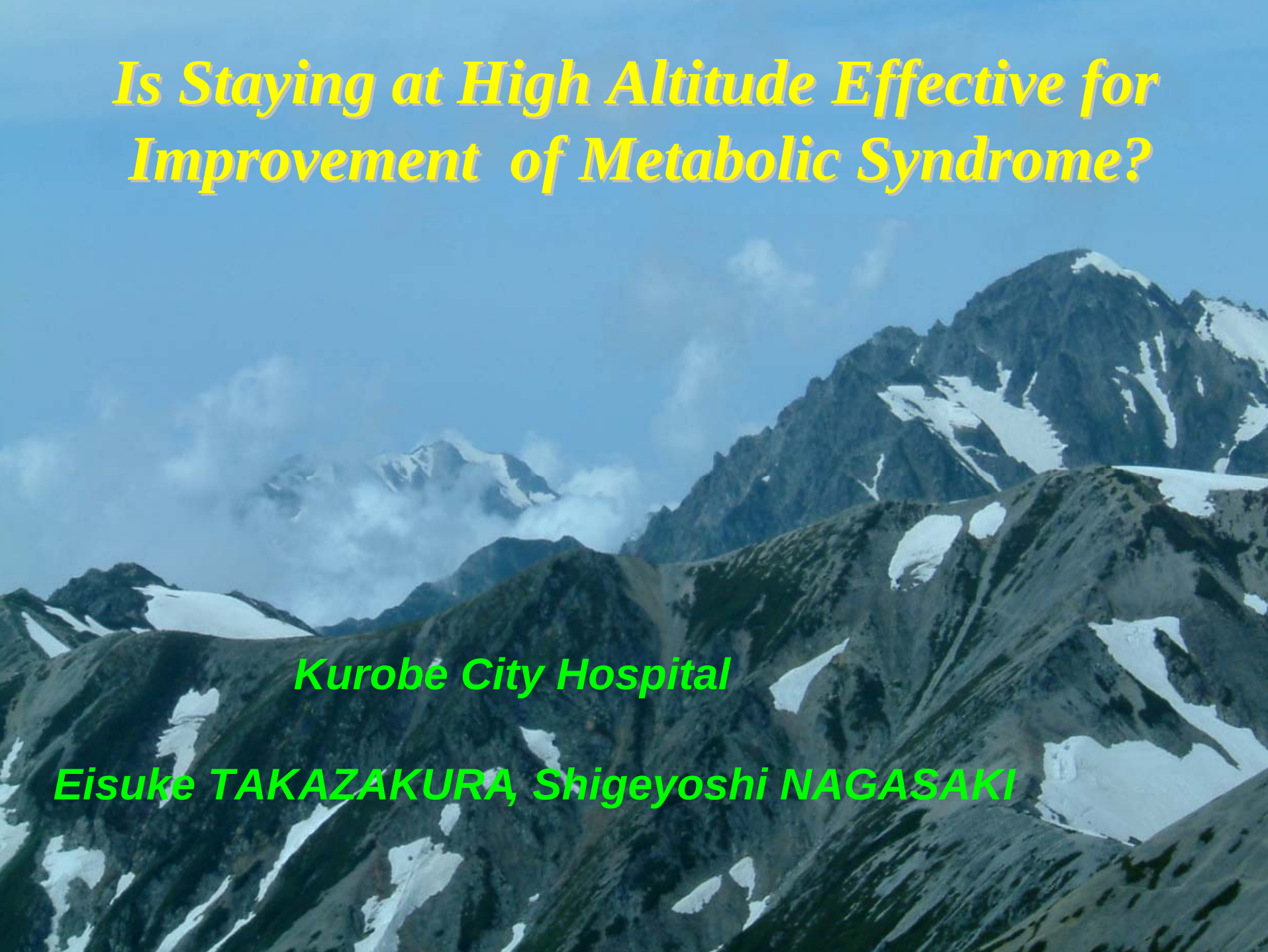
Is Staying at High Altitude Effective for Improvement of Metabolic Syndrome?



Kurobe City Hospital

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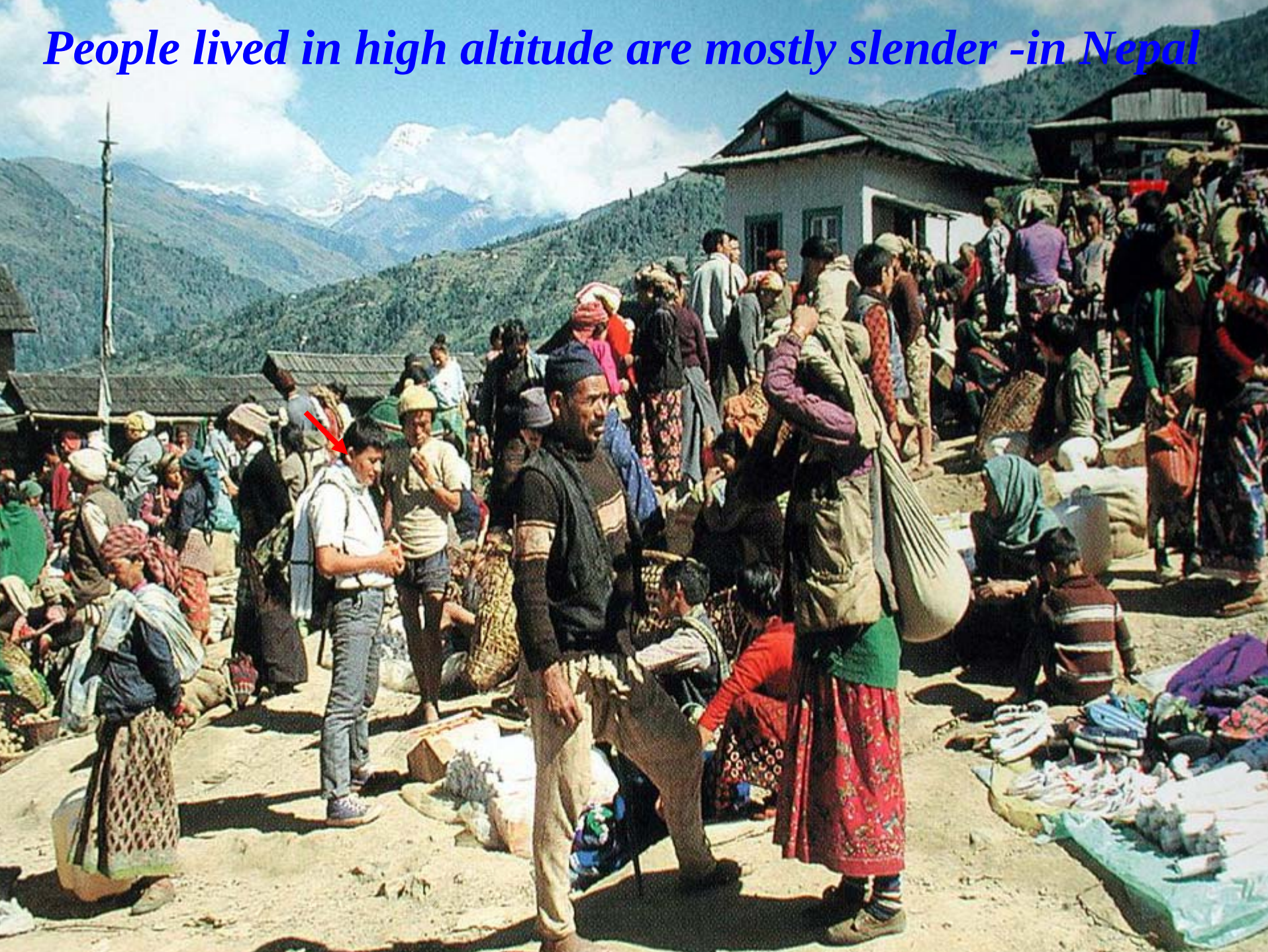
Metabolic Syndrome

