The association between heart rate and energy expenditure in various people

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INTRODUCTION:

Energy expenditure in humans can be determined by the body size and body mass of a person. This can be well explained by basal metabolic rate, which composed of about 60-75% of daily energy expenditure. Basal metabolic rate is the energy used by individual at rest. Other factors like environment can affect the expenditure of energy to individual. Studies have shown that the energy expenditure and heart rate in humans are determined by body size and body composition, body mass, physical environment (such as temperature), type of physical activities being carried out, and behaviour control.

Energy expenditure is reviewed by comparing the total energy expenditure and resting energy expenditure to energy intake, by ingested food. Diet-induced energy expenditure and activity-induced energy expenditure also plays a part in a person's total energy expenditure. Energy expenditure is higher in larger subjects due to higher energy expenditure for maintenance. However, smaller, and size are subjected generally move more as activity energy expenditure in larger subjects is not higher in proportion to the cost of moving with higher body weight (Aguiar et al., 2015).

The aim of this study was to test how daily energy expenditure is affected by body composition and gender in humans. It was hypothesized that body mass is positively correlated to daily energy expenditure, and therefore, that individuals with higher body mass will have higher value of daily energy expenditure. Based on previous findings from other studies, that stated that most males have higher average daily energy expenditures compared to females. It is therefore also hypothesized that males have higher daily energy expenditure than females.

METHODS AND MATERIALS:

For this study, the energy expenditures and heart rates of the test subjects were measured using a beurer pm25 heart rate monitor watch. 57 individuals were asked to participate and have their heart rates (beats/minute) and their metabolic rates (cal/kg.min) measured. Within this group of people, there was a variety of ages and it also contained both males and females.

Once the test individuals were chosen and placed in their age groups, namely below 18, 20 to 30 years, 30 to 40 years, 40 to 53 years and 53 years and above, they were categorized into height groups. There were four groups with the first being ≤1.5meters. The second group was 1.6-1.7 meters with the third being 1.7 to 1.8 meters. The last group was ≥ 1.8.

Similarly, they were also divided into groups for body mass. Five groups were formed with lowest value include 60 kilograms or below and highest group include 100 kilograms and above. The experiments were conducted at different locations including a gym, personal home, open road and even walking up a mountain. The activities that were involved in the study were short walking distances, fast running, hiking, and a gym workout.

Cumulative heart rate measurements

From the cumulative heart rate and metabolic rate recorded over the whole period of the activities the following factors were calculated for each study using the equations below

Factors:	Equations:
Energy expenditure per beat	

Energy expenditure per beat (cal/kg. beat) is the mean metabolic rate duration of the study (min)/cumulated heartbeats average BPM The max beats per minute (bpm) maximal heart rate can was then calculated using age. Subtract the age from 220 to get estimate of your maximum age-related heart rate. The predicted maximum age-related heart rate for a 50-year-old person, for example, would be 220 – 50 years = 170 beats per minute (bpm).

In order to obtain the daily energy expenditure, the time data had to be converted to days by dividing each time data by 24 hours, so as to conclude the equivalent value in days.

Using R studio (2021), Regression analyses was performed to define the relationship between these variables. The data was analyzed based on the number of people that were tested in defined heart rate categories at intervals of beats/min and regression was constructed of the mean metabolic rate with the corresponding mean heart rate. The approximate number of calories an individual burned during a day of abstract services or activity met metabolic equivalent up BMR duration of time was determined. To maintain essential functions such as minimal brain activity. Heart rate and breathing rate generated during exercises and the minimum amount of energy required to sustain essential physiological functioning.

RESULTS:

Most of the data came from the age group of 18 to 24 year olds. With oldest person being 53 years old and the youngest person being 18 years old.

Effect of height on daily energy expenditure

In Figure 1 below, we can observe that at 1 231 953.4 kj/day, Group 1.6 meters to 1.7 meters had the highest daily energy expenditure, and this was 371.83% higher than 1.5 meters and below, which had the lowest Daily energy expenditure at 261 100.17 kj/day. After the 1.6 to 1.7 meter group it was 1.7 meters to 1.8 meters, 1.8 meters and above, and 1.5 meters and below respectively. 1.6 meters to 1.7 meters accounted for 38.99% of Daily energy expenditure (kj/day).
Across all 4 Height groups, Daily energy expenditure (kj/day) ranged from 261100.17 kj/day to 1 231 953.44 kj/day.

