, Puerto Rico had the largest prevalence of diabetes within all states that participated in the Behavioral Risk Factor Surveillance System (BRFSS) in 1999, 2000 and 2001 (5). Similar to other populations, obesity was present in a large proportion (85%) of diabetes cases (6-7).

The rising trends of the disease in adolescents coincide with the rising prevalence of overweight and physical inactivity. Other risk factors associated with diabetes type 2 in adolescents are puberty (mean age at diagnosis is approximately 13.5 years), female sex, increased body mass index, family history of type 2 diabetes, exposure to diabetes *in utero* and signs of insulin resistance (8-13).

The high prevalence of type 2 diabetes in the Puerto Rican population and the known influence of family history of the disease may suggest that the Puerto Rican youth has a large prevalence of the disease. Overall proportion of type 1 and type 2 diabetes in a group of medically insured patients aged 19 years or less was 1.2% (14). Incidence of Type 1 diabetes in Puerto Rican children aged 14 years or less was estimated as 18 per 100,000 (15). However, incidence or prevalence of type 2 diabetes in youth has not been documented.

From the *Department of Biostatistics and Epidemiology, Medical Science Campus, Graduate School of Public Health, University of Puerto Rico, the †Endocrinology Section, Department of Medicine, Medical Sciences Campus, University of Puerto Rico and the ‡Diabetes Center of Commonwealth of Puerto Rico at the Puerto Rico Medical Center

This work was supported in part by Eli Lilly Export S.A. PO Box 191268 San Juan, PR 00919-1268

Address correspondence to: Rosa Pérez-Perdomo, MD, MPH, PhD, Graduate School of Public Health, Medical Sciences Campus, University of Puerto Rico, PO Box 365067, San Juan, Puerto Rico 00936-5067. Telephone: (787) 758-2525 ext. 1401; Fax: (787) 759-6719

Therefore, we conducted a retrospective review of medical records of cases diagnosed by pediatric endocrinologists to describe the clinical presentation at diagnosis and estimate the prevalence of type 2 diabetes in Puerto Rican youth.

Methods

All studied cases were identified from pediatric endocrinology practices. In Puerto Rico there are 13 certified pediatric endocrinologists, of whom, 11 (84.6%) agreed to participate in the study. The pediatric practices of these endocrinologists are located in eight out of 78 municipalities of the island, but most of them have a practice that serves several municipalities as well as different health facilities. A total of 25 medical and other health facilities where these specialists exercise their practice were visited. A case was defined as any youth less than 20 years of age with written documentation of a diagnosis of type 2 diabetes in the medical record.

The methods used to identify eligible cases included:

1. revision of all physicians' active records,
2. revision of master patient index and disease registry,
3. records that met the inclusion criteria were previously identified and selected by the pediatric endocrinologist record system.

A data form was designed to abstract demographic, clinical and biochemical characteristics upon diagnosis and last follow-up visit from medical records. Blood pressure, body mass index, total cholesterol, triglycerides, glycosilated hemoglobin, c-peptide levels, and fasting blood sugar were classified according to national standards (16-25). Frequency distributions for categorical variables and summary measures (mean ± standard deviation) for quantitative variables were computed.

A total of 32,444 medical records covering the period from 1995 to 2003 were reviewed. The revision was performed during the year 2003. Of all the records reviewed, 109 cases met the diagnostic criteria for type 2 diabetes. Of these, 93 (85.3%) cases agreed to participate in the study. In addition, a total of 2, 707 cases were identified as type 1 diabetic cases. The information recorded at the first visit and at last follow up visit was abstracted. From the information obtained at the medical record it was not possible to establish if the diagnosis was made in the first visit or if the case was previously diagnosed in other setting and referred to the endocrinologist. Data entry and analysis were performed using the Statistical Program for Social Sciences (SPSS). Given the small sample size, stratification by sex and age group was not included.