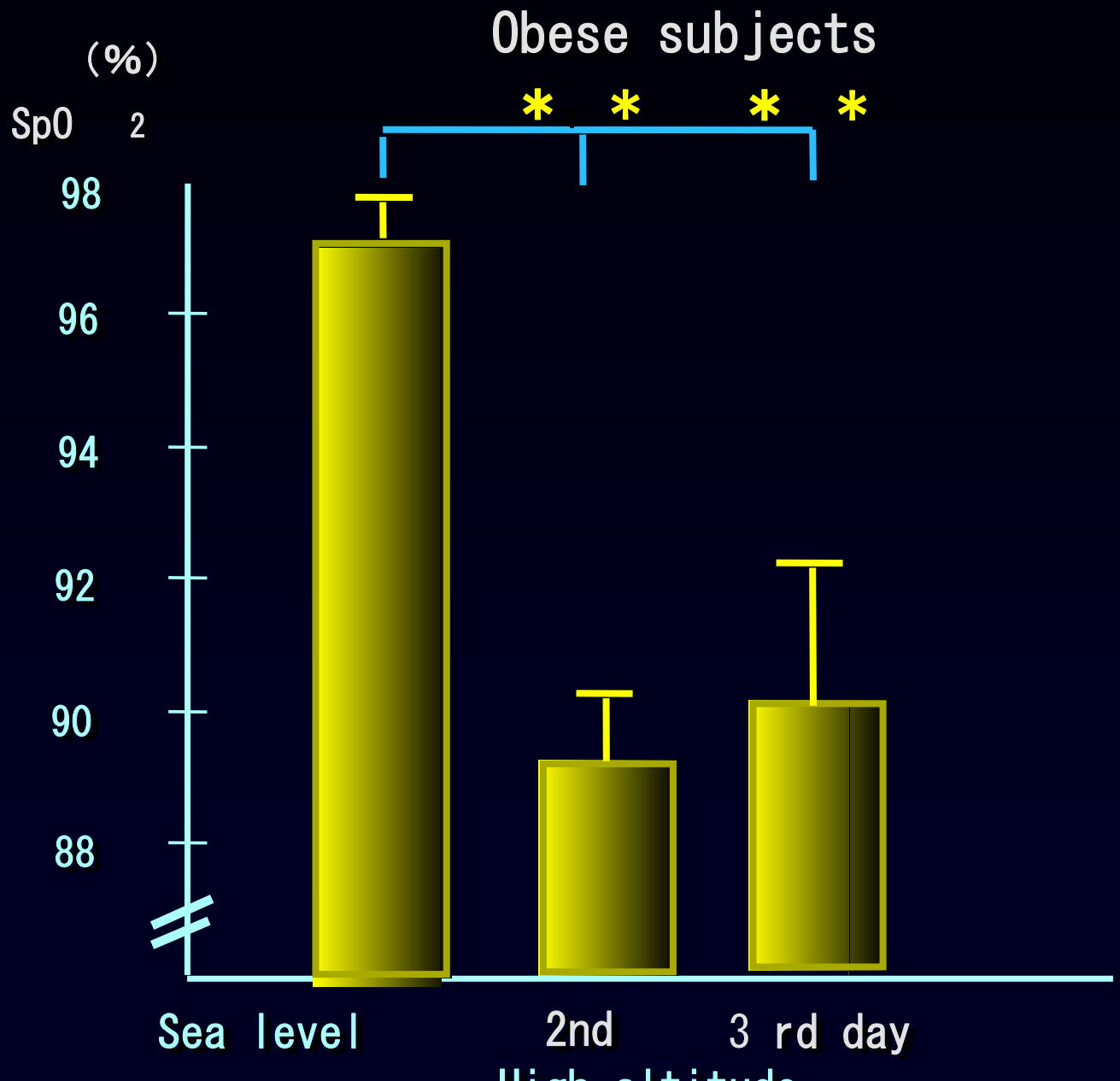
- **Abdominal obesity:**
  waist ≧ 34in.(male)
  ≧ 36in.(female)
- **Hypertriglyceridemia:**
  TG ≧ 150mg/dl
- **HDL-C < 40mg/dl**
- **Hypertension:**
  systolic ≧ 130mmHg
  diastolic ≧ 85mmHg

Coronary Event

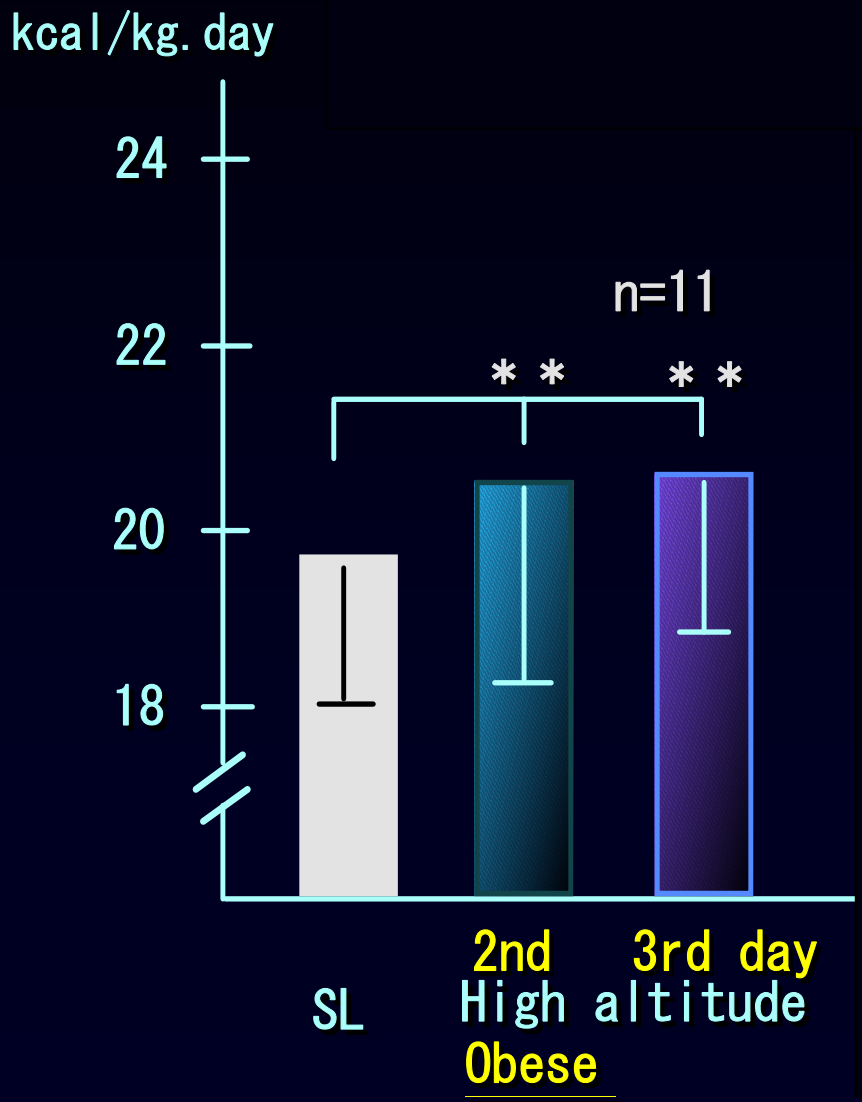
People lived in high altitude are mostly slender -in Nepal



