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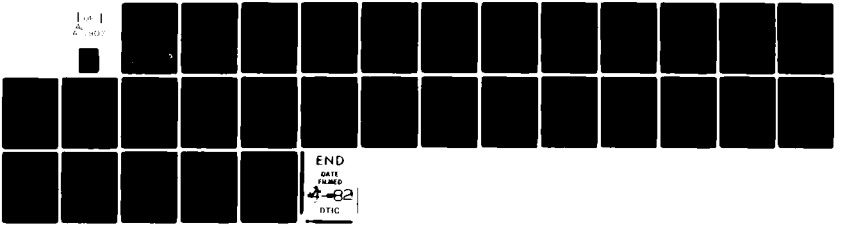

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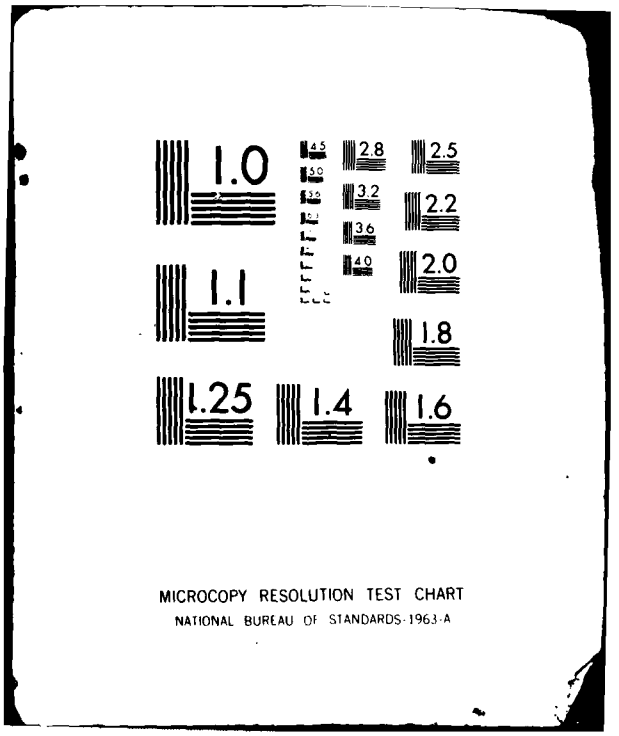
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Final Scientific Report
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An Evaluation of Localized Sweating Rates for Predicting Total Body Sweating Rates

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This project accessed the accuracy of estimating whole body sweating rates (WBSR) from local sweating rates (LSR) measured with sweat collection capsules containing filter paper.

Sweat was collected in capsules strapped on five locations of the body: (1) midforehead, (2) superiorflexor side of the right forearm, 3) left pectoralis major, 4) medial midsection of the left thigh and (5) upper medial side of the left calf.

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Sweating rates of 10 male subjects were measured while they rested at an air temperature of 39.4°C and 58.4% RH, and while they ran on a treadmill at a work output of 60% VO_2 max with an air temperature of 35.5°C and 33.2% RH.

Among all subjects the WBSR averaged 4.3147 g/min · m^2 during rest and 7.6062 g/min · m^2 during exercise. The LSR from any one of the five locations was a poor predictor of WBSR. Multiple regression equations which included LSRs from all five locations gave an $r^2 > 90$ for 5 subjects during rest and exercise.

The multiple regression equations derived from the data combined from all subjects was not as good a predictor of WBSR as some of the equations derived for individual subjects, i.e., $r^2 = 70.3$ for data during rest and $r^2 = 46.1$ for data during exercise.

Four equations which weighted the LSRs with the corresponding skin area factors provide a poor estimate of WBSR ($r^2 = 53.9$).

Introduction:

The rate of water loss by sweating is a good index of heat stress and of the rate of dehydration, however direct measurements of this water loss from pilots or other workers in many aerospace environments is impractical or impossible, since the subject must be weighed, repeatedly, in the nude. In these situations an indirect measure of whole body sweating rate would be desirable.

Tam et al. (1976) used hygrometric measurements of sweating rate within sweat collection capsules at five locations on the body to predict the actual sweating rate from the whole body. The predicted value which they called mean sweating rate (MSR) was calculated by weighting the local sweating rates (LSR) with the corresponding skin area factors. They reported a correlation coefficient (r) between actual whole body sweating rates (WBSR) and MSR of 0.74, or a r^2 (coefficient of determination) of 0.55. This means that 45% of the variation in WBSR was not accounted for by variations in MSR, and therefore WBSR could not be predicted with high accuracy from MSR. The equations which they derived (relating WBSR to MSR) from data on 22 subjects (11 male and 11 female) are applicable to subjects who are resting in a $25\pm5\%$ relative humidity environment with a slow air movement and who are dressed in swim suits.

Sweat collection capsules equipped with hygrometric sensors have tubing leading to and from them and hard wires run between the sensors & recording equipment. This arrangement of tubes, hard wires and recorders is impractical to use in a cockpit or under chemical protective clothing. The technique of using filter paper within sweat collection capsules to measure LSRs involves less instrumentation, is less expensive and is easier to use then the hydrometric method, but its accuracy has not been previously documented.

This investigation was undertaken :

1) to use sweat collection capsules containing filter paper (rather than hydrometric sensors),
2) to measure sweating rates during exercise as well as rest and
3) to access the accuracy of estimating WBSR directly from LSRs (rather than computing an MSR from LSRs).

Methods:

One hundred and eighty measurements of WBSR and LSRs were performed on 10 male subjects (age range: 18-28 years, mean: 22.7; height range: 161.3 - 190.5 cm, mean: 177.2; weight range: 61-80 kg, mean: 70.9; surface area range: 1.71 - 2.01, mean: 1.83; (see Table 1 for measurements on each subject).

The sweat collection capsules used have two parts (Figure 1), a metal ring, flanged on one side, and a metal cap which fits snuggly into the ring. The flanged surface of the ring is covered with a rubber gasket and is held in place against the skin surface by an elastic band (like a watch is held on the wrist). The ring (4.38 cm diam.) houses one or more filter paper discs (4.25 cm diam). An O-ring on the periphery of the metal cap seals off the capsule cavity from the atmosphere.

Sweat was collected in capsules strapped on five locations of the body: 1) midforehead, 2) superiorflexor side of the right forearm, 3) left pectoralis major 4) medial midsection of the left thigh and 5) upper medial side of left calf.

The following procedures were employed in the measurement of sweating rate during rest and exercise. Within a few hours of the sweat measurements, filter paper discs were sealed into 35 mm film vials (these plastic containers form a water vapor tight seal) and the containers were weighed to the nearest 0.1 mg. The elastic bands attached to the metal rings of the sweat collection capsules were wetted and the 5 rings and their elastic bands were weighed together (mean wt = 120g). Then the 5 rings were strapped on the five locations of the body. The subject was then asked to dry off thoroughly with a towel, to remove his swim trunks and to step onto the scale. All body weights were recorded to the nearest 5 g. The subject then sat in a chair while each plastic container was opened a few seconds before its filter paper contents were removed by tweezers and placed on the skin within each ring. The rings were then immediately capped.

Two filter paper discs were placed in the forehead and chest capsules and one disc in the other 3 capsules since the sweating rates on the forehead and chest are usually significantly greater than in the other 3 locations. 14.73 min (the average time during the measurement taken at rest) after the filter papers had been sealed in the forehead capsule, the capsule

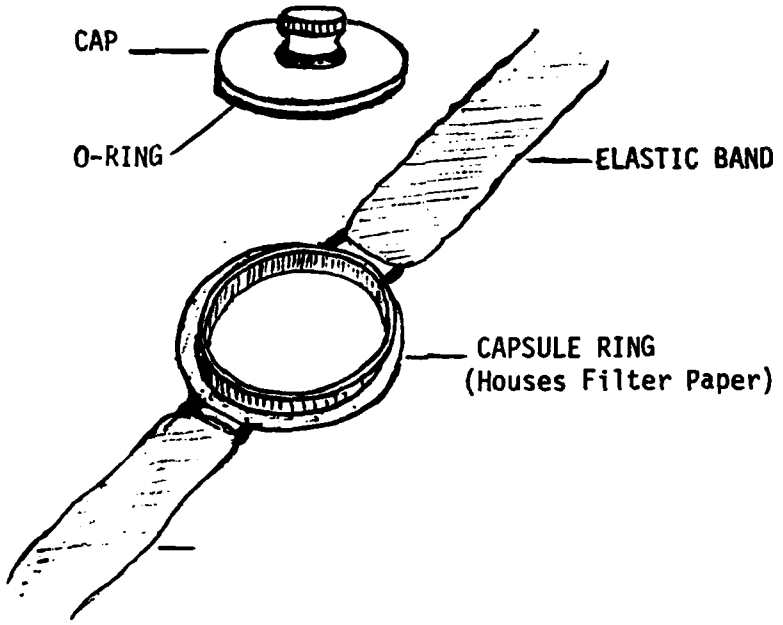


Figure 1. Sweat collection capsule, 4.38 cm diameter, 15.067 cm^2 area within the capsule ring.

