



The Acute Physiological Effects Of Relax Far-infrared (FIR) Sauna Use

These preliminary results show that Relax FIR saunas produce measurable and statistically significant physiological responses during a 20-30 sauna sessions.

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Introduction

Over the last several years, the use of dry and far-infrared (FIR) saunas has dramatically increased. As a result, several groups, such as Relax Sauna, have developed more affordable and portable FIR saunas for personal use.

Historically, traditional Finnish saunas constitute the bulk of literature. These studies typically involved short exposures (5-20 mins) with sauna temperatures between 80°C-100°C. Reported health claims include detoxification, increased metabolism, weight loss, improved blood circulation, pain reduction, improved cardiovascular function, enhanced immune function, improved sleep, and

stress-relaxation management. However, rigorous medical data to support these claims are still in the preliminary stages. However, there is considerable evidence that traditional Finnish sauna use produces considerable and measurable physiological responses. These responses included improvements in heart rate variability, hemodynamic responses, endocrine effects, reduced inflammation-related oxidative stress, increased heat shock proteins, enhanced nitric oxide production, increased insulin function, and improved innate and adaptive immune responses.

Compared to traditional saunas, FIR saunas usually operate at lower temperatures (45°C-60°C) with similar exposure times.

FIR manufacturers report that despite the lower sauna temperatures, because FIR waves penetrate the body, FIR sauna use should produce responses similar to those of traditional saunas.

Testing Overview

The testing took place over several months. The primary purpose of testing was to determine how Relax saunas affected a user's physiological responses over a standard 20-30 min session. We attempted to determine the best protocols and methods to develop a future IRB-approved study.

All testing data followed standardized research protocols. For example, when multiple trials were performed on a given individual, data

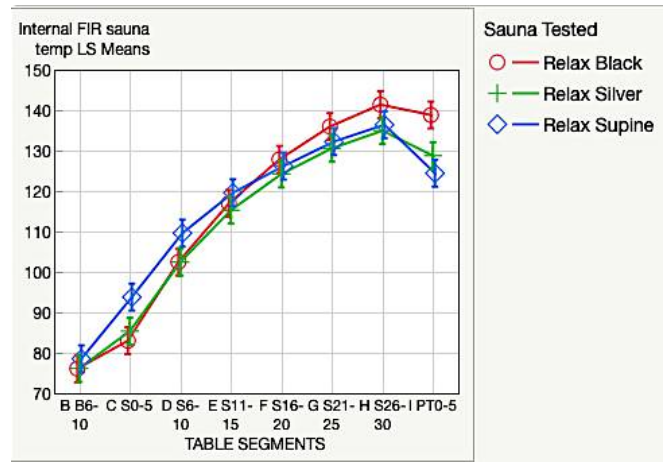
were collected at the same time of the day for each trial (i.e., 9 am). In order to properly investigate what resting metabolic effects sauna use had during the session, the subject came to a lab-fasted and well-rested state (no intense exercise the day prior to testing). Data were collected using a variety of systems throughout the testing period. Table 1 highlights the systems used and provides a brief overview of the data collected. All the data collection systems followed research-based calibration and testing protocols. This allowed us to collect data that minimized the day-to-day system-related measurement errors.

Data Collection Device Summary

Measurement System	Description/Data Collected
COSMED Quark Metabolic System https://www.cosmed.com/en/products/cardio-pulmonary-exercise-test/quark-rmr	Used to collect resting metabolic rate data (oxygen uptake, ventilation responses, & substrate oxidation data.)
PhysioFlow Advanced Cardiac Impedance System https://www.physioflow.com/	Used to collect data to assess changes in cardiac output, heart rate, stroke volume, & vascular resistance changes.
SphygmoCor XCEL aortic pulse-wave system. https://atcormedical.com/technology/sphygmocor/	Used to collect data to assess systemic & aortic blood pressure related changes pre to post sauna.
Moxy Monitors https://www.moxymonitor.com/researchers/	Used to collect data to determine changes in real-time muscle oxygenation and hemoglobin index.
CORE Body Temperature Sensors https://corebodytemp.com/pages/the-core-body-temperature-sensor-technology	Used to collect core body and skin temperature changes for determining sauna related affects on thermal stress loads on the body.
Tempo Bluetooth temperature sensor and data logger. https://bluemaestro.com/products/tempo-disc-bluetooth-temperature-humidity-sensor-beacon-logger	Used to collect temperature, humidity, dew point measures within the sauna during each recorded session.