SpO2 at sea level and high altitude



Resting energy xpenditure at sea level and high altitude



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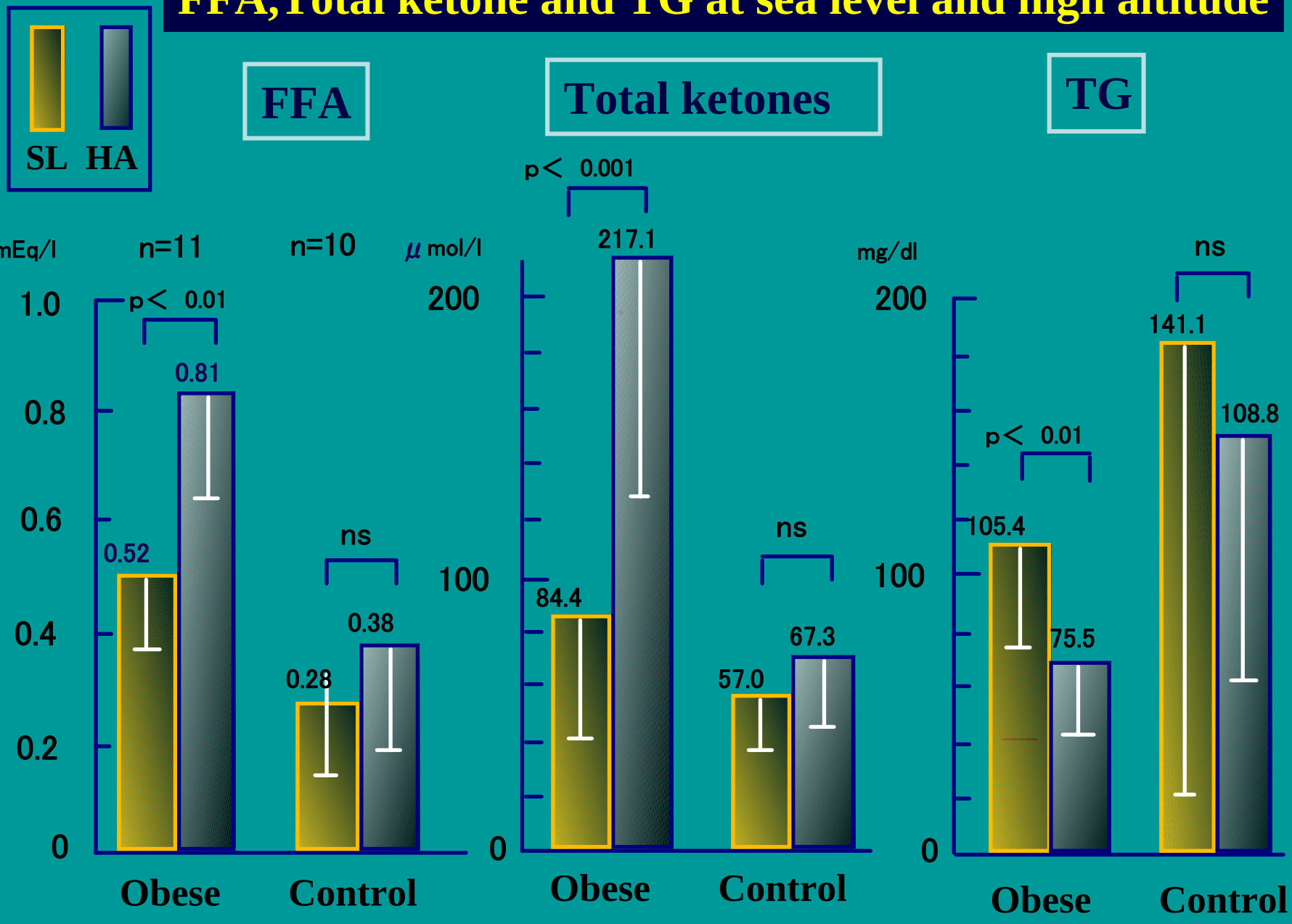
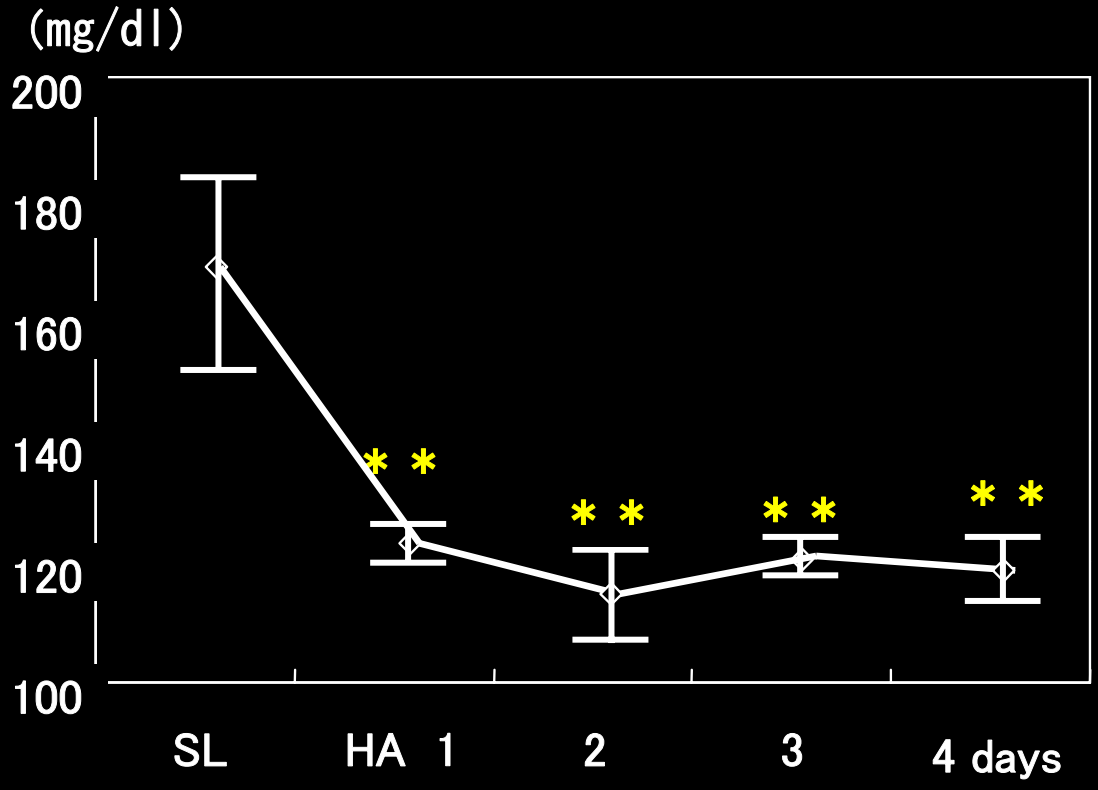
vs **Sea Level**

FFA,Total ketone and TG at sea level and high altitude



Changes of Blood Glucose (mouse)