TABLE 1

Subject	Height (cm)	Weight (kg)	Surface Area[1] (m^2)	Age
1	177.8	79	1.94	20
2	190.5	80	2.01	24
3	161.3	68	1.72	18
4	177.8	61	1.71	22
5	176.5	68	1.80	28
6	177.8	72	1.84	24
7	174.0	65	1.73	18
8	175.3	71	1.82	26
9	165.1	65	1.75	24
10	182.9	80	1.95	23
Mean (±SD)	177.17 (± 7.29)	70.9 (±6.81)	1.83 (±.12)	22.7 (±3.3)

[1]Estimated from the nomogram by Sendroy and Collison (1960)

was uncapped. The filter paper discs were used to quickly soak up beads of sweat on the skin along the inside periphery of the ring and on the backside of the capsule cap and then were returned to their original vial; the vial was immediately capped. This same procedure was then used on the other four capsules, going from chest to forearm to thigh to calf. After all of the filter papers had been removed from the capsules the subject was asked to dry off thoroughly, remove his trunks and he was then reweighed. The vials containing the filter paper discs were reweighed within one hour of the termination of the 3 consecutive sweating trials. The rings and elastic bands of the sweat capsules were reweighed and any change in weight from the initial weighing was divided equally among the 3 trials. A gain in the weight of the straps during a trial was added to the change in the subject's body wt. during that trial and a loss was subtracted.

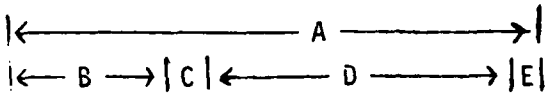
The mean time interval between the pre and post-weighing of subjects averaged 18.3 $\pm$ 1.87 min and 14.2 $\pm$ 1.56 min for measurements made at rest and during exercise, respectively. Table 2 shows mean time intervals of other activities which occurred within the period between weighings of the subjects.

Nine measurements (3 per week for 3 weeks) of WBSR and LSRs were made on each subject while he rested on a lounge chair in an environmental chamber at a mean ($\pm$ SD) air temperature of 39.4 $\pm$ 0.8 and a mean ($\pm$ SD) RH of 58.4 $\pm$ 5.8%. The subject's legs were resting on the chair parallel to the floor and the upper half of his body was elevated 20^{o}. Each subject entered the chamber approximately 30 minutes before the measurements of sweating rates were begun. Sweat was visible on the skin of all subjects after the 30 minutes.

Three measurements of WBSR and LSRs were made on each subject during a week of preliminary studies that preceded the above 3 weeks. During these preliminary studies, my assistant, Scott Straker, and I perfected our techniques of weighing subjects and of quickly moving filter papers in and out of sweat capsules, while the subjects became acquainted with the procedures and the hot environment.

Nine measurements (3 per week for 3 weeks) of WBSR and LSRs were also made on each subject while they ran on a treadmill at a work output of 60% VO_2 max. The mean ($\pm$ SD) air temperature and mean ($\pm$ SD) RH during these

TABLE 2



A = mean time between weighings of the subject
= 18.3 $\pm$ 1.87 min at rest
= 14.2 $\pm$ 1.56 min during exercise

B = mean time between weighing the subject and placing filter paper in the first capsule (forehead)
= 1.77 $\pm$ 0.73 min

C = mean time interval between sealing the first and the fifth capsule (calf)
= 0.83 $\pm$ 0.16 min

D = mean time the filter papers are absorbing sweat within the capsules
= 14.73 min at rest
= 10.63 min during exercise

E = mean time between removing the filter paper from the fifth capsule and weighing the subject
= 0.97 $\pm$ .55 min

measurements were 35.5 $\pm$ 1.5°C and 33.2 $\pm$ 4.3%, respectively. Subjects "warmed up" for 10 minutes on the treadmill before sweating rate measurements were begun..

Preceding the nine sweating rate measurements during exercise, VO_2s of each subject were measured at maximal and submaximal workloads with a Beckman Metabolic Cart and the treadmill speed and elevation which produced a 60% of maximal workload were recorded for each subject (Table 3).

A statistical computing system called MINITAB was used to compute maximums, minimums, and averages; to do regression analysis and plot data and to perform arithmetic computations and manipulations on the original data. The following approach was used in the data analysis:

1. Data were analyzed for each subject separately and then were combined for all subjects and reanalyzed.
2. Data collected during rest was analyzed separately from that taken during exercise. The two data sets were then combined and reanalyzed.
3. Using multiple regression analysis WBSR ($g/min \cdot m^2$ and g/min) was regressed against all five LSRs (g/min).
4. Using simple linear regression analysis WBSR was regressed separately, against the LSRs from each of the 5 body locations, i.e., 5 regressions were performed. This was done for sweating rates expressed in two different units of measure.
    a. WBSR (g/min) vs. LSR (g/min) and
    b. WBSR ($g/min/m^2$) vs. LSR (g/min)
5. The following 4 equations, which weight the LSRs with the corresponding skin area factors (Tam et al., 1976) were used to estimate WBSR. The estimate was compared with the measured WBSR.

(1) $WBSR_E$ = 0.11 LSR forehead + 0.29 LSR chest + 0.14 LSR forearm + 0.22 LSR thigh + 0.24 LSR calf

(2) $WBSR_E$ = 0.32 LSR chest + 0.16 LSR forearm + 0.25 LSR thigh + 0.27 LSR calf

(3) $WBSR_E$ = 0.39 LSR chest + 0.29 LSR thigh + 0.32 LSR calf

(4) $WBSR_E$ = 0.57 LSR chest + 0. 3 LSR thigh

TABLE 3

Subject	VO_2 Max (ml/kg/min)	60% VO_2 Max (ml/kg/min)	Treadmill[1] Speed (mph)	Treadmill[1] Elevation (degrees)
1	54.0	32.4	3.0	11.5
2	58.0	34.8	3.0	11.0
3	40.6	24.4	3.0	9.0
4	60.0	36.0	3.0	11.0
5	57.7	34.6	3.0	10.0
6	51.2	30.7	3.0	11.0
7	54.6	32.8	3.0	10.0
8	58.6	35.2	3.0	14.0
9	58.6	35.2	3.0	14.0
10	54.2	32.5	3.0	12.5

[1]Treadmill settings which produced a 60% VO_2 max for each subject

The coefficient of determination (r^2) was computed for all regressions and correlations. r^2 is a measure of how much the total variability in Y (e.g. WBSR) is accounted for by regressing Y on X (e.g. LSR). An r^2 of 90 means that 90% of the variation in the Ys about the mean of Y is explained by the regression. In other words, changes in Y are highly correlated with changes in X and therefore X is a good predictor of Y.

Results

The data from 7 of the 180 trials were not included in the following analyses. During these 7 trials, one or more filter papers either became totally saturated and were unable to absorb all of the sweat in the capsule or fell from the capsule onto the floor or against the subject's wet skin. The WBSRs and LSRs measured during rest and exercise for the other 173 trials are presented (in g/min and g/min · m^2) in Appendix Tables 1 through 4.

Among all subjects the WBSR during rest averaged 4.3147g/min· m^2 and ranged from 2.3717 to 6.2557 g/min · m^2 (Table 4). During exercise the mean WBSR ranged from 6.5337 to 9.8057 g/min · m^2 among subjects and averaged 7.6062 g/min · m^2 (Table 5). The overall mean WBSR during exercise was 76% greater than that during rest.

During rest and exercise the mean LSRs were greatest on the forehead and least on the thigh. During rest the mean LSRs decreased from chest to calf to forearm, and during exercise they decreased from chest to forehead to calf. Mean sweating rates on the forehead, forearm and calf were 30%, 49.6% and 9.9% greater during exercise than during rest, respectively. In contrast, the mean sweating rates were 5.5% and 9.9% less on the chest and calf, respectively, during exercise.