Results

Table 1 describes the demographic characteristics of children and adolescents with type 2 diabetes. The mean age at the first visit for type 2 diabetes was 14±2.7 years,

Table 1. Demographic characteristics of Children and Adolescents Diagnosed with Type 2 Diabetes Mellitus, Puerto Rico, 2003

Variable	Male		Female		Total	
	Cases	%	Cases	%	Cases	%
Age at first visit (years)						
< 10	-		5	7.9	5	5.4
10-14	12	41.4	36	57.1	48	52.2
15-18	17	58.6	21	33.3	38	41.3
≥ 19	-		1	1.6	1	1.1
Total	29	100.0	63	100.0	92	100.0
Age at most recent visit (years)						
< 10	-	-	5	7.8	5	5.4
10-14	7	24.1	29	45.3	36	38.7
15-18	18	62.1	29	45.3	47	50.5
≥ 19	4	13.8	1	1.6	5	5.4
Total	29	100.0	64	100.0	93	100.0
Educational level (n=40)						
Elementary	1	3.4	10	15.6	11	11.8
Intermediate	5	17.2	8	12.5	13	14.0
High school	4	13.8	10	15.6	14	15.0
High school graduate	1	3.4	1	1.6	2	2.2
Not documented in medical records	18	62.1	35	54.7	53	57.0
Total	29	100.0	64	100.0	93	100.0

corresponding to puberty. Only five patients were under 10 years of age at the first visit and the youngest case was 5 years. All cases less than 10 years of age were females. More than half of the cases were between 10 and 14 years of age (52.2%). The majority of the cases were females, with a female/male ratio 2.2:1. Among those who had the educational level documented in the medical record, only 15.0% of children and adolescents were in high school.

Table 2 shows selected clinical characteristics of these patients. Among cases with the information documented in the medical record, 73 (78.5%) had a family history of

Table 2. Clinical Characteristics of Youth with Type 2 Diabetes Mellitus, Puerto Rico, 2003

Clinical characteristic	N with the information documented	N with the information not documented	N with the characteristic present	Percent of cases with the characteristics present	Total
Diabetes family history	74	19	73	78.5%	93
Body mass index	86	7	86	92.5%	93
Normal (<85th percentile)	9		9	9.7%	
At risk of overweight (85th – 95th percentiles)	8		8	8.6%	
Overweight (≥ 95th percentile)	69		69	74.2%	
Insulin resistance evidence	56	37	49	52.7%	93
Acanthosis nigricans	51	42	45	48.4%	93
Polycystic ovarian syndrome	16	48	12	18.8%	64
Polyuria	47	46	30	32.3%	93
Polydipsia	37	56	25	26.9%	93
Consistent hunger	22	71	15	16.1%	93
Headaches	13	80	13	14.0%	93
Hypoglycemic therapy	60	33	60	64.5%	93
Oral agent only	38		38	40.9%	
Insulin therapy only	6		6	6.5%	
Oral agent and insulin therapy	16		16	17.2%	

the disease, and 74.2% were overweight. Approximately 53% had documented insulin resistance, 48% presented acanthosis nigricans, and 13% of the female patients had polycystic ovarian syndrome. Among cases with symptoms documented, 30 (32.3%) reported polyuria, 25 (26.9%) polydipsia, 15 (16.1%) consistent hunger, and 13 (14.0%) headaches. Clinical management of patients varied. sixty cases were receiving hypoglycemic medications of which 38 (40.9%) were solely under therapy with oral agents, 6 (6.5%) were receiving insulin only and 16 (17.2%) had both oral and insulin medications. Of those receiving oral agents, most of them were receiving Metformin, while 33 patients were not receiving any type of medication or did not have information documented. Twenty-five cases were on dietary management (data not shown).

