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Studies of Basal Metabolism and Energy Expenditure of Koreans in Daily Life*

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1. Introduction

In the report of two committees on Calorie Requirements of the Food and Agriculture Organization of the United Nations (1) attention was called to the dearth of information on energy requirements. The diets consumed provide no direct yardstick of requirement. Human beings have remarkable capacity for adjustment to restricted calorie intakes. This is to some extent the result of physiological adjustments. There is a real difficulty in converting the results of dietary surveys into tables of food requirements. In most circumstances, we believe that estimations of energy expenditure rates can be at least as accurate, and previde more accurate information than less precise family dietary surveys and the calculated nutrients per capita *from unreliable statistics of food production and consumption in Korea.* A more precise understanding of energy expenditure of Korean daily life and work will increase our practical knowledge of Koreans' food requirments and capacity for physical work.

Several reports of such studies on Koreans have been previously published by the author and colleagues (2). Those studies were done on orphans, students, nurses, housewives and soldiers. Since 1963 the present study has also been undertaken to include wide variations in age, professions and activities in order to establish a standard of basal metabolic rate for Koreans, and to estimate daily energy expenditures, particularly of agricultural and construction laborers.

2. Experimental procedures

The measurements of basal metabolic rates (B.M.R.) were made by indirect calorimetry using a Douglas bag and Scholander gas analyser on more than 1,000 healthy individuals (5~92 years old) selected at random. The lowest value of the 6 measurements was taken during the 3 day usual survey with each subject in the basal state, i.e. not above 80/min. pulse rate, below 25 /min. respiratory frequency, no fever and R.Q.: 0.8~0.9. A single determination of B.M.R. was also made with the Sanborn Metabulator on over 600 individuals and about 500 army soldiers. The energy expenditure of various activities was also measured by the Douglas bag and Scholander analyser(Fig. 2).

The assessment of the total daily energy expenditure was made for each subject by the factorial method, nemely, the subjects kept a special diary sheet, a record of their activities throughout the 24 hours of every day during

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Table 1. Basal metabolic rates of Koreans by Douglas method

	Male			Female		
Age	Av. of	Cal/m²/hr	S.D.	Av. of	Cal/m²/hr	S.D.
5	5	53.4	±5.7	9	51.1	±6.8
6	32	53.7	±3.2	20	51.3	±3.01
7	18	50.7	±4.36	18	49.5	±5.1
8	27	50.9	±3.1	20	48.7	±3.3
9	15	48.3	±4.3	23	47.3	±4.7
10	13	45.2	±4.6	29	45.1	±4.8
11	20	47.3	±3.8	11	45.2	±3.5
12	28	45.2	±3.9	32	41.8	±4.3
13	24	41.8	±3.7	22	40.3	±1.78
14	26	41.8	±1.7	23	38.6	±3.5
15	27	41.1	±3.3	31	37.3	±3.6
16	14	40.6	±3.7	9	35.1	±1.9
17	12	39.3	±1.6	11	35.6	±3.2
18	12	38.8	±1.1	18	35.7	±3.7
19	28	37.6	±2.5	35	36.5	±4
20	26	37.6	±2.9	32	36.5	±4
21~24	26	37.1	±5.14	46	34.4	±3.6
25~34	24	38.4	±3.3	37	36	±4.35
35~44	21	38.6	±4.21	36	35	±4.94
45~54	23	36.4	±3.66	30	36	±3.34
55~	9	34	±3.58	16	33.1	±3.48
	430			508		

Total 938 S.D.: standard deviation

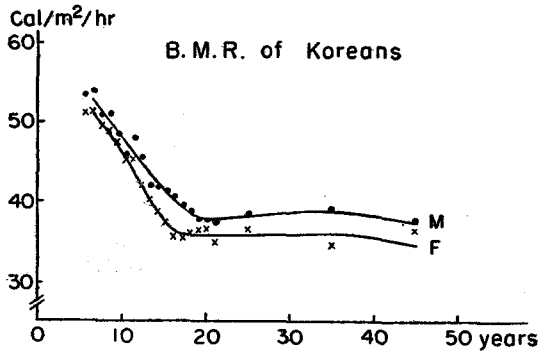

Fig. 1

the 3~7day survey. Results of typical subjects from each activity were also recorded in minute form.

The total energy expenditure was estimated by multiplying the caloric value of B.M.R. and from each activity by the length of time spent in it and summing the separate totals. The caloric value of sleeping in bed was assumed to be equal to the basal metabolism. Some figures were from the tables of Passmore and Durnin (3), Consolazio(4), and Morehouse(5).

