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VI. Energy expenditure and climatic exposure of Yemenite and Kurdish Jews in Israel

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The daily energy expenditure of Yemenite and Kurdish Jews has been assessed in summer and winter. The majority of the male subjects were engaged in farming; the women were mainly housewives.

A timed activity survey was carried out on all subjects. The differences between summer and winter were, in general, small and the time spent by the men in different activities averaged for the two seasons were, for the Yemenite Jews 7.69 h lying, 7.16 h sitting, 7.6 h working. The Kurdish Jews spent 8.44 h lying, 6.4 h sitting and 7.4 h working.

Energy expenditure was computed from the timed activity survey and measurements of oxygen consumption in a number of tasks. The energy expenditure of the men in the summer was 3050 kcal (12760 kJ) per day for both the Yemenite and the Kurdish Jews. In the winter, the Yemenite Jews expended 3000 kcal (12560 kJ) and the Kurdish Jews 3110 kcal (13020 kJ) per day. The Yemenite Jewish women expended 2280 kcal (9550 kJ) per day in the summer and 2400 kcal (10040 kJ) per day in the winter, and the Kurdish Jewish women expended 2250 kcal (9420 kJ) per day in the summer and 2390 kcal (10000 kJ) per day in the winter.

Integrated heart rates were recorded in the two seasons, during the night and during the day. The night rates were significantly lower in the summer than in the winter. The average night rates were:

	summer, beats/min	winter, beats/min
Kurdish Jews		
men	56.3	60.9
women	63.0	70.6
Yemenite Jews		
men	60.4	65.6
women	66.6	70.5

The time spent out of doors in the daylight hours was 348 min/day in the summer and 347 min/day in the winter for the Yemenite Jewish men. The Kurdish Jewish men spent 401 min/day out of doors in the summer and 342 min/day out of doors in the winter. The Yemenite Jewish women were out of doors for 205 min/day in the summer and 243 min/day in the winter. The corresponding figures for the Kurdish Jewish women were 203 and 81 min/day.

The main objectives of the field study were to record climatic conditions, to observe the subjects activities and to measure their energy expenditure. Food intakes were assessed at the same time (Bavly 1973) and an anthropometric survey (Lourie 1973*a*), together with tests of lung function (Lourie 1973*b*) were also made on the same people.

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Methods and material

The position and population of the villages have been described (Edholm & Samueloff 1973, this volume). There were two Yemenite villages, Bitha and Peduim, with a total of 75 subjects between the age of 20 to 30, and three Kurdish villages, Eshbol, Paame Tashaz and Pattish with a total of 119 subjects in the same age group plus one Yemenite girl from the village of Peduim married to a Kurd, who was also a subject. Not all of the total of 195 subjects could be studied so work was concentrated on all the subjects described as 'fit' (Lehmann, Gadoth & Samueloff 1973).

Environmental climate

Measurements were made in the villages of dry- and wet-bulb temperature using an Assmann aspirating psychorometer, black globe temperature as a measure of radiation, and air movement using a vane anemometer. Such measurements were made at irregular intervals during the day in the period when subjects were observed in each particular village; the total number of measurements were few in the summer but more extensive in the winter. Meteorological measurements were obtained from the Agriculture Research Station situated at Gilat (Edholm & Samueloff 1973) which was within approximately 10 km from all the five villages studied. These measurements included sunshine recording but not globe temperatures.

Habitual activity

Each subject was observed continuously for the greater part of one working day. Activity was noted and coded whenever there was a change of activity. Careful timing was made of characteristic occupational details, such as specific farming work, e.g. hoeing, weeding, ploughing, etc. In some cases, a subject would be engaged in the same activities each day of the week and would follow an almost identical routine throughout each day. In other cases, activities varied considerably from day to day. As the intention was to obtain an estimate of energy expenditure over the period of a week, the subject was interviewed, in addition to the detailed one-day study, on two or three occasions and particulars of his or her activities during the day were recorded. There was considerable variation in the ability of subjects to recall such details with sufficient accuracy. However, the value of the interviews was enhanced in two ways. First, a subject was seldom interviewed alone; husband and wife were usually seen together and were able to pool their memories. In most cases, other members of the family were also present and could correct or amend the subject's recall. In addition, when a member of the team was observing subject A, it was common to observe other subjects at various times during the day and so their recollections could be checked.