Blood pressure levels were available for 27 patients at the first visit and 44 patients at last follow-up visit. Mean levels for systolic blood pressure were 118.27 ± 16.72 mm Hg and 115.27 ± 16.42 mm Hg at first visit and during the last follow-up visit, respectively. Mean diastolic blood pressure was 77.64 ± 16.55 mm Hg at first visit and 73.52 ± 13.08 mm Hg at last follow-up visit (data not shown). The blood pressure readings indicated that among patients aged 17 years or less, 22.2% had significant or severe hypertension at diagnosis (Table 3). The majority of the patients (23 cases) in this age group had a normal blood pressure during the last follow-up visit. Among patients aged 18-19 years, 5 had prehypertension and 2 had hypertension during the last follow-up visit.

Total cholesterol levels at first visit were documented in 40 cases, with seven cases (17.5%) considered at increased

Table 3. Blood Pressure Levels of Youths with Type 2 Diabetes Mellitus in Puerto Rico, 2003

Blood pressure (mm Hg)	Total	
	Cases	%*
At first visit:		
Age ≤ 17 years (n=27)		
Normal (Percentile < 90th)	12	44.4
High normal (Percentiles 90th – 94th)	9	33.3
Significant hypertension (Percentiles 95th – 99th)	1	3.7
Severe hypertension (Percentiles > 99th)	5	18.5
Total	27	100.0
Most recent visit:		
Age ≤ 17 years (n= 35)		
Normal (Percentile < 90th)	23	65.7
High normal (Percentiles 90th – 94th)	9	25.7
Significant hypertension (Percentiles 95th – 99th)	1	2.9
Severe hypertension (Percentiles > 99th)	2	5.7
Total	35	100.0
Age 18 – 19 years (n=9)		
Optimal (< 120/80)	2	22.2
Prehypertension (120 - 139/80 - 89)	5	55.6
Stage 1 hypertension (140 - 159/90 - 99)	1	11.1
Stage 2 hypertension (≥ 160/≥ 100)	1	11.1
Total	9	100.0

*Percentage based on the number of cases with the information documented.

Table 4. Laboratory Test Results at First visit of Youth with Type 2 Diabetes Mellitus by Sex, Puerto Rico, 2003

Variable	Total	
	Cases	%*
Total serum cholesterol (mg/dl		
Normal (< 170)	24	60.0
Bordeline (170-199)	9	22.5
Increased risk (≥ 200)	7	17.5
Total	40	100.0
Triglycerides (mg/dl)		
Acceptable (< 150)	23	63.9
At risk (≥ 150)	13	36.1
Total	36	100.0
Glycosilated hemoglobin (%)		
Normal (< 6)	7	15.6
Acceptable (6-7)	11	24.4
High (> 7)	27	60.0
Total	45	100.0
C-peptide levels (ng/ml)		
Acceptable (0.5-2.0)	2	13.3
High (≥ 2.0)	13	86.7
Total	15	100.0
Fasting blood sugar (mg/dl)		
Acceptable (≤ 100)	13	17.1
Borderline (100-125)	18	23.7
High (≥ 126)	45	59.2
Total	76	100.0

*Percentage based on the number of cases with the information documented.

risk (≥ 200). Regarding the triglycerides values, 13 (36.1%) were above 150 mg/dl, while 45 cases had information on glycosilated hemoglobin at first visit with 27 (60.0%) having above 7%. Only 15 cases had data related with C-peptide levels at first visit, of which 13 (86.7%) had levels above 2 ng/ml. Seventy-six cases had documented information on fasting blood sugar levels at first visit with 45 (59.2%) having levels above 126 mg/dl (Table 4). Among the 93 cases of diabetes type 2, at the first recorded visit there were 43 (46.2%) patients with normal values of glycosilated hemoglobin or fasting blood sugar levels. When these groups of cases were analyzed, the following characteristics were observed. Of the 43 patients, 34 (79%) had family history of diabetes, 24 (56%) had insulin resistance evidence, and 31 (72%) were overweight.