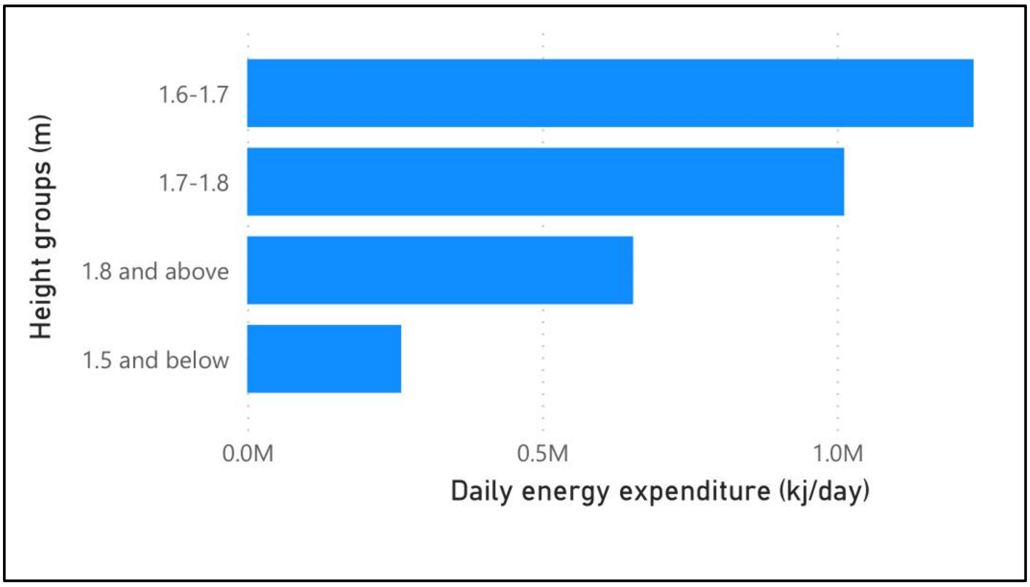


Figure 1: Bar graph showing the daily energy expenditure (kj/day) in the height groups (m).

Effect of body mass on daily energy expenditure

For daily energy expenditure, the highest mark recorded in Figure.02 was recorded by the group with 60 kilograms and below. The lowest mark was recorded by the group with 100 kilograms and above, which is notably the group of highest body mass. At 1,728,465.r3, the 60 kilograms and below group had the highest total daily energy expenditure (kj/day) and was 5,053.6% higher than the 100 kilograms and above group, which had the lowest total daily energy expenditure (kj/day) at 33,538.9. The 60 kilograms and below group accounted for 54.7% of the total daily energy expenditure (kj/day) recorded.

Figure.02

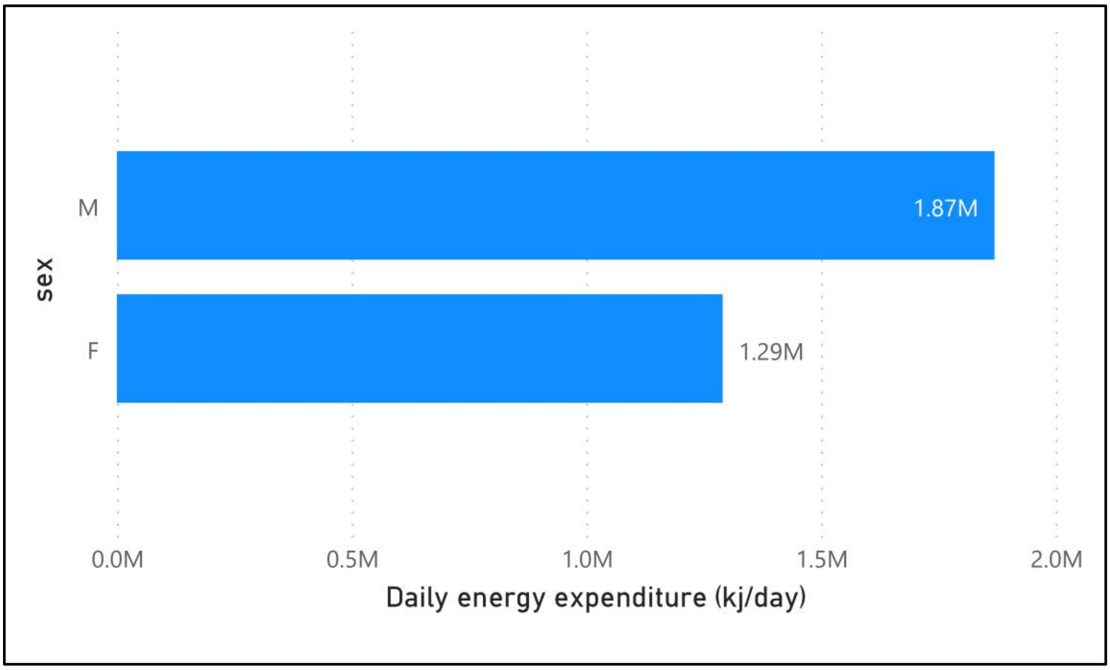
Body mass group	Daily energy expenditure (kj/day)
60 and below	1,728,465.33
70-80	748,101.69
90-100	464,243.37
80-90	185,699.55
100 and above	33,538.94
Total	**3,160,048.89**

