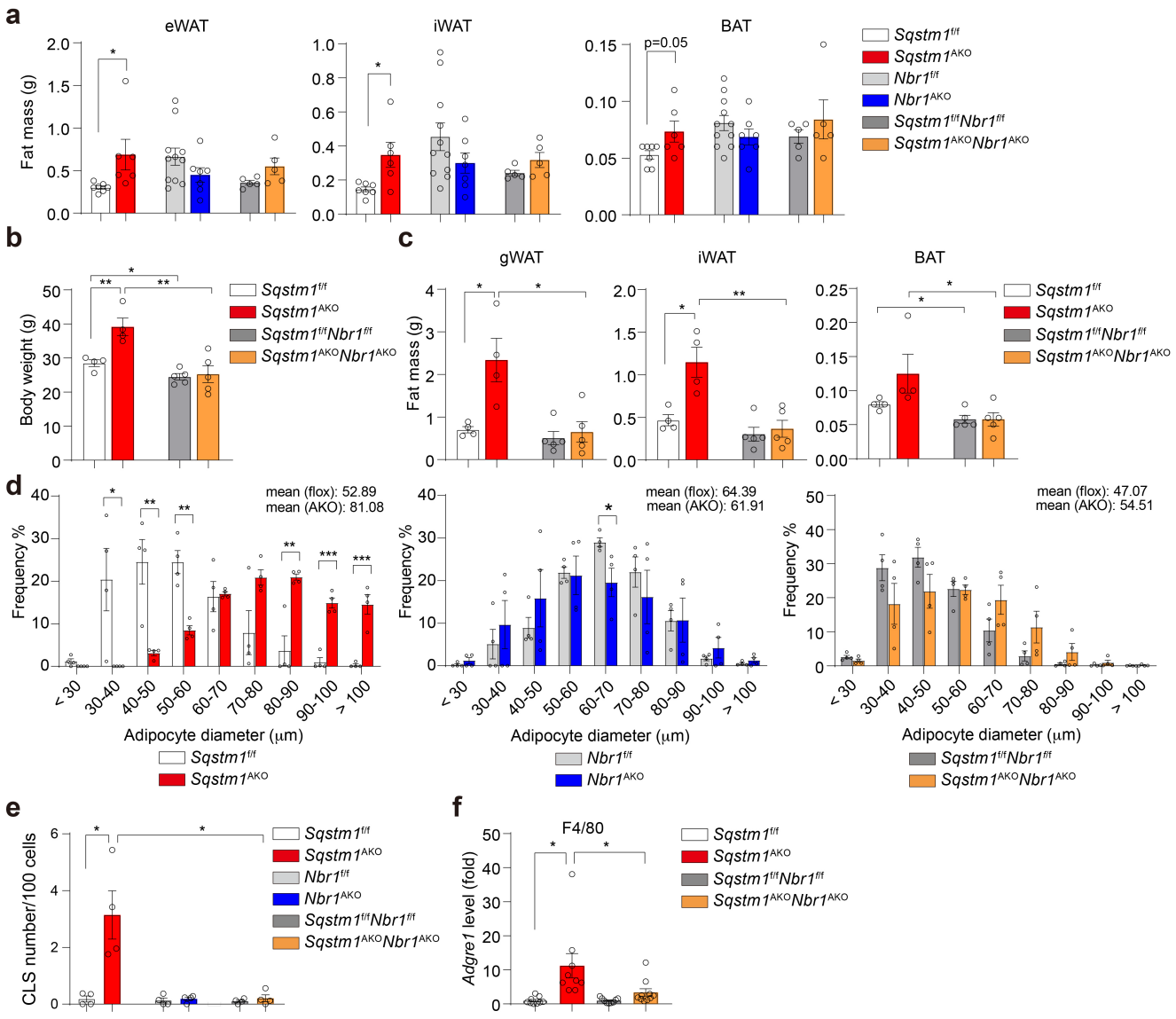
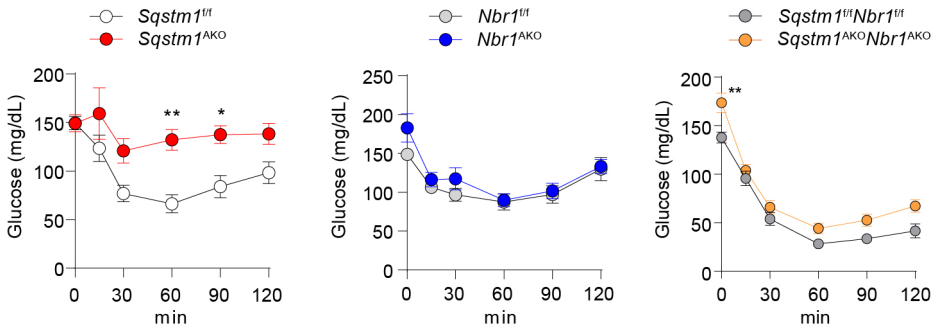
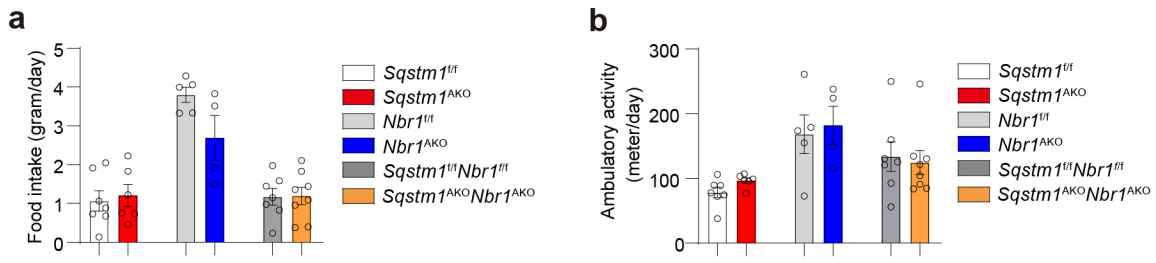
## SUPPLEMENTARY INFORMATION



