JOURNAL OF
HUMAN ECOLOGY

J. Hum. Ecol., 5 (3): 197-200 (1994)

Interrelationships Between Blood Glucose and Blood Pressure *vis-a-vis* Factors, Such as Age and Sampling Time in Urban Population of Raipur, Madhya Pradesh

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KEY WORDS Blood Glucose. Systolic BP. Diastolic BP. Human Population. Age Effect. Sampling Time Effect.

ABSTRACT Postprandial blood glucose (BG) and blood pressure, both systolic (BPS) and diastolic (BPD), were monitored in 159 human subjects. The data were obtained over two consecutive days between 09:30 and 15:30. Thereafter, subjects were grouped on the basis of age, sampling time, levels of blood glucose and blood pressure. Of the total subjects, 21 were diabetic (13.2%), 13 hypertensive (8.18%) and 23 mild hypertensive (14.46%). Statistically significant age and sampling time effects were established on blood glucose. Diabetic, hypertensive and mild hypertensive subjects had statistically significantly higher BG, BPS and BPD values as compared with the respective variables in healthy human subjects. However, BG in hypertensive group was not statistically significant when compared with normal subjects. BPS and BPD were found to be positively correlated with each other in all the groups except mild hypertensive subjects. In normal subjects alone blood glucose was found to be age-dependent. It was observed that in mild hypertensive subjects, BPD increased with the age and in the same subjects BG and BPS were positively correlated with each other. The results of the present study appear to have clinical significance.

Levels of blood glucose and blood pressure are clinically important marker variables, usually monitored for the testing of diabetes and hypertension, respectively.

Levels of blood glucose (BG), systolic blood pressure (BPS) and diastolic blood pressure (BPD) have been known to change with the increasing age. Lee et al. (1990) have found in their study that there was an increasing number of diabetics with age. However, they have also shown that hypertension found in 38% of the diabetic patients was not associated with age factor. It has been reported that the diabetes tend to become multicomplicated over the age of 50 years (Rebollo et al., 1990).

Levels of BG, BPS and BPD fluctuate with the time. The blood pressure in non-diabetic hypertensive controls increased during the daytime but in some diabetic patient it remains elevated in the night and early morning (Sakurada et al., 1990).

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Some relationship may also be found between diabetes and hypertension. Morrish et al. (1990b) have reported that both systolic blood pressure and hypertension (as a categorical variable) are significant in insulin dependent diabetes. While Tsutsu et al. (1990) observed that blood pressure both systolic and diastolic was not at hypertensive levels in the patients with insulinoma.

The present work is aimed at finding out the frequency of diabetes and hypertension in random, in human population of moderate size. Attempts have been made to establish interrelationship between blood glucose and blood pressure *vis a vis* factors, such as age and sampling time.

SUBJECT AND METHODS

One hundred and fifty nine human subjects between 30-60 years of age, participated in this investigation. Postprandial blood glucose

(BG) and blood pressure (BP) were monitored over a period of two days. Each individual was studied only once. Blood glucose was measured by Miles glucometer and blood pressure by Sphygmomanometer. The subjects were grouped on the basis of age and time of sampling. Agewise subjects were divided into two groups, *viz.*, younger (30-45y) and aged (46-60y). According to time of sampling subjects were divided into 6 groups, *viz.*, 09:30-10:30, 10:30-11:30, 11:30-12:30, 12:30-13:30, 13:30-14:30 and 14:30-15:30. Furthermore, subjects were also categorized as normal, diabetic, hypertensive and mild hypertensive.

Statistical Analysis

The mean and standard errors were computed groupwise. The data were analyzed with the help of ANOVA, Duncan's multiple-range test and t-test (Bruning and Kintz, 1977). The correlation coefficient was also determined for each pair of variables within various groups.

RESULTS

Of the total subjects, 13.2% (N=21) were diabetic, 8.18% hypertensive (N=13) and 14.46% mild hypertensive (N=23) (Fig. 1).

