Author Correction: Metformin inhibits gluconeogenesis via a redox-dependent mechanism in vivo

Anila K. Madiraju, Yang Qiu, Rachel J. Perry, Yasmeen Rahimi, Xian-Man Zhang, Dongyan Zhang, João-Paulo G. Camporez, Gary W. Cline, Gina M. Butrico, Bruce E. Kemp , Gregori Casals, Gregory R. Steinberg, Daniel F. Vatner, Kitt F. Petersen and Gerald I. Shulman

Correction to: *Nature Medicine* <https://doi.org/10.1038/s41591-018-0125-4>, published online 23 July 2018.

In the version of this article originally published, the V_{PC} and V_{CS} flux data shown in Fig. 6e,f were inadvertently duplicated from Fig. 5j,k. The correct data are now shown in Fig. 6e,f. In these corrected data, V_{PC} flux in response to chronic oral metformin treatment was still significantly decreased (Fig. 6e), and there was still no impact of metformin on V_{CS} flux (Fig. 6f). Therefore, the text describing these data remains the same and this correction does not change the conclusion of this study.

Fig. 6 | Original and Corrected.

In the original version of Fig. 4h, an asterisk indicating statistical significance was present over the metformin data. This asterisk should not have been in the figure. It has been removed.

Additionally, in the legend for Fig. 6, control rats were incorrectly described as saline rats. The rats are now described as control rats in this legend.

Also, the n values reported in some of the figure legends did not accurately represent the number of samples in each of the panels. The correct n values are provided below.

The legend for Fig. 1 originally stated that the n values were as follows: for $[3-^{13}\text{C}]$ Lactate, Saline: $n = 8$, Metformin: $n = 9$; and for $[3-^{13}\text{C}]$ Alanine, Saline: $n = 6$, Metformin: $n = 6$.

The n values were actually: for c: $[3-^{13}\text{C}]$ Lactate, Saline: $n = 8$, Metformin: $n = 9$; $[3-^{13}\text{C}]$ Alanine, Saline: $n = 6$, Metformin: $n = 6$; for d: $[3-^{13}\text{C}]$ Lactate, Saline: $n = 3$, Metformin: $n = 4$; $[3-^{13}\text{C}]$ Alanine, Saline: $n = 4$, Metformin: $n = 4$; for e: $n = 3$ per group; and for f: $[3-^{13}\text{C}]$ Lactate, Saline: $n = 7$, Metformin: $n = 8$; $[3-^{13}\text{C}]$ Alanine, Saline: $n = 5$, Metformin: $n = 5$.

The Fig. 1 legend also originally stated that results were presented as mean $\pm$ s.e.m. for a–f. Results were actually presented as mean $\pm$ s.e.m. for c–f and as mean $\pm$ s.d. for g. Further, the legend originally stated that a two-way ANOVA with Sidak's multiple comparisons test was used in panels a–f. This was only used in c–f.

The legend for Fig. 2 originally stated that the n values were as follows: for $[3-^{13}\text{C}]$ Lactate, Saline: $n = 9$, Metformin: $n = 11$; and for $[3-^{13}\text{C}]$ Alanine, Saline: $n = 12$, Metformin: $n = 11$.

The n values were actually: for a: $[3-^{13}\text{C}]$ Lactate, Saline: $n = 9$, Metformin: $n = 11$; $[3-^{13}\text{C}]$ Alanine, Saline: $n = 12$, Metformin: $n = 11$; for b: $[3-^{13}\text{C}]$ Lactate, Saline: $n = 5$, Metformin: $n = 3$; $[3-^{13}\text{C}]$ Alanine, Saline: $n = 6$, Metformin: $n = 3$; for c: $n = 3$ per group; and for d: $[3-^{13}\text{C}]$ Lactate, Saline: $n = 11$, Metformin: $n = 11$; $[3-^{13}\text{C}]$ Alanine, Saline: $n = 12$, Metformin: $n = 11$.

The legend for Fig. 3 originally stated that the n values were as follows: (WT, $n = 7$; ACC DKI, $n = 9$ per group for plasma glucose (a), EGP (d); and $n = 6$ per group for liver redox (b,c), TG and protein expression (e–j)).

The *n* values were actually: for a,d: WT: *n* = 9 per group; ACC DKI: *n* = 7 per group; for b: Saline: *n* = 6 per group; Metformin: *n* = 8 per group; for c: Saline, WT: *n* = 4, ACC DKI *n* = 6; Metformin, WT: *n* = 8, ACC DKI: *n* = 6; and for e–j: *n* = 6 per group.