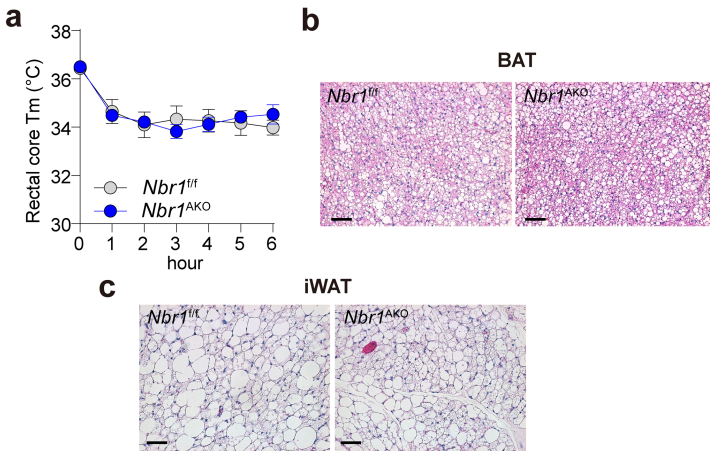
**Supplementary Fig. 1. Role of adipocyte *NBR1* in the control of adiposity. a** Fat tissue weight of eWAT, iWAT, BAT from adipocyte-specific knock out male mice at 10 - 12 weeks of age. *Sqstm1*$^{f/f}$ (n = 7), *Sqstm1*$^{AKO}$ (n = 6), *Nbr1*$^{f/f}$ (n = 11), *Nbr1*$^{AKO}$ (n = 7), *Sqstm1*$^{f/f}$ *Nbr1*$^{f/f}$ (n = 5) and *Sqstm1*$^{AKO}$*Nbr1*$^{AKO}$ (n = 5). $p = 0.0417$ (eWAT), $p = 0.0138$ (iWAT) *Sqstm1*$^{AKO}$ vs *Sqstm1*$^{f/f}$. **b**, **c** Body weight (**b**) and fat tissue weight (**c**) of gWAT, iWAT, BAT from adipocyte-specific knock out female mice at 20 - 25 weeks of age. Results are presented as change fold related to individual controls. *Sqstm1*$^{f/f}$ (n = 4), *Sqstm1*$^{AKO}$ (n = 4), *Sqstm1*$^{f/f}$*Nbr1*$^{f/f}$ (n = 5) and *Sqstm1*$^{AKO}$*Nbr1*$^{AKO}$ (n = 5). gWAT: gonadal WAT. **d** Adipocyte size measurement from H&E staining of eWAT from adipocyte-specific knock out male mice at 25 - 28 weeks of age (n = 4, per genotype). Distribution arrange and frequency was shown. **e** Quantification of CLS number in eWAT from staining described in (**d**) (n = 4, per genotype). CLS: clown-like structure. **f** qPCR analysis of macrophage marker F4/80 (encoded by *Adgre1*) in eWAT. Results are presented as change fold related to individual controls. WT (n = 9), *Sqstm1*$^{-/-}$ (n = 9), *Nbr1*$^{-/-}$ (n = 9) and *Sqstm1*$^{-/-}$*Nbr1*$^{-/-}$ (n = 10). Data are presented as mean ± s.e.m (**a** - **f**). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Two tailed Student's T-test (**a** - **f**). Source data are provided as a Source Data file.