The LSR from any one of the five locations was a poor predictor of WBSR. The ability to predict WBSR was much improved when the sweating rates from all five locations were used together in a multiple regression model (Table 6). Multiple regression analysis of the data collected when the subjects were at rest produced an $r^2 > 90$ for 5 subjects (#2, 4, 5, 7 and 9). In 2 subjects (#3 and 8) the r^2s were less than 25. In the other 3 subjects r^2 ranged from 57.8 to 77.8. Multiple regression analysis of the data taken during exercise produced an $r^2 > 90$ for 5 subjects (#3, 4, 6, 9 and 10), an r^2 of 57.1 for 2 subjects (#2 and 5) and the r^2s of the other 3 subjects ranged from 72.4 - 87.6.

TABLE 4

SWEATING RATES (g/min · m^2), DURING REST

Subject		LOCAL (LSR) Forehead	Chest	Forearm	Thigh	Calf	Whole Body (WBSR)
1	MAX	6.4379	2.6548	5.4424	1.9247	4.9114	
	MIN	3.2521	0.4646	.9955	.9955	1.5929	
	AVE	4.5353	1.1725	2.2050	1.5044	3.3038	2.3717
2	MAX	22.3000	8.5618	6.7034	2.2566	10.2870	
	MIN	6.9025	1.6593	1.6593	1.6593	2.7212	
	AVE	12.455	4.0855	3.3406	1.9469	5.5161	4.8379
3	MAX	16.7920	2.9203	5.1769	1.7256	2.5884	
	MIN	7.1680	.9292	1.4601	.7301	1.1283	
	AVE	10.5620	2.0280	2.9055	1.3200	2.0280	2.3517
4	MAX	40.6190	32.5880	13.2080	10.9510	5.7742	
	MIN	7.5662	2.7875	2.5884	2.1238	3.8495	
	AVE	22.5660	17.4040	7.5662	4.6975	4.8450	6.0946
5	MAX	26.747	28.8710	12.7430	8.0972	10.8180	
	MIN	5.5751	1.8584	2.8539	1.4601	2.5221	
	AVE	17.5720	15.5890	8.2714	4.6127	6.7615	6.2557
6	MAX	12.6100	4.1150	2.6548	1.9911	3.7831	
	MIN	2.0575	1.4601	1.6593	1.1947	1.7920	
	AVE	5.6857	2.5811	2.0943	1.5413	2.5737	2.5911
7	MAX	18.8490	29.7340	6.3052	2.5221	7.1016	
	MIN	10.7520	5.2432	2.0575	1.3274	3.3185	
	AVE	14.8596	12.0204	3.4586	1.9616	5.3538	4.1027
8	MAX	7.7653	11.748	3.5840	4.5132	5.2432	
	MIN	2.5221	.6637	.7964	1.6593	.7964	
	AVE	4.2643	4.5049	2.4059	3.1692	3.3102	3.3767
9	MAX	6.9025	17.654	8.8272	6.9025	9.8892	
	MIN	3.5840	4.1150	3.8495	2.1238	6.3715	
	AVE	5.4258	8.0308	5.7327	4.4717	7.8483	5.9179

Table 4 (Cont).

Subject		Forehead	Chest	Forearm	Thigh	Calf	Whole Body (WBSR)
	MAX	29.269	26.216	8.8936	2.7875	11.217	
10	MIN	9.0927	5.5751	4.0486	1.5929	3.9158	
	AVE	18.997	14.933	6.3715	2.2345	7.1237	5.7391
All	MAX	40.619	32.588	13.208	10.951	11.217	
Subjects	MIN	2.0575	.4646	.7964	.7301	.7964	
Combined	AVE	11.7841	8.1956	4.3995	2.6998	4.8282	4.3147

TABLE 5

SWEATING RATES (g/min · m^2) DURING EXERCISE

Subject		LOCAL (LSR) Forehead	Chest	Forearm	Thigh	Calf	Whole Body (WBSR)
	MAX	23.893	14.933	10.951	3.0530	8.4954	
1	MIN	5.3096	2.9203	3.6504	1.4601	3.4513	
	AVE	10.5860	6.6121	7.6824	2.0741	6.4213	7.5995
	MAX	25.818	10.420	6.9025	4.3141	7.1016	
2	MIN	6.9689	4.6459	3.7167	1.7256	4.1150	
	AVE	13.6428	7.6178	5.2359	2.4188	5.6783	7.5957
	MAX	26.083	4.3804	9.6901	2.9203	3.2521	
3	MIN	18.185	3.2521	6.5043	1.3274	2.4557	
	AVE	21.6450	3.8163	8.1635	1.8335	2.8871	7.3439
	MAX	43.008	24.358	13.274	4.3804	8.1635	
4	MIN	4.8450	2.3893	2.9867	1.2610	2.4557	
	AVE	24.681	11.6646	8.8438	2.8124	5.5585	9.8057
	MAX	23.163	25.685	16.858	3.7831	6.9025	
5	MIN	11.681	7.1016	6.9689	1.8584	4.9114	
	AVE	17.0276	13.9230	10.8552	2.8023	5.7521	8.0873
	MAX	24.955	5.9733	3.8495	2.3230	4.1150	
6	MIN	9.8892	2.5884	2.0575	1.3938	1.9911	
	AVE	16.3437	3.8577	2.8539	1.7920	3.1941	6.5337
	MAX	25.884	15.663	8.6989	2.2566	6.3715	
7	MIN	4.6459	2.5221	2.4557	.6637	2.4557	
	AVE	16.0690	8.8272	5.2506	1.5339	4.8597	6.6855
	MAX	24.0920	12.4780	6.2388	2.4557	6.7698	
8	MIN	2.8539	1.4601	1.7256	.9291	2.9867	
	AVE	10.4570	7.6547	4.3952	1.6519	5.0515	7.4218
	MAX	10.8850	7.6989	12.6770	3.5840	10.9510	
9	MIN	2.2566	2.1902	3.0530	0.9292	4.3141	
	AVE	6.6665	5.0146	7.0057	1.9174	7.4335	7.9686

Table 5 Cont.

Subject		Forehead	Chest	Forearm	Thigh	Calf	Whole Body (WBSR)
	MAX	31.0610	15.7300	7.1016	2.0575	7.1016	
10	MIN	10.4200	4.3804	4.3804	1.0619	4.9114	
	AVE	17.3890	7.9423	5.6636	1.4749	5.8553	7.1153
All	MAX	43.0080	25.6850	16.8580	4.3804	10.9510	
Subjects	MIN	2.2566	1.4601	1.7256	.6637	1.9911	
Combined	AVE	15.3176	7.7491	6.5815	2.0266	5.3042	7.6062

TABLE 6

Subject	# of measurements		Coefficient of Determination (R^2) from: Simple linear regression analysis of total body sweating rate (g/min vs. each local sweating rate (g/min)					Multiple regression analysis using all 5 LSRs together
			Forehead	Chest	Forearm	Thigh	Calf	
	9	RST[1]	7.7	0.1	2.2	27.7	35.2	67.6
1	8	EX	45.6	10.9	49.7	3.3	57.7	72.4
		RST+EX	57.4	47.9	74.5	37.6	68.1	77.4
	9	RST	38.5	50.5	60.0	5.4	25.3	97.0
2	9	EX	19.6	15.0	11.2	0.0	12.7	57.1
		RST+EX	21.3	47.4	43.1	5.3	0.0	55.4
	9	RST	0.9	7.4	16.1	5.4	0.2	21.3
3	8	EX	10.2	26.6	38.5	11.5	2.6	94.7
		RST+EX	73.8	74.0	86.4	23.3	50.9	92.2
	9	RST	3.7	6.1	31.1	9.7	15.1	91.3
4	8	EX	88.4	74.0	71.6	78.0	76.3	99.2
		RST+EX	36.9	1.3	48.6	1.5	58.6	80.6
	8	RST	61.2	89.9	79.9	70.9	89.9	98.6
5	9	EX	21.3	33.3	19.5	31.1	13.9	57.1
		RST+EX	30.2	43.9	45.7	12.6	26.6	59.0
	9	RST	35.3	4.6	1.4	23.7	0.8	57.8
6	8	EX	0.8	1.0	1.8	0.4	8.9	95.3
		RST+EX	43.1	22.4	29.7	7.0	18.8	50.7
	9	RST	40.8	72.3	73.0	37.5	35.3	93.7
7	9	EX	60.1	60.3	54.5	52.9	57.9	73.3
		RST+EX	40.2	6.4	62.5	-0.2	14.4	58.1
	8	RST	1.3	1.9	2.9	12.7	1.0	14.2
8	9	EX	56.2	58.5	69.6	67.8	84.4	87.6
		RST+EX	59.3	37.8	65.3	13.5	59.2	82.6
	8	RST	29.1	5.5	10.4	54.7	69.2	92.2
9	9	EX	60.0	60.3	40.4	30.3	54.1	96.7
		RST+EX	57.0	2.4	38.9	0.0	38.1	71.0