The overall crude prevalence of children and adolescents with type 2 under pediatric endocrinologists' treatment was 13.5 per 100,000 population (using as denominator the population age group [5-19 years] of the municipalities of residence of the cases), while for the 10 to 14 age group was 15.9 per 100,000 and 22.19 for the 15 - 19 age group. A total of 2,800 children and adolescents with diabetes were identified within the records reviewed, of which, 2,707 were type 1. Among all diabetic children and adolescent cases, the proportion of diabetes type 2 was approximately 3.9% with a type 1/type 2 ratio of 29:1.

Discussion

This is the first study that describes the frequency of type 2 diabetes in a sample of children and adolescents in Puerto Rico. The cases described in this study illustrate the presence of type 2 diabetes in childhood in Puerto Rico and evidence the importance of accurate diagnosis and management in youth.

The clinical information that was systematically available for each patient in the medical record was limited. Our health system is currently under a managed care model in which health service access is through a primary care provider. Because our source of patients was limited to specialist physicians, type 2 diabetes patients under the medical care of primary health care physicians were not included. There is evidence that a substantial proportion of type 2, and probably not type 1, juvenile diabetic cases may be misclassified, undiagnosed or unreported (1).

Not all the municipalities with type 2 diabetes cases have a local practicing pediatric endocrinologist. This may indicate that the 59 cases residing in municipalities without a pediatric endocrinologist practice received the service outside the area of residence. Thus, to provide at least an estimate of prevalence among Puerto Rican youth we calculated the crude prevalence using as denominator the age-specific population of those municipalities in which the cases reside (26). From this estimate, we found a prevalence of 13.5 per 100,000 population, which is lower than that found in other Hispanic populations (2-4).

In a prevalence study conducted in South Carolina (27) of a total of 245 youth diabetic cases, 181 (74%) were seen by pediatric endocrinologists, of which, 16% were type 2, with a type 1 diabetes / type 2 diabetes ratio of 5:1, while in other study this ratio was 6:1 (3).

The present study documented a total of 2,800 cases receiving medical care by pediatric endocrinologists. The proportion of type 2 cases was 3.3%, with a type 1 diabetes / type 2 diabetes ratio of 29:1; thus, this ratio is higher than in the above references. In this study, the female/ male ratio was 2.2:1, higher than the ratio found in similar studies (28) but lower than other investigations that have reported a ratio of 6:1 (29).

Characteristics of youth diagnosed with type 2 diabetes were similar to previous reports (13, 30, 31) they are overweight, have a family history of diabetes, have signs

of insulin resistance e.g. acanthosis nigricans, polycystic ovarian syndrome, d) mean body mass index in clinical series has ranged from 27 kg/m^2 to 38 kg/m^2, and the majority of children are diagnosed after 10 years of age. The proportion of cases with a family history of diabetes (78.5%) was within the range reported in previous studies (74% through 95%) (1-2). Similarly, the proportion of overweight cases (74.2%) was comparable to that found in previous studies (8-10). Minimal physical exercise and high fat intake have been implicated as risk factors for obesity and thus for type 2 diabetes (30,32,33). Unfortunately this information was limited in our medical record review. Further investigations should gather data on potential risk factors, clinical characteristics, and treatment of young diabetics in Puerto Rico. On the other hand, acanthosis nigricans reported (48.4%) was lower than other studies that have reported percentages ranging from 56% to 92% (34). It must be indicated that 45% of the medical records examined did not have this information available. Although almost half of the cases had normal values of glycosilated hemoglobin or fasting blood sugar at the first recorded visit, these cases presented other risk factors for the disease. These risk factors are: family history, insulin resistance, or are overweight. Furthermore, these cases could have been previously diagnosed and the first visit to the endocrinologist does not necessarily represent the visit for clinical diagnosis of the disease.

Our data evidenced that 54 (58%) of the cases were taking oral agents which is higher than in other studies (46.3%) (35); of those receiving oral agents, the majority were receiving Metformin, 40 (74%). However, 33 cases were not receiving any medical therapy or did not had the information documented.

