Resting Metabolic Rate – Comparing measured to predicted values

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ABSTRACT

Resting Metabolic Rate (RMR), the amount of Calories (kCals) an individual expends at rest in a day's time, accounts for the largest portion of total kCals burned per day. Thus, it is important to quantify this number in people who are trying to balance kCals ingested versus kCals burned for maintaining control of body weight. Several predictive equations are available for estimating RMR, but measurement of oxygen uptake and conversion to caloric expenditure is considered the 'gold standard.' We compared the measured RMR with 3 predictive equations for a small group of college students and older adults. The predictive equations were off by a large margin, 155 kCals per day on the average, in both the too high and too low directions. We conclude that many people do have a high or low resting metabolic rate, and for precisely determining kCals burned, the measurement of RMR with an oxygen analyzer is advisable. Also, it is quite easy to do with modern portable equipment.

INTRODUCTION

Resting Metabolic Rate (RMR) refers to the number of Calories (kCals) burned per 24 hour period, before any increase in body metabolism due to daily activities or specific exercise.

RMR usually accounts for the greatest portion of kCals burned in a day's time – typically ~1200-1400 for females and ~1600-1800 for males.

Daily activity generally requires about 20% of the RMR, then specific exercise can typically add another 200-800 kCals per hour.

People often claim they gain unwanted weight because they have a "low metabolic rate." Conversely, some claim they can eat anything they want because they have a "high metabolic rate."

With a portable oxygen analyzer, we can measure the actual RMR, rather than just estimate it from predictive equations.

If the kCals burned in daily activities and exercise are calculated and added to the RMR, total caloric expenditure for a day can be known. This helps to better inform a client on the total number of kCals they can expect to burn in a day's time.

If total kCals expended is known, then the client knows how many kCals they can eat before starting to gain weight!

PURPOSE

The purpose of this study was first to determine our ability to measure Resting Metabolic Rate using a new portable oxygen analyzer. Second, we wanted to compare our measured values with 3 commonly used predictive equations. Third, we wanted to prepare the groundwork for studying what affects RMR, e.g., lean body mass, activity levels, dietary habits, so that we can better advise clients on their balance of kCals in vs. kCals out.

METHODS

Subjects
  23 students in Biology 354 Physiological Nutrition and 7 adult volunteers from the faculty and community.
Procedures
  All subjects reported to the lab between 6 and 8am having fasted overnight.
  Subjects reclined in chair for 30 minutes to return to a resting metabolic condition.
  Data (O2 uptake, CO2 production, Respiratory Quotient) were collected for 15 minutes. The first 5 minutes' data were discarded and the remaining 10 minutes averaged.
Calculations and Comparisons
  Calories (kCals) burned per the 10 minute resting period were calculated for each subject from the oxygen consumption and RQ.
  This value was then extrapolated out to a full 24 hour period.
  3 different predictive equations were also used to estimate RMR, using each subject's gender, age, height, and weight.
  Comparisons were drawn between our measured and the predicted RMR values.
  The final column in the Table below shows the difference between the predicted (avg of 3 equations) and measured RMR.
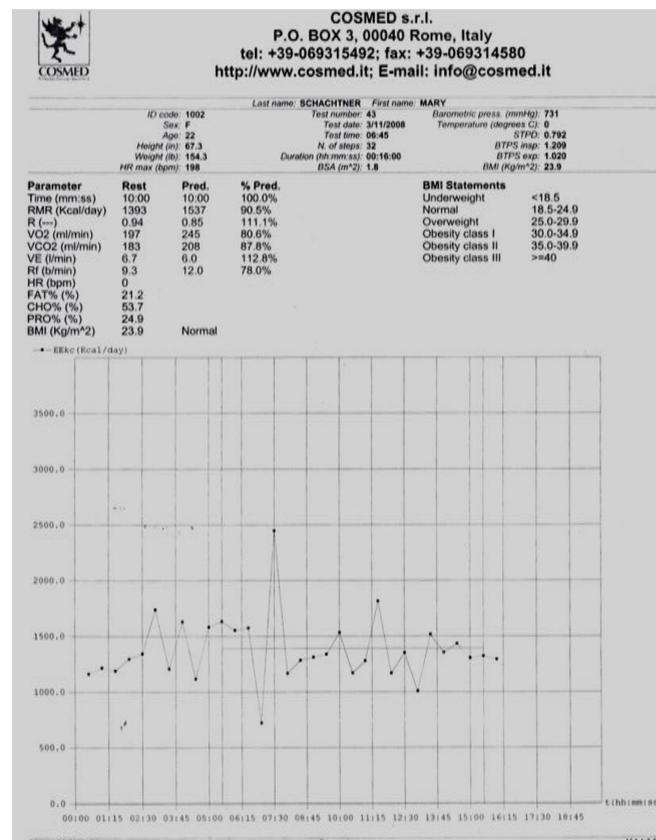
A sample data output for one subject

