2023

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Original Publication Citation

Reynolds, L. J., Powell, K. R., Akhter, T., Twiddy, H. M., & Wilson, P. B. (2023). A single bout of breast milk expression does not increase resting metabolic rate. *American Journal of Human Biology*, e23874. https://doi.org/10.1002/ajhb.23874

Received: 29 September 2022 | Revised: 5 January 2023 | Accepted: 14 January 2023
DOI: 10.1002/ajhb.23874

ORIGINAL ARTICLE

American Journal of Human Biology WILEY

A single bout of breast milk expression does not increase resting metabolic rate

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Abstract

Introduction: Breastfeeding women have elevated resting metabolic rate (RMR); however, whether a single bout of lactation increases RMR is unknown. This study aimed to determine if a single bout of lactation acutely increased RMR.

Methods: Twenty-two lactating women (age: 31 ± 0.9 year, body mass index: 27.3 ± 1.2 kg/m^2) were recruited. RMR was assessed at baseline and at 1- and 2-h following breast milk expression.

Results: RMR was unchanged in lactating women following a single bout of lactation (baseline: 1437 ± 39; 1 h: 1425 ± 37 2 h: 1440 ± 31 kcal/day) ($p > .05$). RMR was not correlated to daily milk produced ($r = 0.05$, $p > .05$), but was correlated to body mass ($r = 0.74$, $p < .001$), fat-free mass (kg) ($r = 0.61$, $p < .01$), and fat mass (kg) ($r = 0.71$, $p < .01$).

Conclusion: RMR in lactating women appears to be more related to body mass or composition in the postpartum period rather than lactation.

1 | INTRODUCTION

Lactation results in a substantial energy demand on the body (Butte et al., 2001). The American College of Obstetricians and Gynecologists recommends that breastfeeding women consume an additional 400–500 kcals a day to make up for the energy used to make breast milk (ACOG, 2019). Spaaij et al. (1994) demonstrated a significant increase in resting metabolic rate (RMR) in women who were lactating. However, body mass, which is known to alter RMR (Halliday et al., 1979), was elevated in the lactating state in this study compared with the nonlactating state. Thus, the actual amount of energy that women expend solely due to lactation may be considerably lower and may be contributing to the 15%–20% of women retaining ≥5 kg of their pregnancy weight by 1-year postpartum (Gunderson & Abrams, 1999). An inability to lose weight gained during pregnancy in the postpartum period plays a role, among other factors, in the development of obesity (Linne et al., 2004). Understanding how lactation may alter RMR, which typically encompasses ~60% of total daily energy expenditure (Levine, 2005), is important for control of body weight.

A number of factors both chronically and acutely impact metabolic rate (Cunningham, 1980). While lactation appears to be correlated with a chronic increase in RMR (Spaaij et al., 1994), whether a single bout of lactation increases RMR is unknown. Furthermore, the time of the last bout of lactation prior to measuring RMR has not been controlled for in previous studies. Given that lactating women appear to have overall increased RMR, it is plausible that a single session of lactation could alter metabolic rate and, thus, contribute to the discrepancies in studies reporting the impact of RMR on lactation (Butte et al., 2001; Spaaij et al., 1994). The purpose of this study was to determine if a single bout of breast milk expression alters RMR. We hypothesized that a single bout of breast milk expression will increase RMR.

2 | MATERIALS AND METHODS

2.1 | Subjects

Protocols were approved by Old Dominion University Institutional Review Board (reference number: 1319781-10) and written informed consent was obtained. The research conformed to the Declaration of Helsinki. Twenty-two lactating women, 18–45 years, who had a singleton pregnancy were recruited. Exclusionary criteria included: pregnancy, metabolic disease, >45 years of age, insomnia, claustrophobia, <8 weeks postpartum. In addition, women who were supplementing breastfeeding more than two times per day were also excluded in an attempt to recruit in women who were primarily breastfeeding their babies as their main source of nutrition.

2.2 | Experimental design

Participants refrained from food and drink for 8 h and any exercise and vigorous exercise for 12 and 24 h prior to their study visits, respectively. Women also refrained from expressing their breast milk for at least 2 h prior to coming into the laboratory. If the women needed to feed their baby within that timeframe, they were encouraged to do so and their study visit was rescheduled. Tests were performed between 6 and 10 a.m.

