

## 36. Chemical and Overt Diabetes

**Source** Reaven, G.M. and Miller, R.G. (1979). An attempt to define the nature of chemical diabetes using a multidimensional analysis. *Diabetologia* **16**, 17-24.

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Reaven and Miller (1979) examined the relationship between chemical subclinical and overt nonketotic diabetes in 145 non-obese adult subjects.

The three primary variables used in the analysis and presented in Table 36.1 are glucose intolerance, insulin response to oral glucose and insulin resistance. The first two variables are the areas under the straight line connecting glucose and insulin levels, respectively, determined from blood samples drawn during a three hour glucose tolerance test following an oral administration of a glucose load. Insulin resistance is measured by the steady state plasma glucose (SSPG) determined after chemical suppression of endogenous insulin secretion. In addition, the relative weight and fasting plasma glucose were measured for each individual in the study conducted at the Stanford Clinical Research Center and are included in Table 36.1.

These multidimensional data were visually inspected with the aid of the Prim 9 program at the Stanford Linear Accelerator Computation Center. The three primary variables have a configuration resembling a boomerang with a fat middle and two wings, or a donkey's head with floppy ears. From the clinical point of view the middle points represent the normal subjects and the two wings, or ears, the chemical and overt diabetic subjects.

Reaven and Miller applied a variant of a clustering algorithm due to Friedman and Rubin (1967) to the three primary variables to form clusters of "normal", "chemical diabetic", and "overt diabetic" subjects. The classifications of the subjects generated by the computer clustering were compared with the classifications obtained by current medical criteria. The latter classification for each patient is given in the last column of Table 36.1. A number of different clustering routines were tried on this same data set by Symons (1981).

### References

- Friedman, H. P. and Rubin, J. (1967). On some invariant criteria for grouping data. *J. Amer. Statist. Assoc.* **62**, 1159-1178.
- Symons, M. J. (1981). Clustering criteria and multivariate normal mixtures. *Biometrics* **37**, 35-43.

**Table 36.1**  
**Measures of Blood Glucose**  
**and Insulin Levels, Relative Weights**  
**and Clinical Classifications**

Patient number	Relative weight	Fasting plasma glucose	Glucose area	Insulin area	SSPG	Clinical classification *
1	0.81	80	356	124	55	3
2	0.95	97	289	117	76	3
3	0.94	105	319	143	105	3
4	1.04	90	356	199	108	3
5	1.00	90	323	240	143	3
6	0.76	86	381	157	165	3
7	0.91	100	350	221	119	3
8	1.10	85	301	186	105	3
9	0.99	97	379	142	98	3
10	0.78	97	296	131	94	3
11	0.90	91	353	221	53	3
12	0.73	87	306	178	66	3
13	0.96	78	290	136	142	3
14	0.84	90	371	200	93	3
15	0.74	86	312	208	68	3
16	0.98	80	393	202	102	3
17	1.10	90	364	152	76	3
18	0.85	99	359	185	37	3
19	0.83	85	296	116	60	3
20	0.93	90	345	123	50	3
21	0.95	90	378	136	47	3
22	0.74	88	304	134	50	3
23	0.95	95	347	184	91	3
24	0.97	90	327	192	124	3
25	0.72	92	386	279	74	3
26	1.11	74	365	228	235	3
27	1.20	98	365	145	158	3
28	1.13	100	352	172	140	3
29	1.00	86	325	179	145	3
30	0.78	98	321	222	99	3
31	1.00	70	360	134	90	3
32	1.00	99	336	143	105	3
33	0.71	75	352	169	32	3
34	0.76	90	353	263	165	3
35	0.89	85	373	174	78	3
36	0.88	99	376	134	80	3
37	1.17	100	367	182	54	3
38	0.85	78	335	241	175	3
39	0.97	106	396	128	80	3
40	1.00	98	277	222	186	3
41	1.00	102	378	165	117	3
42	0.89	90	360	282	160	3
43	0.98	94	291	94	71	3
44	0.78	80	269	121	29	3
45	0.74	93	318	73	42	3
46	0.91	86	328	106	56	3