Table 6 (Cont)

Subject	# of measurements		Forehead	Chest	Forearm	Thigh	Calf	
	9	RST	4.0	23.7	44.4	1.4	24.5	77.8
10	9	EX	24.2	5.3	2.5	0.2	26.0	90.7
		RST+EX	4.7	0.3	4.4	4.4	4.5	29.6
All	87	RST	27.2	38.5	59.5	23.5	49.4	70.3
Subjects	86	EX	25.5	27.4	23.4	23.2	28.7	46.1
Combined		RST+EX	27.5	18.1	43.1	4.2	30.5	53.1
All	87	RST	29.5*	42.2*	63.8*	27.4*	47.0*	71.5*
Subjects	86	EX	29.9*	29.6*	28.0*	25.2*	26.7*	47.9*
Combined		RST+EX						55.1*

*WBSR expressed in $q/min \cdot m^2$

1 RST = Rest; Ex = Exercise

The multiple regression equations derived from the combined data from all subjects were not as good of a predictor of WBSR as were some of the multiple regression equations derived for individuals. The r^2 for data measured during rest (expressed as g/min for both LSR and WBSR) was 70.3 and during exercise was 46.1. When the LSR and WBSR were expressed as g/min and g/min $\cdot$ m^2, respectively, the r^2 was 71.5 and 47.9 for the rest and exercise, respectively.

The multiple regression coefficients within the multiple regression equations for the combined subject data are shown in Table 7, as well as the multiple regression coefficients for individual subjects which provided a good prediction of WBSR ($r^2 > 90$).

The values of $WBSR_E$ computed from Equations (1) thru (4) were in general, poorly correlated with the measured values of WBSR. The r^2 computed when comparing measured WBSR with $WBSR_E$ predicted from equation (1) [using resting LSRs combined for all subjects] is 53.9 and is 42.6 when using exercise LSRs (Table 8).

Discussion and Conclusions

The methods and equipment used in this research had several limitations:

1. The capsule didn't fit snuggly against the mid-forehead in a few subjects because of the curvature of their cranium. In these subjects the forehead capsule was positioned on the periphery of the forehead which sometimes included some hair within the capsule cavity. On a few occasions when it was particularly difficult to fit the capsule snuggly against the forehead, I wondered if sweat might be seaping into the capsule through small gaps between the skin and the rubber gasket of the capsule.

2. Occasionally the capsules on the thigh or chest slipped downward a few centimeters during exercise, creating another measurement and data interpretation problem. In contrast the capsules always fit tightly and remain in place on the forearm and calf.

3. Sometimes when sweating rates were high the filter papers appeared to be saturated with water when removed from the capsule and small beads of sweat remained within the capsule. Two 4.25 cm disks of filter paper, on the average, can hold 0.6361 g of H_2O and one disk can hold 0.2892 g.

TABLE 7

Multiply regression coefficients

Whole body sweat rate[1] = $b_o + b_1 LSR_1 + LSR_2 + b_3 LSR_3 + b_4 LSR_4 + b_5 LSR_4$

Subject		Y-intercept	Forehead	Chest	Forearm	Thigh	Calf
		b_o	b_1	b_2	b_3	b_4	b_5
2	RST	20.0	414	435	586	4243	702
3	EX	8.77	44.1	644	1028	710	2752
3	RST+EX	2.02	76.4	264	1076	2505	698
4	RST	.792	155	69	971	528	1501
4	EX	4.89	670	489	1869	78.1	2405
5	RST	4.90	134	357	21.8	768	648
6	EX	75.8	132	15316	-18610	-38563	5828
7	RST	-.705	108	58.1	746	- 1029	694
9	RST	-.951	35.7	75.8	476	120	1183
9	EX	9.85	840	543	3832	1935	4850
10	EX	20.0	340	1880	2431	-28860	667
All Subjects Combined	RST	2.44	19.4	2.61	583.	244	401
	EX	4.13	133	41.5	129	668	679
	RST+EX	3.35	90.7	39.4	495.	483	496
All Subjects Combined	RST	1.34*	10.3*	5.56*	323 *	101*	186*
	Ex	2.27*	77.2*	22.8 *	21.3*	330*	311*
	RST+EX	1.81*	51.7*	21.2 *	299 *	244*	227*

[1] - WBSR & LSR in g/min

* WBSR in g/min · m^2

TABLE 8

Coefficient of Determination (R^2), Using Equation

Subject		(1)	(2)	(3)	(4)
1	RST	17.3	17.4	23.9	5.5
	EX	37.9	28.6	22.9	10.6
2	RST	25.1	17.9	9.2	48.7
	EX	21.8	17.6	19.0	19.8
3	RST	5.3	8.7	4.5	7.2
	EX	16.5	12.3	1.2	3.9
4	RST	0.2	7.2	6.0	1.9
	EX	81.9	77.5	77.3	75.8
5	RST	86.4	89.2	90.0	88.2
	EX	31.4	32.1	32.7	33.8
6	RST	17.8	0.4	0.3	1.3
	EX	1.7	2.3	2.4	0.5
7	RST	78.6	75.1	72.6	73.0
	EX	63.3	61.6	60.9	59.9
8	RST	3.3	4.0	3.9	3.7
	EX	70.2	68.6	67.7	60.1
9	RST	39.2	39.5	35.9	20.4
	EX	55.0	53.6	58.0	58.2
10	RST	29.6	40.2	36.1	23.5
	EX	26.1	7.9	7.9	4.7
All Subjects Combined	RST	53.9	54.6	50.9	43.8
	EX	42.6	37.0	35.5	31.2

4. There were also limitations in measuring WBSR. Sometimes subjects were a little wiggly while being weighed, making it difficult to balance the scale. The effect that this might have had on the accuracy of weighing is unknown.

5. It was difficult to keep the subject dry ("towelled off") when he was on the scale for weighing. The subject dried off thoroughly before stepping onto the scale, but the sweat secreted while he stood on the scale (about 15 to 25 sec.) was not blotted off his skin.

6. The time of the weighings were recorded to the nearest whole minute, thus all time intervals between weighings were recorded as integers (in minutes). In contrast, the time interval between placement and removal of filter paper from the capsules was recorded to the nearest second.

In spite of the limitations of the method and of this evaluation of its accuracy, LSRs can be used to predict WBSR in some subjects with fairly good accuracy (i.e., $r^2 > 90$). LSRs were a good predictor of WBSR in 5 subjects at rest and 5 subjects during exercise. Two subjects (#4 and 9) were both in the former and latter groups. These two subjects had higher than average WBSRs. Subject 4 had the highest mean WBSR during rest and the 2nd highest during exercise. Subject 9 had the 3rd highest mean WBSR during rest and exercise. WBSR and LSRs from any one location were not well correlated. Tam et al. (1976) also reported that no particular local sweating rate was found to be representative of the MSR in all the 22 subjects.

The functional relationship between WBSR and LSR differed among all 10 subjects and the accuracy of predicting WBSR from LSRs decreased when the sweating rate data from all subjects were combined in a regression analysis. This is undoubtedly due to individual variations of sweating pattern within the population.

Equations (1) thru (4) are poor predictors of WBSR. Tam et al. (1976) reported an r^2 of 56 (see their Fig. 1) when correlating WBSR and MSR (computed from Equation (1)). This agrees quite well with the r^2 of 53.9 which I found when making the same kind of comparison for resting subjects.

Literature Cited

J. Sendroy and H.A. Collison, "Nomogram for Determination of Human Body Surface Area from Height and Weight." J. Appl. Physiol., Vol. 15, pp. 958-959, 1960.

H. Tam, R.C. Darling, J.A. Downey and H. Cheh, "Relationship between Evaporation rate of Sweat and Mean Sweating Rate," J. Appl. Physiol., Vol. 41, pp. 777-780, 1976.