The dietary surveys were also carried for 3 days in certain homes and in the Korean Army Academy as the reference for the assessment of daily energy expenditure. The circumstances of our subjects are known by the Health Center and Social Center of Ewha Womans University. Some farmers' families, under the control of the Health Center in Wondang, near Sinchon

Table 2. Basal metabolic rates of Koreans by Sanborn Metabulator

Age	Av. of	Cal./m²/hr.	S.D.	Av. of	Cal./m²/hr.	S.D.
21~24	14	40.8	±5.63	15	39.2	±4.26
25~34	75	39.8	±7.34	80	39.1	±10.8
35~44	114	41	±7.83	113	37.3	±9.01
45~54	90	38.8	±5.27	74	37.5	±6.19
55~	37	37.5	±5.72	23	37.1	±4.73
	330			305		

Total 635 S.D. standard deviation

Table 3. Basal metabolic rates of Korean soldiers

	Age	Av. of	Cal./m²/hr.	S.D.	
Army Academy students	19~20	29	36.57	±3.63	Douglas bag
Army soldiers	19~20	9	35.94	±4.4	Douglas bag
Army soldiers	19~27	433	41.4	±3.98	Matabolator

S.D.: Standard deviation

Table 4. Seasonal variation of basal metabolic rates

Name	Age	Sex	Spring. Summer & Autumn			Witner			Increase of B.M.R. (%)
			Weather (°C)	Room (°C)	B.M.R. (Cal./m²/hr.)	Weather (°C)	Room (°C)	B.M.R. (Cal./m²/hr.)	
C.S.	13	M	15	20	38.9	10	15	43.8	12.5
K.H.	13	M	15	20	43.6	10	15	47.9	10.5
P.S.	13	M	15	20	44.7	10	15	46.6	4.2
P.H.	15	M	15	20	40.1	10	18	42.3	5.5
K.C.	15	M	15	20	36.6	10	15	44.7	21
C.Y.	15	M	15	20	36.6	10	17	46.4	27
K.U.	16	M	15	20	39.1	10	18	45.1	15
P.F.	17	M	15	20	37.4	10	15	38.9	4
C.K.	17	M	15	20	37.8	10	15	39.7	3.9
K.M.	18	M	28	27	39.7	10	15	42.9	8
K.S.	19	M	28	28	37.9	10	16	38.8	2.3
C.Z.	19	M	28	28	35.1	10	16	40.2	14.5
K.J.	20	M	28	28	36.5	10	16	36.8	0.8
C.Y.	21	M	28	28	32.8	10	16	35.2	7
C.M.	21	M	28	28	38.9	10	16	41.5	6.5
Mean									9.5
P.W.	12	F	18	20	39.4	10	16	45.4	15.2
Y.S.	13	F	18	20	38.2	10	16	45.6	19.4
J.S.	13	F	18	20	36.3	10	17	39.2	8.2
K.N.	13	F	18	20	36.2	10	17	39.4	8.8
S.S.	13	F	18	20	40.3	10	16	44.1	9.4
K.S.	16	F	18	20	36.3	10	18	38.7	6.6
P.H.	16	F	18	20	34.1	10	18	34.3	0.6
J.J.	19	F	28	27	35.5	10	18	33.9	—4.5

K.J.	19	F	28	26.5	30.9	10	18	42.5	32
P.J.	19	F	28	28	30.2	10	18	34.3	13.5
P.S.	19	F	28	25.5	32.8	10	18	38.5	17.4
K.H.	19	F	28	27	35.6	10	18	32.8	−7.9
Mean									9.9

B.M.R.: Basal metabolic rate

Table 5. Basal metabolic rates during menstruation

Name	Age	Weight (kg)	Surface area (m^2)	Ventil (1/min.)	CO_2(%)	O_2(%)	O_2 used (ml/min.)	Nonproteinous R.Q.	B.M.R. (Cal./m^2/hr.)	B.M.R. (menstruation) (Cal./m^2/hr.)	Inerease of B.M.R. (%)
K.A.	21	46.7	1.4	5.56	2.4	2.75	153	0.88	31.8	—	—
		—	—	4.55	2.99	3.71	168.8	0.81	—	34.6	+8.8
K.H.	21	48.1	1.42	5.7	2.59	2.9	165.5	0.89	34.1	—	—
		—	—	4.67	3.11	3.7	172.8	0.84	—	35.1	+3.5
N.J.	20	48.5	1.42	4.76	3.12	3.5	167.3	0.88	34.6	—	—
		—	—	4.67	3.04	3.7	172.8	0.82	—	35.1	+1.5
C.J.	22	46.3	1.41	4.45	3.08	3.5	155.7	0.88	32.4	—	—
		—	—	4.69	2.99	3.69	173.1	0.81	—	35.6	+10
L.H.	21	48.1	1.42	5.48	2.58	3	164.5	0.87	33.5	—	—
		—	—	6.71	2.49	3.06	188.6	0.82	—	37.6	+12
L.J.	21	54.5	1.5	4.88	2.69	3.3	161	0.82	30.8	—	—
		—	—	4.67	2.74	3.38	157.9	0.81	—	32	+3.9
Mean	21	—	—	4.99	2.89	3.54	172.3	0.82	—	35 S.D. ±1.8	+6.6

