Post Surgery Resting Engery Expenditure - STA440 Final Project

Steph Reinke

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1. Background

The recovery processes for surgery patients are often complex. Through understanding their metabolic needs, care can be optimized with targeted feeding. Indirect calorimetry (IC) is a standard method for measuring energy expenditure via respiration. Resting energy expenditure (REE), measured via IC, plays a key role in guiding nutritional support, which can improve post surgery patient outcomes. The goal of this study was to measure REE and REE/kg in these patients during their stays in the intensive care unit (ICU) and subsequently in the step–down unit (SDU), so that this information can be used to improve post–surgery care. A total of 11 patients (4 obese, 7 non–obese) were included in the study, with 35 indirect REE measurements taken throughout their recoveries to capture different stages of metabolic demand. These measurements were collected repeatedly, allowing for comparison between patients on ventilators versus those who were not, as well as between ICU and step–down unit patients.

Research Question:

Characterize the relationship between resting energy expenditure and obesity status, ventilator status and patient location (ICU vs SDU). Are your conclusions the same when REE is weight adjusted (REEperKG)?

2. Data

REE was measured using indirect calorimetry within 72 hours of surgery and then every five to seven days throughout hospitalization. REE and REEperKG are the outcomes variables, REEperKG is REE adjusted for weight. Obese and ventilator are indicator variables for their respective factors. BMI is the patient's body mass index. Measurement is the measurement number for that observation. ICUorSDU tells if the patient was in the intesive care unit or the stepdown unit.

3. EDA

In order to gain an understanding of the data exploratory data analysis was conducted.

4. Modeling

We will take a frequentist apporach

```
Linear mixed model fit by REML ['lmerMod']
Formula: REE ~ Obese + Ventilator + ICUorSDU + (1 | ID)
   Data: REE

REML criterion at convergence: 457

Scaled residuals:
```

```
    Min      1Q  Median      3Q     Max
-2.0390 -0.5295 -0.1412  0.5769  2.1944

Random effects:
 Groups   Name        Variance Std.Dev.
 ID       (Intercept) 18840    137.3
 Residual             96644    310.9
Number of obs: 35, groups:  ID, 11

Fixed effects:
            Estimate Std. Error t value
(Intercept)  1515.99     148.72  10.193
Obese         488.07     144.44   3.379
Ventilator   -340.56     165.10  -2.063
ICUorSDUSDU    89.51     153.56   0.583

Correlation of Fixed Effects:
            (Intr) Obese  Vntltr
Obese       -0.489
Ventilator  -0.740  0.155
ICUorSDUSDU -0.768  0.190  0.684
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: REEperKG ~ Obese + Ventilator + ICUorSDU + (1 | ID)
   Data: REE

REML criterion at convergence: 193.2

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.5237 -0.5836 -0.1221  0.5533  2.5417

Random effects:
 Groups   Name        Variance Std.Dev.
 ID       (Intercept) 13.56    3.682
 Residual             15.53    3.940
Number of obs: 35, groups:  ID, 11

Fixed effects:
            Estimate Std. Error t value
(Intercept)   22.074      2.315   9.535
Obese         -2.990      2.749  -1.088
Ventilator    -2.327      2.374  -0.980
ICUorSDUSDU    1.993      2.057   0.969

Correlation of Fixed Effects:
            (Intr) Obese  Vntltr
Obese       -0.510
Ventilator  -0.636  0.096
ICUorSDUSDU -0.662  0.128  0.694
```

```
[1] "Test for Obese"
```

```
large : REEperKG ~ Obese + Ventilator + ICUorSDU + (1 | ID)
small : REEperKG ~ Ventilator + ICUorSDU + (1 | ID)
```

```
        stat    ndf    ddf F.scaling p.value
Ftest 1.1779 1.0000 8.6975         1   0.307
```

```
[1] "Test for Ventilator"
```

```
large : REEperKG ~ Obese + Ventilator + ICUorSDU + (1 | ID)
small : REEperKG ~ Obese + ICUorSDU + (1 | ID)
         stat     ndf     ddf F.scaling p.value
Ftest  0.8615  1.0000 30.5602         1  0.3606
```

```
[1] "Test for ICUorSDU"
```

```
large : REEperKG ~ Obese + Ventilator + ICUorSDU + (1 | ID)
small : REEperKG ~ Ventilator + Obese + (1 | ID)
         stat     ndf     ddf F.scaling p.value
Ftest  0.8906  1.0000 26.5364         1  0.3538
```