APPENDIX TABLE 1

Sweating Rates (g/min) At Rest

Subject	Local (LSR)					Whole Body (WBSR)
	Forehead	Chest	Forearm	Thigh	Calf	
1.	0.0049000	0.0020000	0.0027000	0.0015000	0.0035000	3.7000
	0.0058000	0.0027000	0.0046000	0.0016000	0.0048000	3.5556
1.	0.0056000	0.0040000	0.0092000	0.0023000	0.0069000	5.8235
1.	0.0056000	0.0009000	0.0015000	0.0027000	0.0069000	7.0556
1.	0.0074000	0.0020000	0.0030000	0.0024000	0.0055000	3.6000
1.	0.0097000	0.0019000	0.0035000	0.0027000	0.0074000	5.1053
1.	0.0063000	0.0009000	0.0022000	0.0018000	0.0024000	4.2222
1.	0.0058000	0.0008000	0.0018000	0.0025000	0.0043000	3.5217
1.	0.0074000	0.0007000	0.0024000	0.0029000	0.0031000	4.8261
2.	0.0155000	0.0064000	0.0051000	0.0025000	0.0041000	13.4444
2.	0.0206000	0.0095000	0.0076000	0.0031000	0.0067000	10.6316
2.	0.0336000	0.0129000	0.0101000	0.0034000	0.0085000	14.3500
2.	0.0104000	0.0025000	0.0025000	0.0026000	0.0073000	8.4500
2.	0.0111000	0.0038000	0.0030000	0.0030000	0.0071000	6.8889
2.	0.0185000	0.0074000	0.0040000	0.0030000	0.0091000	7.4375
2.	0.0155000	0.0027000	0.0029000	0.0031000	0.0075000	8.9444
2.	0.0190000	0.0035000	0.0039000	0.0027000	0.0155000	6.5294
2.	0.0247000	0.0067000	0.0062000	0.0030000	0.0090000	10.8421
3.	0.0253000	0.0040000	0.0078000	0.0026000	0.0037000	3.8947
3.	0.0126000	0.0034000	0.0064000	0.0022000	0.0028000	6.7000
3.	0.0160000	0.0044000	0.0065000	0.0023000	0.0031000	3.5238
3.	0.0146000	0.0020000	0.0026000	0.0015000	0.0024000	3.1579
3.	0.0171000	0.0033000	0.0030000	0.0020000	0.0031000	3.3333
3.	0.0234000	0.0042000	0.0048000	0.0022000	0.0039000	5.0000
3.	0.0129000	0.0014000	0.0022000	0.0011000	0.0017000	4.4545
4.	0.0108000	0.0021000	0.0029000	0.0017000	0.0029000	2.2353
4.	0.0108000	0.0027000	0.0032000	0.0023000	0.0039000	4.1053
4.	0.0150000	0.0137000	0.0084000	0.0034000	0.0067000	10.0000
4.	0.0216000	0.0296000	0.0098000	0.0093000	0.0074000	10.5882
4.	0.0217000	0.0430000	0.0110000	0.0063000	0.0069000	10.5882
4.	0.0114000	0.0042000	0.0039000	0.0032000	0.0058000	7.9444
4.	0.0498000	0.0252000	0.0199000	0.0070000	0.0079000	18.0526
4.	0.0612000	0.0249000	0.0189000	0.0094000	0.0087000	14.8889
4.	0.0209000	0.0194000	0.0046000	0.0036000	0.0065000	8.8421
4.	0.0457000	0.0269000	0.0119000	0.0050000	0.0080000	10.1765
1.	0.0587000	0.0491000	0.0142000	0.0165000	0.0078000	2.7143
5.	0.0400000	0.0207000	0.0146000	0.0067000	0.0102000	8.8500
5.	0.0359000	0.0411000	0.0185000	0.0096000	0.0128000	15.8500
5.	0.0259000	0.0266000	0.0127000	0.0066000	0.0121000	14.7368
5.	0.0382000	0.0366000	0.0173000	0.0090000	0.0163000	16.4706
5.	0.0403000	0.0435000	0.0192000	0.0122000	0.0141000	15.2381
5.	0.0084000	0.0028000	0.0043000	0.0022000	0.0038000	6.1429
5.	0.0111000	0.0055000	0.0054000	0.0031000	0.0053000	5.5000
5.	0.0120000	0.0111000	0.0077000	0.0062000	0.0069000	7.2941

APPENDIX TABLE I (Cont.)

Sweating Rates (g/min) At Rest

Subject	Local (LSR)					Whole Body (WBSR)
	Forehead	Chest	Forearm	Thigh	Calf	
6.	0.0190000	0.0039000	0.0031000	0.0018000	0.0034000	5.8095
6.	0.0165000	0.0056000	0.0037000	0.0022000	0.0039000	7.1000
6.	0.0146000	0.0062000	0.0040000	0.0025000	0.0040000	3.6000
6.	0.0047000	0.0022000	0.0028000	0.0023000	0.0041000	4.4706
6.	0.0040000	0.0029000	0.0031000	0.0025000	0.0048000	4.5263
6.	0.0064000	0.0032000	0.0037000	0.0030000	0.0057000	4.2222
6.	0.0051000	0.0031000	0.0025000	0.0020000	0.0032000	4.8500
6.	0.0031000	0.0035000	0.0025000	0.0022000	0.0027000	4.0526
6.	0.0037000	0.0044000	0.0030000	0.0024000	0.0031000	4.2778
7.	0.0171000	0.0079000	0.0048000	0.0021000	0.0050000	5.1176
7.	0.0239000	0.0228000	0.0086000	0.0030000	0.0073000	9.2778
7.	0.0278000	0.0448000	0.0095000	0.0038000	0.0107000	10.1250
7.	0.0162000	0.0149000	0.0041000	0.0020000	0.0067000	5.8000
7.	0.0190000	0.0193000	0.0050000	0.0027000	0.0081000	7.0000
7.	0.0195000	0.0080000	0.0038000	0.0030000	0.0076000	6.4000
7.	0.0275000	0.0111000	0.0039000	0.0032000	0.0088000	6.6875
7.	0.0221000	0.0196000	0.0041000	0.0037000	0.0097000	6.2941
7.	0.0284000	0.0146000	0.0031000	0.0031000	0.0087000	7.1765
8.	0.0074000	0.0078000	0.0087000	0.0032000	0.0101000	7.2000
8.	0.0086000	0.0266000	0.0073000	0.0043000	0.0109000	10.6111
8.	0.0100000	0.0153000	0.0076000	0.0058000	0.0106000	9.5500
8.	0.0058000	0.0065000	0.0082000	0.0058000	0.0118000	9.8235
8.	0.0104000	0.0136000	0.0133000	0.0082000	0.0149000	12.7368
8.	0.0054000	0.0062000	0.0058000	0.0068000	0.0096000	9.5789
8.	0.0083000	0.0103000	0.0104000	0.0094000	0.0126000	9.8235
8.	0.0095000	0.0105000	0.0078000	0.0104000	0.0141000	13.5263
9.	0.0251000	0.0395000	0.0120000	0.0039000	0.0095000	13.0000
9.	0.0230000	0.0106000	0.0108000	0.0036000	0.0079000	13.0667
9.	0.0322000	0.0360000	0.0134000	0.0031000	0.0163000	15.2857
9.	0.0137000	0.0180000	0.0085000	0.0037000	0.0119000	9.7647
9.	0.0207000	0.0232000	0.0112000	0.0037000	0.0099000	11.4444
9.	0.0233000	0.0241000	0.0113000	0.0042000	0.0059000	9.5000
9.	0.0317000	0.0084000	0.0061000	0.0024000	0.0169000	10.8824
9.	0.0441000	0.0269000	0.0070000	0.0029000	0.0115000	11.9444
10.	0.0438000	0.0158000	0.0061000	0.0028000	0.0068000	5.8333
10.	0.0117000	0.0056000	0.0038000	0.0028000	0.0046000	5.1667
10.	0.0058000	0.0087000	0.0046000	0.0036000	0.0037000	5.7222
10.	0.0038000	0.0010000	0.0012000	0.0025000	0.0042000	4.0000
10.	0.0052000	0.0011000	0.0016000	0.0036000	0.0058000	8.5333
10	0.0059000	0.0016000	0.0029000	0.0061000	0.0057000	5.1667
10.	0.0061000	0.0075000	0.0044000	0.0065000	0.0012000	7.3529
10.	0.0059000	0.0111000	0.0051000	0.0063000	0.0079000	7.2222
10.	0.0070000	0.0177000	0.0054000	0.0068000	0.0068000	6.0000

