Seasonal Changes in Metabolic Response to Temperature Change.* (29573)

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Seasonal changes in metabolism in the human have been reported in some areas(1) but not in others(2). The mechanism of the seasonal change has been assumed primarily to be due to the environmental temperature although the causal relation has not been established. In the course of a long series of calorimeter experiments which covered one full year, an interesting seasonal change in the response to a step change in calorimeter environment occurred which is the subject of this report.

Method. The subject was seated in the calorimeter(3) at a temperature of 30°C and an air movement from foot to head of 3.5 or 4.0 meters per minute. Humidity was always below 10 mm Hg vapor pressure. The subject was basal in experiments initiated at 0630 and had one can of Metrecal at 1200 prior to experiments starting at 1330. The subject was clothed in a suit of underwear containing thermistor temperature sensors. Metabolism was measured with an integrating flowmeter and analysis of expired air for oxygen with a model F3 Beckman oxygen analyzer and for CO_2 with model LB1 Beckman gas analyzer. Metabolism was calculated with consideration for R and reduced to surface area equivalence. After 90 minutes at 30°C the temperature was changed to 25°C with no change in air flow or water vapor pressure.

Results. The data are given in Table I grouped in sections with respect to season. The average values for the final period of 60 minutes at each temperature (30°C followed by 25°C) are given with a rank order of differences and analysis of variance. The significant finding is that in the winter period the shift from 30°C to 25°C resulted in a decrease in metabolism ($p<.05$) while in the summer this same shift resulted in a rise in metabolism ($p<.01$). During the spring period the changes were not significant ($.10<p<.20$). A progressive change in the response from winter to summer was significant $p<.01$ (Fig. 1).

Discussion. Measurements of metabolism are known to be temperature dependent and there are some indications that animals have different temperatures at which minimal metabolism occurs depending on previous environmental temperature history(4). The comfort zone in humans shifts from summer to winter(5). The effective temperature for comfort in winter is 18.6°C and in summer is 21.8°C(5). The difference in response to a temperature change is a further interesting observation that the response of metabolism to temperature varies with the season.

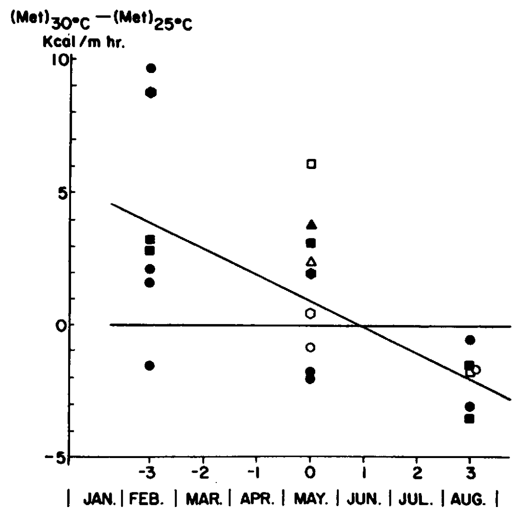

FIG. 1. Difference in metabolic rate in Kilocalories per square meter per hour when temperature was changed from 30°C to 25°C. Measurements made in various seasons are grouped at a mean time in months before and after spring measurements. Winter (Feb.) experiments were performed between Jan. 24 and March 5, spring between April 30 and May 24 and summer between Aug. 5 and 9. Symbols represent subjects: closed circles are morning experiments; open circle, afternoon.

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TABLE I. Values of Metabolism at Different Temperatures and During Different Seasons. Rank order analysis(6) and analysis of variance.

Date	Subject	Room temp 30°C	25°C	Paired replicate analysis		Analysis of variance				
		Kcal/M² hr		Diff						
Winter (AM)										
1-24	WVJ	44.7	43.1	—1.6	—2	SV	SS	DF	MS	F
2- 7	WVJ	43.7	41.6	—2.1	—3	Temp	50.921	1	50.921	6.30 > 5.99
2- 9	LDC	53.0	44.2	—8.8	—6	Subj	151.189	6	25.198	
2-12	TS	46.6	43.8	—2.8	—4	Error	48.494	6	8.082	
2-26	WVJ	44.1	45.6	+1.5	+1					
2-28	WVJ	53.8	44.1	—9.7	—7	Total	250.604	13		
3- 5	TS	40.2	37.0	—3.2	—5				$p < .05$	
				$n = 7$	$p < .05$					
				$T = 1$						
Mean		46.6	42.9	—3.7						
Spring (AM)										
4-30	WVJ	40.5	42.5	+2.0	+4.5					
5- 8	WVJ	36.9	38.7	+1.8	+3					
5- 9	TS	43.4	40.3	—3.1	—7					
5-15	LDC	43.2	41.2	—2.0	—4.5					
5-22	AH	45.3	41.5	—3.8	—8					
Spring (PM)										
4-26	WVJ	48.8	49.6	+ .8	+2	SV	SS	DF	MS	F
5-10	TS	54.8	48.7	—6.1	—9	Temp	9.827	1	9.827	2.643 < 5.32
5-20	LDC	54.2	53.7	— .5	—1	Subj	514.430	8	64.304	
5-24	AH	52.2	49.8	—2.4	—6	Error	29.748	8	3.7185	
				$n = 9$	$p = .10$					
				$T = 9.5$		Total	554.005	17	$.10 < p < .20$	
Mean		46.6	45.1	—1.5						
Summer (AM)										
8-5	WVJ	39.7	42.7	+3.0	5					
8-6	TS	38.5	40.0	+1.5	2					
8-9	WVJ	40.0	40.5	+ .5	1					
8-8	TS	40.3	43.8	+3.5	6					
Summer (PM)						SV	SS	DF	MS	F
8-5	WVJ	42.6	44.2	+1.6	3	Temp	11.60	1	11.60	19.33 > 16.26
8-6	TS	42.0	43.7	+1.7	4	Subj	24.90	5	4.98	
				$n = 6$	$p = .05$	Error	3.00	5	.60	
				$T = 0$		Total	39.50	11		
Mean		40.5	42.5	+2.0					$p < .01$	

Summary. The metabolic response to a shift in temperature from 30°C to 25°C was measured on the same subjects over a one-year period. In winter metabolism reduced significantly when the change in temperature was made; in summer the change was reversed. Measurements made in the spring showed equivocal differences.

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