Table 6. Energy metabolism during sleep

Name	Age	Weight (kg)	Surface area (m^2)	Ventil. (1/min.) S.T.P.D	CO_2(%)	O_2(%)	O_2 used (ml/min.)	Nonproteinous R.Q	B.M.R. (Cal./m^2/hr.)	Energy metabolisn during sleep (Cal./m^2/hr.)	Decrease of metabolic rate(%)
K.J.	18	44.0	1.38	6.16	2.32	2.6	160	0.87	30.9	—	—
				4.56	2.63	3.2	145.9	0.82	—	2.98	−3.5
K.J.	19	44.9	1.33	5.68	2.51	2.85	162	0.8	35.6	—	—
				4.3	3	3.6	155	0.84	—	33.8	−5.1
K.J.	19	49.0	1.46	6.44	2.79	2.7	174	0.89	34.4	—	—
				5.5	2.32	2.9	159.5	0.8	—	31.2	−9.3
K.Z.	19	43.1	1.45	4.68	2.58	3.15	147	0.82	29	—	—
				5.02	2.31	2.7	135.5	0.86	—	27.2	−6.2
K.J.	19	45.9	1.41	5.12	2.80	3.4	174	0.83	35.5	—	—
				4.4	3.13	3.55	156.2	0.88	—	32.5	−8.4
J.H.	18	49.0	1.45	4.94	2.46	2.9	143.3	0.86	30.4	—	—
				4.5	2.51	3	135	0.84	—	26.8	−11.8
P.J.	18	59.0	1.57	5.12	2.67	3.2	164	0.84	30.2	—	—
				4.5	2.88	3.55	159.7	0.81	—	27.9	−7.6
P.S.	19	52.2	1.52	4.94	2.54	2.9	143	0.88	32.8	—	—
				3.94	2.88	3.6	142	0.8	—	30.2	−7.9
P.E.	19	42.2	1.29	7.28	2.25	2.5	182	0.9	32.1	—	—
				6	2.66	3.05	185	0.88	—	35	+9
Mean	19	47.7	1.43	5.59	2.5	2.91	161	0.86	32.3	30.2 S.D. ±2.91	−5.6
				4.74	2.7	3.24	152.7	0.83			

Table 7. Energy expenditure in domestic life (1)

Subj.	Sex.	Age.	Weight, kg.	Observ.	Activity	Cal./min.
7	F	18～19	47.8(43.1～59)	16	Sleeping	0.67(0.57～0.86)
26	F	18～22	50.8(40.8～68.1)	28	Lying rest	0.85(0.64～1.01)
10	F	18～20	49.7(44.4～59)	10	Lying, listening to radio	0.92(0.73～1.14)
2	F	21～46	65.8(63.5～68.1)	4	Lying on belly, reading	1.54(1.38～1.7)
65	M	13～55	53.7(37.2～68.1)	135	Sitting rest	1.56(0.81～2.61)
91	F	13～68	48.3(39 ～59.5)	132	Sitting rest	1.08(0.63～1.9)
8	M	16～17	55.7(48.5～62.2)	8	Sitting reading	1.39(1.17～1.64)
17	F	14～22	49 (42.2～59)	20	Sitting reading	1.11(0.85～1.37)
4	M	16～17	55.3(48.5～62.2)	4	Sitting writing	1.46(1.35～1.44)
3	F	21	50.5(48.1～54.4)	6	Sitting writing	1.18(1.16～1.21)
15	F	18～22	51.5(44 ～59)	19	Lecture	1.27(0.9 ～1.21)
16	F	18～20	49.3(44 ～59)	21	Standing rest	1.23(1 ～1.57)
12	M	16～56	56.9(48.5～68.1)	22	Standing normally	1.99(1.18～4.34)
9	F	13～55	46.3(34 ～54)	13	Standing normally	1.49(1.12～2.38)
12	F	18～20	49.3(42.2～59)	12	Morning personal activity	1.32(0.99～1.87)
4	F	20～21	50.4(48.1～53.5)	4	Bed making	3.82(2.72～4.94)
4	F	20～21	50.4(48.1～53.5)	4	Mattress folding	4.29(3.58～5.1)
6	M	11～13	34.8(38.3～46.4)	6	Food intake	1.44(1.36～1.82)
4	F	11～14	33.9(28.5～42.7)	4	Food intake	1.42(1.4 ～1.5)
7	M	17～23	59.3(48.5～62.7)	17	Walking indoors (110 paces/min.)	4.54(3.42～6.86)
24	F	13～22	48.6(34.9～53.5)	25	Walking indoors (110 paces/min.)	3.1 (2.07～4.58)
9	M	16～57	57.4(48.5～64.5)	14	Walking outdoos (110 paces/min.)	4.4 (2.22～7.48)
18	F	13～55	48.5(34.9～59)	20	Walking outdoors	2.75(1.63～4.29)
6	F	14～22	49.1(43.1～53)	6	Walking upstairs	4.93(3.57～7.1)
6	F	14～22	49.1(43.1～53)	6	Walking downstairs	2.74(2.13～3.6)
6	M	11～13	34.8(28.3～46.4)	6	Running, 180 paces/min.	3.75(3.00～5)
5	F	21	52.6(47.2～55.4)	5	Sewing by hand	1.39(1.13～1.54)
3	F	20～55	52.9(50.8～56.3)	6	Sewing by machine	1.5 (1.30～2.04)
6	F	21～29	51.2(45 ～57.2)	8	Washing clothes by hand	3.35(2.07～4.28)
5	F	20～55	53.5(49.5～57.2)	8	Ironing clothes	1.96(1.52～2.54)
3	F	14～16	45.7(43.1～55)	3	Cleaning table	3.16(2.48～4.28)
5	F	21	49.7(40.8～53.5)	6	Dusting	2.95(2.45～3.32)
5	F	21～51	49.5(40.8～53.5)	7	Sweeping floors	3.76(2.94～4.46)
5	F	31	52.3(40.8～59)	5	Mooping floors	4.57(3.90～5.52)
7	M	16～61	56.2(48.5～62.2)	9	Sweeping outdoors	5.52(2.39～7.99)
5	F	21～22	50.8(49.5～53.5)	7	Sweeping outdoors	4.14(3.12～4.88)
3	M	19～46	57 (53.5～63.6)	6	Sweeping snow	7.51(5.81～10.39)
4	F	21～22	50.5(46.7～55.4)	4	Washing spinach	1.93(1.75～2.2)
4	F	20～21	50.5(46.7～55.4)	4	Trimming spinach	1.60(1.43～1.92)
3	F	20	53.8(49.9～57.2)	4	Cutting potatoes for salad	1.79(1.39～2 23)
3	F	22	53.3(49.9～55.4)	4	Shredding carrots	1.45(1.17～1.19)
4	F	21	50.5(46.7～55.4)	4	Paring apples	1.53(1.26～1.78)
5	F	20～21	49.1(48.1～49.9)	5	Changing briquets	3.77(3.05～5.57)
3	F	24～55	50.2(43.6～53.5)	4	Walking with baby on back (80 paces/min)	2.02(1.63～2.89)
12	F	18～20	49.2(42.2～59)	12	Gymnastic exercises	2.44(1.94～3.31)