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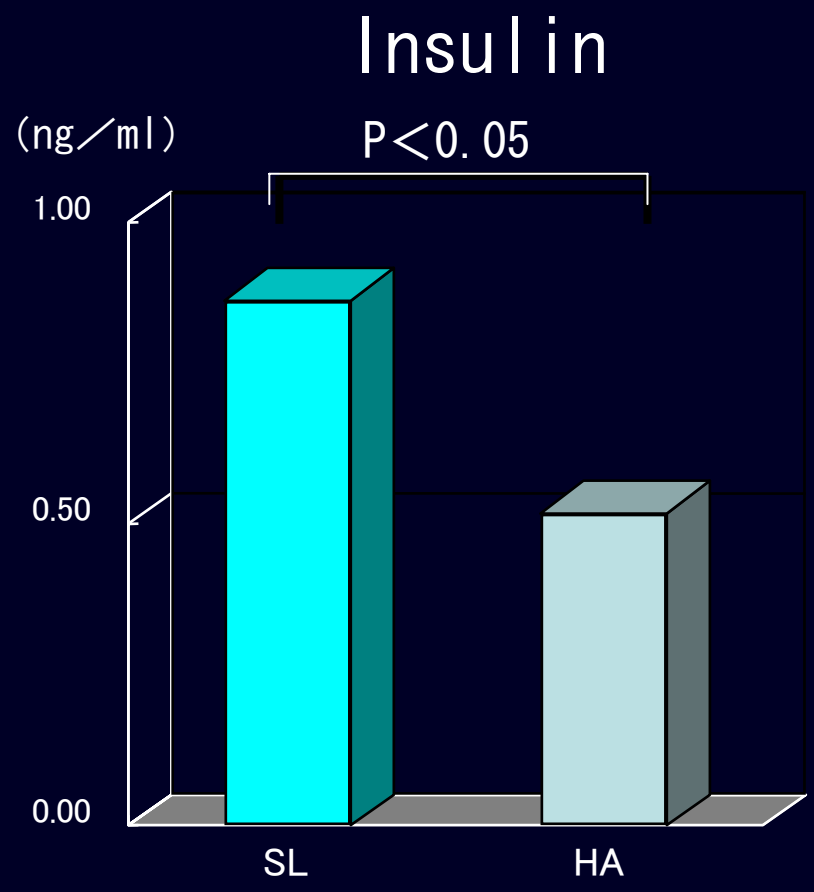
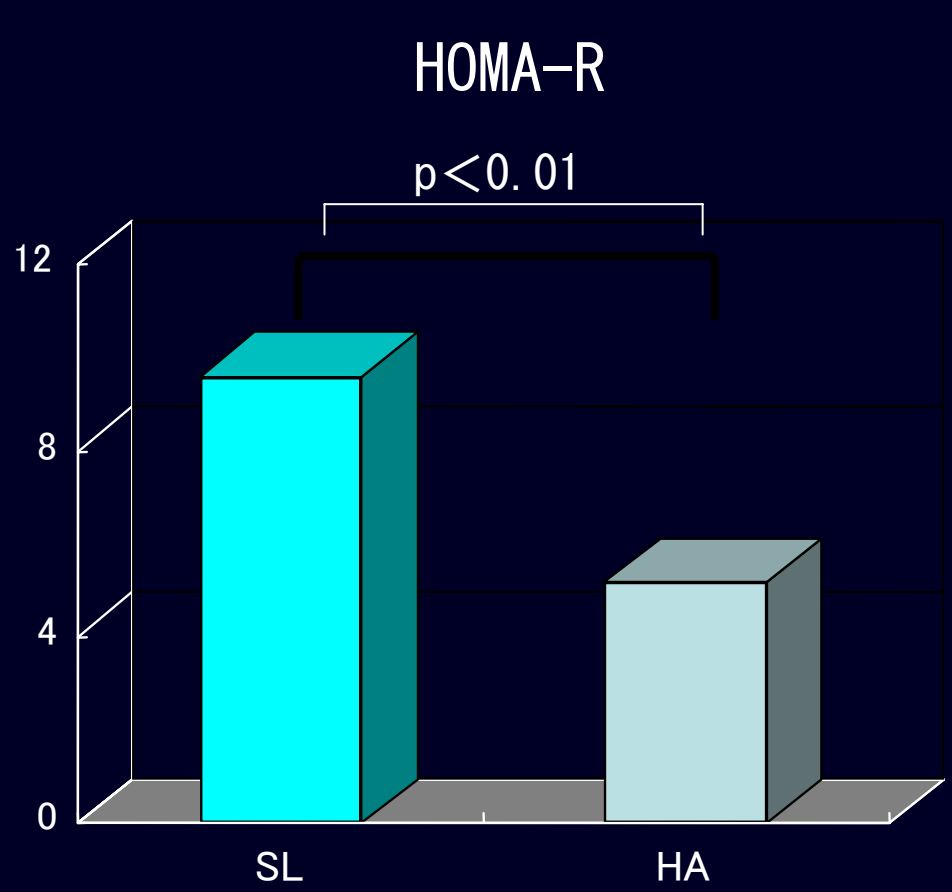
vs Sea Level

HOMA-R at Sea Level and High Altitude(mouse)





HOMA-R=Blood Glucose×IRI／405


In this study

Subjects and methods

Subjects	n	Age(yr)	BMI	% Fat
	6	49.7±12.0	23.7±1.5	23.5±8.4

Measurements

SpO2, HR, RR, REE

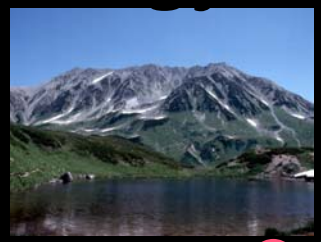
FBS, IRI,

S-Ketone bodies, FFA ,Noradrenalin

Leptin,Adiponectin

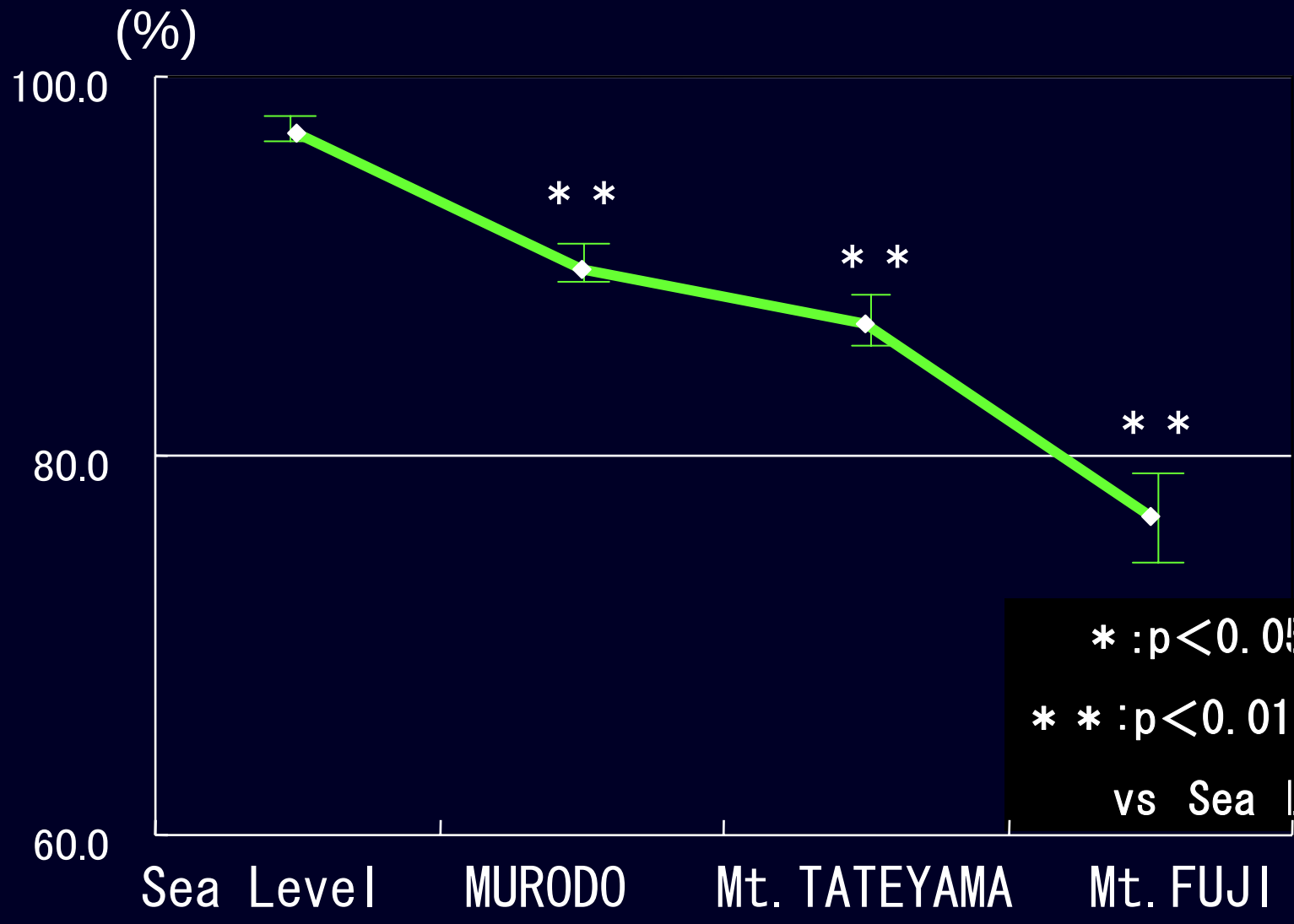
BW : Body weight　　REE : Resting energy expenditure　　SL :