5. Conclusions

6. Appendix

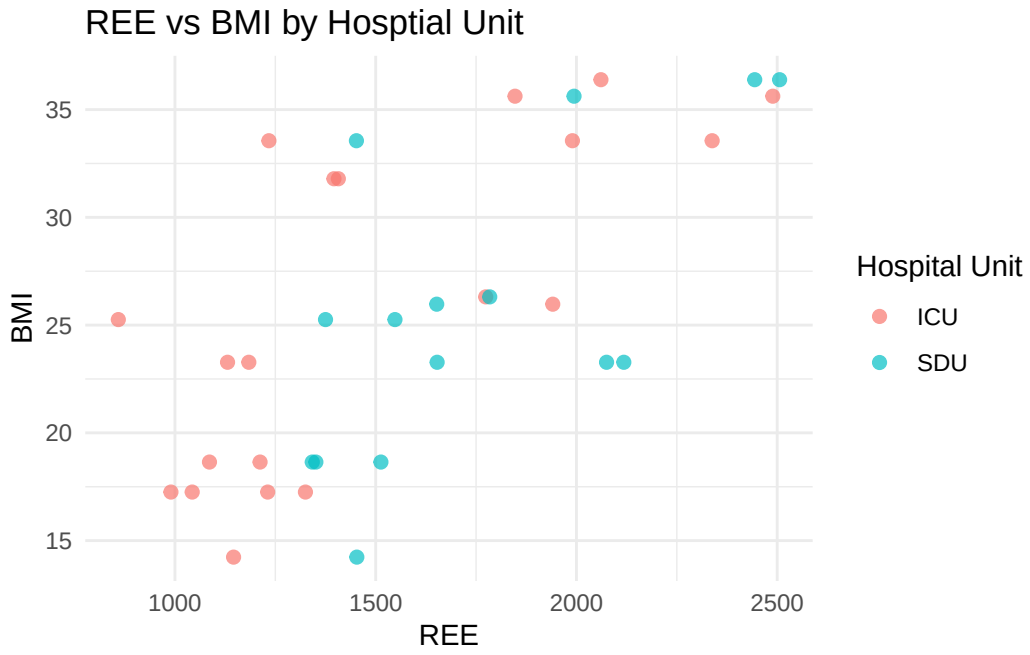

Figure 1: Roughly linear between BMI and REE, more ICU at lower REEs

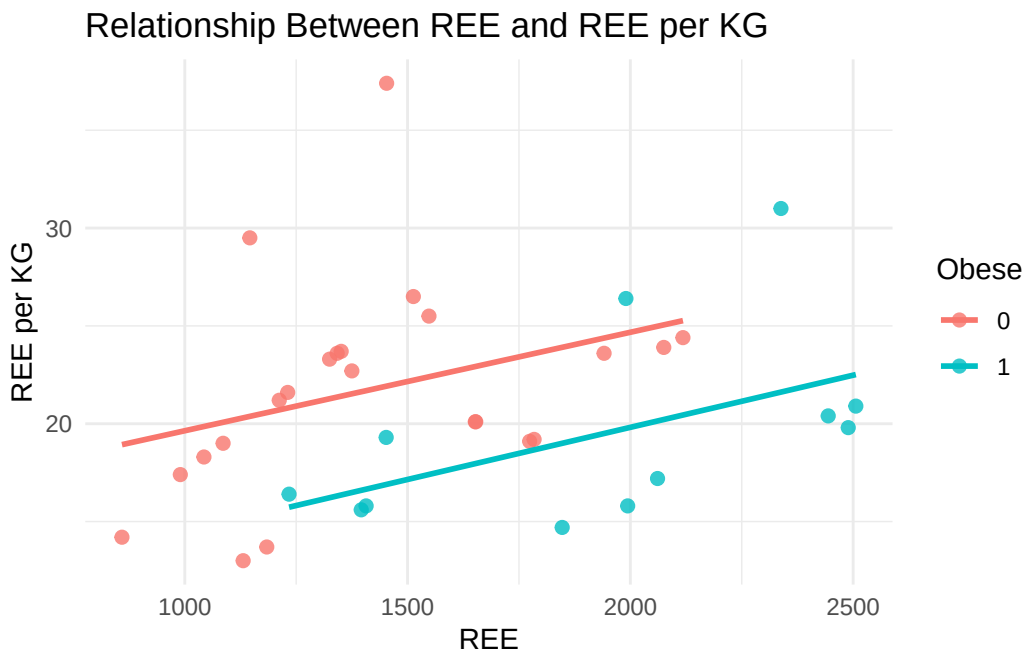

Figure 2: REE per KG is lower for higher REEs and obese patients

