

## ORIGINAL ARTICLE

# The Reference Intervals and Roles of GIR, HOMA and QUICKI Indexes to Judge Insulin Resistance/Insufficiency for Newly Diagnosed Diabetes Mellitus

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### SUMMARY

**Background:** To establish the reference intervals of GIR, HOMA, and QUICKI index and to identify the clinical value of the three indexes for newly diagnosed diabetes mellitus.

**Methods:** The results of fasting glucose and insulin were acquired for 123 healthy individuals using Roche cobas-8000 to establish reference intervals of GIR, HOMA, and QUICKI based on Clinical and Laboratory Standards Institute (CLSI) EP28-A3. Meanwhile, 36 newly diagnosed type 1 and type 2 diabetes mellitus (DM) patients were enrolled to judge the effect of insulin resistance/insufficiency using the three indexes based on clinical initial treatment procedures. All the data were acquired from Wangjing Hospital, China Academy of Traditional Chinese Medicine.

**Results:** The reference intervals of GIR, HOMA, and QUICKI were 5.83 - 21.15, 0.87 - 4.22, and 0.309 - 0.392, respectively. Concerning to GIR, HOMA, and QUICKI, there were 57.7% (15/26), 80.8% (21/26), and 80.8% (21/26) outside of the reference limit among type 2 DM patients, respectively; The area under the curve (AUC) of the GIR > 10.937, HOMA < 5.436, and QUICKI > 0.299 were 0.937 (95% CI 0.681 - 1.000), 0.689 (95% CI 0.510 - 0.868), and 0.689 (95% CI 0.510 - 0.868) by ROC curves when insulin insufficiency was judged based on whether insulin was included in initial treatment procedures. There concordance rates were 77.8% (28/36), 50% (18/36), and 50% (18/36) using the three indexes, GIR, HOMA, and QUICKI, respectively.

**Conclusions:** We established reference intervals for GIR, HOMA, and QUICKI. HOMA and QUICKI were more reliable indexes to identify insulin resistance among type 2 DM patients, but GIR was a more reliable index to identify insulin relatively or absolutely insufficiency than HOMA and QUICKI among DM patients.

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## Supplement Tables and Figures

Table 1. Characteristics of reference individuals.

No.	Gender	Age	Glucose	Insulin	GIR	HOMA	QUICKI
1	male	24	5.27	7.81	12.25	1.83	0.348
2	male	28	4.68	6.54	12.99	1.36	0.364
3	female	20	5.55	7.38	13.65	1.82	0.348
4	female	20	4.7	14.05	6.07	2.93	0.325
5	female	45	5.9	9.5	11.27	2.49	0.333
6	female	24	5.33	12.89	7.50	3.05	0.323
7	male	23	4.52	10.55	7.78	2.12	0.340
8	male	25	4.78	4.1	21.16	0.87	0.392
9	male	21	4.72	7.14	12.00	1.50	0.359
10	female	35	5.23	6.33	14.99	1.47	0.360
11	female	34	5.54	9.42	10.67	2.32	0.336
12	female	23	5.39	8.24	11.87	1.97	0.344
13	female	56	5.55	4.61	21.85	1.14	0.375
14	female	18	4.3	10.99	7.10	2.10	0.341
15	female	32	4.62	12.01	6.98	2.47	0.333
16	female	28	5.08	12.53	7.36	2.83	0.327
17	female	25	5.27	12.13	7.88	2.84	0.326
18	female	27	5.17	11.77	7.97	2.70	0.329
19	female	28	5.19	9.32	10.11	2.15	0.340
20	male	27	4.96	11.79	7.64	2.60	0.330
21	male	25	5.06	11.24	8.17	2.53	0.332
22	male	25	4.78	6.78	12.80	1.44	0.361
23	male	31	4.98	5.1	17.72	1.13	0.375
24	male	21	5.23	24.7	3.84	5.74	0.297
25	female	25	4.68	14.44	5.88	3.00	0.324
26	male	24	4.5	7.56	10.80	1.51	0.358
27	female	36	5.29	7.77	12.36	1.83	0.348
28	male	28	5.67	7.82	13.16	1.97	0.344
29	female	23	4.61	8.07	10.37	1.65	0.353
30	female	28	4.85	5.41	16.27	1.17	0.373
31	male	23	5.06	15.36	5.98	3.45	0.318
32	male	28	5	6.06	14.97	1.35	0.365
33	female	24	5.08	8.37	11.02	1.89	0.346
34	female	28	5.29	15.21	6.31	3.58	0.316
35	male	24	4.61	9	9.30	1.84	0.348
36	male	22	4.98	12.63	7.16	2.80	0.327
37	male	26	4.99	4.43	20.44	0.98	0.384
38	male	24	4.84	6.96	12.62	1.50	0.359
39	male	36	5.88	18.32	5.83	4.79	0.304
40	male	28	5.32	7.92	12.19	1.87	0.347
41	female	29	4.49	6.7	12.16	1.34	0.365
42	male	29	4.95	5.02	17.90	1.10	0.377
43	male	40	5.52	13.15	7.62	3.23	0.321