Some of the farming activities were seasonal and so it could happen that an activity such as gathering the potato crop would have engaged many subjects in one village but by the time studies had started in another village such an activity had finished. Nevertheless, it was decided to keep to the plan of making observations and recording interviews in one village over a period of one week before proceeding to the next village.

Subsequently, the records of the daily observations and interviews were analysed and set out in the form of a daily diary of activities, each day starting and ending at midnight. This was then reduced to a table giving the total time spent during each day in each activity. An energy expenditure value for each activity for each individual was calculated, based on (*a*) measured values where available, (*b*) published values (e.g. Durnin & Passmore 1967) with adjustments for body mass, and (*c*) unpublished values obtained in previous energy expenditure studies. The total energy expenditure for each individual was computed.

Energy expenditure

A limited number of measurements of oxygen consumption or ventilation volume was made, using the Max Planck respirometer or the Wright flowmeter. Gas samples were analysed using a Lloyd-Haldane apparatus, the analyses being completed within 1 to 3 h of collection. A mouth piece and nose clip were used in all cases in preference to a mask.

Heart rate

The heart-rate recorder developed by Wolff (Baker, Humphrey & Wolff 1967) is one of a family of instruments known as S.A.M.I. (socially acceptable monitoring instruments). The system consists of a signal processing and amplifying unit which converts the impulses from two chest electrodes to pulses of a standard shape and strength; these are stored in an electrochemical integrating cell ('E-cell'). The latter is essentially a coulometer in which, during a recording cycle, silver from the anode is plated on to a gold cathode in direct proportion to the charge passed. The E-cell is screwed into a holder in the S.A.M.I. and removed at the end of a recording period. After use it is 'replayed' by passing a reverse current through a separate instrument to replate the silver electrode. The amount of current required is a measure of the stored charge, i.e. the total number of heart beats during the measurement period.

The chest electrodes were fitted to the subject in the evening and the instrument was worn for approximately 36 h during 2 nights and the intervening day. The subjects were given separate E-cells to insert during the first night, during the day and during the second night, and each E-cell was provided in an envelope on which the subject recorded the time of changing over from one cell to another.

When the chest electrodes were fitted, skin resistance was reduced to less than 10 MΩ by abrading the skin surface, and the presence of an adequate signal was checked using a portable electrocardiogram.

Heart-rate recordings were used for estimating energy expenditure by calculating the slope relating measured energy expenditure and heart rate. Energy expenditure at rest and at five different levels of work on the bicycle ergometer were determined in 70 subjects (Samueloff, Davies & Schvartz 1973, this volume) and in a number of other subjects measurements of oxygen consumption during various activities were available (see above).

Results

Environmental climate

It is of importance to reassess the climate (Edholm & Samueloff 1973, this volume) in order that it should represent more clearly the environmental exposure of the villagers. 'Summer' will refer to the months May to September 1968 and 'winter' to the months November 1968 to March 1969.

Light westerly or northwesterly winds prevailed throughout the year and except on days of rain there was an early morning breeze of 0.5 to 1.5 m/s. This increased to 2 to 3 m/s by midday but died away to give calm evenings.

The mean monthly air temperatures at particular times of day are shown in figure 1. The curves for the remaining summer months fall between those for May and July, those for the remaining winter months between November and January. The air temperature rose sharply from dawn until 10 h 00, remained fairly constant between 10 h 00 and 16 h 00 and then fell steadily over the evening hours. In summer, air temperatures ranged from 14 to 23 °C at 05 h 00 and from 25 to 36 °C at midday. In winter, air temperatures ranged from 5 to 15 °C at 06 h 00 and from 13 to 36 °C at midday. In summer, maximum and minimum indoor temperatures occurred about 4 h later than outdoors so that it was customary for villagers to spend summer evenings on their verandahs where temperatures were cooler than indoors. In winter, midday indoor temperatures were similar to those outdoors. The villagers sought the warmth of their houses at sunset (about 17 h 30).