**Table 36.1** (*cont.*)

Patient number	Relative weight	Fasting plasma glucose	Glucose area	Insulin area	SSPG	Clinical classification *
47	0.95	85	334	118	122	3
48	0.95	96	356	112	73	3
49	1.03	88	291	157	122	3
50	0.87	87	360	292	128	3
51	0.87	94	313	200	233	3
52	1.17	93	306	220	132	3
53	0.83	86	319	144	138	3
54	0.82	86	349	109	83	3
55	0.86	96	332	151	109	3
56	1.01	86	323	158	96	3
57	0.88	89	323	73	52	3
58	0.75	83	351	81	42	3
59	0.99	98	478	151	122	2
60	1.12	100	398	122	176	3
61	1.09	110	426	117	118	3
62	1.02	88	439	208	244	2
63	1.19	100	429	201	194	2
64	1.06	80	333	131	136	3
65	1.20	89	472	162	257	2
66	1.05	91	436	148	167	2
67	1.18	96	418	130	153	3
68	1.01	95	391	137	248	3
69	0.91	82	390	375	273	3
70	0.81	84	416	146	80	3
71	1.10	90	413	344	270	2
72	1.03	100	385	192	180	3
73	0.97	86	393	115	85	3
74	0.96	93	376	195	106	3
75	1.10	107	403	267	254	3
76	1.07	112	414	281	119	3
77	1.08	94	426	213	177	2
78	0.95	93	364	156	159	3
79	0.74	93	391	221	103	3
80	0.84	90	356	199	59	3
81	0.89	99	398	76	108	3
82	1.11	93	393	490	259	3
83	1.19	85	425	143	204	2
84	1.18	89	318	73	220	3
85	1.06	96	465	237	111	2
86	0.95	111	558	748	122	2
87	1.06	107	503	320	253	2
88	0.98	114	540	188	211	2
89	1.16	101	469	607	271	2
90	1.18	108	486	297	220	2
91	1.20	112	568	232	276	2
92	1.08	105	527	480	233	2
93	0.91	103	537	622	264	2
94	1.03	99	466	287	231	2
95	1.09	102	599	266	268	2
96	1.05	110	477	124	60	2

**Table 36.1** (cont.)

Patient number	Relative weight	Fasting plasma glucose	Glucose area	Insulin area	SSPG	Clinical classification *
97	1.20	102	472	297	272	2
98	1.05	96	456	326	235	2
99	1.10	95	517	564	206	2
100	1.12	112	503	408	300	2
101	0.96	110	522	325	286	2
102	1.13	92	476	433	226	2
103	1.07	104	472	180	239	2
104	1.10	75	455	392	242	2
105	0.94	92	442	109	157	2
106	1.12	92	541	313	267	2
107	0.88	92	580	132	155	2
108	0.93	93	472	285	194	2
109	1.16	112	562	139	198	2
110	0.94	88	423	212	156	2
111	0.91	114	643	155	100	2
112	0.83	103	533	120	135	2
113	0.92	300	1468	28	455	1
114	0.86	303	1487	23	327	1
115	0.85	125	714	232	279	1
116	0.83	280	1470	54	382	1
117	0.85	216	1113	81	378	1
118	1.06	190	972	87	374	1
119	1.06	151	854	76	260	1
120	0.92	303	1364	42	346	1
121	1.20	173	832	102	319	1
122	1.04	203	967	138	351	1
123	1.16	195	920	160	357	1
124	1.08	140	613	131	248	1
125	0.95	151	857	145	324	1
126	0.86	275	1373	45	300	1
127	0.90	260	1133	118	300	1
128	0.97	149	849	159	310	1
129	1.16	233	1183	73	458	1
130	1.12	146	847	103	339	1
131	1.07	124	538	460	320	1
132	0.93	213	1001	42	297	1
133	0.85	330	1520	13	303	1
134	0.81	123	557	130	152	1
135	0.98	130	670	44	167	1
136	1.01	120	636	314	220	1
137	1.19	138	741	219	209	1
138	1.04	188	958	100	351	1
139	1.06	339	1354	10	450	1
140	1.03	265	1263	83	413	1
141	1.05	353	1428	41	480	1
142	0.91	180	923	77	150	1
143	0.90	213	1025	29	209	1
144	1.11	328	1246	124	442	1
145	0.74	346	1568	15	253	1

\* Clinical classification: 1, overt diabetic; 2, chemical diabetic; 3, normal.