Table 1. Characteristics of reference individuals (continued).

No.	Gender	Age	Glucose	Insulin	GIR	HOMA	QUICKI
44	female	28	4.8	5.87	14.84	1.25	0.369
45	female	33	4.94	6.96	12.88	1.53	0.358
46	female	31	5.67	13.47	7.64	3.39	0.318
47	male	23	6.09	10.39	10.64	2.81	0.327
48	female	24	5.04	11.07	8.26	2.48	0.333
49	female	23	4.87	10.53	8.39	2.28	0.337
50	male	36	5.32	9.56	10.10	2.26	0.337
51	male	29	4.95	6.16	14.58	1.36	0.365
52	female	43	5.94	15.13	7.13	3.99	0.311
53	female	27	5.27	18.07	5.29	4.23	0.309
54	male	25	4.94	7.35	12.20	1.61	0.355
55	female	31	5.48	11.96	8.32	2.91	0.325
56	male	33	5.43	9.46	10.42	2.28	0.337
57	female	24	4.48	4.07	19.98	0.81	0.397
58	male	38	5.35	13.81	7.03	3.28	0.320
59	male	35	5.34	10.8	8.97	2.56	0.331
60	male	33	5.32	13.72	7.04	3.24	0.320
61	male	23	4.38	3.33	23.87	0.65	0.413
62	male	23	4.79	6.97	12.47	1.48	0.359
63	female	28	5.04	13.33	6.86	2.99	0.324
64	female	31	4.55	6.59	12.53	1.33	0.366
65	male	39	5.26	8.66	11.02	2.02	0.343
66	male	22	5.51	8.29	12.06	2.03	0.343
67	male	20	5.16	4.82	19.43	1.11	0.377
68	male	26	4.78	9.75	8.90	2.07	0.342
69	female	28	4.85	6.37	13.82	1.37	0.364
70	female	27	4.69	6.03	14.12	1.26	0.369
71	female	35	4.77	4.96	17.45	1.05	0.380
72	female	24	4.75	9.75	8.84	2.06	0.342
73	female	28	4.82	7.98	10.96	1.71	0.352
74	male	29	5.04	4.45	20.56	1.00	0.383
75	male	35	5.38	10	9.76	2.39	0.334
76	female	29	5.1	9.33	9.92	2.11	0.341
77	male	26	4.87	7.62	11.60	1.65	0.354
78	male	21	5.17	6.72	13.96	1.54	0.357
79	female	29	5.36	9.32	10.44	2.22	0.338
80	female	20	4.87	7.43	11.90	1.61	0.355
81	female	20	5.21	20.64	4.58	4.78	0.304
82	female	29	4.61	6.81	12.29	1.40	0.363
83	male	30	5.65	13.33	7.69	3.35	0.319
84	male	32	5.11	10.32	8.99	2.34	0.335
85	male	30	5.08	4.41	20.91	1.00	0.383
86	male	25	5.26	7.93	12.04	1.85	0.347
87	male	26	5.62	8.3	12.29	2.07	0.342

Table 1. Characteristics of reference individuals (continued).