Based in our findings, it can be concluded that the lower than expected prevalence of type 2 diabetes mellitus in the youth, in a population with a high prevalence of the disease in adults, could be partially attributed to under-diagnosis, or that a significant number of cases remain under the care of primary care physicians. All the cases in the present study received medical care by pediatric endocrinologists; therefore we expected that the probability of misclassification, which in some studies has been reported as high as 25% (30), would be low. However, the high ratio of type 1 diabetes / type 2 diabetes cases found could suggest that misclassification of the cases is also possible. Future studies should consider the use of multiple data sources to better define the burden of type 2 diabetes in Puerto Rican youth, and to raise awareness of this challenging condition among healthcare professionals.

Acknowledgements

We are indebted to all participating pediatric endocrinologists for their support, sustained commitment, and the independence they provided in the conduct of this study; and to all Directors of the Health Information Management Departments and hospitals for their contribution in accessing medical records.

Adanette Wiscovitch, MD	Yagüez Community Clinic, Mayagüez, Puerto Rico
Sallie Montes, RHIA	Villa Los Santos Clínic, Arecibo, Puerto Rico
Lorena Del Pilar Sabathié, BS	Hospital Auxilio Mutuo San Juan, Puerto Rico
Angel L. Vélez Solla, MD Carlos J. Bourdony Báez, MD	San Juan City Hospital, San Juan, Puerto Rico
Carmen A. Sáenz de Rodríguez, MD Ana Lugo, BSN,CDE	Menonite Hospital, Cayey, Puerto Rico
Fermín Sánchez Lugo, MD, FAAP, DE	Dr. Ramón Ruiz-Arnau, University Hospital, Bayamón, Puerto Rico
Francisco Nieves Rivera, MD Lilliam González de Pijem, MD Annie Martínez, RHIA María Cardenales, RHIA	Dr. Antonio Ortiz Pediatric Hospital, San Juan, Puerto Rico
Lydia Irizarry González, MD	San Lucas Hospital, Ponce, Puerto Rico
Annette Santiago, RHIA	Ramón Emeterio Betances Medical Center, Mayagüez, Puerto Rico
Elsa Maldonado, RHIA	HIMA, Hospital Caguas, Puerto Rico
Miriam Alicea Rodríguez, MD Miladi Lugo, MD, FAAP	San Juan City Hospital, San Juan, Puerto Rico
Olga Fiol, RHIA	Ryder Memorial Hospital, Humacao, Puerto Rico
Rebeca Saenz Kuffner, MD	San Jorge Children's Hospital, San Juan, Puerto Rico

Resumen

Objetivos. Describir las características clínicas y estimar la prevalencia de diabetes mellitus tipo 2 en niños y adolescentes puertorriqueños entre los años 1995 y 2003.

Métodos. Se identificaron todos los pacientes menores de 20 años de edad con un diagnóstico de diabetes tipo 2 confirmado en las prácticas médicas de los endocrinólogos pediátricos de Puerto Rico. Se revisaron los expedientes médicos de cada paciente para confirmar el diagnóstico de diabetes mellitus, clasificar el tipo de diabetes y obtener características clínicas y sociodemográficas. Un total de 32,444 expedientes médicos se revisaron entre 1995 y 2003. Se identificaron 2,800 niños con diabetes, de los cuales 2,702 eran tipo 1 y 93 tipo 2, equivalente a una razón tipo1/ tipo 2 de 29:1. Se realizaron distribuciones de frecuencia para variables categóricas en el estudio y se calcularon medidas de resumen (media y desviación estándar) para variables cuantitativas. *Resultados.* La edad promedio en la primera visita al endocrinólogo pediátrico fue de 14 años. La mayoría de los casos eran niñas (69%), con una razón de niña/niño de 2.2:1. Se encontró un 78.5% con historial familiar de diabetes, 74.2% estaban sobrepeso, y 48% tenían acanthosis nigricans. Un 64.5% de los casos estaba recibiendo alguna terapia hipoglucémica. Un18.5% de los casos tenía hipertensión severa, mientras que 17.5% tenía niveles de colesterol a un nivel elevado de riesgo (≥200). La prevalencia general fue 13.5 por 100,000 habitantes. *Conclusiones.* Este estudio es el primer estudio que describe la frecuencia y presentación clínica de la diabetes tipo 2 en niños y adolescentes, en una muestra de puertorriqueños. Sin embargo, es necesario realizar nuevas investigaciones para obtener un estimado más preciso de la carga que representa la diabetes tipo 2 en jóvenes y crear conciencia de esta condición entre los profesionales de la salud.