Diagram of altitude and meteorology

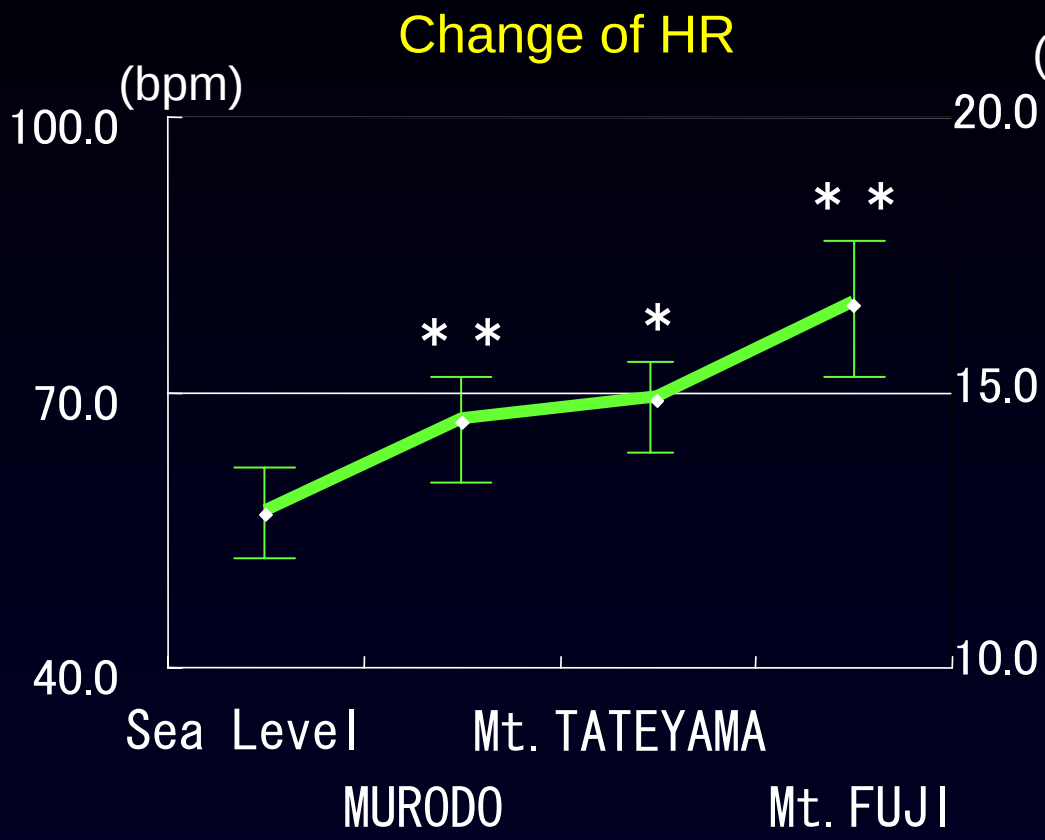


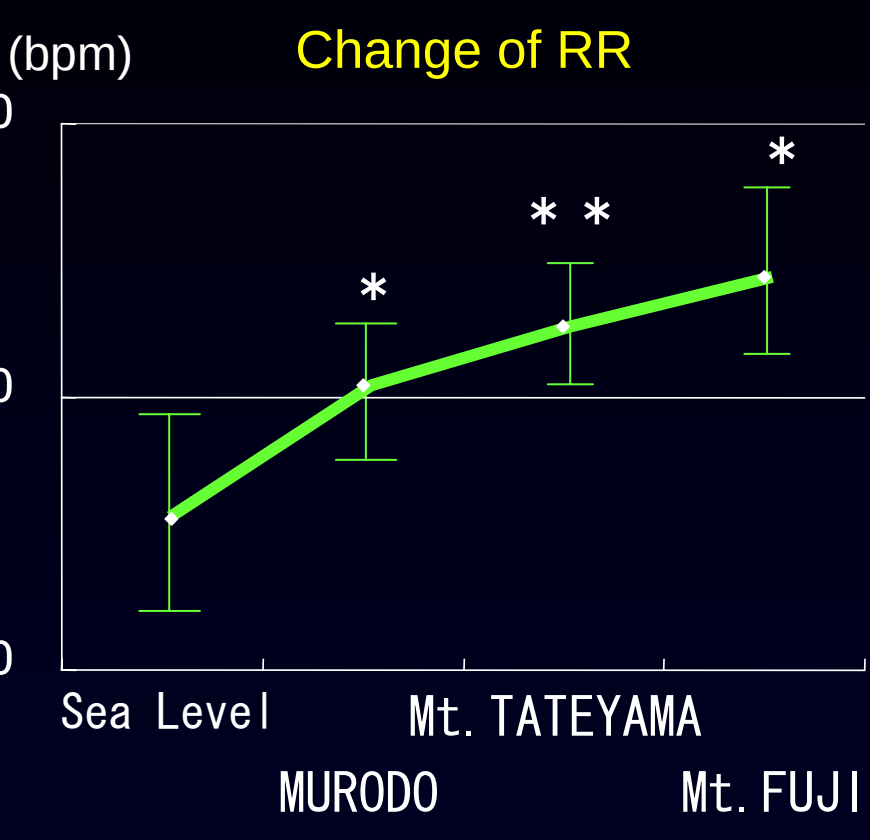
	Height	Atmos press.	Temp(room)	Humidity
Sea level	33 (m)	1,005 (hps)	20.5 (℃)	45.9 (%)
HA:Murodou	2,450	752	19.5	37.8
HA:Mt.Tateyama	3,000	701	23.7	51.3
HA:Mt.Fuji	3,776	635	20.8	51.5