RESULTS

Subject	Sex (M/F)	Weight (Kg)	Height (cm)	Age (yrs.)	Eq #1	Eq #2	Eq #3 Cosmed	RMR (kCal/day)	kCal Diff.
					Predictive Equations (kCal/Day)				
1001	F	60.2	167.7	21.0	1444	1464	1449	1505	52
1002	F	70.0	171.0	23.0	1535	1579	1537	1393	-157
1003	M	64.9	180.0	23.0	1699	1710	1717	1691	-17
1004	F	63.6	164.0	20.0	1475	1475	1473	1598	124
1005	F	70.0	172.6	21.0	1548	1594	1545	1795	233
1006	F	66.4	171.0	20.0	1515	1548	1512	1521	-4
1007	F	60.1	171.5	21.0	1451	1487	1447	1308	-154
1008	M	84.1	175.3	60.0	1687	1704	1693	1580	-115
1009	F	85.1	179.1	22.0	1700	1774	1696	1470	-253
1010	M	82.6	176.8	22.0	1932	1879	1937	1641	-275
1011	F	97.0	167.8	23.0	1789	1789	1785	1980	192
1012	M	86.0	185.5	22.0	2022	1980	2028	1897	-113
1013	M	85.5	176.5	21.0	1977	1919	1983	1626	-334
1014	F	67.0	164.4	22.0	1499	1506	1497	1580	79
1015	M	143.2	191.0	27.0	2799	2434	2808	2617	-64
1016	F	63.2	163.2	22.0	1460	1462	1462	1698	237
1017	F	57.3	156.5	22.0	1391	1360	1392	1160	-221
1018	F	59.4	166.5	21.0	1435	1448	1423	1481	46
1019	F	65.0	171.0	21.0	1497	1534	1674	1484	-84
1020	F	57.0	166.5	22.0	1407	1419	1405	1505	95
1021	F	90.0	165.0	22.0	1721	1712	1718	1749	32
1022	F	56.1	170.3	55.0	1250	1350	1254	987	-298
1023	F	95.0	171.5	47.0	1663	1722	1641	1202	-473
1024	F	89.4	167.3	20.0	1729	1729	1726	1856	128
1025	F	54.5	165.5	22.0	1381	1386	1379	1297	-85
1026	F	66.0	168.8	67.0	1286	1370	1289	892	-423
1027	M	78.8	179.0	77.0	1517	1588	1305	1779	309
1028	F	68.6	176.5	54.0	1386	1509	1386	1464	37
1029	M	95.0	185.0	59.0	1891	1867	1899	2083	197
1030	M	86.0	184.0	21.0	2021	1983	2027	2674	664
Averages		75.8	171.3	27.2	1640	1627	1621	1566	-57

SUMMARY AND CONCLUSIONS

◆ **We determined it was feasible to use our new portable metabolic system, the Cosmed K4b2, to measure resting metabolic rate in college students as well as older adults. The resting energy expenditure ranged from 892 to 2674 kCals/day.**

◆ **We were able to compare our measured RMR with 3 different predictive equations that have historically been used to estimate RMR.**

◆ **Our measured RMR varied widely both above and below estimated RMR (the average of the 3 equations): from the highest of 664 Calories per day over estimated, to a low of 473 Calories below predicted.**

◆ **16 of the 30 subjects had higher than predicted RMR, while 14 of 30 had lower.**

◆ **For the whole group average, the measured RMR was 57 Calories below predicted. However, when taken as an absolute value of difference between measured and predicted, the average discrepancy was 155 Calories per day.**

◆ **With an accurate RMR individualized to the person, a much more accurate calculation of total calories burned per day is possible – that is, when the calories for general activity and specific exercise are added to the RMR.**

◆ **With this ability to closely measure RMR, we will next try to correlate body composition (especially lean body mass) and activity levels to the RMR. This will help us to better advise clients on what lifestyle changes may help balance their caloric intake and expenditure.**

Reference

McArdle WD, Katch FI, Katch VL. Essentials of Exercise Physiology (3rd ed.) Baltimore: Lippincott, Williams and Williams, 2006..

Acknowledgement