Figure 3: Non obese patients have larger range of REE per KG with higher median than obese patients

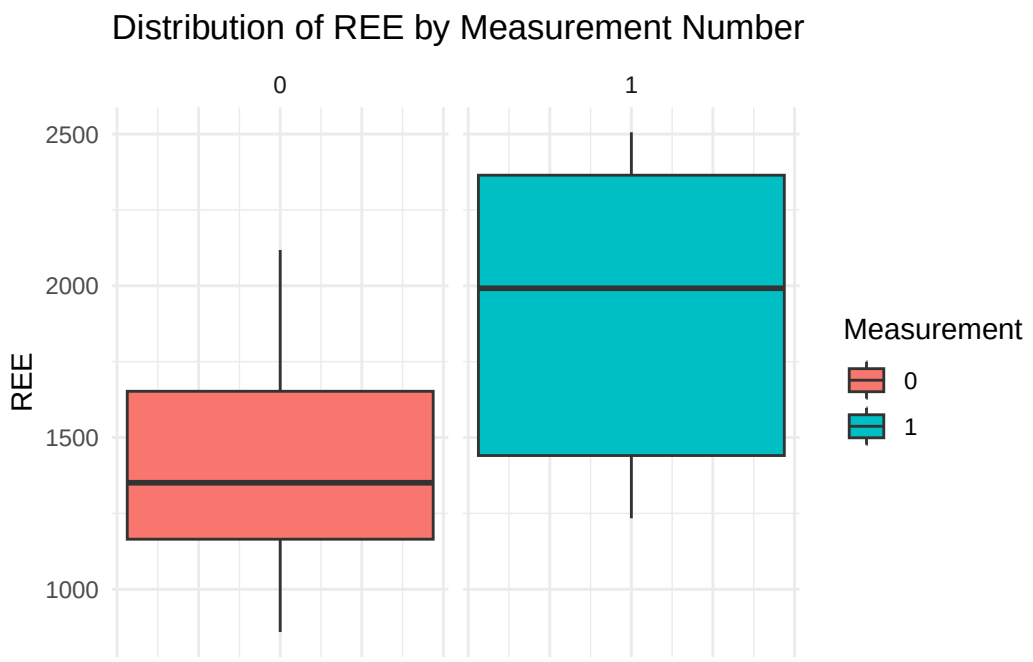

Figure 4: Non obese patients have smaller median REE with lower IQR than obese patients