Changes of SpO_2 at Sea Level and High Altitude



Changes of HR・RR at Sea Level and High Altitude





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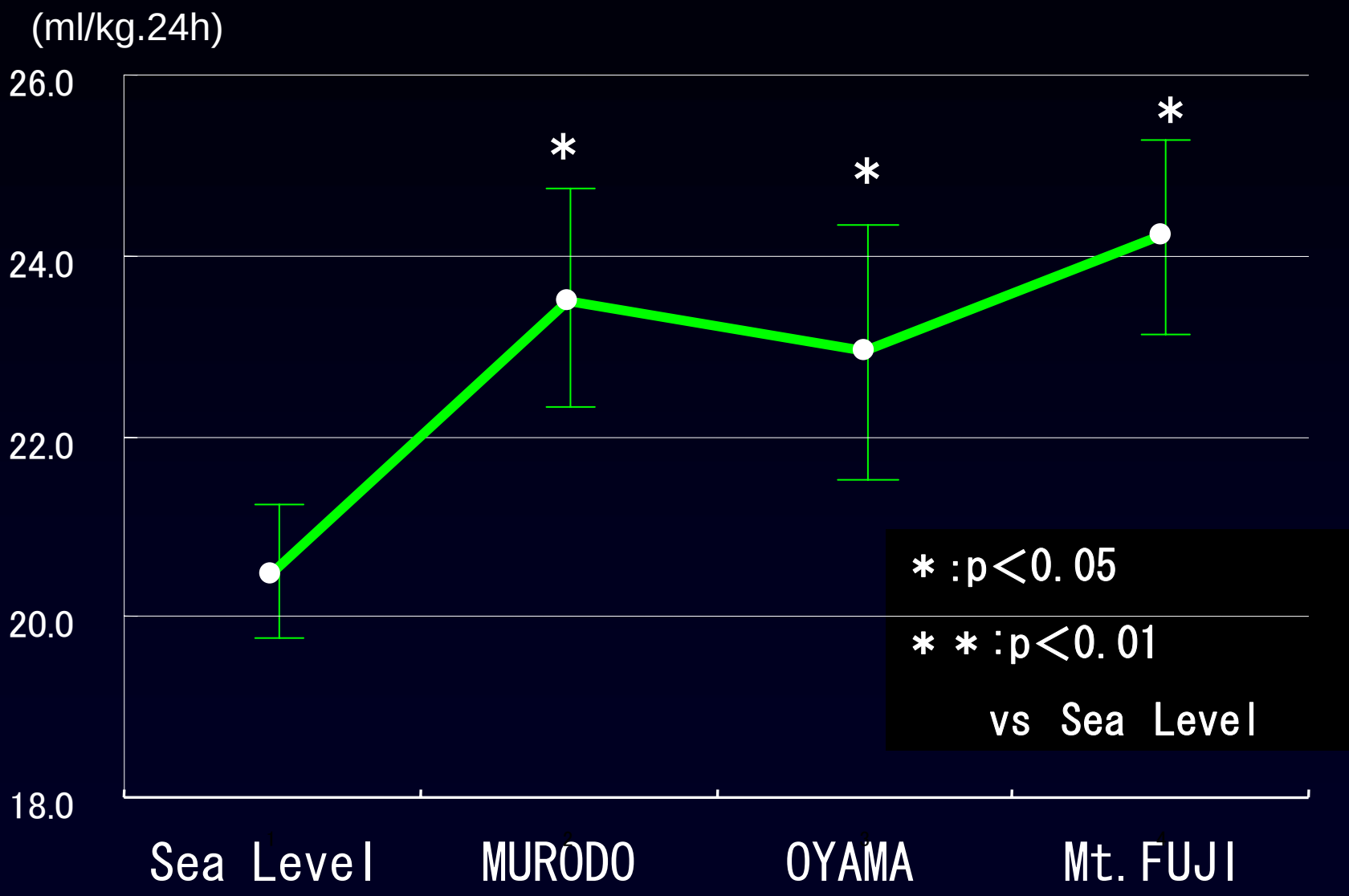
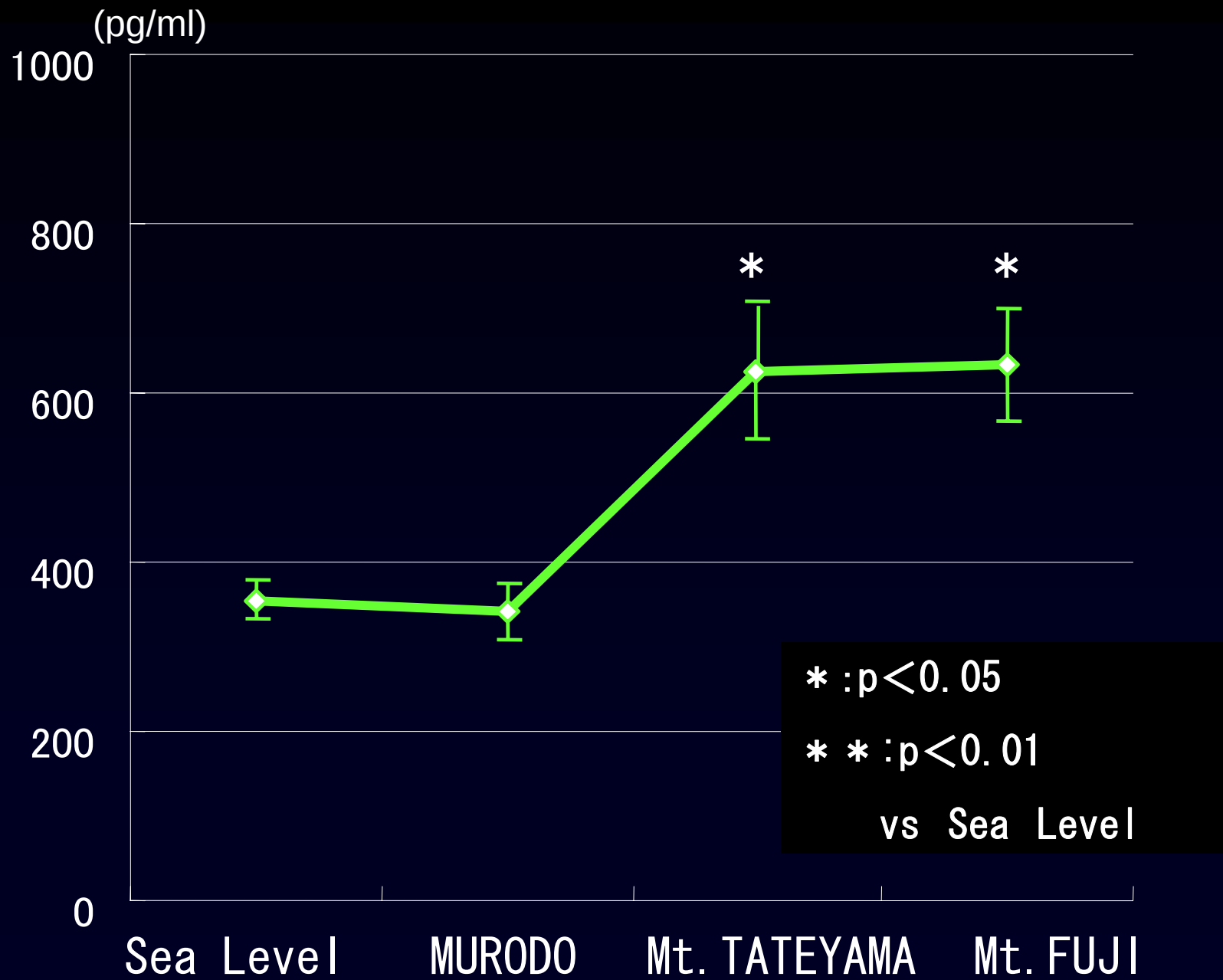
vs Sea Level