Fig. 2. Removal of barn yard millet.

Table 8. Energy expenditure in agriculture (1)

Subj.	Sex.	Age.	Weight, kg	Obserb	Activity	Cal./min.
10	M	16~49	52.2(51.7~69)	18	Plowing in paddy field by cattle (120p/min)	5.85(4.3 ~7.39)
2	M	21~29	59.9(51.7~68.1)	3	Scattering fertilizer in paddy field	4.55(3.84~5.62)
3	M	29~36	65.2(55.8~65.2)	5	Cultivation of field with hoe	5.01(4.16~6.37)
2	M	21~40	65.8	3	Furrow plastering with hoe	5.72(4.7 ~6.81)
2	M	37~56	65.5(65 ~66)	4	Manuring in paddy field	4.48(3.79~5.51)
4	M	21~45	58.3(51.6~64.9)	7	Removing seedling from nursery	4.22(3.21~5.16)
1	M	21	68.1	3	Carrying A-frame with seedlings (110p/min)	7.57(6.07~9.75)
1	M	24	68.1	1	Walking with A-frame	4.4
6	M	21~45	59.3(51.6~64.9)	12	Planting seedling in fields	4.11(2.91~5.52)
8	M	16~53	57.9(49 ~68.1)	14	Hand weeding of paddy fields	5.16(2.95~9.59)
2	F	49~55	55.4(50.8~59.9)	4	Hand weeding of paddy fields	4.16(3.61~4.54)
2	M	19~52	50.4(49 ~51.7)	4	Hand weeding of bean fields	3.28(2.72~3.45)
4	M	24~57	59.2(49 ~68.1)	8	Removal of barn yard millet	5.05(3.41~6.31)
8	M	21~52	57.4(50.4~67.2)	8	Reaping rice with sickle	7.58(4.52~10.32)
2	M	45~50	58 (55 ~61)	3	Spreading barley bundles	3.23(2.85~3.93)
9	M	28~61	57.6(49.9~66.7)	11	Threshing barley with flail	5.57(3.12~9.44)
2	F	50~52	52 (44.0~59.9)	2	Threshing barley with flail	6.09(5.11~7.06)
5	M	21~50	92.5(61.3~63.5)	10	Threshing rice with pedal thresher	10.21(7.52~13.34)
2	M	27~45	62.3(61 ~63.5)	3	Harvesting unhulled barley with bamboo-rake	5.34(4.1 ~7.21)
2	M	27~45	62.3(61.0~63.5)	3	Raking straw	5.53(4.1 ~7.21)
4	M	21~55	60.4(55.0~68.1)	8	Picking cucumbers	4.33(2.9 ~5.87)
6	M	21~57	62.9(49.0~68.1)	11	Cutting grass with sickle	4.93(3.17~6.52)
2	M	30	60.4(59.9~61)	4	Carrying woods on shoulder	4.38(4.12~4.7)
5	M	33~58	49.5(43.6~63.5)	10	Cutting flower garden	3.26(1.37~6.08)
4	M	33~58	46.1(43.6~48.1)	8	Cultivating flower garden	2.63(1.37~6.08)

Table 8. Energy expenditure in agriculture (2)

Subj.	Sex.	Age.	Weight, kg	Observ	Activity	Cal./min.
2	M	21~60	55.8(51.7~59.9)	4	Cutting sod with shovel	5.64(4.52~6.24)
3	M	28~60	57.5(51.8~62.6)	6	Beating on sods	6.89(4.52~10.23)
5	M	28~33	60.1(56.0~65.4)	12	Lying sod by hand	4.31(2.68~6.53)
5	M	22~30	58.5(56.3~61)	9	Spreading drit on lawn with shovel	6.10(2.5 ~10.71)
5	M	26~33	64.8(59.0~71.7)	9	Tramping down sod, 20~22/min.	8.28(6.25~10.9)
2	M	30	62.2(61.7~62.6)	5	Spraying water	1.99(1.32~2.68)

Table 9. Energy expenditure in construction (1)