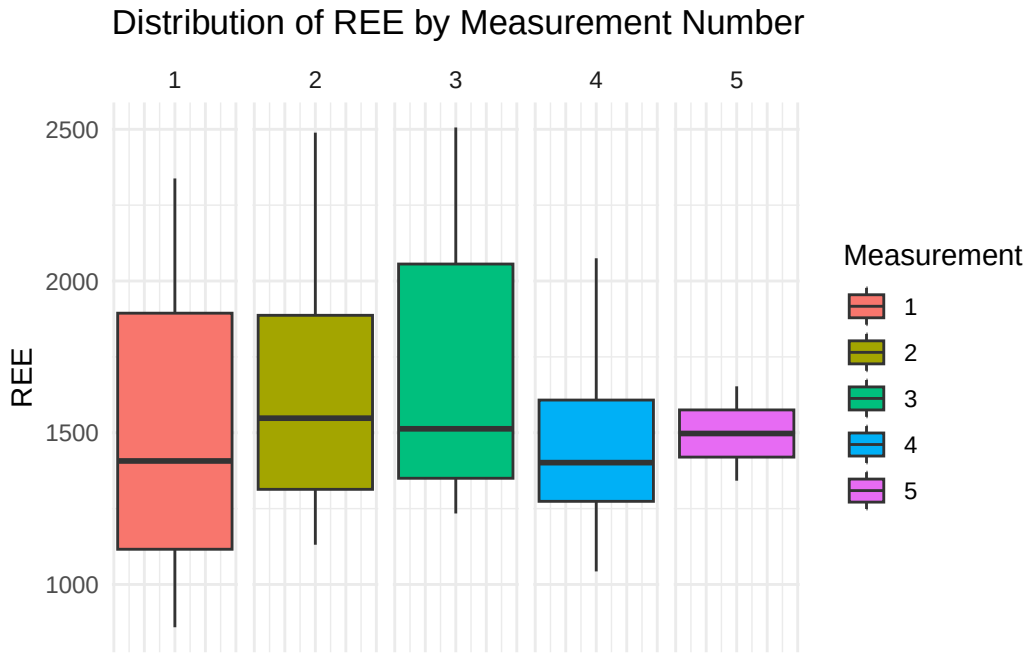

Figure 5: Median REE is consistent, but range varies drastically over time

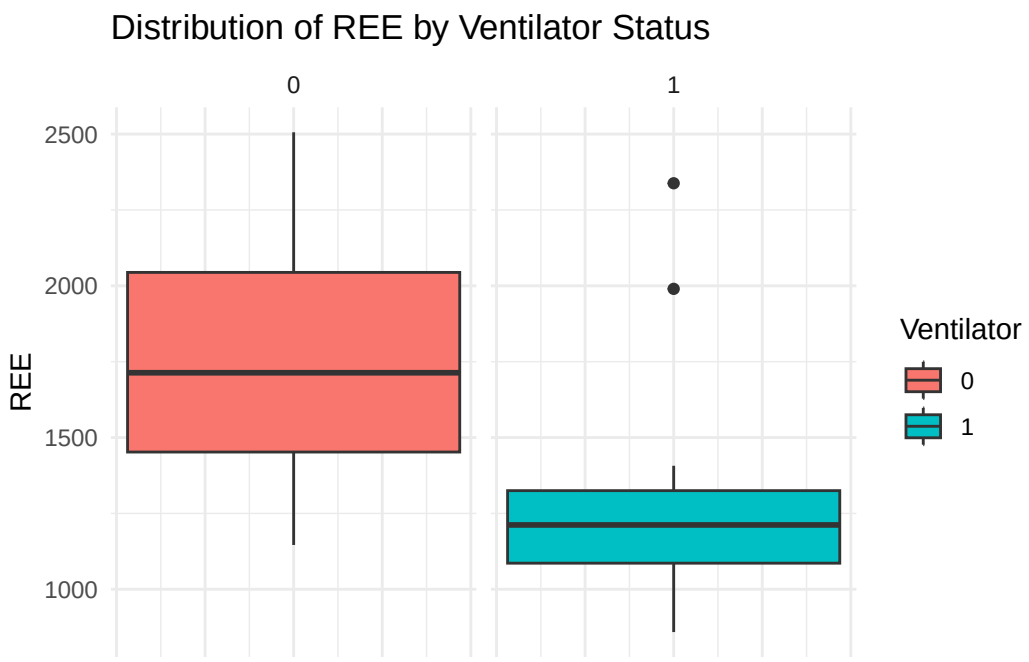

Figure 6: Higher REE for patients not on ventilator, but similar ranges