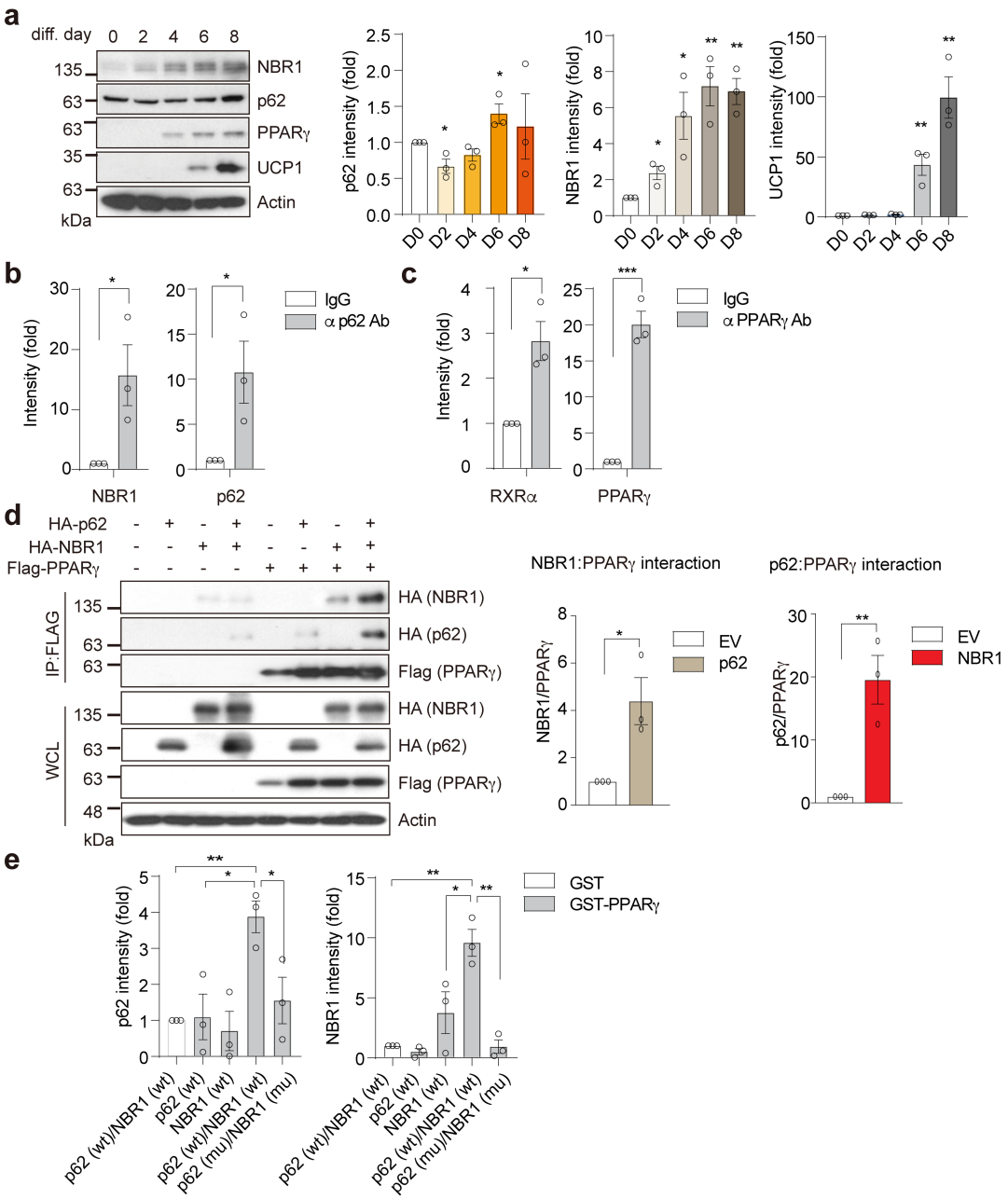

**Supplementary Fig. 2. Role of adipocyte *NBR1* in the control of insulin resistance.** Insulin tolerance test (ITT) were performed in male mice at 25 - 28 weeks of age. Results are presented as raw values. *Sqstm1*$^{f/f}$ (n = 7), *Sqstm1*$^{Ako}$ (n = 6), *Nbr1*$^{f/f}$ (n = 7), *Nbr1*$^{AKO}$ (n = 6), *Sqstm1*$^{f/f}$*Nbr1*$^{f/f}$ (n = 8) and *Sqstm1*$^{AKO}$*Nbr1*$^{AKO}$ (n = 11). Data are presented as mean ± s.e.m. *$p < 0.05$, **$p < 0.01$. Two-way ANOVA followed by Bonferroni's post-test. Source data are provided as a Source Data file.