Subj.	Sex.	Age.	Weight, kg	Observ.	Activity	Cal/min.
2	M	20~29	57.7(56.3~59)	4	Shoveling soil, 6 kg, 90 throws/min.	5.77(4.24~7.13)
7	M	21~37	60.7(57.2~68.1)	9	Cutting earth with a hand shovel	7.99(4.85~10.95)
6	M	21~53	56.7(53.0~60.9)	13	Breaking earth with a pick	6.53(4.85~10.95)
6	M	20~42	59.2(56.0~71.3)	12	Loading a truck with dirt by shovel	6.06(4.21~8.66)
3	M	18~23	55.8(56.3~61.3)	12	Loading a push car with dirt and pushing it	4.81(2.25~6.7)
6	M	40~49	59.2(57.2~59.9)	10	Ramming wit hwood on road	3.30(2.59~4.18)
2	M	21~30	59.3(59.0~59.5)	5	Pulling a rear-car, 60 kg	5.24(2.35~8.92)
4	F	39~43	50.8(43.1~58.1)	6	Carrying stones in a basket	3.02(2.07~3.6)
2	M	43~53	62.4(59.9~64.9)	4	Carrying A-frame with gravel	5.91(5.12~6.79)
7	M	18~38	56.7(50.8~68.1)	11	Mixing cement with shovel(150/min.)	6.88(5.14~10.28)
3	M	30~50	55.5(51.3~62.6)	5	Crushing stone with a hammer (110/min.)	5.45(4.63~7.02)
2	F	34~39	49.3(48.5~50)	2	Crushing stone with a hammer 〃	5.45(4.63~7.02)
4	M	41~53	58.1(53.5~65)	9	Crushing stone with a hammer, 4.5kg	4.51(2.84~8.71)
4	M	34~39	55.0(48.6~62.6)	4	Carrying stone in a baske(60paces/min.)	4.39(4.2 ~4.5)
2	F	34~36	47.7(47.2~48.1)	6	Carrying stones	4.15(3.57~4.09)
2	M	51~53	54.6(53.5~55)	14	Well drilling by hand	2.39(1.68~2.91)
2	M	44~55	62.5(59.0~66)	4	Moving large stones with lever	6.40(5.51~8.27)
6	M	23~38	56.6(51.0~62.2)	10	Shaping corner stone with iron bar	3.61(2.65~5.1)
3	M	21~42	57.2(55.4~59)	9	Finishing cornerstone	4.42(3.1 ~6.36)
5	M	21~37	60.7(57.2~66.1)	9	Carrying stone on back, 100 kg	5.44(3.63~9.39)
3	M	46~51	52.6(41.7~58.1)	12	Fortification with stone	4.72(3.59~6.85)
2	M	24~51	55.6(50.8~60.4)	8	Driving roller	2.81(1.88~
2	M	37~60	53.1(52.6~53.5)	4	Mixing materials for cement	3.73(3.31~4.14)
1	M	30	57.2	2	Cementing stones	3.94(3.13~4.75)
1	M	26	68.1	2	Cementing with shovel	3.71(2.89~4.53)
4	M	27~43	61.6(59.9~65.4)	8	Brick laying	4 (3.34~5.11)
3	M	46~48	56.1(63 ~65)	6	Tiling slates on roof	4.55(3.22~
5	M	27~42	56.2(51.3~62.6)	10	Plastering walls	3.89(3.03~4.78)
4	M	29~33	59.2(56.3~65.4)	6	Plastering ceiling	4.22(3.24~5.15)
3	M	22~46	54.4(49 ~61.7)	8	Cutting reinforcing steel	4.69(2.68~6.63)
5	M	28~55	50.5(45.4~55.8)	10	Fabrication of reinforcing steel	3.61(3.26~5.6)
5	M	15~36	54.3(49.9~59.9)	6	Plumbing pipes	7.59(5.53~9.39)
5	M	19~57	57(53.5~61.3)	11	Electric welding	2.08(1.59~3.39)

Table 9. Energy expenditure in construction (2)

Subj.	Sex.	Age.	Weight, kg	Observ	Activity	Cal./min.
4	M	29~48	54.5(49.9~59.9)	8	Fireman	5.58(3.95~7.42)
2	M	39	59 (57.2~60.8)	4	Carpentering	5.75(4.65~7.35)
1	M	29	49.9	2	Carpentering, automatic saw	2.63(2.86~2.44)
1	M	18	47.2	2	Carpentering, automatic boring	1.88(1.72~2.03)
1	M	41	54.5	2	Leveling	2.63(2.47~2.78)
7	M	36~42	51.7(49.9~54.5)	12	Finishing with a plane	4.1 (2.72~5.27)
3	M	19~38	53.6(39.9~68.1)	6	Operating floor finisher	3.48(2.34~4.45)
10	F	34~51	46.8(39.9~54.5)	20	Finishing room corner stone by hand	3.24(2.59~4.05)
2	M	18~21	54.5	2	Lifting cement tray by pully	6.36(4.56~8.16)
3	M	23~24	60.5(54.5~63.5)	5	Painting walls	3.12(2.61~4.29)
2	M	29~30	56.7(49.9~63.5)	3	Electric works	3.74(3.17~4.49)

were also selected. The laborers usually have 3~5 in the family and their living cost dependent upon the daily earning, 140~350 won (about 50 cents~1 dollar).

Their wives have to work as laborers or peddlers to supplement the family income. The farmers of Wondang are energetic, and eat or drink 4 or 5 times on the days of seedling planting or weeding.

Because of such poor economic conditions, most of Korean laborers have only one room to serve as living room, dining room, and even bed room, so it is difficult to have the subject in a basal state for the B.M.R. at their own homes. Subjects must come to our laboratory on foot. Some times it takes us a week or more to establish a basal state.