Milk produced each day and number of times breast milk was expressed were determined via questionnaire. Participants rested supine for 20 min prior to RMR testing being performed for 10 min via indirect calorimetry (ParvoMedics TrueOne 2400, Salt Lake City, UT) as previously described (Wilson et al., 2020). Heart rate was measured during the test (Polar H10 monitor, Polar Electro, Kempele, Finland). Twenty lactating participants then expressed their breast milk via personal double-electric breast pumps. Two women breastfed their infants from both breasts. RMR was assessed again at 1 and 2 h postlactation using the same pretesting procedures as described above. Timing for the 1- and 2-h RMR measurements began when the women started pumping/breastfeeding. To ensure that any changes in RMR following lactation were not due to a time effect, RMR was also measured in 21 nonlactating participants at the same time intervals as lactating participants.

2.3 | Resting metabolic rate

ParvoMedics TrueOne 2400 indirect calorimetry system has been shown to be a valid measure for assessment of metabolic rate (Cooper et al., 2009). Furthermore, it has been found to be an accurate means to determine gas exchange compared with the Douglas Bag method (Bassett Jr. et al., 2001). The protocol listed in the ParvoMedics user manual for "Dilution Method" (RMR) was used for this study (TrueOne® 2400 Metabolic Measurement System, 2020). Briefly, gas calibration was performed using 16.00% O_2 and 1.004% CO_2. Airflow calibration consisted of using a 3-L syringe to determine peak flow of each stroke maintained at 50–60 L/min. The average difference of both the gas and airflow calibrations were <1%. VO_2 (L/min), VCO_2 (L/min), ventilation (V_E in STPD), respiratory exchange ratio (RER), and RMR (kcal/day) were analyzed during the last 5 min of each 10-min test.

2.4 | Body composition assessment

Body density was assessed via air displacement plethysmography (Bod Pod, Cosmed USA Inc., Concord, CA) as previously described (Splinter & Wilson, 2019). Black individuals have greater bone mineral density compared with white individuals; thus, they also tend to have greater body density. Studies show that this may lead to an overestimation of lean body mass in black individuals (Ortiz et al., 1992; Schutte et al., 1984). Thus, the Bod Pod uses race-specific equations (Siri or Schutte) when calculating body fat to account for this. In addition, predicted thoracic gas volumes were used in the body composition calculations. Body composition was not obtained in one participant due to technical difficulties.

2.5 | Data analysis

Data were analyzed using SigmaPlot software version 12.5 (Systat Software Inc., San Jose, CA). Data are expressed as mean ± S.E. $p < .05$ was considered statistically significant.

A one-way repeated measures ANOVA was used to analyze VO_2, VCO_2, V_E, RER, and RMR across the three different time points (baseline, 1 h, and 2 h) in lactating women. Furthermore, another one-way repeated measures ANOVA was used to analyze VO_2, VCO_2, V_E, RER, and RMR across the three different time points (baseline, 1 h, and 2 h) in nonlactating women. A Pearson correlation was used to determine if the amount of milk expressed each day, number of times milk was expressed, body mass (kg), fat mass (kg), or fat-free mass (kg) were correlated to baseline RMR. In addition, multilinear regression was performed to determine which variables (fat-free mass, number of times milk was expressed, or amount of milk expressed each day) were predictive of RMR. Fat mass and body weight were not included in the multilinear regression to prevent multicolinearity given that 1) fat mass, fat-free mass and body weight are inter-correlated and 2) that fat-free mass has been shown previously to be a better indicator of RMR than fat mass (Halliday et al., 1979).

TABLE 1 Subject characteristics

Group	Characteristics	Data
Lactating ($n = 22$)	Age (years)	31 ± 0.9
	BMI (kg/m^2)	27.3 ± 1.2
	%Fat[a]	38.0 ± 2.1
	%FFM[a]	62.0 ± 2.1
	Average amount of milk produced per day (oz)	37.4 ± 2.9
	Average number of feedings per day	7.9 ± 0.5
Nonlactating ($n = 21$)	Age	27 ± 1.3
	BMI	27.5 ± 1.2
	%Fat	34.7 ± 2.1
	%FFM	65.3 ± 2.1

Abbreviations: BMI, body mass index; FFM, fat-free mass.
[a]Data was not collected in one subject.