APPENDIX TABLE 2

Sweating Rates (g/min · m^2) At Rest

Subject	Local (LSR)					Whole Body (WBSR)
	Forehead	Chest	Forearm	Thigh	Calf	
1.	3.2521	1.3274	1.7920	0.9955	2.3230	1.9072
1	3.8495	1.7920	3.0530	1.0619	3.1858	1.8328
1.	5.7078	2.6548	5.4424	1.5265	4.5795	3.0018
1.	3.7167	0.5973	0.9955	1.7920	4.5795	3.6369
1.	4.9114	1.3274	1.9911	1.5929	3.6504	1.8557
1.	6.4379	1.2610	2.3230	1.7920	4.9114	2.6316
1.	4.1813	0.5973	1.4601	1.1947	1.5929	2.1764
1.	3.8495	0.5310	1.1947	1.6593	2.8539	1.8153
1.	4.9114	0.4646	1.5929	1.9247	2.0575	2.4877
2.	10.2874	4.2477	3.3849	1.6593	2.7212	6.6888
2.	13.6723	6.3052	5.0441	2.0575	4.4468	5.2894
2.	22.3004	8.5618	6.7034	2.2566	5.6415	7.1393
2.	6.9025	1.6593	1.6593	1.7256	4.8450	4.2040
2.	7.3671	2.5221	1.9911	1.9911	4.7123	3.4273
2.	13.2765	4.9114	2.6548	1.9911	6.0397	3.7092
2.	10.2874	1.7920	1.9247	2.0575	4.9778	4.4500
2.	13.6103	2.3230	2.5884	1.7920	10.2874	3.2485
2.	16.3934	4.4469	4.1150	1.9911	5.9733	5.3941
3.	16.7917	2.6548	5.1769	1.7256	2.4557	2.2644
3.	8.3626	2.2566	4.2477	1.4601	1.8584	3.8953
3.	10.6192	2.9203	4.3141	1.5265	2.0575	2.0487
3.	9.6901	1.3274	1.7256	0.9955	1.5929	1.8360
3.	11.3493	2 1902	1.9911	1.3274	2.0575	1.9380
3.	15.5306	2.7875	3.1858	1.4601	2.5884	2.9070
3.	8.5618	0.9292	1.4601	0.7301	1.1283	2.5898
3.	7.1680	1.3938	1.9247	1.1283	1.9247	1.2996
3.	7.1680	1.7920	2.1239	1.5265	2.5884	2.3868
4.	9.9555	9.0927	5.5751	2.2566	4.4468	5.8479
4.	14.3360	19.6456	6.5043	6.1724	4.9114	6.1919
4.	14.4023	28.5392	7.3007	4.1813	4.5795	6.1919
4.	7.5662	2.7875	2.5884	2.1239	3.8495	4.6459
4.	33.0524	16.7253	13.2077	4.6459	5.2432	10.5571
4.	40.6186	16.5262	12.5440	6.2388	5.7742	8.7070
4.	13.8714	12.8758	3.0530	2.3893	4.3141	5.1708
4.	30.3312	17.8536	7.8981	3.4185	5.3096	5.9512
4.	38.9593	32.5878	9.4246	10.9511	5.1769	1.5873
5.	26.5481	13.7686	9.6901	4.4468	6.7698	4.9167
5.	33.8269	27.2782	12.2785	6.3715	8.4954	8.8056
5.	17.1899	17.6545	8.4290	4.3804	8.0308	8.1871
5.	25.3534	24.2915	11.4820	5.9733	10.8183	9.1503
5.	26.7472	28.8710	12.7431	8.0972	9.3582	8.4656
5.	5.5751	1.8584	2.8539	1.4601	2.5221	3.4127
5.	7.3671	3.6504	3.5840	2.0575	3.5176	3.0556
5.	7.9644	7.3671	5.1105	4.1150	4.5795	4.0523

Sweating Rates (g/min · m^2) At Rest

Subject	Local (LSR)					Whole Body (WBSR)
	Forhead	Chest	Forearm	Thigh	Calf	
6.	12.6103	2.5884	2.05748	1.19466	2.2566	3.15734
6.	10.9511	3.7167	2.45570	1.46014	2.5884	3.85870
6.	9.6901	4.1150	2.65481	1.65926	2.6548	1.95652
6.	3.1194	1.4601	1.85837	1.52652	2.7212	2.42967
6.	2.6548	1.9247	2.05748	1.65926	3.1858	2.45995
6.	4.2477	2.1238	2.45570	1.99111	3.7831	2.29467
6.	3.3949	2.0575	1.65926	1.32740	2.1239	2.63587
6.	2.0575	2.3230	1.65926	1.46014	1.7920	2.20250
6.	2.4557	2.9203	1.99111	1.59289	2.0575	2.32489
7.	11.3493	5.2432	3.18577	1.39377	3.3185	2.95815
7.	15.8625	15.1324	5.70784	1.99111	4.8450	5.36289
7.	18.4509	29.7339	6.30517	2.52207	7.1016	5.85260
7.	10.7520	9.8892	2.72118	1.32740	4.4468	3.35260
7.	12.6103	12.8095	3.31851	1.79200	5.3760	4.04624
7.	12.9422	5.3096	2.52207	1.99111	5.0441	3.69942
7.	18.2518	7.3671	2.58844	2.12385	5.8406	3.8[illegible]
7.	14.6678	13.0086	2.72118	2.45570	6.4379	3.4[illegible]
7.	18.8491	9.6901	2.05748	2.05748	5.7742	4.14627
8.	4.9114	5.1769	5.77421	2.12385	6.7034	3.95604
8.	5.7078	17.6545	4.84503	2.85392	7.2344	5.83027
9.	6.6370	10.1546	5.04414	3.84947	7.0352	5.24725
9.	3.8495	4.3141	5.44236	3.84947	7.8317	5.39753
8.	6.9025	9.0263	8.82724	5.44236	9.8892	6.99824
8.	3.5840	4.1150	3.84947	4.51317	6.3715	5.26313
9.	5.5087	6.8361	6.90250	6.23880	8.3626	5.39753
8.	6.3052	6.9689	5.17688	6.90250	9.3582	7.43203
9.	16.6589	26.2162	7.96443	2.58844	6.3052	6.66667
9.	15.2651	7.0352	7.16798	2.38933	5.2432	6.70087
9.	21.3712	23.8933	8.89361	2.05748	10.8183	7.83882
9.	9.0927	11.9466	5.64147	2.45570	7.8981	5.00754
9.	13.7386	15.3979	7.43346	2.45570	6.5707	5.86892
9.	15.4643	15.9952	7.49983	2.78755	3.9158	4.87179
9.	21.0394	5.5751	4.04858	1.59289	11.2166	5.58072
9.	29.2693	17.6536	4.64592	1.92474	7.6326	6.12533
10.	29.0702	10.4865	4.04858	1.85837	4.5132	2.99144
10.	7.7653	3.7167	2.52207	1.85837	3.0530	2.83883
10.	3.8495	5.7742	3.05303	2.38933	2.4557	3.14408
10.	2.5221	0.6637	0.79644	1.65926	2.7875	2.19780
10.	3.4513	0.7301	1.06192	2.38933	3.8495	4.68864
10.	3.9158	1.0619	1.92474	4.04858	3.7831	2.83883
10.	4.0486	4.9778	2.92029	4.31406	0.7964	4.04008
10.	6.9158	7.3671	3.38488	4.18132	5.2432	3.96825
10.	4.6459	11.7475	3.59399	4.51317	4.5132	3.29670