**Supplementary Fig. 3. Role of *NBR1* in systemic energy expenditure. a**, **b** Food intake (**a**) and sum of all directed ambulatory locomotor activity (**b**) were determined in male mice at 50 - 55 weeks-old using an automated indirect calorimetry system (CLAMS). *Sqstm1*$^{f/f}$ (n = 7), *Sqstm1*$^{AKO}$ (n = 6), *Nbr1*$^{f/f}$ (n = 5), *Nbr1*$^{AKO}$ (n = 4), *Sqstm1*$^{f/f}$*Nbr1*$^{f/f}$ (n = 7) and *Sqstm1*$^{AKO}$*Nbr1*$^{AKO}$ (n = 8). Results are presented as mean ± s.e.m (**a**, **b**). Two-tailed Student's T-test (**a**, **b**). Source data are provided as a Source Data file.




**Supplementary Fig. 4. Role of NBR1 in adaptive thermogenesis in BAT and inguinal WAT.** **a**,**b** Male mice at 25-weeks of age were subjected to acute cold exposure (4°C) for 7 hours to stimulate brown thermogenesis. **a** Rectal core temperature was measured for consecutive 6 hours. *Nbr1*$^{f/f}$ (n = 6), *Nbr1*$^{AKO}$ (n = 6). Two-way ANOVA followed by Bonferroni's post-test. Data are presented as mean ± s.e.m. **b** Representative H&E staining in BAT of indicated mice (n = 3, per genotype). Scale bar = 100 μm. **c** Male mice at 25-weeks of age were injected with CL316,243 or saline as control for consecutive 5 days. Representative H&E staining in iWAT of indicated mice (n = 3, per genotype). Scale bar = 100 μm. Source data are provided as a Source Data file.




**Supplementary Fig. 5. p62 and NBR1 interact with PPARγ and controls its regulation thermogenesis in brown adipocytes. a** Representative immunoblotting of p62 and NBR1 levels during brown adipocyte differentiation. Densitometric quantification from 3 independent experiments was shown. **b**, **c** Endogenous interaction of PPARγ with p62 and NBR1. p62 (**b**) or

PPARγ (**c**) immunoprecipitates from nuclear lysates extracted from ISO and rosiglitazone-treated brown adipocytes were analyzed for the levels of specified proteins. Densitometric quantification was shown (n = 3 independent experiments for both). **d** HEK293T cells were transfected with HA-p62, HA-NBR1 and FLAG-tagged PPARγ. Anti-FLAG immunoprecipitates were analyzed by immunoblotting and densitometric quantification was shown (n = 3 independent experiments). **e** HEK293T cells were transfected with cDNA vectors expressing WT/mutants of HA-p62 or HA-NBR1, and GST-PPARγ. The interacting proteins were pulled down using glutathione-beads against GST-PPARγ and analyzed by immunoblotting. Densitometric quantification was shown (n = 3, independent experiments). Data are presented as mean ± s.e.m (**a** - **e**). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ for Two tailed Student's T-test (**a** - **e**). Source data are provided as a Source Data file.

**Supplementary Table 1.** Quantitative PCR primer sequences

| Gene Symbol | Forward | Reverse |
|---|---|---|
| *Ldlr* | CAACAATGGTGGCTGTTCCCACAT | ACTCACACTTGTAGCTGCCTTCCA |
| *Fasn* | CTTCAACCTGGCCATGGTTTT | GTTGGCGAAGCCGTAGTTAGTT |
| *Srebf1* | TATGGAGGGCATGAAACCCGAAGT | TTGACCTGGCTATCCTCAAAGGCT |
| *Srebf2* | ATGGAGACCCTCACGGA | TGCTGTTGTTGCCACTG |
| *Hmgcr* | TCAGTGGGAACTATTGCACCG | TGGAATGACGGCTTCACAAAC |
| *Ucp1* | TCTTCTCAGCCGGAGTTTCAGCTT | ACCTTGGATCTGAAGGCGGACTTT |
| *Dio2* | AAGGCTGCCGAATGTCAACGAATG | TGCTGGTTCAGACTCACCTTGGAA |
| *Cox7α* | CAGCGTCATGGTCAGTCTGT | AGAAAACCGTGTGGCAGAGA |
| *Pgc1a* | AGCTGTGTTTGACGACAAATC | CGACACGGAGAGTTAAAGGAAG |
| *CIDEα* | ATCACAACTGGCCTGGTTACG | TACTACCCGGTGTCCATTTCT |
| *Adgre1* | TGTCTGACAATTGGGATCTGCCCT | ATAGCTTCCGAGAGTGTTGTGGCA |
| *18s* | GTAACCCGTTGAACCCATT | CCATCCAATCGGTAGTAGCG |