References

1. Fagot-Campagna A, Pettitt DJ, Engelgau MM, Burrows NR, Geiss LS, Valdez R, et al. Type 2 diabetes among North American children and adolescents: an epidemiologic review and public health perspective. J Pediatr 2000;136:664-672.
2. Glaser NS, Jones KL. Non-insulin-dependent diabetes mellitus in Mexican-American children. West J Med 1998;168:11-16.
3. Hale DE, Danney KM. Non-insulin dependent diabetes in Hispanic youth (type 2Y) [abstract]. Diabetes 1998;47 Suppl 1:A82.
4. Neufeld ND, Raffel LJ, Landon C, Chen Y-DI, Vadheim CM. Early presentation of type 2 diabetes in Mexican-American youth. Diabetes Care 1998;21:80-86.
5. Pérez-Cardona C, Pérez-Perdomo R. Prevalence and associated factors of diabetes mellitus in Puerto Rican adults: behavioral risk factor surveillance system, 1999. PR Health Sci J 2001; 20:147-155.
6. Trissler R. Type 2 Diabetes on the Rise in Children. J Am Diet Assoc 1999;99:1354.
7. Ehtisham S, Barrett TG, Shawn NJ. Type 2 diabetes mellitus in UK children- an emerging problem. Diabet Med 2000;17: 867-871.
8. Dietz W. Overweight and precursors of type 2 diabetes mellitus in children and adolescents. J Pediatr 2001;138:453-454.
9. Young T, Dean H, Flett B, Wood-Steinman P. Childhood obesity in a population at high risk for type 2 diabetes. J Pediatr 2000; 136:365-369.
10. Uauy R, Albala C, Kain J. Obesity trends in Latin America: transiting from under to overweight. J Nutr 2001;131:893S-899S.
11. Kobayashi K, Amemiya S, Higashida K, Ishihara T, Sawanobori E, Mochizuki M, et al. Pathogenic factors of glucose intolerance in obese Japanese adolescents with type 2 diabetes. Metabolism 2000;49:186-191.
12. Carter J, Gilliand S, Perez G, Skipper B, Gilliand F. Public health and clinical implications of high hemoglobin A1c levels and weight in younger adult Native American people with diabetes. Arch Intern Med 2000;160:3471-3476.
13. Arslanian S. Type 2 diabetes in children: clinical aspects and risk factors. Horm Res 2002;57 Suppl 1:19-20.
14. Pérez-Perdomo R, Pérez-Cardona C, Rodríguez-Lugo L. Prevalence of diabetes and patterns of health services utilization: a comparative analysis between a private and a health reform group of insured, 1997-1998. PR Health Sci *J* 2001;20:139-146.
15. Fraser-De Lladó T, González-De-Pijem L, Hawk B. Incidence of IDDM in children living in Puerto Rico. Diabetes Care 1998; 21:744-746.
16. The Medical Algorithms Project. Cardiovascular System - Classification of high blood pressure in children and adolescents. Retrieved on: 5/5/03 from: http://www.medal.org/ch6.html
17. Lucile Packard Children's Hospital, Standford University Medical Center, Cardiovascular Diseases – Cholesterol, LDL, HDL, and Triglycerides. 2004. Retrieved on: 1/13/04 from: http://www.lpch.org/DiseaseHealthInfo/HealthLibrary/cardiac/clht.html
18. Brown T. Yahoo! Health Diabetes Health Center. Diagnosis and Test: Glycosylated Hemoglobin Test. (Provided by VeriMed Healthcare Network). John Hopkins University, Baltimore, MD. Retrieved on: 1/13/04, from: http://health.yahoo.com/health/centers/diabetes/003640.html
19. American Heart Association. What is High Blood Pressure? Retrieved on: 2/10/04 from: http://www.americanheart.org/presenter.jhtml?identifier=2112
20. National High Blood Pressure Education Program Working Group on hypertension control in children and adolescents. Update on the 1987 task force report on high blood pressure in children and adolescents: a working group report from the National High Blood Pressure Education Program. Pediatrics 1996;98:649-658.
21. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. JAMA 2003;289:2560–2572.
22. Quest Diagnostic Nicole Institute, Pediatric Endocrinology, Test Information - C - Peptide, Plasma. April, 2001.
23. NCEP Expert Panel on Blood Cholesterol: Levels in children and adolescents: National Cholesterol Education Program (NCEP): highlights of the Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents. Pediatrics 1992; 89:495-501.