APPENDIX TABLE 3

Sweating Rates (g/min) During Exercise

Subject	Local (LSR)					Whole Body (WBSR)
	Forehead	Chest	Forearm	Thigh	Calf	
1.	0.0146000	0.0194000	0.0148000	0.00320000	0.0117000	14.3750
1.	0.0182000	0.0225000	0.0165000	0.00460000	0.0124000	15.6667
1.	0.0142000	0.0047000	0.0125000	0.00240000	0.0115000	14.7692
1.	0.0163000	0.0096000	0.0147000	0.00310000	0.0125000	17.8000
1.	0.0360000	0.0112000	0.0159000	0.00350000	0.0128000	18.3571
1.	0.0080000	0.0044000	0.0055000	0.00250000	0.0058000	15.3333
1.	0.0091000	0.0045000	0.0061000	0.00350000	0.0055000	9.6429
1.	0.0112000	0.0044000	0.0066000	0.00220000	0.0052000	12.0000
2.	0.0098000	0.0096000	0.0070000	0.00280000	0.0082000	17.7143
2.	0.0232000	0.0138000	0.0094000	0.00290000	0.0090000	14.8571
2.	0.0399000	0.0124000	0.0091000	0.00300000	0.0098000	19.5000
2.	0.0190000	0.0109000	0.0079000	0.00310000	0.0096000	15.7857
2.	0.0254000	0.0147000	0.0099000	0.00340000	0.0107000	14.4000
2.	0.0242000	0.0157000	0.0104000	0.00310000	0.0107000	17.7333
2.	0.0109000	0.0091000	0.0056000	0.00260000	0.0063000	5.8750
2.	0.0105000	0.0101000	0.0057000	0.00540000	0.0062000	21.6000
2.	0.0115000	0.0070000	0.0060000	0.00650000	0.0065000	9.9412
3.	0.0326000	0.0049000	0.0098000	0.00230000	0.0037000	12.1429
3.	0.0390000	0.0055000	0.0131000	0.00270000	0.0043000	13.5714
3.	0.0393000	0.0053000	0.0146000	0.00440000	0.0049000	12.3333
3.	0.0339000	0.0065000	0.0130000	0.00200000	0.0040000	15.0000
3.	0.0282000	0.0060000	0.0136000	0.00210000	0.0044000	14.6429
3.	0.0274000	0.0049000	0.0102000	0.00260000	0.0043000	9.3571
3.	0.0316000	0.0063000	0.0121000	0.00300000	0.0047000	12.0667
3.	0.0289000	0.0066000	0.0120000	0.00300000	0.0045000	11.9375
4.	0.0600000	0.0289000	0.0178000	0.00530000	0.0123000	28.0000
4.	0.0634000	0.0367000	0.0200000	0.00600000	0.0117000	20.5455
4.	0.0648000	0.0254000	0.0186000	0.00660000	0.0101000	25.3636
4.	0.0250000	0.0116000	0.0118000	0.00280000	0.0077000	12.0833
1.	0.0295000	0.0134000	0.0141000	0.00430000	0.0089000	12.9167
1.	0.0371000	0.0153000	0.0148000	0.00450000	0.0084000	16.5000
1.	0.0073000	0.0036000	0.0045000	0.00190000	0.0037000	8.5333
1.	0.0104000	0.0057000	0.0050000	0.00250000	0.0042000	10.2000
5.	0.0208000	0.0182000	0.0123000	0.00320000	0.0080000	18.0769
5.	0.0328000	0.0256000	0.0190000	0.00510000	0.0097000	13.2353
5.	0.0349000	0.0305000	0.0196000	0.00570000	0.0100000	18.6667
5.	0.0176000	0.0107000	0.0123000	0.00280000	0.0074000	10.0000
5.	0.0295000	0.0387000	0.0229000	0.00540000	0.0098000	19.2857
5.	0.0310000	0.0209000	0.0254000	0.00510000	0.0104000	15.7143
5.	0.0194000	0.0121000	0.0108000	0.00300000	0.0077000	1.8000
5.	0.0211000	0.0141000	0.0144000	0.00380000	0.0075000	18.0000
5.	0.0238000	0.0180000	0.0105000	0.00390000	0.0075000	16.2353

APPENDIX TABLE 3 (Continued)

Sweating Rates (g/min) During Exercise

Subject	Local (LSR) Forehead	Chest	Forearm	Thigh	Calf	Whole Body (WBSR)
5.	[illegible]	0.0046[illegible]	[illegible]	0.00230000	0.0054000	12.[illegible]1
6.	[illegible]	0.0064[illegible]	.0046000	0.00300000	0.0061000	8.6154
6.	0.0366000	0.0077000	.0051000	0.00320000	0.0062000	16.3077
6.	0.0218000	0.0057000	0.0048000	0.00280000	0.0052000	12.5333
6.	0.0313000	0.0090000	0.0058000	0.00350000	0.0060000	10.8667
6.	0.0195000	0.0040000	0.0033000	0.00210000	0.0030000	15.0667
6.	0.0146000	[illegible]	0.0031000	0.00230000	0.0032000	[illegible]
6.	0.0172000	0.0042[illegible]	.0035000	0.00240000	0.0034000	5.0714
7.	0.0210000	[illegible]	.0075000	0.00220000	0.0063000	10.8571
7.	0.0327000	0.0151[illegible]	0.0095000	0.00260000	0.0091000	16.2143
7.	0.0291000	[illegible]	.0088000	0.00380000	0.0096000	13.1333
7.	0.0325[illegible]	0.0141[illegible]	.0096000	0.00280000	0.0080000	10.8571
7.	[illegible]	[illegible]	[illegible]	[illegible]	0.0092000	13.8571
7.	[illegible]	0.0124[illegible]	.0129000	0.00340000	0.0142000	17.2750
7.	[illegible]	[illegible]	.0087000	0.00130000	0.0047000	11.8000
7.	0.0138000	[illegible]	0.0046000	0.00140000	0.0042000	[illegible].8000
7.	0.0096000	0.0055[illegible]	0.0050000	0.00160000	0.0045000	3.6750
8.	0.0209000	0.0114[illegible]	0.0075000	0.00260000	0.0095000	18.0000
8.	[illegible]	[illegible]	.0094000	0.00320000	0.0102000	14.9286
8.	0.0285000	0.0158	.0087000	0.00370000	0.0102000	18.6000
8.	0.0114000	0.0091[illegible]	0.0074000	0.00220000	0.0082000	13.6000
8.	0.0143000	0.0181[illegible]	0.0082000	0.00260000	0.0082000	13.0625
8.	0.0148000	0.0185[illegible]	0.0089000	0.00280000	0.0075000	14.9286
8.	0.0043000	0.0022[illegible]	0.0026000	0.00140000	0.0045000	9.2353
8.	[illegible]	[illegible]	[illegible]	0.00160000	0.0050000	[illegible]
9.	0.0060000	0.0042[illegible]	.0034000	0.00280000	0.0052000	9.4286
9.	[illegible]	[illegible]	.0094000	0.00310000	0.0107000	13.3846
9.	0.0127000	0.0058[illegible]	.0134000	0.00410000	0.0131000	16.1538
9.	0.0144000	0.0100[illegible]	0.0123000	0.00540000	0.0121000	18.8462
9.	0.0127000	0.0087[illegible]	0.0113000	0.00210000	0.0123000	16.4167
9.	[illegible]	[illegible]	[illegible]	0.00240000	0.0136000	20.[illegible]
9.	0.0144000	[illegible]	.0141000	0.00440000	0.0165000	12.6429
9.	[illegible]	[illegible]	.0152000	0.00140000	0.0068000	7.1429
9.	[illegible]	[illegible]	0.0046000	0.00150000	0.0065000	6.0714
9.	0.0034000	0.0067[illegible]	0.0046000	0.00160000	0.0073000	12.3077
10.	0.0227000	0.0066[illegible]	.0066000	0.00160000	0.0074000	13.2857
10.	[illegible]	[illegible]	[illegible]	0.00210000	0.0089000	14.4000
10.	0.0324[illegible]	[illegible]	.0104000	0.00240000	0.0091000	5.0000
10.	[illegible]	[illegible]	.0163000	0.00200000	0.0104000	21.6667
10.	[illegible]	[illegible]	.0107000	0.00240000	0.0103000	22.1875
10.	0.0260000	0.0267[illegible]	.0109000	0.00310000	0.0107000	15.0000
10.	0.0165000	0.0022[illegible]	.0071000	0.00200000	0.0079000	10.6667
10.	[illegible]	[illegible]	.0074000	0.00210000	0.0077000	[illegible].3333
10.	0.0157000	0.0120[illegible]	.0075000	0.00230000	0.0077000	8.3333