The legend for Fig. 4 originally stated that the *n* values were as follows: for substrate infusion (a–e): Saline: *n* = 7, Metformin: *n* = 6; and for MB infusion (f–i): Saline: *n* = 8; MB: *n* = 12; Metformin: *n* = 7; MB and Metformin: *n* = 10.

The *n* values were actually: for a: Saline: *n* = 7; Metformin: *n* = 6; Metformin +Pyr +DHA: *n* = 6; Metformin +Lac +Gly: *n* = 6; for b,c: *n* = 6 per group; for d: Saline: *n* = 8; Metformin: *n* = 9; Metformin +Pyr +DHA: *n* = 8; Metformin +Lac +Gly: *n* = 6; for e: Saline: *n* = 5; Metformin: *n* = 6; Metformin +Pyr +DHA: *n* = 6; Metformin +Lac +Gly: *n* = 6; for f: Saline: *n* = 7; MB: *n* = 17; Metformin: *n* = 7; Metformin +MB: *n* = 11; for g: Saline: *n* = 7; MB: *n* = 9; Metformin: *n* = 6; Metformin +MB: *n* = 6; for h: Saline: *n* = 6; MB: *n* = 8; Metformin: *n* = 6; Metformin +MB: *n* = 10; and for i: Saline: *n* = 5; MB: *n* = 5; Metformin: *n* = 10; Metformin +MB: *n* = 6.

The legend for Fig. 5 originally stated that the *n* values were as follows: for a,b,g: Saline: *n* = 8; Metformin: *n* = 9; for e: Saline: *n* = 12; Metformin: *n* = 11; for f: Saline: *n* = 12; Metformin: *n* = 9; for c,d,h,i: Saline: *n* = 7; Metformin: *n* = 7; and for j,k: Saline: *n* = 8; Metformin: *n* = 8.

The values were actually: for a,e: Saline: *n* = 12; Metformin: *n* = 11; for b: Saline: *n* = 11, Metformin: *n* = 11; for c,d,h,i: Premetformin: *n* = 7, Postmetformin: *n* = 7; for f: Saline: *n* = 12, Metformin: *n* = 9; for g: Saline: *n* = 8, Metformin: *n* = 9; and for j,k: Saline: *n* = 9, Metformin: *n* = 8. The legend has been corrected and now states the correct values.

The legend for Fig. 6 stated that, the *n* values were as follows: for a,d: [3-¹³C]Lactate, Control: *n* = 7, Metformin: *n* = 6; [3-¹³C]Alanine, Control: *n* = 6, Metformin: *n* = 9; for b,c: Control: *n* = 13, Metformin: *n* = 15; and for e,f: Control: *n* = 9, Metformin: *n* = 8.

The values were actually: for a,d: [3-¹³C]Lactate, Control: *n* = 7, Metformin: *n* = 6; [3-¹³C]Alanine, Control: *n* = 6, Metformin: *n* = 9; for b: Control *n* = 13, Metformin *n* = 14; for c,e: Control *n* = 13, Metformin *n* = 15; and for f: Control: *n* = 13, Metformin: *n* = 12.

The legend also stated that an unpaired two-tailed *t*-test with Welch's correction was used for analysis in panel a. Only a two-way ANOVA was used for analysis in panel a, and the legend has been updated to reflect this.

The legends have all been corrected and now state the correct values.

In the main text, the sentence beginning with “However, consistent with the prior oral metformin treatment study [...]” contained an error. In the described study, metformin was administered through the portal vein. The text has been corrected and now says “However, consistent with the prior portal vein metformin treatment study [...]”.

All described errors have been corrected in the HTML and PDF versions of this article.

For Supplementary Figs. 4 and 6, all western blots were rerun using the same original tissue samples from the animal study in order to provide full blots. Prior reported data came from blots that were probed from membranes cut into sections by molecular weight—as the standards for data reporting have since changed, blots were repeated to meet the updated criteria. The repetition of these blots yielded the same results: acute i.v. 50 mg kg⁻¹ metformin treatment in SD rats had no impact on G6Pase protein expression and ACC phosphorylation, but it increased PC and PEPCK-C protein expression, CREB phosphorylation and AMPK phosphorylation (Supplementary Fig. 4). Similarly, the data from the rerun blots in Supplementary Fig. 6 did not change the final conclusions: acute i.v. 50 mg kg⁻¹ metformin treatment in ZDF rats had no impact on G6Pase, PC and PEPCK-C protein expression and no effect on CREB and ACC phosphorylation, but it increased AMPK phosphorylation. Therefore, the text describing these data remains the same and does not alter the conclusions of this study. The correct Supplementary Information is now available online.

Supplementary Fig. 4 | Original and Corrected.

Supplementary Fig. 6 | Original and Corrected.

Published online: 7 February 2019
<https://doi.org/10.1038/s41591-018-0220-6>