Changes of REE at Sea Level and High Altitude

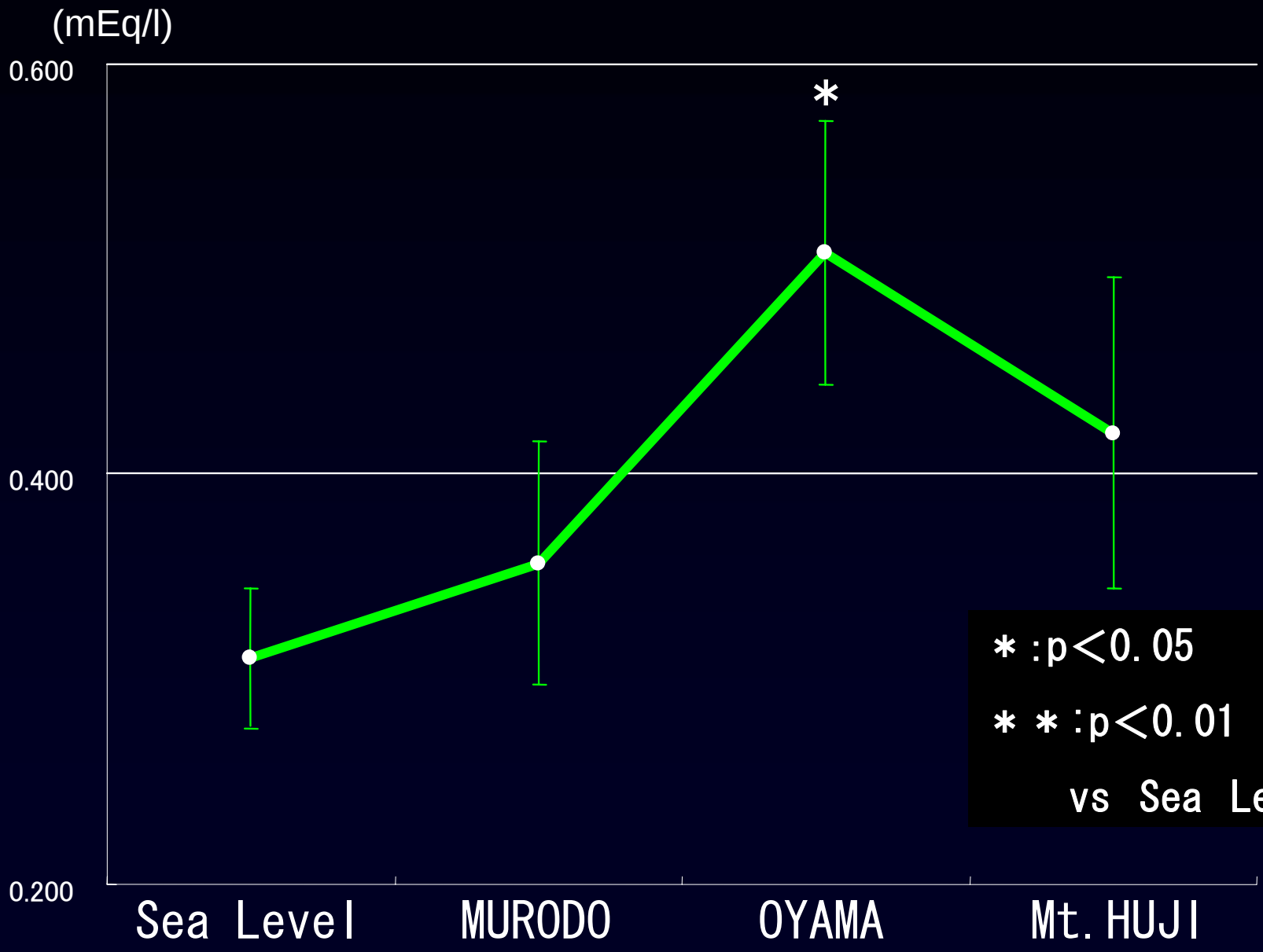


REE＝Resting Energy Expenditure

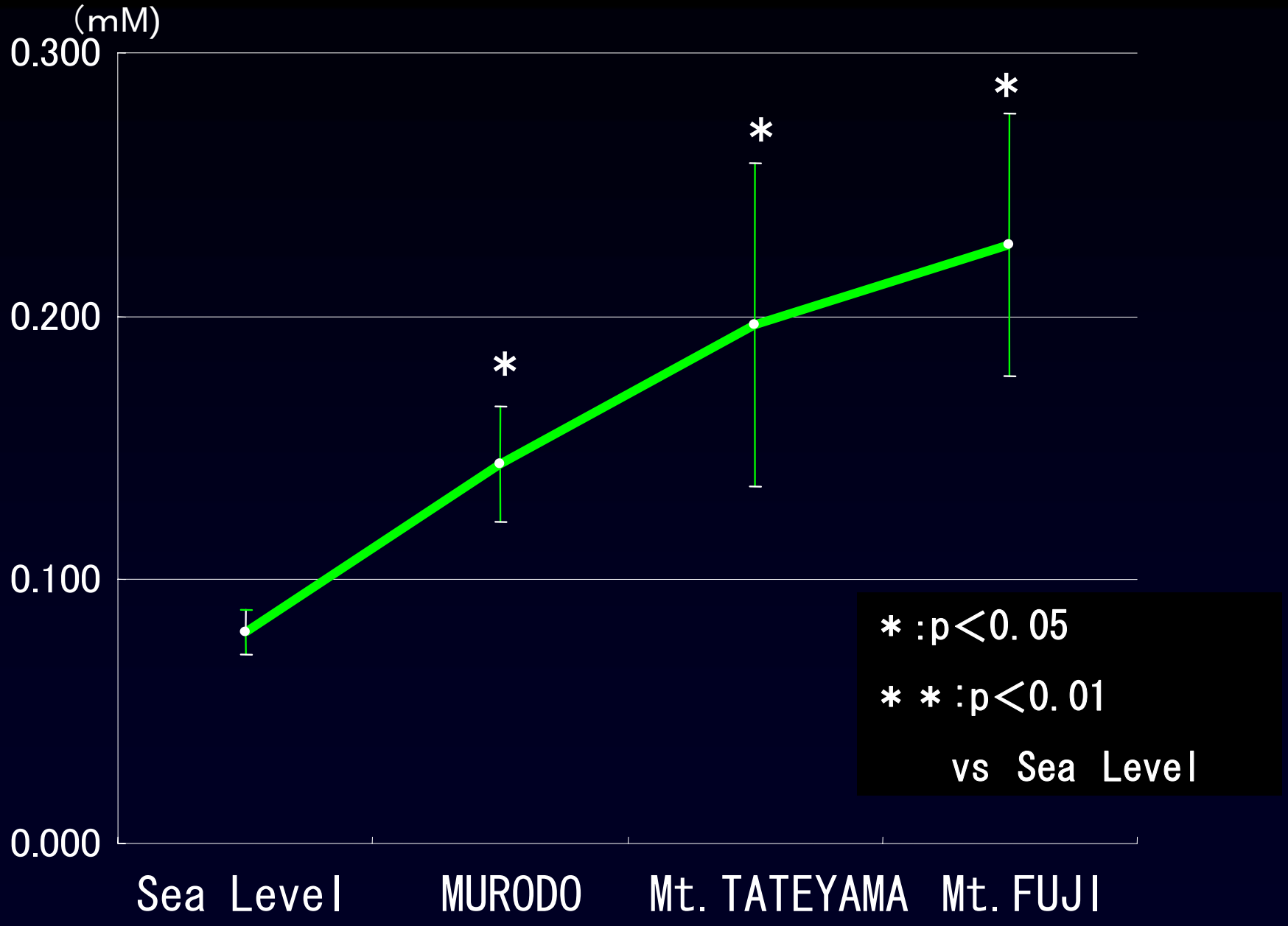
Changes of noradrenaline at Sea Level and High Altitude