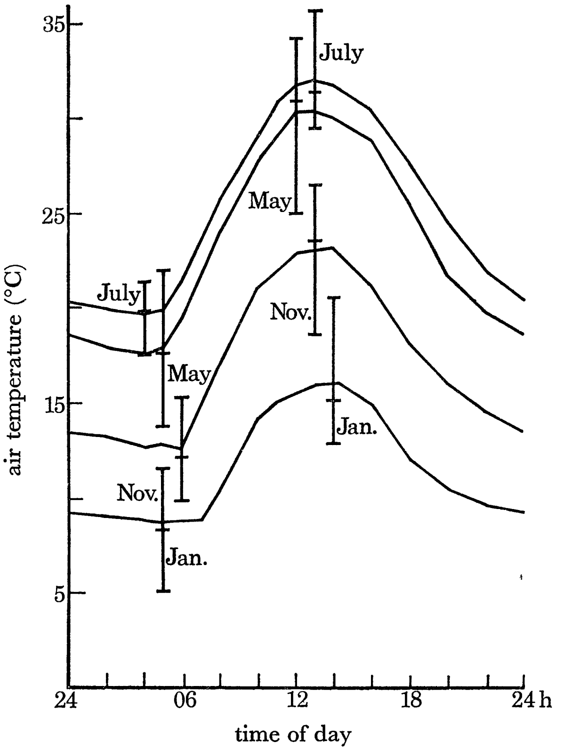

FIGURE 1. Air temperature (°C) at different times of day. Curves indicate mean for each of 4 months in the year April 1968 to March 1969; vertical lines indicate median and percentiles (10 and 90) per month.

The marked fall in air temperature resulted in relative humidities of more than 85 % (with few exceptions) at night. The vapour pressure, though higher in summer than in winter, was remarkably constant over the 24 h. At midday, the relative humidity ranged from 31 to 58 % in summer and from 33 to 80 % in winter. More than half the winter days had relative humidities within the summer range, the higher humidities being indicative of the prevalence of cloud. Rain fell on a few days in winter only.

The air temperature at 06 h 00 and 14 h 00 over the 6-week periods of the summer and winter field studies are shown in figure 2. During the summer visit the air temperature was very constant varying only by 5 °C at 06 h 00 and 9 °C at 14 h 00. A temperature of 36 °C was recorded on 16 July. There were more than 10 h of sunshine on each day and clear skies prevailed. During the winter visit air temperatures at 14 h 00 were lower (except on 4 days) than those even at 06 h 00 in summer and were more variable. The air temperature at 14 h 00 fell from 23.5 °C on 17 January to 9 °C on 29 January and in this period, while at Eshbol and Paame Tashaz, there were several days with less than 5 h sunshine. On 28 and 29 January,

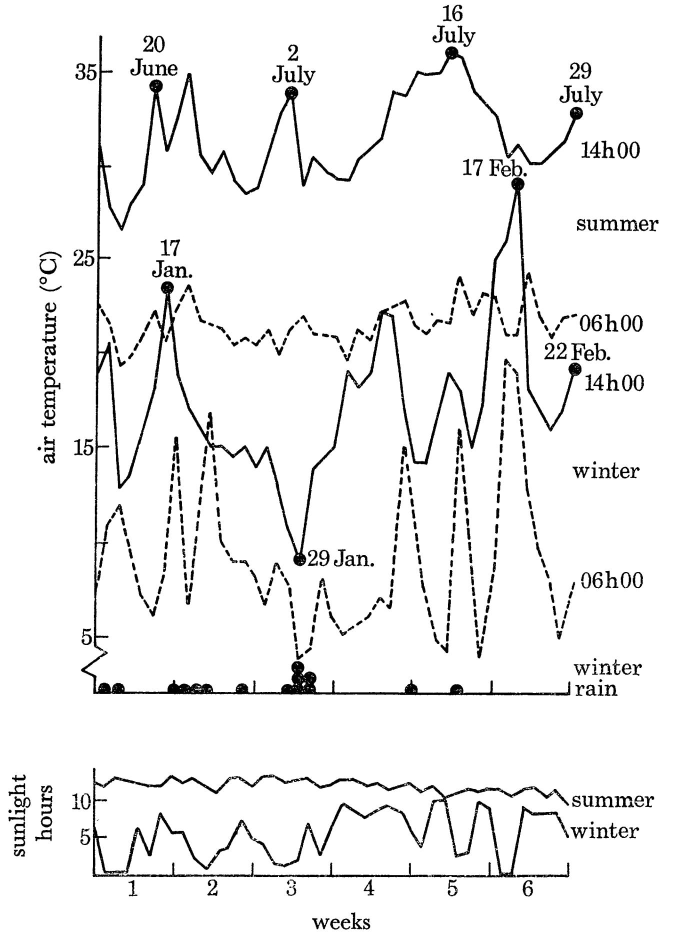

FIGURE 2. Air temperature (°C) at 06 h 00 and 14 h 00 during the summer and winter field studies in the Negev villages; hours of sunlight and winter days of rain per week.

heavy rain (34 mm) and gusty winds (7.5 to 10 m/s) prevented all outdoor work. Such days were exceptional. In February, air temperatures ranged from 14 to 29 °C at 14 h 00 and there were many days with clear skies, more than 8 h of sunshine and almost calm conditions. On 16 and 17 February a dust cloud obliterated the sun and reduced visibility to 90 m.