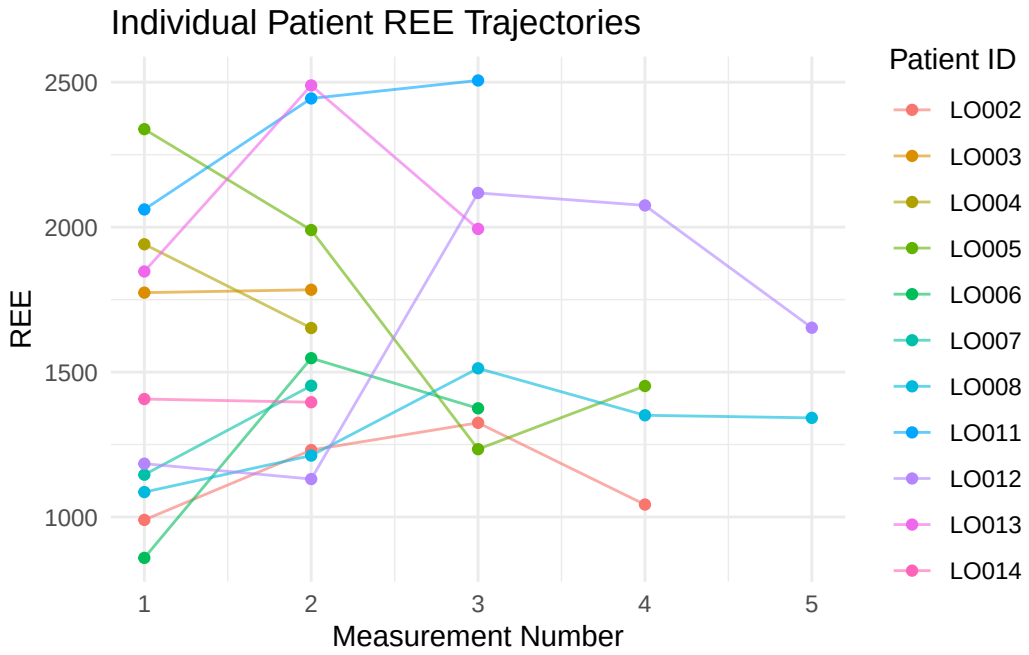

Figure 7: No clear trends by patient overtime

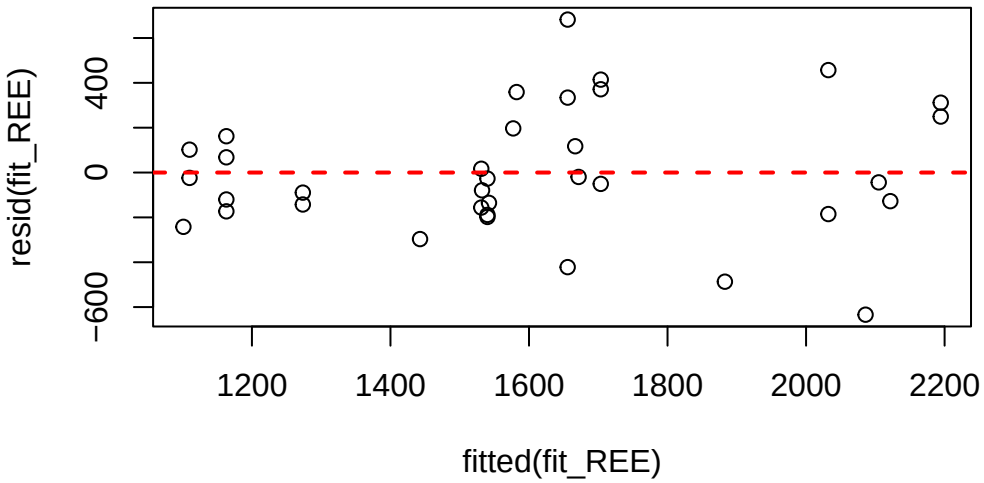

Figure 8: Residual plot for REE model shows okay scatter but coning shaped variance