24. Blood sugar levels: what's normal? Retrieved on 01/13/04 from: http://www.cnn.com/HEALTH/library/SA/00102.html
25. Medline Plus Encyclopedia Health Information. A service of the U. S. National Library and the National Institute. Insulin C-peptide. Retrieved on 01/13/04 from: http://www.nlm.nih.gov/medlineplus/ency/article/003701.htm
26. U.S. Department of Commerce, Economics and Statistics Administration U S Bureau of the Census, Census 2000 Summary File. Sex by age for the population under 20 years P14. From: http://factfinder.census.gov/home/en/datanotes/expsf1u.htm
27. Oeltmann, JE, Liese AD, Heinze HJ, Addy CL, Mayer-Davis EJ. Prevalence of diagnosed diabetes among African-American and Non-Hispanic White youth, 1999. Diabetes Care 2003; 26:2531 – 2535.
28. Grinstein G, Muzumdar R, Aponte L, Vuguin P, Saenger P, DiMartino-Nardi J. Presentation and 5-year follow-up of type 2 diabetes mellitus in African-American and Caribbean-Hispanic adolescents. Horm Res 2003;60:121-126.
29. Harris SB, Perkins BA, Whalen-Brough E. Non-insulin-dependent diabetes mellitus among First Nations children. New entity among First Nations people of north western Ontario. Can Fam Physician 1996;42:869-876.
30. American Diabetes Association. Type 2 diabetes in children and adolescents. Diabetes Care 2000;23:381-389.
31. Steinberger J, Daniels S. Obesity, insulin resistance, diabetes, and cardiovascular risk in children. An American Heart Association scientific statement from the Atherosclerosis, Hypertension, and Obesity in the Young Committee (Council on Cardiovascular Disease in the Young) and the Diabetes Committee (Council on Nutrition, Physical Activity, and Metabolism). American Heart Association Scientific Statement. Circulation 2003;107:1448 – 1453.
32. Pinhas-Hamiel O, Standiford D, Hamiel D, Dolan L, Cohen R, Zeitler P. A setting for development and treatment of adolescent type 2 diabetes mellitus. Arch Pediatr Adolesc Med 1999;153: 1063-1067.
33. Kiess W, Bottner A, Raile K, Kapellen T, Muller G, Galler A, et al. Type 2 diabetes mellitus in children and adolescents: a review from a European perspective. Horm Res 2003;59 Suppl 1: 77 – 84.
34. Quarry-Horn JL, Evans BJ, Kerrigan JR. Type 2 diabetes mellitus in youth. J Sch Nurs 2003;19:195-203.
35. Upchurch SL, Brosnan CA, Meininger JC, Wright DE, Campbell JA, McKay SV, et al. Characteristics of 98 children and adolescents diagnosed with type 2 diabetes by their health care provider at initial presentation. (Observations). Diabetes Care 2003.