Internal Sauna Temperatures

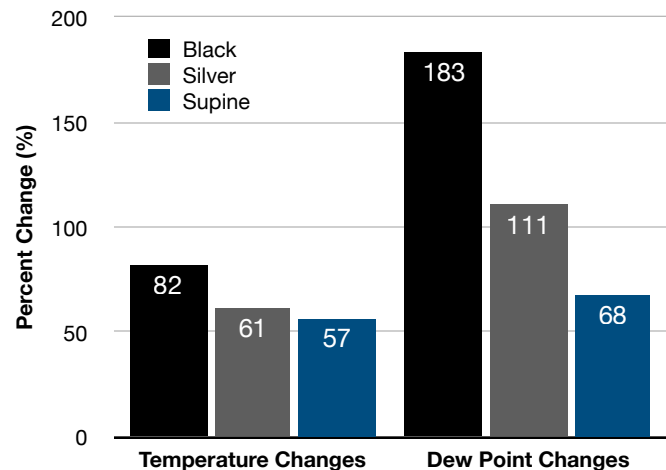
	Relax Supine	Relax Silver	Relax Black
Number of values collected	3,000	3,000	3,000
Measurement Period (mins)	50	50	50
Minimum (F°)	82	74	80
Maximum (F°)	174	177	175
Mean Temperature (F°)	152	149	149



The table data above show the temperature changes over a 50-min measurement period without a subject in the sauna. A Tempo Bluetooth sensor was placed at the center of each unit. One can see that the maximum temperature reached ranged between 174°F and 177°F. The figure above right shows data collected within the sauna during an actual sauna session (5-mins pre sauna off, 30 min sauna on, 5-mins post sauna off). One can see that at that at 21-mins into the sauna session, the Relax Black sauna produced high internal temperatures. The Black sauna system has a thicker tent, as stated by the manufacturer, and produces a stronger reflection response. As a result, one can see that after the Black sauna system was shut off, it was able to maintain internal temperatures better (10-15 degrees), indicating that the thicker materials used allowed better heat retention.

Furthermore, one can see that compared to baseline, the Relax Black Sauna had strongest temperature and dew point change responses of the three saunas tested.

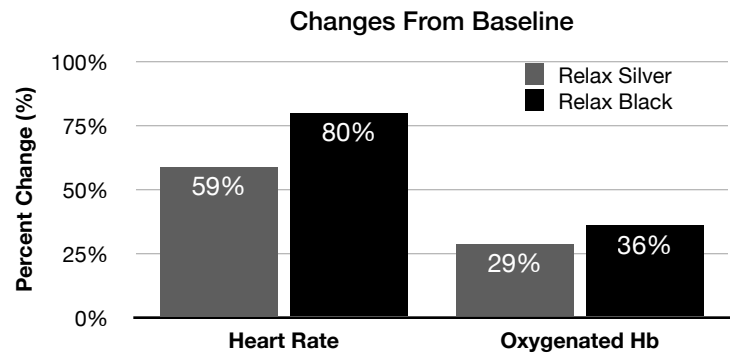
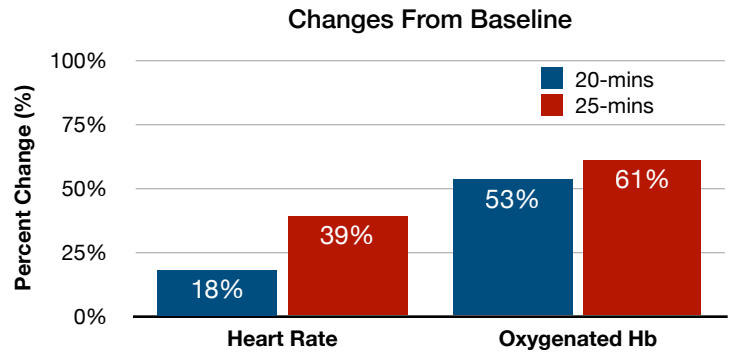
Relative Changes From Baseline



The Effects of Sauna on Resting Heart Rate & % Skeletal Muscle Oxygenation (%SMO2).

