Plasma Insulin and Growth Hormone during Antarctic Residence

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Summary: Circulatory levels of insulin and growth hormone (GH) were estimated in nine tropical euglycemic men in New Delhi and during the first week of every month of stay in Dakshin Gangotri, Antarctica. Prolonged residency in Antarctica did not alter GH levels because mean GH values during Austral summer and Austral winter were not significantly different from the New Delhi values. Compared with GH, the insulin levels during March, April, and June were found to be significantly lower than the New Delhi values. In Antarctica, the insulin levels in March, April, May, June, July, and August were also found to be significantly lower than the December values. This decline in insulin in Antarctica might be important in increasing substrate availability for heat production by facilitating lipolysis and hepatic glucose output. [Japanese Journal of Physiology, 48, 167–169, 1998]

Key words: Antarctica, insulin, growth hormone.

Much evidence has accumulated to indicate that euthermic mammals during exposure to cold can maintain body temperature and homeostasis through hormonally mediated cardiovascular and metabolic effects [1–3]. In fact, an intact sympathoadrenal system is a necessity for defense against exposure to cold [3]. However, most investigations on hormonal adaptation to cold have been carried out in humans exposed to cold in a cold climatic chamber or during changing seasons. Studies on hormonal adaptation in humans exposed to extremes of cold climatic conditions in the presence of prolonged light and dark cycles, geomagnetism, increased amounts of solar and ultraviolet radiations, high wind velocity, isolation, and monotony prevalent at polar latitudes have received little attention. We have recently reported thyroidal adaptation and cortisol levels in tropical men during the 12 months of their stay in Antarctica [4]. The present investigation describes alterations in plasma insulin and growth hormone (GH) in the same subjects at New Delhi and during their prolonged residency in the icy continent.

The study was carried out on nine healthy euglycemic men with no history of diabetes mellitus; age, 34.70 ± 0.33 years (mean ± SE) and body mass 68.60 ± 2.62 kg. The study was approved by the institute’s ethical committee, and all subjects gave written consent to voluntarily participate in the investigation. The detailed study protocol, location of the study, and climatic conditions prevalent during their stay at Dakshin Gangotri, Antarctica (70°S, 12°E) have been described previously [4]. In brief, the baseline studies were carried out in New Delhi in the month of September, where the maximum temperature was 32–40°C and the minimum 21–28°C. These subjects were transported to Dakshin Gangotri in the month of December, where they stayed for 12 months. The subjects stayed in centrally heated huts where the ambient temperature was maintained between 18 to 20°C. During their residency in Antarctica, the daily cold exposure in the months of March and April ranged from 10 to 12 h d⁻¹ and from May to December about 4 to 6 h d⁻¹. The highest temperature, +6°C, was recorded in January and the lowest temperature, −43°C, was observed in August. In New Delhi, the daily dietary intake of calories was 3,000–3,500 kcal d⁻¹ (protein...
### Table 1. Alterations in body mass, growth hormone (GH), and insulin levels in nine healthy euglycemic men in New Delhi and during different months of stay in Antarctica.

<table>
<thead>
<tr>
<th>New Delhi</th>
<th>Months of stay in Antarctica</th>
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<tbody>
<tr>
<td></td>
<td>Sep</td>
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<tr>
<td>Body mass (kg)</td>
<td>68.60</td>
</tr>
<tr>
<td>GH (ng/ml)</td>
<td>±1.57</td>
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<tr>
<td>Insulin (uU/ml)</td>
<td>13.12</td>
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Values are mean±SE. *p vs. New Delhi <0.05, **p vs. New Delhi <0.001, *p vs. Dec <0.05, **p vs. Dec <0.001.

14.60%, fats 24.9%, and carbohydrates 60.5%), whereas in Antarctica the dietary intake was 3,500–4,000 kcal d⁻¹ (proteins 11.9%, fats 26.30%, carbohydrates 61.80%). Serial blood samples after an overnight fast of ~10 h were collected from the antecubital vein in New Delhi and during the first week of every month throughout the entire period of their stay in Antarctica. Plasma was separated and stored at −20°C, and hormonal investigations were carried out in New Delhi. The insulin and GH levels were estimated by specific radioimmunoassay [5]. All samples for GH and insulin were processed in the same assay to avoid larger interassay variations. The statistical analysis was carried out by a two-way classification of analysis of variance by using Newman Keul’s multiple range test.