Table 1: Blood glucose level, systolic and diastolic blood pressure in young and aged human subjects[1]

Group	*N*	*Blood glucose (mg/dl)*	*Systolic blood pressure (mmHg)*	*Diastolic blood pressure (mmHg)*
Young	69	97.38±2.86[b]	124.14± 2.00[a]	81.48±1.39[a]
Aged	69	109.35±3.19[a]	129.51±2.34[a]	84.54±1.36[a]

1. The diabetic subjects have been excluded

Means having similar alphabets as superscripts are not statistically significant from each other at P<0.05 (Based on Duncan's multiple range test).

ANOVA Result: Age effect for blood glucose F value 7.79, df 1,136, P<0.01

Mean values for BG, BPS and BPD in young and aged groups are shown in table 1. Results of ANOVA reveal statistically significant age effect (P<0.01) on BG only.

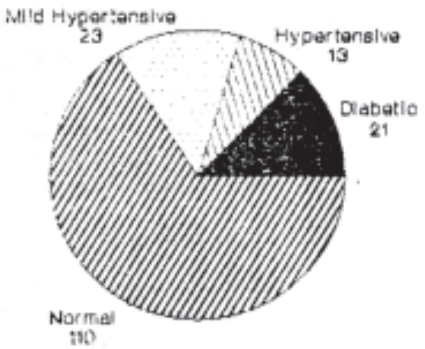

Fig. 1. Pie chart showing tne frequency of diabetic, hypertensive and mild hypertensive human subjects in a random population. Of the 8 diabetic subjects, 2 are hypertensive and 6 are mild hypertensive. Therefore, total number of subjects shown in the chart is 8 more than the actual number of subjects participated in this study

Table 2: Blood glucose level, systolic and diastolic blood pressure at different time points

Time	*N*	*Blood glucose (mg/dl)*	*Systolic blood pressure (mmHg)*	*Diastolic blood pressure (mmHg)*
09:30-10:30	17	107.00 ± 12.21[b]	127.29 ± 4.37[a]	82.00 ± 2.33[a]
10:30-11:30	18	170.44 ± 23.15[a]	133.33 ± 5.29[a]	88.11 ± 3.03[a]
11:30-12:30	30	137.20 ± 14.26[ab]	128.93 ± 2.78[a]	84.10 ± 1.73[a]
12:30-13:30	36	148.64 ± 12.67[a]	131.72 ± 4.18[a]	83.61 ± 1.80[a]
13:30-14:30	34	108.23 ± 8.58[b]	124.35 ± 3.33[a]	83.53 ± 2.12[a]
14:30-15:30	24	103.29 ± 9.91[b]	130.92 ± 3.89[a]	84.58 ± 2.86[a]

Means having similar alphabets as superscripts are not statistically significant from each other at P<0.05 (Based on Duncan's multiple range test).

ANOVA Result: Time effect for blood glucose F value 3.63, df 5,153, P<0.01

A statistically significant sampling time effect on blood glucose was detected by ANOVA (P<0.01) (Table 2). Group averages were compared with the help of Duncan's multiple-range test and the results supported the ANOVA outcome (Table 2).

Table 3 represents averages for BG, BPS and BPD in diabetic and normal subjects. Diabetic subjects had statistically significant high BPS (P<0.01) and BPD (P<0.001) as compared to normal subjects. Means and standard errors for BG, BPS and BPD for hypertensive and mild hypertensive subjects are presented in table 4. Mild hypertensive subjects had higher BG (P<0.001) value as compared from normal as well as hypertensive subjects (Table 4).

Table 3: Blood glucose level, systolic and diastolic blood pressure in diabetic and normal human subjects

Subject	*N*	*Blood glucose (mg/dl)*	*Systolic blood pressure (mmHg)*	*Diastolic blood pressure (mmHg)*
Diabetic*	21	293.57 ± 11.14[c]	144.38 ± 5.66[b]	91.62±1.9[c]
Normal	110	103.03 ± 2.42	122.14 ± 1.43	78.81 ± 0.78

*Includes 2 hypertensive and 6 mild hypertensive subjects.
[b,c] differ. from respective mean value of normal group: P<0.01, P<0.001, respectively (based on Student's t-test).