The long hours of sunshine and cloudless skies, particularly in summer, were an indication that radiation was very high in this area. Mean radiant temperatures calculated from globe

TABLE 1. MEAN RADIANT TEMPERATURE AND WET-BULB GLOBE TEMPERATURE INDEX IN SUMMER AND WINTER

	m.r.t./°C		w.b.g.t./°C	
time of day	summer	winter	summer	winter
08 h 30	69	53	30	14
10 h 00	74	59	30	17
12 h 00	75	70	30	19

thermometer readings taken in the villages were about 70 °C throughout the day in summer. (Half day shown in table 1.) On clear days in winter they were also high but only reached summer levels over a period of 3 h at midday.

As the wet-bulb globe temperature (w.b.g.t.) index (Yaglou 1956) takes into account all the climatic factors associated with heat exchange between man and his environment, it may be used to indicate the degree of heat stress to which the villagers were subject. In summer, the w.b.g.t. index was 30 °C throughout the day, only 1 °C lower than the critical level above which there is a risk of heat illness (Minard, Belding & Kingston 1957). In winter, even on clear days, the w.b.g.t. index was less than 20 °C (table 1).

Climatic exposure time

Exposure was assessed by recording time spent outdoors by each subject between 06 h 00 and 18 h 00. These 12 h included 12 of the 14 daylight hours in the summer and the 11 winter daylight hours. The results are set out in table 2. The men in the two communities spent the same time outdoors in the winter; in the summer the male Kurdish Jews were outside, on the average, about 1 h longer than the male Yemenite Jews, although this difference was not statistically significant. The women were out of doors for a much shorter time than the men; in both seasons the Yemenite Jewish women were outside for approximately 1 h longer than the Kurdish Jewish women.

TABLE 2. EXPOSURE TIME

	Yemenite Jews				Kurdish Jews			
	males		females		males		females	
	(n = 32)		(n = 21)		(n = 48)		(n = 23)	
	h	min	h	min	h	min	h	min
summer	5	48	3	25	6	42	2	10
range/min	(35–640)		(10–500)		(55–660)		(17–525)	
	(n = 27)		(n = 24)		(n = 51)		(n = 28)	
	h	min	h	min	h	min	h	min
winter	5	47	2	43	5	42	1	21
range/min	(25–660)		(20–325)		(10–652)		(5–228)	

Time spent out of doors was significantly correlated with energy expenditure, as might be predicted, since so much of the working time was outside. The male farm-workers in both communities were out of doors, summer and winter, for approximately $8\frac{1}{2}$ h between 06 h 00 and 18 h 00. The hottest time of day was from 10 h 00 to 16 h 00; nevertheless, the farm-workers were outside for 4.1 h in the summer and 4.8 h in the winter during this period.

Habitual activity

Sabbath began on Friday at sunset, when all work ceased until sunset on Saturday. Both Yemenites and Kurds were orthodox Jews and the majority of men attended the synagogue both on Friday and Saturday. The traditional family meal, with various special dishes, was prepared by the housewife throughout Friday and consumed Friday evening. Although a number of men stopped work an hour or two earlier on Friday than on other days, in general the majority worked a 6-day week. Essential work was also done during the Sabbath, such as feeding animals and milking cows, goats and sheep. Football and basketball were played on Saturday, when a number also attended football matches in other towns.

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The most usual pattern of activity for the men included an early start, about 05 h 00, with a cup of tea and biscuits, followed by work in the fields, usually breakfast in the fields between 08 h 00 and 09 h 00, returning home for lunch and rest at 12 h 00 and back to the fields about 14 h 00, finishing work at 18 h 00. At home, after a shower and change of clothes, would follow the evening meal and then many strolled around the village, visiting relatives and friends for 2 to 3 h before going to bed. But there was a great variety of activity patterns, partly due to the breakdown of equipment, and there were frequent visits to Beer Sheva or Tel Aviv for repairs or to obtain spare parts. The farmers were also independent, could and did work according to their own plans provided they did not seriously neglect their land. Sometimes very long hours were worked and on other days there might be only 1 to 2 h activity.