The mean±SE body mass, plasma insulin, and GH levels in New Delhi and during different months of stay in Antarctica are shown in Table 1. The mean body mass at Antarctica showed no appreciable change (p>0.05). The GH levels during different months of stay in Antarctica were also not significantly different (p>0.05) from the New Delhi values. The GH levels during the Austral summer (November and December) and Austral winter (April to August) were also not significantly different (p>0.05) from each other. The fasting insulin levels in March, April, and June were significantly lower than the New Delhi values. The insulin levels in July and August, however, tended to decline, but the levels were not significantly different (p>0.05) from the New Delhi values. Plasma insulin in September, November, and December was not significantly different from the New Delhi values. The lowest insulin levels were seen in the month of June, and the highest levels were observed in the month of December. The insulin levels in March, April, May, June, July, and August were found to be significantly lower than the December values. Because of limited laboratory facilities in Antarctica, the estimation of blood glucose could not be carried out.

The exact mechanism and significance of decline in insulin in Antarctica remains speculative. Cold-induced stimulation of the sympathoadrenal system resulting in increased secretion of norepinephrine might have contributed to the inhibition of the pancreatic secretion of insulin [3]. The cortisol levels were found to be higher in these subjects in Antarctica [4]; therefore they may not be contributing toward observed decline in plasma insulin. This decrease in insulin does not also appear to be due to cold-induced stimulation of the thyroid function because T₃ levels were found to be lower during Austral summer in comparison with the New Delhi values [4]. Other factors would include altered food intake, energy expenditure, and weight changes. Although calorie intake was more in Antarctica, the precise difference in food intake during Austral summer and Austral winter could not be evaluated in the present study. In fact, a higher energy intake has been reported during Austral summer, but energy expenditure has been reported as more or less identical during the Austral winter and Austral summer months [6]. Because body weights showed no appreciable changes, altered insulin levels may not be due to weight changes at Antarctica.

Additional factors would include excessive physical exertion and prolonged exposure to the outside temperature in the ice shelf during March and April. The observation that body weights showed no appreciable changes in spite of increased physical exertion indicates that energy intake during these months might have been higher to maintain the body weight. However, physical exertion is also known to cause sympathetic alpha receptor stimulation of the pancreas, which in turn might have been responsible for a decline in plasma insulin [7–9]. Compared to the period of May–December, when the subjects were confined to their dwelling units, in March and April they under-
went excessive physical exertion. They had to perform exhaustive manual work for storing and shifting gas cylinders and fuel drums, shifting equipment, constructing platforms and huts, clearing snow, and maintaining vehicles, among other tasks, in preparation for the long dark winter. The daily cold exposure during March and April ranged from 10 to 12 h, whereas during May to December the daily cold exposure was 4 to 6 h. Besides the complete absence of sunlight in the month of June, the lowest temperature was −41°C and the maximum wind velocity was more than 100 knots; whereas in December, the duration of sunlight was 24 h, the lowest temperature was −17.5°C, and the maximum wind velocity was 35 knots. Besides the extreme cold, whether the duration of sunlight and high wind velocity also affected the pancreatic secretion of insulin remains to be evaluated.

Our observations on unaltered GH levels in Antarctica agree with the findings of Campbell et al. [10]. GH is secreted in a pulsatile manner with multiple secretory bursts, and the pattern of its secretion is influenced by nutritional status, psychogenic or physical stress, sleep stage, and exercise [11]. Whether a prolonged stay at Antarctica influences the pulsatile rhythmicity of GH remains to be determined. Although our findings on the decline in insulin in Antarctica are also in consonance with the findings of Campbell et al. [10], they do not confirm that the lowest insulin values existed in the month of September. We have no explanation for the discrepancy between our observations and those of Campbell et al. [10], except that they carried out insulin estimations in the Caucasians at three monthly intervals and baseline observations could not be performed. We measured plasma insulin in tropical men in New Delhi and during every month of their stay in Antarctica. The exact significance of the decline in insulin in Antarctica remains unknown. But it may be important at acclimatization to cold stress through increased substrate availability for heat production by facilitating lipolysis and hepatic glucose output.

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REFERENCES