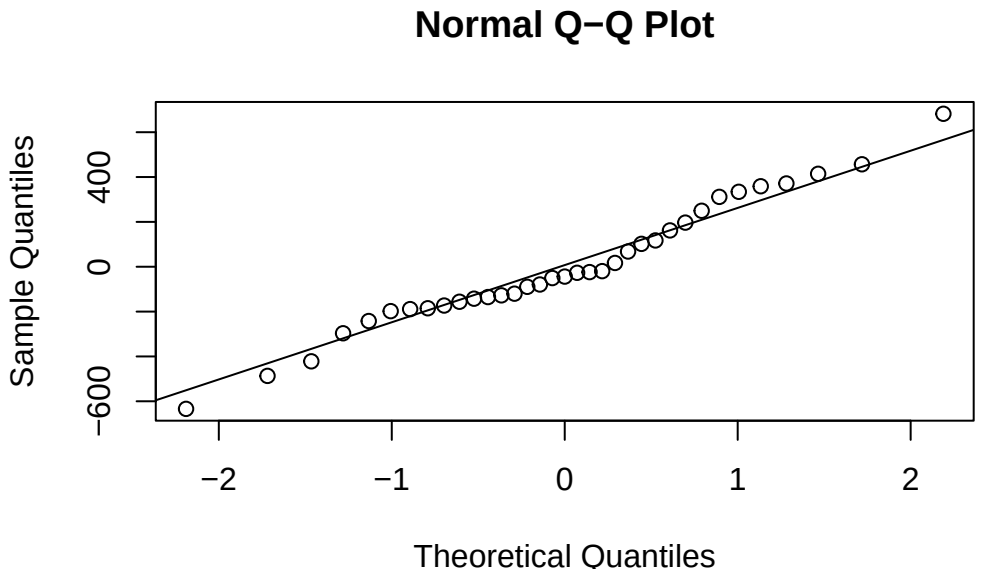

Figure 9: QQ plot for REE model shows slight devation from diagnol at center and tails

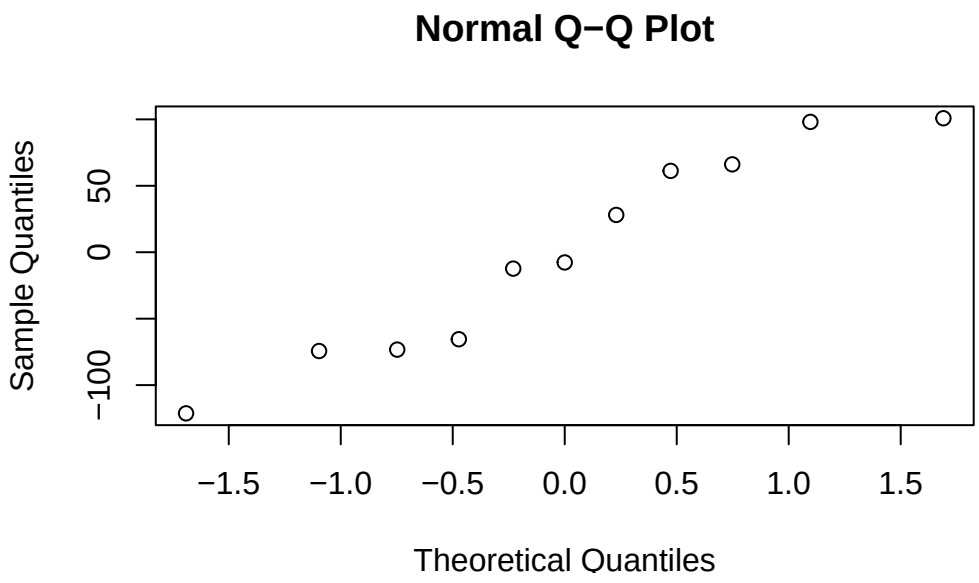

Figure 10: QQ plot by patient for REE model shows deviation from normality

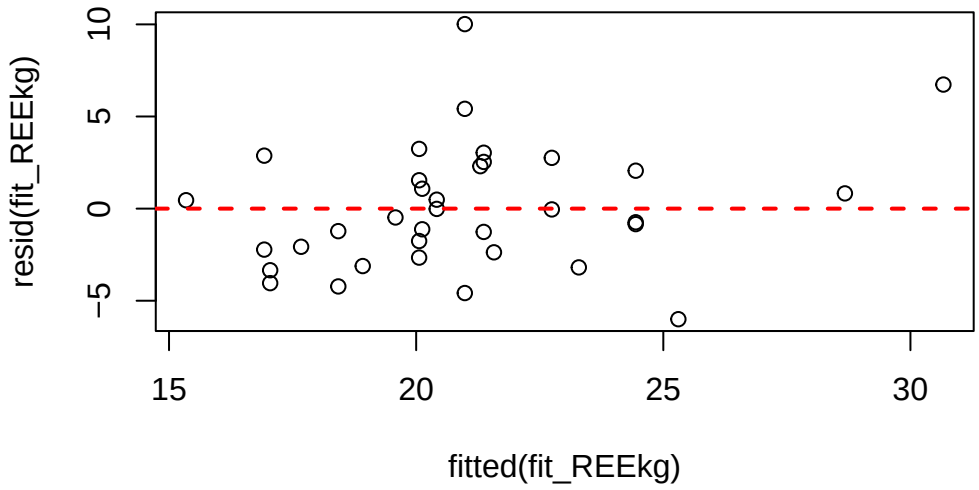

Figure 11: Residual plot for REE KG model shows okay scatter but denser at lower fitted values