In addition to regular military service, men could sometimes be called up for 24 h service coverage at very short notice. No account has been taken of such 'military' days in calculating energy expenditure as details of military duties were not available. When subjects were absent for other reasons (funerals, weddings, etc.) for 24 h or more, such days were classified as 'missing', and average energy expenditure was calculated only from observation or recall of days spent in the village or absences connected with the subject's work or habitual activity. On the other hand, it might happen that a subject employed by some organization could be on holiday but spend this in the village. He was observed in the same way as other subjects and his energy expenditure calculated even though this could be very different from his usual level.

Hours of work

The hours of work per day and per week were assessed; there was no difficulty in making this assessment in the case of subjects receiving a wage, as 'hours of work' were those for which the subject was paid irrespective of his activity. Hours of work of self-employed farmers were computed from time spent in the fields, tending animals or driving tractors but the journeys and time spent in connexion with equipment repair, or in discussions and bargaining over the sale of crops and agreements about work, were not easy to evaluate. The discussions were clearly part of an individual's occupation, but they were equally clearly also social occasions. As far as journeys in connexion with repairs were concerned, time spent travelling and actually in the garage were included in 'hours of work' but not the time spent shopping, visiting friends, etc. Discussions and bargaining were included to a maximum of 6 h in any one day. Such arbitrary decisions have probably resulted in errors, but these are unlikely to have been differently distributed between the Kurdish and Yemenite Jews and, as shown in table 3, hours of work in the two communities amongst the men was similar, nor was there any significant difference in the hours of work between summer and winter.

Estimates of the hours spent in work by women have not been included as there were even greater difficulties in defining 'work' as far as the housewife was concerned. In so far as comparisons are possible, it appeared that the Yemenite women as a whole worked longer than the Kurdish women, but the differences were not large.

TABLE 3. AVERAGE DAILY HOURS OF WORK (MALES)

	n	summer	*n*	winter
Yemenite Jews	31	8 h 18 min	29	8 h 05 min
range		(1 h 30 min–11 h 45 min)		(1 h 00 min–11 h 30 min)
Kurdish Jews	49	7 h 36 min	49	7 h 25 min
range		(0 h–13 h)		(1 h 10 min–12 h 10 min)

The degree of irregularity of work among the men was examined. Where there was a difference of 3 h or more between the shortest and longest working day (excluding Friday and Saturday) it was classified as 'irregular'. About one-third of the men in both communities worked irregular hours and some examples are given in table 4.

TABLE 4. EXAMPLES OF IRREGULARITY OF WORK

subject	day 1, h	min	day 2, h	min	day 3, h	min	day 4, h	min	day 5, h	min
1	6	45	9	15	9	15	5	00	2	00
2	2	00	7	00	10	10	7	20	6	45
3	12	15	3	40	9	30	8	45	9	45
4	12	45	13	30	13	30	3	00	0	
5	9	30	2	00	4	00	7	00	11	15
6	0		9	00	10	00	12	00	12	00

Energy expenditure

The results of the measurements of energy expenditure are set out in table 5. There was no evidence of significant differences between the Kurdish and the Yemenite Jews in the energy expended in specific tasks.

TABLE 5. ENERGY EXPENDITURE DURING PARTICULAR TASKS

males				females			
activity	kcal min^{-1}	kJ min^{-1}	number	activity	kcal min^{-1}	kJ min^{-1}	number
tractor driving	2.2	9.2	9	housework:			
truckdriving	1.9	7.9	2	wash and tidy	2.5	10.5	3
horse-cart driving	2.1	8.8	1	cook	2.0	8.4	1
(standing)				scrub floor	3.2	13.4	2
potato picking	6.58	27.6	2				
potato, filling sacks	3.4	14.2	3	animal work:			
potato, load sacks on	9.3	39.0	2	feed cows	3.4	14.2	2
truck				feed chickens	3.1	13.0	1
potato grading	3.15	13.2	1				
orange picking	3.7	15.5	1	field work:			
weeding	3.0	12.5	2	weeding	3.32	13.9	2
carrots, picking	2.6	10.9	1	scything	11.25	47.0	1
seed casting	4.5	18.8	2	top carrots	2.14	8.9	1
spray insecticide	5.0	20.9	2	fork grass	4.5	18.8	2
manure spreading	6.3	26.4	1				
prune vines	4.05	16.9	3				
scythe grass	5.9	24.7	2				
fork grass	6.0	25.1	1				
irrigation pipes, move	7.7	32.2	4				
sitting	1.32	5.5	3	sitting	1.36	5.7	2
walking	4.0	16.7	3	walking and shopping	4.15	17.4	2
walking in mud	8.0	33.4	1				
repair work (tractors)	4.5	18.8	2				
bicycling	7.6	31.8	2				