Table 4: Blood glucose level, systolic and diastolic blood pressure in hypertensive, mild hypertensive human subjects[1]

Subject	*N*	*Blood glucose (mg/dl)*	*Systolic blood pressure (mmHg)*	*Diastolic blood pressure (mmHg)*
Hypertensive	13	128.23 ± 21.92	153.85 ± 5.72[c]	105.08 ± 1.7[c]
Mild hypertensive	23	154.13 ± 17.51[b]	148.09 ± 4.56[c]	96.61 ± 0.58[c]
Normal	110	103.03 ± 2.42	122.14 ± 1.43	78.81 ± 0.78

1. Diabetics with no signs of hypertension or mild hypertension (13) have been excluded.
[b,c] differ from respective mean value of normal group: P<0.01, P<0.001, respectively (based on Student's t-test).

Analysis of correlation revealed a statistically significant positive correlation between age and BG (P<0.001) in normal subjects (Table 5).

Table 5: Summary of relationships (Correlation coefficient, r) between pairs of variables

Subject	*Age vs BG*	*Age vs BPD*	*BG vs BPS*	*BPS vs BPD*
Normal	0.37[3]	NC	NC	0.5[3]
Diabetic	NC	NC	NC	0.68[3]
Hypertensive	NC	NC	NC	0.75[2]
Mild hypertensive	NC	0.44[1]	0.56[2]	NC

NC = No correlation
1. P<0.05 2. P<0.01 3. P<0.001

Furthermore, increase in BPD (P<0.05) appeared to be statistically significantly age dependent in mild hypertensive subjects. In the same subjects BG and BPS (P<0.01) were also positively correlated with each other.

BPS was highly positively associated with BPD in normal (P<0.001), diabetic (P<0.01) and hypertensive (P<0.01) subjects (Table 5).

DISCUSSION

The results of the present study are presented in figure 1 and tables 1-5. The results exhibit an increase in postprandial BG in older subjects and corroborate the results reported by Lee et al. (1990) wherein it was observed that a substantial proportion of cases of diabetes was above 70 years of age. Furthermore, age standardized mortality was higher both in type-1 and type-2 diabetes (Morrish et al., 1990a).

BG, BPS and BPD were significantly higher in diabetic subjects as compared to normal subjects. Danielsen (1988) reported elevated heart rate, systolic and diastolic blood pressure in diabetic than control subjects. Both systolic blood pressure and levels of hypertension (as a categorical variable) have been shown to be significant in insulin dependent diabetes (Morrish et al., 1990b). However, the former one is true for the men only.

In this study it was observed that in hypertensive and mild hypertensive subjects, BG, BPS and BPD were significantly higher than in normal subjects. Furthermore, a close association was found between BPS and BPD in diabetic subjects. It has been reported the systolic blood pressure and hypertension are also significantly linked with cardiovascular mortality in type-1 diabetes (Morrish et al., 1990b). Tsutsu et al. (1990) reported that blood pressure, both systolic and diastolic was not at hypertensive levels in the patients with insulinoma. However, in the present study, it was not possible to categorize the subjects into type-1 and type-2 diabetics. Therefore, it is difficult to interpret results in terms of insulin linkage.

In mild hypertensive subjects, BPD increased as age increased and support the result by Jansen et al. (1989) wherein it was observed that the hypertensive young patients showed an enhanced diastolic blood pressure in contrast to the normotensive young subjects. However, it is not possible to differentiate the effect of hypertension *versus* aging on diastole function, beyond the age of approximately 55 years (White et al., 1989).

The interpretation of these results is complex but they emphasize that increase in BG appears to be age dependent. Analysis of data also reveals that diabetic subjects tend to become hypertensive. Furthermore, sampling time must also be considered to explain statistically significant changes in the BG.

ACKNOWLEDGEMENT

We are grateful to Council for Scientific and Industrial Research (CSIR), New Delhi, for awarding Senior Research Fellowship to SG. We also thank Pt. Ravishankar Shukla University for awarding Junior Research Fellowship to AC.

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