No.	Gender	Age	Glucose	Insulin	GIR	HOMA	QUICKI
88	female	39	5.45	16.34	6.05	3.96	0.312
89	female	19	5.12	10.15	9.15	2.31	0.336
90	female	21	5.41	10.48	9.37	2.52	0.332
91	female	30	4.72	4.24	20.20	0.89	0.391
92	male	20	4.77	10.04	8.62	2.13	0.340
93	female	30	5.23	10.94	8.68	2.54	0.332
94	male	33	4.95	5.11	17.58	1.12	0.376
95	male	37	4.77	5.01	17.28	1.06	0.379
96	female	31	4.68	5.84	14.54	1.21	0.371
97	female	24	5.08	7.61	12.12	1.72	0.351
98	female	28	4.77	7.44	11.64	1.58	0.356
99	male	30	4.9	8.49	10.47	1.85	0.347
100	male	30	4.9	7.36	12.08	1.60	0.355
101	female	30	5	12.15	7.47	2.70	0.329
102	female	36	4.78	6.3	13.77	1.34	0.365
103	female	33	5.26	10.15	9.41	2.37	0.335
104	female	24	5.25	11.29	8.44	2.63	0.330
105	female	31	5.13	3.5	26.60	0.80	0.398
106	female	25	5	7.08	12.82	1.57	0.356
107	male	40	5.67	8.42	12.22	2.12	0.340
108	male	43	5.62	6.43	15.86	1.61	0.355
109	female	25	4.5	7.09	11.52	1.42	0.362
110	male	25	4.97	13.51	6.68	2.98	0.324
111	male	28	5.48	12.89	7.72	3.14	0.322
112	male	27	5.03	10.2	8.95	2.28	0.337
113	male	23	4.79	6.25	13.91	1.33	0.366
114	female	38	4.93	4.35	20.57	0.95	0.386
115	male	40	6.06	14.69	7.49	3.96	0.312
116	female	26	4.86	10.55	8.36	2.28	0.337
117	male	27	5.06	7.53	12.20	1.69	0.352
118	female	25	4.92	7.33	12.18	1.60	0.355
119	male	34	5.61	10.22	9.96	2.55	0.331
120	male	23	4.84	11.6	7.57	2.50	0.332
121	male	26	4.91	6.2	14.37	1.35	0.365
122	male	36	5.48	8.78	11.33	2.14	0.340
123	female	36	5.57	6.14	16.46	1.52	0.358

Table 2. Characteristics of type 2 diabetes mellitus.

No.	Gender	Age	Glucose	Insulin	GIR	HOMA	QUICKI	DM type
1	male	57	11.25	258.4	0.79	129.20	0.212	2
2	male	84	7.5	28.54	4.77	9.51	0.279	2
3	male	64	13.28	9.92	24.30	5.86	0.296	2
4	male	57	4.79	3.43	25.34	0.73	0.404	2
5	female	52	6.44	21.52	5.43	6.16	0.294	2
6	male	31	6.58	27.23	4.39	7.96	0.285	2
7	male	43	12.16	7.6	29.04	4.11	0.310	2
8	male	56	8.01	39.29	3.70	13.99	0.266	2
9	male	48	6.36	22.43	5.15	6.34	0.293	2
10	male	41	10.41	40.56	4.66	18.77	0.257	2
11	female	49	6.68	29.1	4.17	8.64	0.282	2
12	male	45	7.58	24.97	5.51	8.41	0.283	2
13	male	40	6.71	26.71	4.56	7.97	0.285	2
14	male	43	5.03	16.29	5.60	3.64	0.315	2
15	male	42	9.01	26.69	6.13	10.69	0.275	2
16	male	52	10.6	20.79	9.25	9.79	0.278	2
17	female	33	6.52	34.78	3.40	10.08	0.277	2
18	female	21	5.12	79.24	1.17	18.03	0.259	2
19	female	20	5.91	82.15	1.31	21.58	0.253	2
20	female	40	10.72	42.21	4.61	20.11	0.255	2
21	female	58	11.73	9.5	22.41	4.95	0.302	2
22	male	41	10.65	9.07	21.31	4.29	0.308	2
23	male	73	5.45	3.73	26.52	0.90	0.390	2
24	female	35	8.86	12.74	12.62	5.02	0.302	2
25	male	37	8.42	11.27	13.56	4.22	0.309	2
26	male	48	20.35	11.65	31.70	10.54	0.275	2