The energy expenditure of each subject was computed so far as possible for each day of the week. However, even interviews were frequently inadequate to cover a complete week, so mean daily energy expenditures had to be based in most cases on less than 7 days and an average covered 4 to 5 days. Where subjects were engaged in regular employment, the pattern of activity

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was usually the same each day. Farm work was also in some cases extremely regular. So every effort was made to ensure that those engaged in irregular work were sufficiently studied for valid estimates of energy expenditure to be made. The time spent in particular activities was set out for each day and an energy expenditure figure assigned for each activity. In table 6 are shown the average times in each community for major activities.

TABLE 6. TIME SPENT IN DIFFERENT ACTIVITIES (MALE)

	Yemenite Jews		Kurdish Jews	
	summer h min	winter h min	summer h min	winter h min
lying	7 25	8 00	8 25	8 30
sitting	6 45	7 35	5 35	7 15
stand, walk, work	7 50	7 25	8 30	6 20
transport	2 30	1 20	2 30	1 55

The mean energy expenditures of men and women in each community are given in table 7. There were no significant differences between summer and winter. The range was very considerable between subjects and, owing to the irregularity of working hours, also in any one subject. In those subjects on whom observations were made in both seasons there was a fair agreement in level of energy expenditure.

The estimates of the energy expenditure of farm-workers were considered to be the most reliable as observation of activities was relatively simple, and measurements were made of oxygen consumption during the performance of particular tasks. The results are set out in table 8. Average energy expenditure of the farm-workers, both for Yemenite and Kurdish Jews, was similar in summer and winter and higher than for the remaining subjects.

Energy expenditure and food intake

A comparison is made in table 7 of the estimated energy expenditure and food intake. In the case of the Yemenite Jews there was a close agreement for the women between intake and expenditure. The men had an excess of intake of approximately 150 kcal (627 kJ) per day. Both male and female Kurds had a substantial excess of intake over expenditure of approximately 500 kcal (2090 kJ) per day. The results were similar when comparison was made between those subjects in whom both intake and expenditure were measured.

Integrated heart rate

The number of subjects studied in the summer was 142 and in the winter 120. There were a number of failures due to a fault in the instrument, an error by the subject, or to electrodes being detached or connectors broken.

Results obtained were accepted as satisfactory and suitable for inclusion in the analysis if at least one night heart rate within the range 40 to 90 beats/min or a daytime heart rate between 55 and 110 beats/min was obtained. Where two night heart rates were obtained they were required to be within 20 beats/min of each other if satisfactory day heart rate was also obtained; if not, they were required to be within 10 beats/min of each other. The average of the two night heart rates was then used in the analysis.

Acceptable measurements of night heart rates were obtained in 81 % of subjects in the summer and 80 % in the winter. Both day and night heart rates were satisfactory in 72 % of subjects in the summer and 78 % in the winter.

TABLE 7. DAILY ENERGY EXPENDITURE AND INTAKE

	Yemenite Jews				Kurdish Jews			
	males		females		males		females	
	kcal	kJ	kcal	kJ	kcal	kJ	kcal	kJ
	(n = 32)		(n = 21)		(n = 48)		(n = 23)	
summer								
expenditure	3050	12760	2280	9550	3050	12760	2250	9420
range	(2380–4560)	(9950–19080)	(1850–2860)	(7740–11970)	(2280–4200)	(9940–17570)	(1640–3820)	(6860–15980)
	(n = 14)		(n = 31)		(n = 29)		(n = 39)	
intake	3210	13430	2270	9500	3570	14940	2720	11380
range	(2530–4380)	(10600–18330)	(1570–3190)	(6570–13350)	(2980–4780)	(12470–20000)	(1700–4550)	(7120–19040)
	(n = 27)		(n = 24)		(n = 51)		(n = 28)	
winter								
expenditure	3000	12560	2400	10040	3110	13020	2390	10000
range	(2190–4240)	(9170–17740)	(1640–3230)	(6860–13520)	(2010–6390)	(8400–26740)	(1720–4070)	(7200–17030)
	(n = 7)		(n = 12)		(n = 7)		(n = 9)	
intake	2830	11840	2280	9550	3845	16090	2860	11970
range	(2600–3070)	(10880–12850)	(1790–2700)	(7500–11300)	(3280–4330)	(13720–18100)	(2610–3320)	(10920–13890)