3 | RESULTS

Subject characteristics are listed in Table 1.

No statistically significant differences in VO_2, VCO_2, V_E, RER, and RMR (Figure 1) ($p > .05$) were found in the lactating women. RMR at baseline was not significantly correlated to the average amount of milk produced per day ($r = 0.05$, $p = .82$) or the number of times breast milk was expressed per day ($r = 0.10$, $p = .69$). Baseline RMR was significantly correlated to body mass (kg) ($r = 0.73$, $p < .001$), fat-free mass (kg) ($r = 0.61$, $p < .01$), and fat

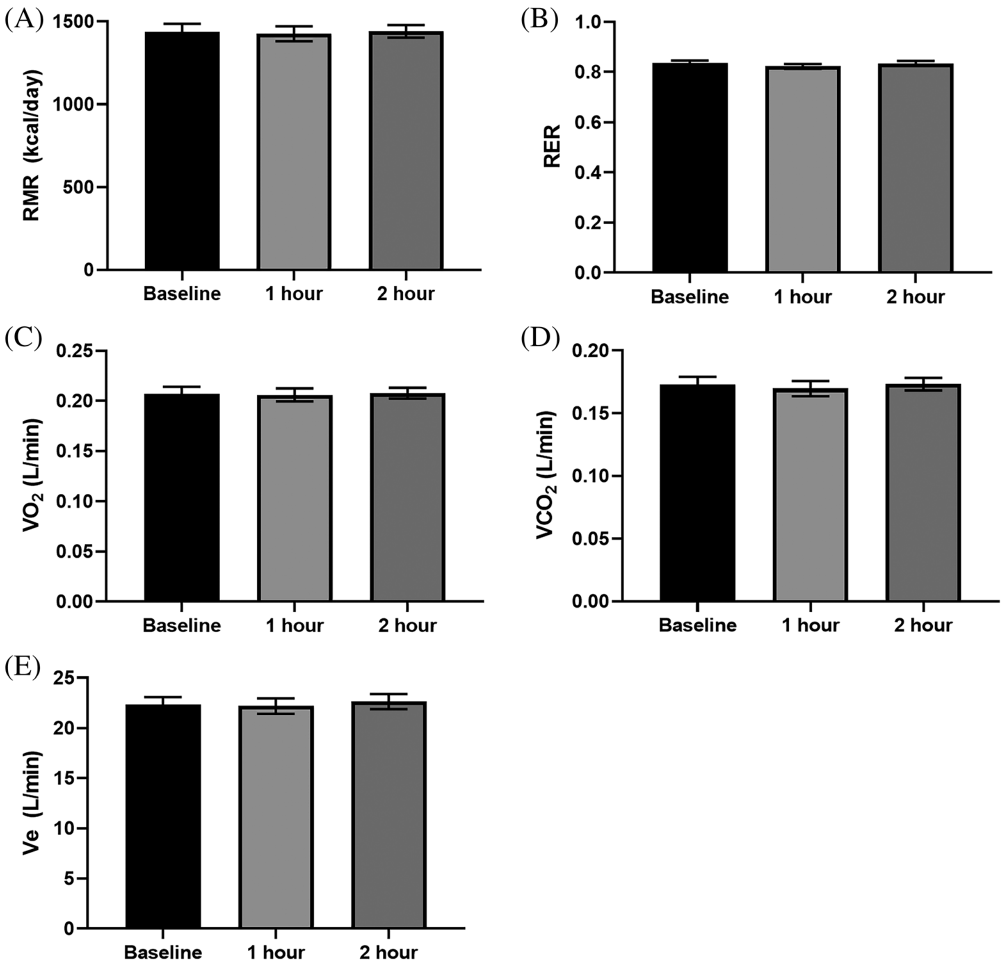

FIGURE 1 Cardiorespiratory measures during resting metabolic rate in lactating women. (A) Resting metabolic rate (RMR), (B) respiratory exchange ratio (RER), (C) oxygen consumption (VO_2), (D) carbon dioxide production (VCO_2), and (E) ventilation (V_E) in the lactating women before (baseline) and 1 and 2 h following breast milk expression. Data are presented as mean ± standard error.

mass (kg) ($r = 0.71$, $p < .01$) in the lactating women. Furthermore, the multilinear regression model was statistically significant ($r^2 = 0.53$, $p = .02$); however only fat-free mass was a significant predictor of baseline RMR ($p < .01$). The average amount of milk produced each day and the number of times breast milk was expressed each day were not statistically significant ($p > .05$).