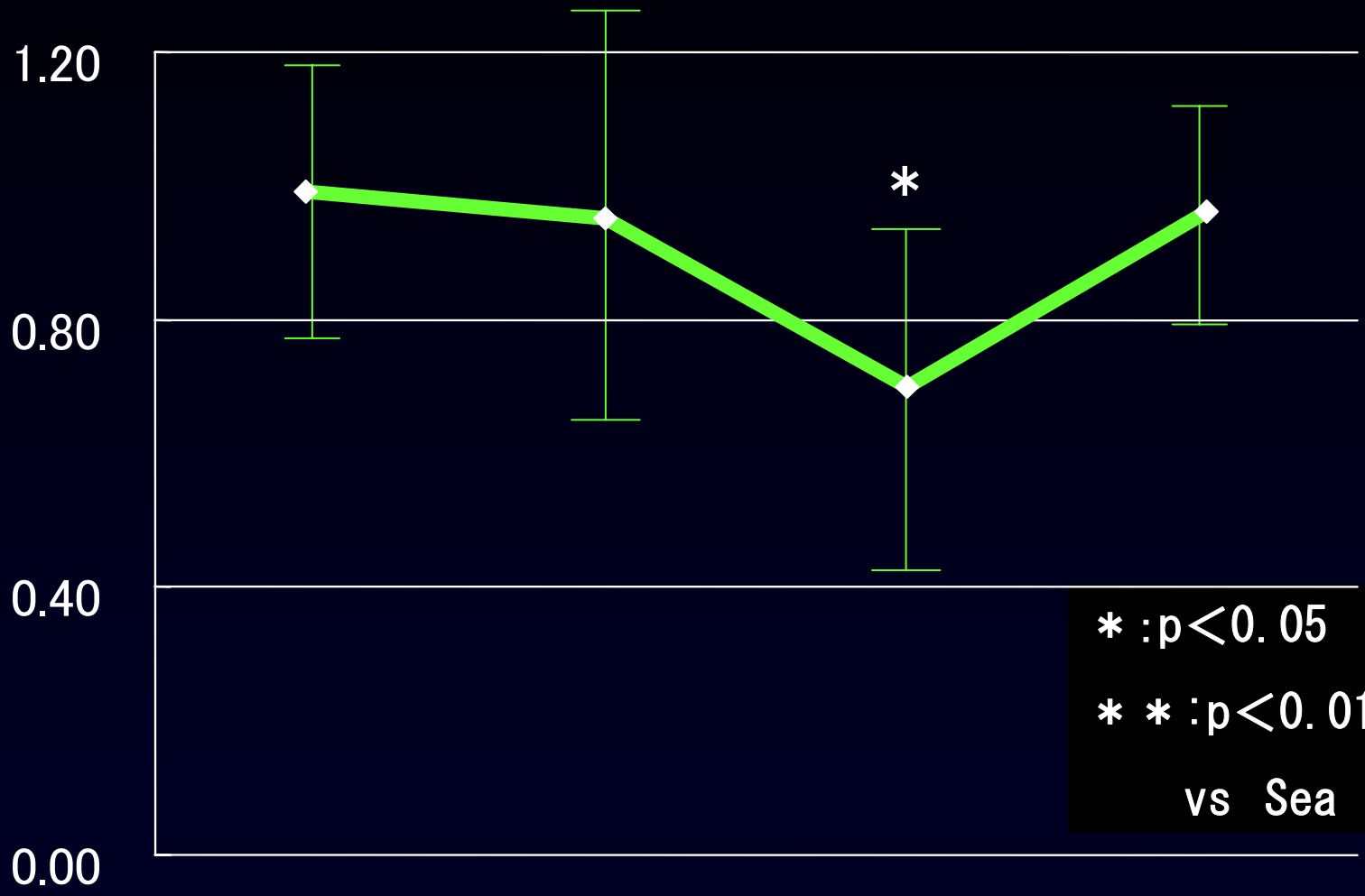
Changes of FFA at Sea Level and High Altitude



Changes of S-Ketone bodies at Sea Level and High Altitude



Changes of HOMA-R at Sea Level and High Altitude



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vs Sea Level

HOMA-R＝FBS×IRI／405

A Possible Mechanism for the Effects on REE,Fat and Glucose Metabolism by Hypoxia at High Altitude

- Hypoxia

Chemo-receptor

Hypothalamus

M.O./Symp.N.C. ↑

Resp.rate ↑

Heart rate ↑

BMR ↑

NA ↑

β 3AR

Lipolysis ↑

FFA

- Methohormin
- Exercise
- Adiponectin
- Leptin

NA ↑

UCP1 ↑

A M P-K ↑

?

BAT

Glycogen

Anerobic

Glucose

pyruvate

ACC ↓

GLUT4 Transloc. ↑

Acetyl CoA

Malonyl CoA ↓

Glucose utiliz. ↑

Glucose utiliz. ↑

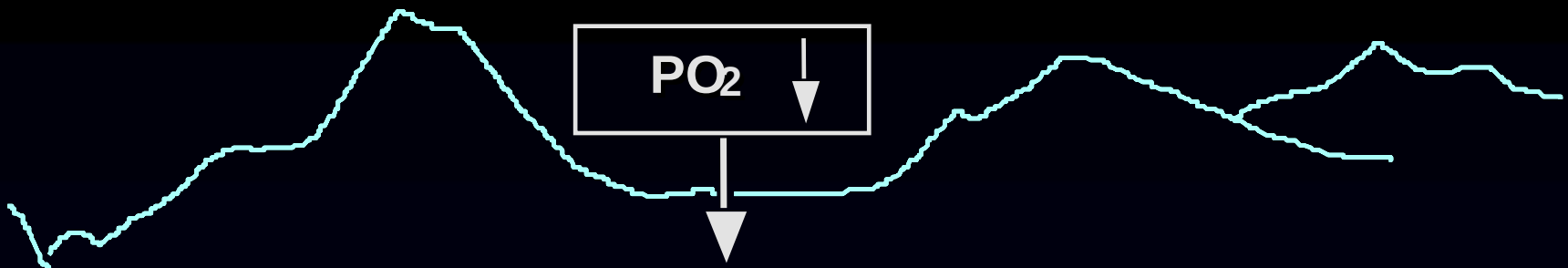
CPT1 ↑

TCA-C

β -Oxid. ↑

ACC:acetyl coenzyme A carboxylase

CPT1:carnitine palmitoyl transferase 1



Lipolysis and improvement of insulin resistance may be facilitated owing to an increase of adrenergic activity and energy expenditure brought by hypoxia.

In conclusion, staying at high altitude may have beneficial effects on the subjects with metabolic syndrome.

Stop the metabolic syndrome


Thank you for your attention
Eisuke Takazakura,
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Kurobe, Japan