Table 8. Mean daily energy expenditure of agricultural workers

	summer					winter				
	n	kcal	s.d.	kJ	s.d.	*n*	kcal	s.d.	kJ	s.d.
Yemenite Jews	18	3250	560.4	13600	2340	18	3165	621.5	13240	2600
Kurdish Jews	30	3090	424.2	12920	1770	22†	3350	886.2	14020	3710

† One village (Paame Tashaz) excluded because of rain (no fieldwork).

Table 9. Heart rates (beats/min)

	male			female		
	n.†	d.‡	d. – n.	n.	d.	d. – n.
summer						
Kurdish Jews	56.3	83.0	26.7	63.0	89.1	25.1
Yemenite Jews	60.4	87.2	26.8	66.6	88.7	22.1
winter						
Kurdish Jews	60.9	87.4	26.5	70.6	95.9	25.3
Yemenite Jews	65.6	89.1	23.5	70.5	93.7	23.2

† Night ‡ Day.

The mean heart rates are set out in table 9. In the summer the mean night rates were lower in the Kurdish Jews than in the Yemenite Jews, but the increase in heart rate in the day was almost identical in the men in the two communities and the increase in the Kurdish Jewish women was also similar. However, the Yemenite Jewish women had a smaller increase although the differences are not significant. In the winter, the male Kurdish Jews had lower night rates than the male Yemenite Jews, but the women in the two communities had identical night heart rates. The increase in heart rate in the daytime was slightly less in Yemenite men and women than in the Kurdish Jews.

In the winter, night heart rates were higher than in the summer; this increase was observed in nearly all subjects, men and women, Kurds and Yemenites, and the difference was highly significant. Day rates were also higher in the winter, so the difference between day and night was only slightly less in the winter than in the summer.

Energy expenditure was computed in those subjects who had been calibrated by relating measured heart rate and oxygen consumption and calculating the slope of the line relating the two variables. The energy expenditure corresponding to the day heart rates was read from this slope and compared with estimates of energy expenditure based on timed activities. Although the two estimates were significantly related, there was a very large scatter. The average energy expenditure determined from heart rate measurements was substantially higher than the estimates based on timed activities.

Discussion

The question which the field investigations were designed to answer was to assess the similarity or difference of the environmental conditions of the Kurdish and Yemenite Jews. The climatic environment was virtually identical in the five villages studied and was typical of a desert area, with high insulation, low rainfall and large temperature differences between day and night.

The climatic conditions to which the individual subject was exposed each day were assessed by measuring the time spent out of doors during daylight hours. During the summer there was no significant difference between the two communities (table 2), although the Kurdish men, on the average, spent 1 h longer out of doors than the Yemenite men, whereas the Yemenite women were outside for about 1 h more than the Kurdish women. In the winter, the men of both communities had identical outdoor time but the Kurdish women again spent less time outside than the Yemenite women. Farm-workers, Yemenite and Kurd, spent about 8 h each day out of doors both in the summer and in the winter.

The subjects, men and women, were habitually out of doors in the evenings during the summer, and frequently in the winter also, but this time was not included as outdoor dry-bulb temperatures were in general lower than indoor temperatures and there was no solar radiation.

The use of time spent out of doors in daylight hours can be justified as a basis for comparison of climatic environmental conditions to which the Kurdish and Yemenite Jewish subjects were exposed. Outdoor time may be considered a relatively crude index since direct and reflected solar radiation received by an individual will depend on time of day and posture. However, in the case of farm work there was virtually no shade and the hours spent outside were fairly similar. It was not possible to calculate the radiation heat load of individual subjects, but using the outdoor time between 06 h 00 and 18 h 00 meant that in the summer 12 of the 14 daylight hours, and in the winter all 11 daylight hours, were included. Direct solar radiation was considerable in both seasons since in the summer there were over 10 h sunshine each day and in the winter 6 h. The radiation heat load received during the summer months by men working out of doors between 10 h 00 and 16 h 00 could have been up to 240 kcal (1010 kJ) per hour (Blum 1945). In spite of such a heat load and high environmental temperatures, it was unusual to find raised oral temperatures amongst the farm-workers, or a very high water intake while working. The subjects appeared to be skilled in maintaining levels of activity which did not affect their thermal balance. It could be concluded that in the summer the subjects were acclimatized to heat and also avoided increasing their work rate to a degree which would have raised body temperature or heart rate to uncomfortable levels. In the winter, when the observers thought the weather was agreeably warm, many of the subjects complained of cold and wore clothing more appropriate to an English winter.