3. Results

The B.M.R. by the Douglas bag and Scholander gas analyzer of 938 individuals is given in Table 1. and Fig. 1, and the Sanborn Metabolator of 635 in Table 2. The B.M.R. of soldiers and Korean Army Academy students are given in Table 3.

The variation of B.M.R. in seasons and in menstruation are in Table 4 and 5. The average increase in B.M.R. in winter(environment -10°C) was approximately 9.7% (9.5% in male and 9.9% in female). During the menstruation of 7 college girls it was increased 6.6%. The energy metabolism during sleep was about -6% of the B.M.R. (Table 6).

The energy expenditures in domstic life are given in Table 7. These values of domestic life are in close agreement with the values of Passmore and Durnin.

The energy expenditures in agriculture are given in Tabe 8; those in construction in Table 9. The values in agriculture and construction are also very close to the values of Passmore and Durnin, and Japanese reports.

The energy expenditures during various activities of soldiers and students and Korean students Academy are given in Table 10.

The daily energy expenditure on various occasions was estimated on each subject during the 3~7 day survey as previously explained. The daily life of Koreans is usually divided into 8 hour working, and 8 hour rest and recreation. But on busy days of planting seedlings or weeding in the field, farmers cut down their sleeping time from 8 hours to 6 or 7 hours, even to 5 hours daily to accomplish more work in the limited time(Table 11). The laborer's sleeping time is usually 7 or 8 hours,

Table 10. Energy expendliture in military activities
Age 18-28. weight 59. 9(50. 8-70. 4)kg

Aclivity	Av. of	Cal/min.	Activity	Av. of	Cal/min.
Dressing	9	3. 61	Policing area	9	2. 9
Lying rest	15	1. 19	Scouting patrol	9	7. 03
Sitting rest	14	1. 25	Digging fox hole	8	8. 32
Sitting reading	8	1. 34	Raking area	9	6. 46
Sitting wrighting	8	1. 55	Camoulflaging	9	6. 41
Standing rest	7	1. 52	Sweeping	9	5. 91
Standing at attention	8	1. 87	Riding truck	7	2. 42
Walking, 120 paces/min.	11	6. 32	Crawling	9	12. 42
Walking, 120 paces/min. with full field pack	7	6. 14	Installing individual tent	7	1. 52
			Land readjustment	3	10. 15
Running, 180 paces/min.	7	14. 08	Drainage	2	10. 77
Running, 180 paces/min. with full fields pack	8	16. 13	Sguad combat	8	6. 62
			Platoon in attack. MI	8	15. 59
Cleaning MI	4	2. 51	Platoon in attack. AR	4	14. 03
Cleaning AR	4	3. 82	// LMG	4	14. 94
Bayonet drill	8	10. 50	Weapon platoon attack, Mortar	4	12. 62
Calisthenics	8	3. 43	// Recoiles rifle	3	11. 66
Guard duty	8	1. 69	// Rocket	1	14. 16

Table 11. Energy expenditure of farmer on seedling transplanting day
Av. of 7. age 21-49, weight 54. 5-62. 6kg

Activity			Activity		
In bed	362 min	361 Cal.	Working:		
Recreation and off work			Standing activities	69 min	328 Cal.
Dressing and washing	12	18	Removing seedlings from nursery	117	494
Light domestic activities	43	60	Planting Seedlings	532	2054
Light Sedentary activities	235	304	Walking	70	288
	290	382		788	3164
Total				1440	3907

but the female laborer's sleeping time is only 5 hours because of house keeping.

The undeveloped and unmechanized facilities of home life, agriculture, and construction in Korea force people to work harder physically than in more highly developed countries.

The daily energy expenditures of various professions are also given in Table 12.

4. Discussion

Selective sampling schemes i.e. means of the lowest of 6 duplicates from one subject were measured using the Douglas bag and Scholander gas analyser. The figures of our B.M.R. determinations are in close agreement with the standard values of Boothby, Fleisch, and Reid in pre-school as well as school ages(6). However, considerable degree of fluctuation of B.M.R. was observed at the adult level. We learned on the trip to the 23rd International Congress of Physiological Sciences in Tokyo, 1965, that Suzuki also found a high B.M.R. in Japanese

Table 12. Daily energy expenditure (1)