Body mass group (kg) and daily energy expenditure (kj/day)

Effect of sex on daily energy expenditure

In Figure.03 below, males showed to have the highest daily expenditure reach to that of females. Males accounted for 59.1% of total daily energy expenditure (kj/day) and a highest of 1,869,644.1 total daily energy expenditure (kj/day). From the findings, males had a total of 1,869,644.1 daily energy expenditure (kj/day) and females had 1,290,404.7.

Figure.03



Daily energy expenditure (kj/day) by sex

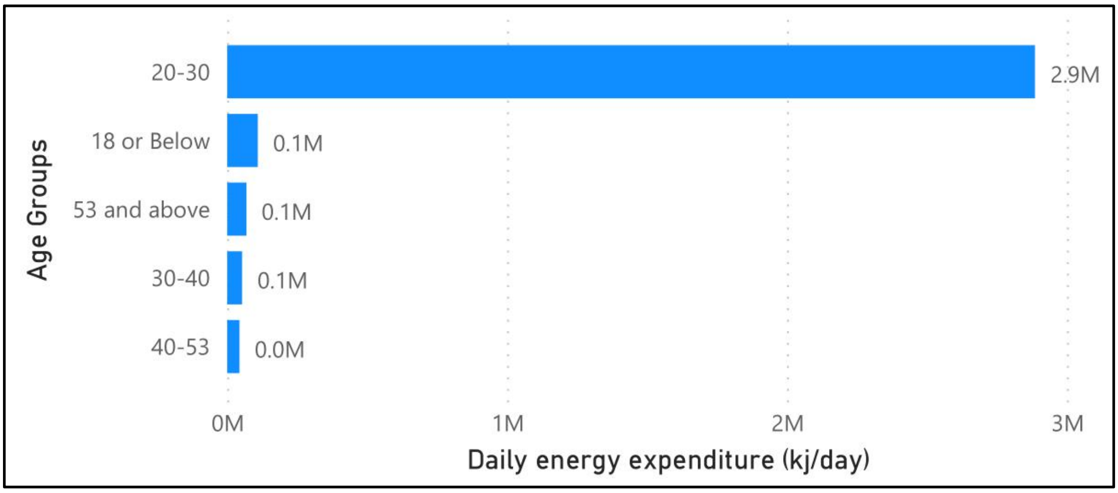
Effect of age on daily energy expenditure

In Figure.04 below, we can see that Age Group 53 and above had the third highest daily energy expenditure, while the first highest expenditure mark was recorded by

Age Group 20-30 years. The highest Age Group for daily energy expenditure accounted for 91.3% of total daily energy expenditure (kj/day).