There was no significant difference between the Kurdish and Yemenite men in the average daily hours of work, nor was there any seasonal difference.

The estimated daily expenditure of the male Kurdish Jews and Yemenite Jews was identical in the summer and similar in the winter, nor were there any differences between the women either in the summer or the winter. The estimated energy expenditure of the Yemenite Jews agrees closely with their estimated energy intake. Both the male and female Kurdish Jews had intakes which were substantially higher than their energy expenditure. A considerable proportion of the female Kurdish Jews were overweight, and it is probable they were continuing to gain mass so an excess of expenditure over intake might be expected. But it is not easy to explain the excess in the case of the Jewish Kurdish men who were heavier and taller than the male Yemenite Jews but not, on the average, fatter. Although in a number of investigations a positive correlation between body mass and food intake has been found, the significance is low (Edholm *et al.* 1970). The energy expenditure of the male Kurdish Jews might have been underestimated; the heart rate increase during the day compared with the night was the same as that of the male Yemenite Jews in the summer (table 9). The increase in heart rate in the day compared with the night was similar in the men and women of both communities, summer and winter which tends to confirm the estimates of similar energy expenditures. The slightly larger increase in heart rate of the Kurdish Jewish women than in the Yemenite Jewish women during the day could be attributed to the greater body mass of the former. The Yemenite Jews had faster night rates than the Kurdish Jews in the summer, and in winter there was the same difference between the men in the two communities. There was no evident reason for this finding.

A significant and unexpected seasonal change in heart rate was observed in the men and women of both communities, with faster heart rates at night during the winter. The opposite could have been predicted since indoor night temperatures during the summer were high, averaging about 29 °C. Gold, Zornitzer & Samueloff (1969) have reported an increased resting heart rate during the winter in subjects studied in Israel. Such seasonal differences in measured heart rate have also been observed by Whitney (personal communication) in experiments carried out in England. There is no evident explanation, although it may be associated with seasonal changes in body mass. Increased mass in the winter and a decrease in the summer was observed by Harries & Hollingsworth (1953) and seasonal changes have been reported in groups of men living in polar regions (Lewis, Masterton & Rosenbaum 1960; Edholm & Lewis 1964). The Kurds and Yemenites all showed an increase in body mass in the winter compared with the previous summer, which is consistent with a seasonal change, although it could also be part of a steady increase in mass.

The measurement of heart rate, using the S.A.M.I. heart rate integrator was undertaken to provide an independent estimate of energy expenditure. The linear relationship between heart rate and energy expenditure has been demonstrated by many workers hence it could be expected that estimates of energy expenditure could be derived from measurement of heart rate. There are other factors in addition to muscular work which affect heart rate, including posture, emotion and changes in body temperature. Nearly all non-muscular factors increase heart rate so it can be predicted that the integrated heart rate increase in the daytime over the night heart rate will be greater than the increase due to energy expenditure. And energy expenditure calculated from heart rates in subjects who had been suitably calibrated was occasionally similar to but more usually considerably higher than the energy expenditure computed from timed activity studies.

The present investigation was the first in which the S.A.M.I. heart rate integrator was used on an extensive scale. Although there were a number of difficulties, useful results were obtained in 75 % of cases. Errors due to mistakes made by the subject were less than anticipated, and it is clear that untrained and relatively unsophisticated subjects can learn to use the instrument satisfactorily.

There was considerable individual variation of habitual activity, but the averaged results were similar amongst the men in the two communities (table 6) and showed only small seasonal differences. The high proportion of time spent lying or sitting (14 to 15.5 h) even in these active men confirms previous observations (Edholm, Fletcher, Widdowson & McCance, 1955).

It can be concluded that in terms of climatic exposure, habitual activity, energy expenditure and night to day heart rate increases, the Kurdish and Yemenite Jews were similar and no significant differences were found either in the summer or in the winter.

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