	Age	Weight, kg	Av. of	Cal./day
Middle school boy	12~16	28.1~52.2	32	2280
High school boy	15~20	37.2~64.9	39	2363
College boy	18~27	48.1~83	62	2306
Middle school girl	12~14	30.4~52.7	18	1870
High school girl	15~17	39 ~62.6	24	1928
College girl	18~24	40.8~68.1	48	2133
Army academy student	19~34	50.8~72.2	32	3264
Graduate student	25~27	54 ~68	3	2442
Gov't official	23~57	48 ~73	64	2526
〃 〃 (F)	20~27	46 ~54	6	2449
File clerk	20~59	50 ~85	60	2546
〃 〃 (F)	18~60	41 ~60	28	2311
Bank clerk	22~52	54 ~83	70	2477
〃 〃 (F)	21~23	44 ~48	45	2089
Railway clerk	28~39	50 ~80	5	2476
Army official	24~39	61 ~77.5	8	2601
Shop keeper	21~62	52 ~85	17	2513
〃 〃 (F)	11~53	39 ~62.6	10	2466
Business man	29~56	50 ~72	10	2537
Teacher	29~57	55 ~82	27	2402
〃 (F)	21~53	43 ~59.9	15	2563
Tutor	21~27	54.5~63.5	6	2489
〃 (F)	18	50 ~67	2	2583
Proflessor	33~52	53 ~70	10	2356
〃 (F)	49~47	58 ~06	2	2344
Draftman	26~43	51 ~73	5	2567
Assistant	25~28	50 ~52	2	2444
〃 (F)	22~25	52	2	2499
Research worker	23~44	54 ~64	3	2317
〃 assistant	20~33	52 ~62	7	2483
〃 〃 (F)	24~31	43 ~57	2	2287
Typist (F)	25	55.6	10	2341
Social worker (F)	23~36	51 ~60	3	2442
Lawyer	50~56	55 ~80	4	2287
Medical doctor	28~58	47 ~72	23	2616
〃 〃 (F)	27~40	45 ~62	16	2609
Dentist	28~58	62 ~78	5	2319
Dietitian (F)	23~43	44.5~50	3	2445
Nurse	18~27	48.1~54	11	2740
Nurse's aid (F)	17~27	45 ~62	10	2588
Pharmacist	23~43	48 ~62	5	2619
〃 (F)	23~50	45 ~70	7	2486
Journalist	27~34	60.8~72	4	2677
House wife	23~59	40.8~68	65	2383
Maid	14~46	52 ~63	10	2562
Disignr	20~58	47 ~63	11	2934

Table 12. Daily energy expenditure (2)

	Age	Weight, kg	Av. of	Cal./day
Barber	21~40	55 ~68	10	2557
Beautican	21~31	46 ~56	7	2279
Tiling slate	46~48	55.8~56.7	2	2637
Chimney-layer	18~21	54.5~56.7	2	2907
Messenger	16~19	46.3~63.1	4	2529
〃 (F)	16~20	45 ~50	2	2390
Unemployed man	18~74	45 ~65	14	2265
〃 〃 (F)	24~73	60 ~65	7	2160
Guard	31~48	42 ~75	12	3112
Laundress	28~47	45 ~59	10	2925
Janitor (F)	33~49	45 ~55	10	2986
Room maid	31~46	45.5~59.5	9	2608
Room service	21~23	54 ~56	4	2603
〃 (F)	20~23	46.5~54	4	2219
Bell boy	22~31	50 ~72	8	2781
Shoeshine boy	19~24	49 ~65	10	2562
Cook	16~53	55 ~70	10	2993
〃 (F)	22~40	48.4~57	3	2680
Waiter	20~27	51.4~65	11	3301
Waitress	18~21	46 ~49	4	2302
Elevator operator (F)	15~19	43 ~54	6	1873
Owner of mill	43~56	68 ~78	3	2387
Electrician	29~42	46 ~77.2	7	2638
Construction engineer	22~38	46 ~69	7	2741
Factory worker	20~49	58 ~75	3	3319
Taxi driver	24~51	50.8~87	20	2668
Rice farmer	16~52	49 ~68.1	9	4207
Bean farmer	16~55	51.7~68.1	10	3691
〃 (F)	21~61	45.4~59	4	3089
Farmer	16~57	49 ~68.1	12	3395
Stock farmer	16~30	54 ~64	6	3059
Plowing by field	24~49	57 ~69.2	5	2887
Gardener	23~29	57.2~65.3	8	2609
Planting lawn	23~31	43.6~48.7	4	2436
Weeding of lawn	33~48	43.6~48.7	4	2302
Painter	24~25	61.7~63.5	5	2428
Carpenter	18~48	47 ~59.9	5	2753
Brick layer	29~48	59.9~65.4	7	2506
Earth digger	29~48	52.2~53.1	3	2650
Earth worker	21~45	45.4~59.1	17	3556
Cementing	20~43	51 ~56	6	2686
Plumber	16~38	48.1~75	12	3323
Plumber supervisor	38~51	60 ~64	2	2901
Welder	23~57	59	3	2292
Furnace-tender	24~59	45 ~62	9	2650
Hodman (F)	27~45	50.8~59.9	12	3032

Table 12. Daily energy expenditure (3)

	Age	Weight, kg	Av. of	Cal./day
Carrier, gravel	37~48	59.9~64.9	2	2829
Floor finisher	21~23	50 ~64	4	3044
〃 (F)	21~44	44 ~50	6	2891
Plasterer	27~44	51.3~57.6	3	4753
Wall-plasterer	37~56	51.1~59.9	2	2874
Mason	27~34	45 ~59	2	2957
Rock excavator	27~53	52.6~85.6	7	3540
Stone cuter	21~42	52.6~62.2	8	3533
Stone-crusher (F)	32~54	45 ~59.5	9	3528
Corner stone fini-sher	37~40	49.9~54.5	4	2825

farmers(7).

The figure of a single determination using the Sanborn Metabulator are higher in the means and in the standard deviation than those obtained when during duplicates, and there is more fluctuation in the former. We found that single determination are not ideal for B.M.R. standard. The average of 433 soldiers, 41.1 Cal/m^2/hr. is the same as the B.M.R. of Chinese soldiers, 41 Cal/m^2/hr. reported by Consolazio.