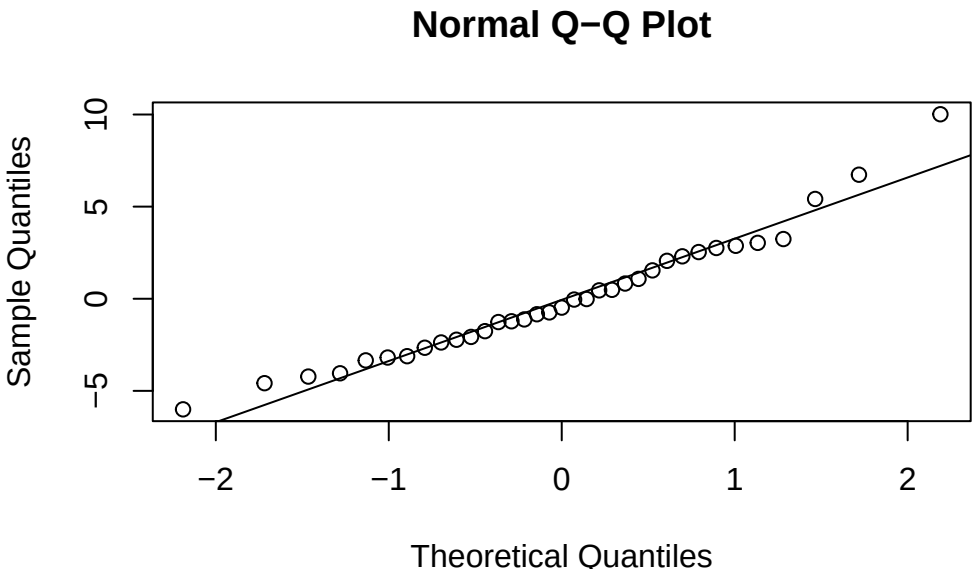

Figure 12: QQ plot for REE KG model shows slight devation from diagnol at tails

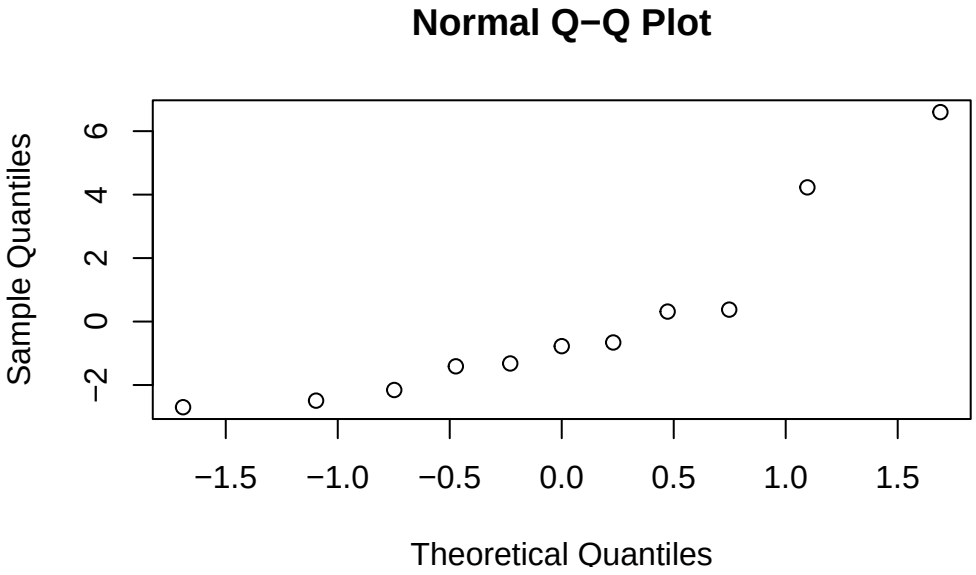

Figure 13: QQ plot by patient for REE KG model shows deviation from normality

Table 1: Kenward–Roger Tests for Fixed Effects

type	stat	ndf	ddf	p.value	predictor
Ftest	11.1640	1	8.4779	0.0094	Obese
Ftest	3.6838	1	28.8472	0.0649	Ventilator
Ftest	0.3132	1	29.5406	0.5800	ICUorSDU