The data presented were collected prior to exercise in a 69 year old ultra-endurance cyclist who had been recovering from stage 4/3 aggressive prostate cancer. For the male subject, data were collected using the Relax Silver Sauna system. The baseline heart rate, %SMO2, and muscle oxygenation were 72, 51.7% and 6.1 mg/dL, respectively. At the 20-minute mark, the heart rate increased to 85 bpm, %SMO2 to 78.8%, and oxygenated Hb to 9.3 mg/dL. At the 25-minute mark, the heart rate increased to 100 bpm, %SMO2 to 81.8%, and oxygenated Hb to 9.8 mg/dL. The figure to the right shows that both the pre-exercise resting heart rate and muscle oxygenation increased at each measurement time point.

These findings are similar to those often observed during pre-event exercise warmup routines. In the second figure on the right, data were collected from a 48 year old female recreational person who runs 3-4 times per week. Her VO2 max was measured at the 75th percentile for her age. Data were collected in both the Relax Silver and Black saunas over a 30-min sauna session. At baseline, this female subject had a much higher %SMO2 value prior to the sauna session than the male master cyclists, which is not unusual. The baseline %SMO2 was 65% in female subjects and 47% in male cyclists. Thus, this is the reason why the relative change in oxygenated Hb from baseline was lower in female subjects. In both cases, the changes were statistically significant. It is interesting to note that the positive effect of increasing muscle oxygenation prior to exercise occurred in both the middle-aged female and male master athlete. *These findings suggest that pre-sauna use has a positive effect on enhancing muscle oxygenation and can play an important role in a person's pre-exercise warm-up routine or after exercise to help in the recovery process to clear lactate following high-intensity exercise, such as HIIT intervals.*



The Effects of Sauna Use on Ventilation, Cardiac Function, Resting Energy Expenditure, and Blood Pressure

Ventilation increased by 29.6% and 17.9% in Relax Black and Silver saunas, respectively in a 48 year old female recreational runner. Correspondingly, resting energy expenditure increased by 21.7% and 17.3% in the Black and Silver saunas, respectively. For the male cyclist, resting expenditure was only measured in the Silver sauna but at Heat-Level-1 and Heat-Level-2. At Heat-Level-1, the metabolic rate increased by 3.0%, whereas at Heat Level-2, the metabolic rate increased by 41.6%. These results may indicate that a minimum thermic load (higher dew points) may be required to increase a person's metabolic rate with sauna use. In the male cyclist, we also measured cardiac output and systemic vascular resistance. For the Heat-Level-2 setting, cardiac output increased by 21.6% and systemic vascular resistance decreased by 18.3%.

Blood pressure was measured before and after a 30 minute sauna session in both athletes using Silver Sauna. One can observe that the female subject had normal resting blood pressure prior to the sauna session, whereas the male subject was hypertensive. While minimal blood pressure reductions were observed in the systemic blood pressure for the female subject, the aortic blood pressure effects were approximately 4-fold greater, implying that the sauna session lowered the aortic pressure load on the heart by 4-7%. For the male subject, both the systemic and aortic pressure loads on the body and heart were lowered by approximately 4.7% after the sauna session. *Thus, these data imply that in a person with normal blood pressure or moderate hypertension, acute sauna use may have a positive effect on both resting systemic and aortic blood pressures.*

	Pre Female Subject	Post Female Subject	Percent Change	Pre Male Subject	Post-Male Subject	Percent Change
Systolic Blood Pressure	129	127	1.6%	142	135	4.9%
Diastolic Blood Pressure	76	75	1.3%	97	92	4.8%
Aortic Systolic Blood Pressure	118	113	4.2%	130	125	3.8%
Aortic Diastolic Blood Pressure	78	72	7.7%	98	93	5.1%

In conclusion, the data presented for the various Relax sauna trials show that despite producing lower internal sauna temperatures than traditional saunas, measurable positive physiological changes occurred in the male and female subjects tested during this proof-of-concept study design pilot data collection project.