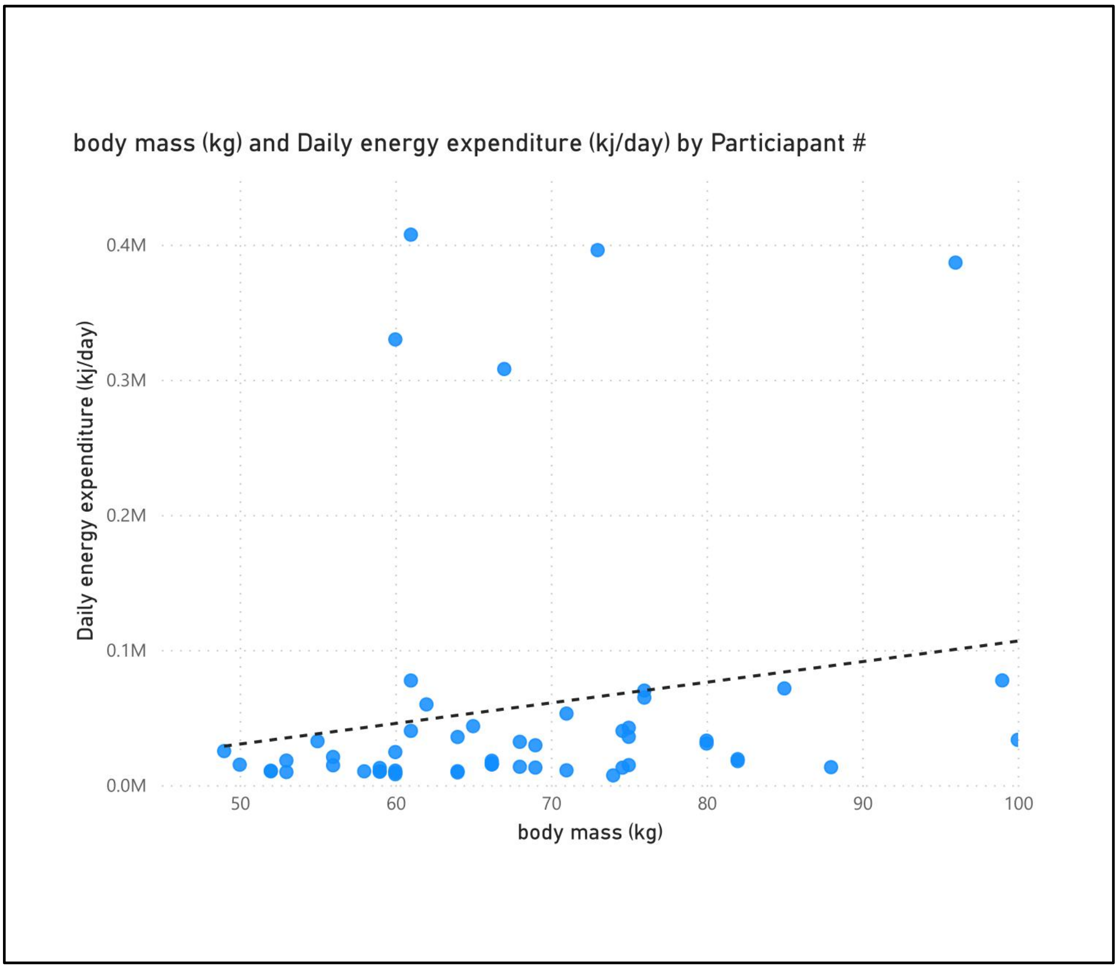
In Figure.05 below, we can observe that at 2,885,579.2, Age Group 20-30 years had the highest total daily energy expenditure (kj/day) and was 6,506.0% higher than 40-53, which had the lowest total daily energy expenditure (kj/day) at 43,680.9. Across all five Age Groups, total daily energy expenditure (kj/day) ranged from 43,680.9 to 2,885,579.2. Additionally, daily energy expenditure is positively correlated to the body mass with coefficient correlation of about 0.18.

Figure.04



Daily energy expenditure (kj/day) by age groups

Figure.05



Body mass (kg) and daily energy expenditure (kj/day) by participants

DISCUSSION AND CONCLUSION:

The results of this study conclude that the group that contained the lowest possible body mass (60 kilograms or below) had the highest total daily energy expenditure. These findings are contradicting the results in KR Westerterp (2016), who stated that energy expenditure is higher in larger subjects. From the perspective of sex, results from this study suggest that males tend to have higher daily energy expenditure than females. These findings correlate with other researcher's findings (Miller, 1992). It might be important to note here that the total energy expenditure for males and females could be more similar if body mass and fat-free mass were considered (Castellani et al., 2006). For this reason, it is biased and inaccurate to determine daily energy expenditure by sex alone.

Body size mainly affects the maintenance component of total energy expenditure, through the relation between body size and fat-free mass. Larger body size implies a larger fat-free mass. Taller subjects have a larger fat-free mass than subjects with a short stature and fat-free mass is larger in overweight and obese subjects than in lean subjects with the same stature (Westerterp, 2016). As studies show, the difference in total energy expenditure between humans tends to increase with body size (National Research Council (US) Committee on Diet and Health, 2015). Other studies show that this slow metabolism is what made humans grow slower and live longer than most other mammals (Pontzer et al., 2014). These same studies also found that primates that were living in captivity were expending as many calories in a day as their fellow primates that were living in the wild. This finding suggests that physical activity may actually have less of an impact on daily energy expenditure than what was thought before these studies concluded.

It can be concluded that over time, an increase in human's body mass led to an increase in human's daily energy expenditure. From previous research we have learned that an increase in a human's body size directly affected their metabolisms. (Friedman, 2019). Research findings also suggest that there is a noticeable difference in daily energy expenditure between male and females. This is largely because women are more efficient at storing energy in their body in the form of fat-free mass while men usually have larger body sizes and greater muscle mass ratios. By understanding this we can conclude that body mass is generally one of the most important factors when examining total energy expenditure, as correlated by Figure.05 in this report.

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