Table 3. Characteristics of type 1 and type 2 diabetes mellitus.

No.	Gender	Age	Glucose	Insulin	GIR	HOMA	QUICKI	DM type	Insulin
1	male	57	11.25	258.4	0.79	129.20	0.212	2	NO
2	male	84	7.5	28.54	4.77	9.51	0.279	2	NO
3	male	64	13.28	9.92	24.30	5.86	0.296	2	NO
4	male	57	4.79	3.43	25.34	0.73	0.404	2	NO
5	female	52	6.44	21.52	5.43	6.16	0.294	2	NO
6	male	31	6.58	27.23	4.39	7.96	0.285	2	NO
7	male	43	12.16	7.6	29.04	4.11	0.310	2	NO
8	male	56	8.01	39.29	3.70	13.99	0.266	2	NO
9	male	48	6.36	22.43	5.15	6.34	0.293	2	NO
10	male	41	10.41	40.56	4.66	18.77	0.257	2	NO
11	female	49	6.68	29.1	4.17	8.64	0.282	2	NO
12	male	45	7.58	24.97	5.51	8.41	0.283	2	NO

Table 3. Characteristics of type 1 and type 2 diabetes mellitus (continued).

No.	Gender	Age	Glucose	Insulin	GIR	HOMA	QUICKI	DM type	Insulin
13	male	40	6.71	26.71	4.56	7.97	0.285	2	NO
14	male	43	5.03	16.29	5.60	3.64	0.315	2	NO
15	male	42	9.01	26.69	6.13	10.69	0.275	2	NO
16	male	52	10.6	20.79	9.25	9.79	0.278	2	NO
17	female	33	6.52	34.78	3.40	10.08	0.277	2	NO
18	female	21	5.12	79.24	1.17	18.03	0.259	2	NO
19	female	20	5.91	82.15	1.31	21.58	0.253	2	NO
20	female	40	10.72	42.21	4.61	20.11	0.255	2	NO
21	female	58	11.73	9.5	22.41	4.95	0.302	2	NO
22	male	41	10.65	9.07	21.31	4.29	0.308	2	YES
23	male	73	5.45	3.73	26.52	0.90	0.390	2	YES
24	female	35	8.86	12.74	12.62	5.02	0.302	2	YES
25	male	37	8.42	11.27	13.56	4.22	0.309	2	YES
26	male	48	20.35	11.65	31.70	10.54	0.275	2	YES
27	female	29	7.62	3.18	43.49	1.08	0.378	1	YES
28	female	42	11.46	7.65	27.19	3.90	0.312	1	YES
29	female	52	11.89	8.41	25.66	4.44	0.307	1	YES
30	male	26	27.31	11.48	43.17	13.93	0.266	1	YES
31	male	39	14.48	7.77	33.82	5.00	0.302	1	YES
32	male	40	17.21	11.67	26.76	8.93	0.281	1	YES
33	male	45	7.57	5.67	24.23	1.91	0.346	1	YES
34	male	24	21.33	8.88	43.59	8.42	0.283	1	YES
35	male	23	17.28	11.75	26.69	9.02	0.280	1	YES
36	male	30	34.93	8.56	74.06	13.29	0.268	1	YES