Multiple epidemiologic studies\(^1\)\(^2\)\(^3\) have linked chronic exposure to environmental noise with an increased risk of metabolic disorders, including obesity and diabetes. An experimental study published recently in *Environmental Health Perspectives* found consistent results in rodents, with gene expression and tissue analyses suggesting potential underlying mechanisms.\(^4\)

Researchers at Université de Picardie Jules Verne in Amiens, France, exposed 12 male Wistar rats to subchronic noise, meaning intermittent noisy periods of relatively long duration. For 37 days, starting at 3 weeks of age, the rats were exposed during their 12-hour sleep period to different sounds at levels comparable to the threshold commonly used in human studies of urban traffic noise. The noise exposure was followed by a noise-free 12-hour active period. Another 12 rats made up the control group.

In the two groups of rats, the researchers compared physiologic parameters, sleep patterns, sleep apnea symptoms, postsacrifice organ weights, and tissue mRNA expression levels of genes that regulate food intake and appetite. The noise-exposed rats consumed more food and water and gained 6% more body weight than the control animals. They also had heavier thymus and adrenal glands. Forebrain (hypothalamus) mRNA expression levels were higher for one gene (the cocaine- and amphetamine-regulated transcript gene, or *CART*) and lower for another (leptin receptor). Differences in sleep parameters between exposed and nonexposed animals, such as the duration of REM and non-REM sleep, were subtle, and there was no evidence of an effect on apnea during sleep.

“Our study’s main finding is that noise exposure during the rest period increased food and water consumption, resulting in body and organ weight gain,” says senior author Amandine Pelletier, a lecturer in physiology. “Similar effects have been observed in human studies.\(^1\)\(^2\)\(^3\)

An association between chronic noise exposure and greater thymus weight was previously reported in female adult rats.\(^5\) That finding suggested that noise-induced stress may influence metabolic function.\(^6\) Another study found that noise exposure increased the adrenal gland production of corticosterone in rats,\(^7\) which may lead to hypertrophy of the organ.\(^8\) Measuring blood levels of corticosterone and other hormones under a similar exposure protocol would be an interesting next step, says Pelletier.

The noise-associated changes in mRNA expression levels may partially explain the observed body weight gain. Leptin is a
The CART gene codes for neuropeptides involved in stress and reward pathways, whose expression is partially regulated by leptin. It is plausible that the leptin receptor and CART mRNAs may jointly influence circulating levels of leptin and other hormones, contributing to an increased appetite.

Jennifer Teske, an associate professor of nutritional sciences at the University of Arizona in Tucson, who was not involved in the project, notes that an earlier study of rodents reported similar associations between noise exposure and weight gain. Recent work on long-term exposure to road traffic noise and incident diabetes: a prospective cohort study. Environ Health Perspect 121(2):217–222, PMID: 18549620, https://doi.org/10.1148/radiographics.262045213.

The current study’s gene expression analysis adds to the body of evidence by suggesting potential underlying mechanisms, she says.

Zorana Jovanovic Andersen, a professor of environmental epidemiology at the University of Copenhagen, notes that, given the rat’s life span, the 36-day exposure period mimics long-term exposures that are relevant for human chronic disease development. For Andersen, who also was not involved in the study, the rodent findings are consistent with associations between chronic noise, sleep disturbances, and human diabetes. “The researchers also identified interesting and plausible explanations for these associations,” she says, “pointing at noise-related increased appetite and weight gain as the most relevant pathway.”

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References

1. Sørensen M, Andersen ZJ, Nordsborg RB, Becker T, Tjønneland A, Overvad K, et al. 2013. Long-term exposure to road traffic noise and incident diabetes: a cohort study. Environ Health Perspect 121(2):217–222, PMID: 23229017, https://doi.org/10.1089/ehp.1205503.
2. Eriksson C, Hilding A, Pyko A, Bluhm G, Pershagen G, Östenson C-G, et al. 2014. Long-term aircraft noise exposure and body mass index, waist circumference, and type 2 diabetes: a prospective study. Environ Health Perspect 122(7):697–699, PMID: 24350763, https://doi.org/10.1289/ehp.1307115.
3. Clark C, Sbihi H, Tamburic L, Brauer M, Frank LD, Davies HW, et al. 2017. Association of long-term exposure to transportation noise and traffic-related air pollution with the incidence of diabetes: a prospective cohort study. Environ Health Perspect 125(8):897–902, PMID: 28934721, https://doi.org/10.1002/jat.1279.
4. Bosquillon de Jenlis A, Del Vecchio F, Delanauw S, Gay-Queheillard J, Bach V, Pelletier A, et al. 2019. Impacts of subchronic, high-level noise exposure on sleep and metabolic parameters: a juvenile rodent model. Environ Health Perspect 127(5):5704, PMID: 31067135, https://doi.org/10.1289/EHP4045.
5. Zymantiene J, Zelvyte R, Pampariene I, Aniuliene A, Juodziukyniene N, Kantautaite J, et al. 2017. Effects of long-term construction noise on health of adult female Wistar rats. Pol J Vet Sci 21(1):155–165, PMID: 28525342, https://doi.org/10.1515/pjvs-2017-0020.
6. Nishino M, Ashiku SK, Kocher ON, Thurer RL, Boiselle PM, Hatabu H, et al. 2006. The thymus: a comprehensive review. Radiographics 26(2):335–348, PMID: 16549620, https://doi.org/10.1148/rg.262045213.
7. Gamallo A, Alario P, Villanúa MA, Nava MP. 1988. Effect of chronic stress in the blood pressure in the rat: ACTH administration. Horm Metab Res 20(6):336–338, PMID: 2843449, https://doi.org/10.1055/s-2007-1018030.
8. Harvey PW, Sutcliffe C. 2010. Adrenocortical hypertrophy: establishing cause and toxicological significance. J Appl Toxicol 30(7):617–626, PMID: 20687119, https://doi.org/10.1002/jat.1569.
9. Zhang Y, Proenca R, Maffei M, Barone M, Leopold L, Friedman JM. 1994. Positional cloning of the mouse obese gene and its human homologue. Nature 372(6505):425–432, PMID: 7984236, https://doi.org/10.1038/372425a0.
10. Flier JS, Maratos-Flier E. 2017. Leptin’s physiologic role: does the emperor of energy balance have no clothes? Cell Metab 26(1):24–26, PMID: 28649891, https://doi.org/10.1016/j.cmet.2017.05.013.
11. Thim L, Kristensen P, Nielsen PF, Wulff BS, Clausen JT. 1999. Tissue-specific processing of cocaine- and amphetamine-regulated transcript peptides in the rat. Proc Natl Acad Sci USA 96(6):2722–2727, PMID: 10077578, https://doi.org/10.1073/pnas.96.6.2722.
12. Zou X, Huang W, Lu F, Fang K, Wang D, Zhao S, et al. 2017. The effects of Jiao-Tai-Wan on sleep, inflammation and insulin resistance in obesity-resistant rats with chronic partial sleep deprivation. BMC Complement Altern Med 17(1):185, PMID: 28335761, https://doi.org/10.1186/s12906-017-1648-9.
13. Coborn JE, Lessie RE, Sinton CM, Rance NE, Perez-Leighton CE, Teske JA. 2019. Noise-induced sleep disruption increases weight gain and decreases energy metabolism in female rats. Int J Obes (Lond) 43(9):1759–1768, PMID: 30558287, https://doi.org/10.1038/s41366-018-0293-9.