The main factors of differences of B.M.R. among soldiers and Army Academy students are their living activities as well as the technique of Douglas bag or Metabolator used. The assessment of daily energy expenditure of Army Academy students was 3264 Cal., and the daily intake was 3705 Cal.

There is considerable degree of variation in B.M.R. and daily energy expenditure related to the amount of activity. The main factor influencing the energy expenditure of subjects was really their functional activities.

In the cold weather the B.M.R. increased nearly 10% as reported by other authors. Suzuki also observed the influence of menstruation on B.M.R. of Japanese women as we did.

Althoguh the energy metabolism during sleep showed around 6% decrease of the B.M.R., the metabolism at the begining of a normal night's sleep may be above the basal level if individual has been eaten heavily late in the evening.

These two factors tend to balance each other out, and the B.M.R. is certainly not far from the average rate of energy expenditure throughout a normal night's sleep.

The enegy expenditure during various actions of soldiers is also in close agreement with Consolazio, Passmore and Durnin, and Japanese reports, as well as the energy expenditure in agriculture and construction.

We note that the average daily energy expenditure of a high school boy, 2363 Cal. is higher than that of a middle school boy, 2280 Cal. and of a college boy, 2306 Cal. For an Army Academy student, however, the energy expenditure is much higher, i.e. 3264 Cal.

The daily energy expenditure for girls proved to be somewhat different since we found that the college girl was 2133 Cal. while the middle girl was 1870 Cal. and the high school girl, 2106 Cal.

The daily energy expenditures of a government official, clerk, teacher, medical doctor, pharmacist, businessman, shop keeper, taxi driver, construction engineer, draftman, electrician, gardener, carpenter, painter, brick layer

and furnace tender are quite close to the 2700 Cal. suggested for light work in the author's Korean Recommended Calorie Allowances which was based on the report of the Food and Agriculture Organization; cook, waiter, farmer, earth worker, plumber, rock excavator. stone cutter to 3000 Cal. for moderate work, or 3600 Cal. for heavy work of man; house wife, maid and designer to 2200 Cal. for moderate work of woman; nurse, janitor, cook, corner stone finisher to 2800Cal. for heavy work of woman; the farmer on seedling transplanting day to 4100 Cal. for very heavy work of man respectively. Woman stone crusher and hodcarriers expend almost the same energy as the male heavy laborers.

There was considarable degree of variation in B.M.R. and daily energy expenditure related to the amount of activity. The main factor influencing the enegy expenditure of subjects was really their functional activities. There were not so many variations in metabolic values of the same activities between men and women, young and old. Therefore, it is extremely important to take this factor as well as nutritional status into consideration in the evaluation of B. M.R. and the energy expenditure of each individual, and of the nation.

The Korean food pattern is very different from the western. The subsequent different dietary condition of our nation is surveying by the Ministry of Public Health and Social Affairs, Republic of Korea. The present studies may provide an alternative as well as additional information for the dietary survey for determining the food requirement of the population.

5. Conclusions

The 2044 measurements of basal metabolic rates of over 2000 healthy subjects (5-92 years old), selected at random, are reported to establish Korean standards of B.M.R. The energy expenditures during various activities of domestic life, farmers, laborers and soldiers were also measured. The 1230 estimations of daily energy expenditures in various professions were carried out by the time-motion study.

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=國文抄錄=

韓國人의 基礎代謝量과 1日消費熱量에 關한 硏究

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韓國人의 基礎代謝量과 1日消費熱量을 測定하기 위

하여 Douglas 氏「백」과 Scholander 氏「가스」 分析器를 使用하여 넓은 年齡, 職種, 活動의 領域에 亘하여 實驗을 行하였다. 933 例의 基礎代謝測定値는 Boothby, Fleish, Robertson and Reid 等의 標準値와 近似하였다. 겨울에는 基礎代謝量은 9.9%의 增加를 또한 睡眠中의 代謝量은 基礎代謝量의 約 94%이었다. 또한 Sanborn Metabulator를 使用하여 1,000名 以上의 基礎代謝量을 測定하였다.

또한 여러가지 動作 活動中의 消費熱量이 測定되었다.

하루의 全消費熱量은 3~7日間에 亘하여 하루 24時間의 活動狀況을 分單位로記錄, 集計하고 이것과 基礎代謝量 및 個別活動時의 消費熱量을 參酌, 計算하였다. 睡眠中의 消費熱量은 基礎代謝量에 準하였는데 事務員, 教員, 醫師, 藥師, 店員, 運轉手, 建築技師, 設計師, 應園師, 木工, 「펜기」 工等의 1日消費熱量은 FAO 韓國協會策定의 韓國人「칼로리」勸奬量의 輕한 勞動의 2,700「칼로리」에 近似하였고「쿡」,「웨이터」, 農夫, 土工, 機關工, 石工은 中等程度의 勞動의 3,000「칼로리」나 또는 重한 勞動의 3,900「칼로리」에, 家庭主婦, 下女,「디자이너」는 女子의 中等程度 勞動의 2,200「칼로리」, 看護員, 淸掃婦,「쿡」 房바닥硏磨工은 重한 勞動의 2,800「칼로리」에 모심기 하는 날의 農夫는 激甚한 勞動의 4,100「칼로리」에 各各 가까웠다. 女子일지라도 鋪裝用 돌까기와 돌날르기는 男子의 重勞動程度의「칼로리」를 消費하였다.