RMR did not change in the nonlactating women following 2 h of sitting (baseline: 1427 ± 41; 1 h: 1435 ± 39; 2 h: 1422 ± 38 kcal/day). Furthermore, heart rate was unchanged ($p > .05$) from baseline to 1 and 2 h postlactation or sitting (data not shown).

4 | DISCUSSION

The principal finding of this study is that RMR was not statistically different from pre to 1 or 2 h following a single bout of lactation. RMR was not significantly correlated to average ounces of milk produced each day or number of times breast milk was expressed in a day. However, RMR was positively correlated to body mass, fat mass, and fat-free mass in the lactating women, indicating that elevated body mass—whether it be from additional fat or fat-free mass gained during pregnancy—is related to RMR. These data point to the importance of body mass to influence RMR.

Indeed, studies demonstrate that body mass is an important factor of determining RMR (Halliday et al., 1979). This may also contribute to the variability in results on the consensus of whether lactation increases daily RMR. Several studies which have examined RMR in lactating women have demonstrated mixed results on whether RMR is significantly elevated (Butte et al., 2001; Spaaij et al., 1994). Butte et al. (2001) demonstrated that basal metabolic rate was not significantly different 3 months postpartum (lactating state) compared with 18–24 months postpartum (nonlactating state). The women in that study did not have a significant difference in body weight or fat-free mass in the lactating and nonlactating phases; however, there was a small but statistically significant difference in fat mass between the two time periods. Nonetheless, fat-free mass appears to be a better indicator of RMR than fat mass (Halliday et al., 1979). In contrast to Butte et al. (2001), Spaaij et al. (1994) demonstrated a significant increase in basal metabolic rate 2 months postpartum (lactating state) compared with prepregnancy (nonlactating state). It is important to note, however, that the women weighed more during the postpartum period compared with prepregnancy, which may be accounting for the differences in RMR. Thus, lactation in and of itself may not increase RMR, but may be more related to changes in body mass in the postpartum/lactating period. The findings from the present study support these studies by demonstrating significant, positive correlations between RMR and body mass/composition measures in addition to a lack of significant correlations between RMR and milk production.

5 | CONCLUSIONS

An acute bout of lactation did not alter RMR. Furthermore, RMR was not correlated to milk production or number of times milk was expressed; rather, it was strongly correlated to body mass, fat mass, and fat-free mass. Thus, it appears that body mass and body composition are important predictors of RMR in lactating women.

AUTHOR CONTRIBUTIONS

Leryn J. Reynolds, Hannah M. Twiddy, Kayla R. Powell, Taskina Akhter, and Patrick B. Wilson contributed to the design of the study and data analysis/interpretation. Leryn J. Reynolds, Hannah M. Twiddy, Kayla R. Powell, and Taskina Akhter participated in data collection. Leryn J. Reynolds drafted the manuscript. Leryn J. Reynolds, Hannah M. Twiddy, Kayla R. Powell, Taskina Akhter, and Patrick B. Wilson critically revised the paper and approved the final version. Finally, Leryn J. Reynolds, Hannah M. Twiddy, Kayla R. Powell, Taskina Akhter, and Patrick B. Wilson agree to be accountable for all aspects of the work.

ACKNOWLEDGMENTS

We would like to thank the participants for their valuable time while completing the study.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

Research data are not shared due to ethical restrictions.

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How to cite this article: Reynolds, L. J., Powell, K. R., Akhter, T., Twiddy, H. M., & Wilson, P. B. (2023). A single bout of breast milk expression does not increase resting metabolic rate. *American Journal of Human Biology*, e23874. https://doi.org/10.1002/ajhb.23874