APPENDIX TABLE 4

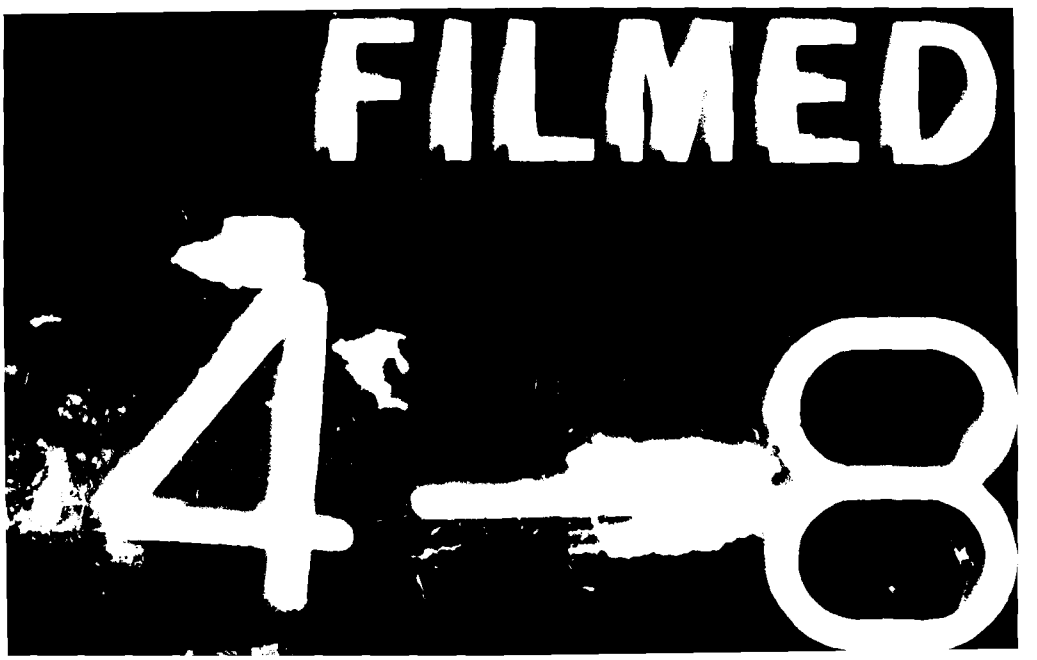
Sweating Rates (g/min · m^2) During Exercise

Subject	Local (LSR)					Whole Body (WBSR)
	Forehead	Chest	Forearm	Thigh	Calf	
1.	9.6901	12.8759	9.8228	2.12385	7.76532	7.4098
1.	12.0794	14.9333	10.9511	3.05303	8.22991	8.0756
1.	9.4246	3.1194	9.2963	1.59289	7.63257	7.6130
1.	10.8183	5.7078	9.7564	2.05748	8.29628	9.1753
1.	25.8933	7.4335	10.5529	2.32296	8.49539	9.4624
1.	5.3096	2.9203	3.6504	1.65926	3.84947	7.9038
1.	6.0397	2.9967	4.0486	2.32296	3.65036	4.9706
1.	7.4335	2.9203	4.3804	1.46014	3.45125	6.1856
2.	13.8050	6.3715	4.6459	1.85837	5.44236	8.8131
2.	15.7961	9.1591	6.2388	1.92474	5.97332	7.3916
2.	25.8180	8.2299	6.0397	1.99111	6.50428	9.7015
2.	12.6103	7.2344	5.2432	2.05748	6.37154	7.8536
2.	18.8590	9.7564	6.5707	2.25659	7.10161	7.1642
2.	16.0616	10.4201	6.9025	2.05748	7.10161	8.8225
2.	7.1344	6.0397	3.7167	1.72563	4.18132	2.9229
2.	9.9689	6.7034	3.7831	3.58399	4.11495	10.7463
2.	7.6326	4.6459	3.9822	4.31406	4.31406	4.9459
3.	21.6367	3.2521	6.5043	1.52652	2.45570	7.0598
3.	25.8844	3.6504	8.6945	1.79200	2.85492	7.8903
3.	26.0835	3.5176	9.6901	2.92029	3.25214	7.1705
3.	22.4995	4.3141	8.6281	1.32740	2.65481	8.7209
3.	19.7164	3.9822	9.0264	1.39377	2.92029	8.5133
3.	18.1854	3.2521	6.7698	1.72563	2.85392	5.4402
3.	26.9730	4.1813	8.0308	1.99111	3.11940	7.0155
3.	19.1810	4.3804	7.9644	1.99111	2.98666	6.9404
4.	39.8221	19.1810	11.8139	3.51762	8.16354	16.3743
4.	42.0787	24.3579	13.2740	3.98221	7.76532	12.0149
4.	43.0079	16.8580	12.3449	4.38043	6.70339	14.8325
4.	16.5926	7.6989	7.8317	1.85837	5.11051	7.0663
4.	19.5792	8.8936	9.3582	2.85392	5.90695	7.5536
4.	24.6233	10.1546	9.8228	2.98666	5.57510	9.6491
4.	4.8450	2.3893	2.9867	1.26103	2.45570	4.9902
4.	6.9635	3.7831	3.3185	1.65926	2.78755	5.9649
5.	13.9050	12.0794	8.1635	2.12385	5.30962	10.0427
5.	21.7694	16.9908	12.6103	3.39488	6.43791	7.3529
5.	23.1632	20.2429	13.0086	3.78310	6.63702	10.3704
5.	11.6912	7.1016	8.1635	1.85837	4.91140	5.5556
5.	19.5792	25.6853	15.1988	3.58399	6.50428	10.7143
5.	20.5746	13.8714	16.8580	3.38488	6.90250	8.7302
5.	10.9758	6.0308	7.1680	1.99111	5.11051	1.0000
5.	14.0041	9.3582	9.5573	2.52207	4.97777	10.0000
5.	15.7961	11.9466	6.9689	2.58844	4.97777	9.0196

APPENDIX TABLE 4 (Continued)

Sweating Rates (g/min · m^2) During Exercise

Subject	Local (LSR)					Whole Body (WBSR)
	Forehead	Chest	Forearm	Thigh	Calf	
5.	13.8050	[illegible]	2.6548	1.32652	3.5840	[illegible]
5.	24.9552	[illegible]	3.1858	1.99111	4.0486	[illegible]
5.	22.8004	[illegible]	3.5347	2.12385	4.1150	[illegible]
6.	14.4687	[illegible]	3.1858	1.85837	3.4513	[illegible]
6.	20.7739	[illegible]	3.8495	2.32296	3.9822	[illegible]
6.	13.1413	[illegible]	2.1902	1.39377	1.9911	[illegible]
6.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6.	11.4157	[illegible]	2.3230	1.59289	2.2566	[illegible]
7.	13.9377	[illegible]	4.9778	1.46014	5.5087	[illegible]
7.	21.7031	10.9511	6.3052	1.72563	6.0397	[illegible]
7.	19.3137	15.6634	5.8406	2.19022	6.3715	[illegible]
7.	21.5703	[illegible]	6.3715	1.52652	5.3096	[illegible]
7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.	24.1588	[illegible]	7.2344	2.25659	6.1061	[illegible]
7.	4.6459	[illegible]	2.4557	0.66370	2.4557	[illegible]
7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.	6.3715	[illegible]	3.3185	1.06192	2.9867	[illegible]
8.	13.5714	[illegible]	4.9778	1.72563	6.3052	[illegible]
8.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.	16.9244	[illegible]	5.7742	2.45570	6.7698	[illegible]
8.	7.5462	[illegible]	4.9114	1.46014	5.4424	[illegible]
8.	9.4909	12.0130	5.4424	1.72563	5.4424	[illegible]
8.	9.8228	12.2765	5.9069	1.85837	4.9778	8.2025
8.	2.8539	1.4601	1.7256	0.92918	2.9867	5.0743
8.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.	3.9822	2.7675	2.3893	1.52652	3.4513	5.1805
9.	5.3760	4.0486	6.2388	2.05748	7.1016	8.7912
9.	8.4290	6.3715	8.8936	2.72118	8.6945	9.2307
9.	9.5573	6.6370	8.1635	3.58399	8.0308	10.7693
9.	8.4290	5.7742	7.4998	1.39377	8.1635	9.3810
9.	10.3538	[illegible]	10.0219	1.59289	10.4865	11.7363
9.	10.8847	7.6989	12.6767	2.92029	10.9511	7.2245
9.	2.3893	2.1902	3.4513	0.92918	4.3141	4.0817
9.	2.3230	2.3230	3.0530	0.99555	4.3141	3.4694
9.	2.2566	2.4557	3.0530	1.06192	4.8450	7.0330
10.	15.0660	4.3804	4.3804	1.06192	4.9114	6.8132
10.	31.0613	4.7123	5.6415	1.39377	5.4424	7.3846
10.	15.1324	5.3760	6.9025	1.59289	6.0397	2.5641
10.	25.1543	6.4379	5.5087	1.32740	6.9025	11.1111
10.	19.6436	10.0219	7.1016	1.59289	6.8361	11.3782
10.	17.2563	15.7297	6.8361	2.05748	7.1016	7.6923
10.	10.9511	8.0972	4.7123	1.32740	5.2432	5.4701
10.	11.8139	8.7609	4.9114	1.39377	5.1105	8.8669
10.	10.4201	7.9604	4.9778	1.52652	5.1105	2.7350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