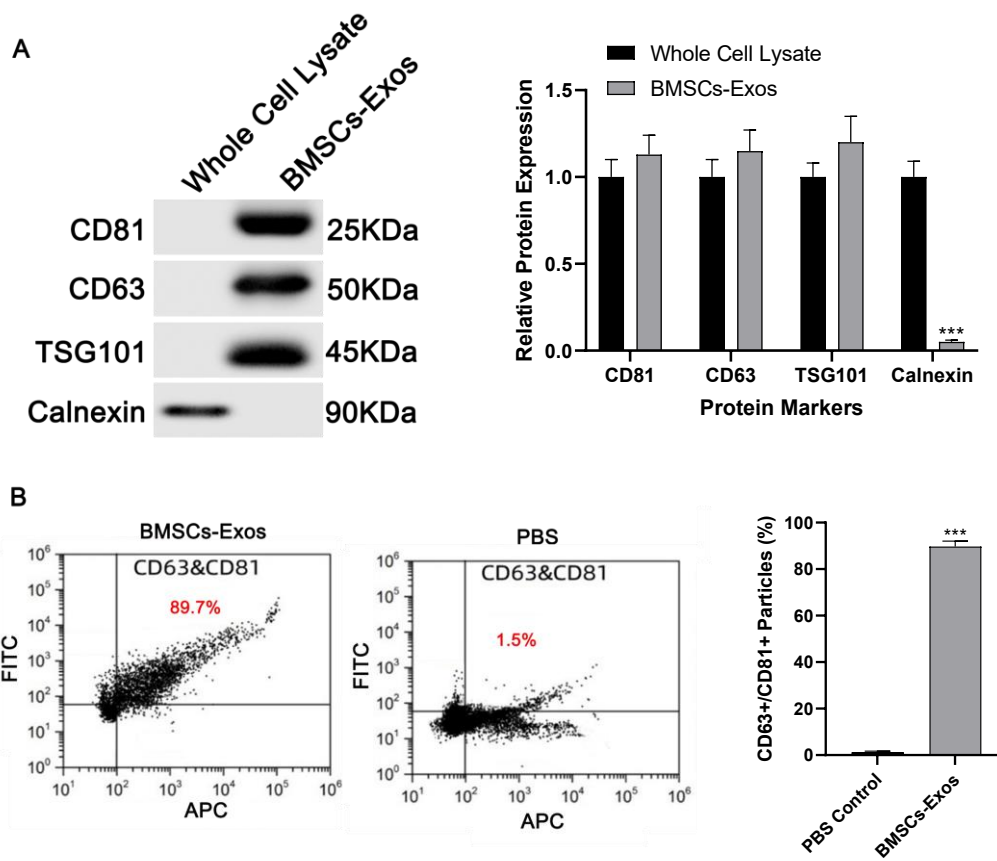
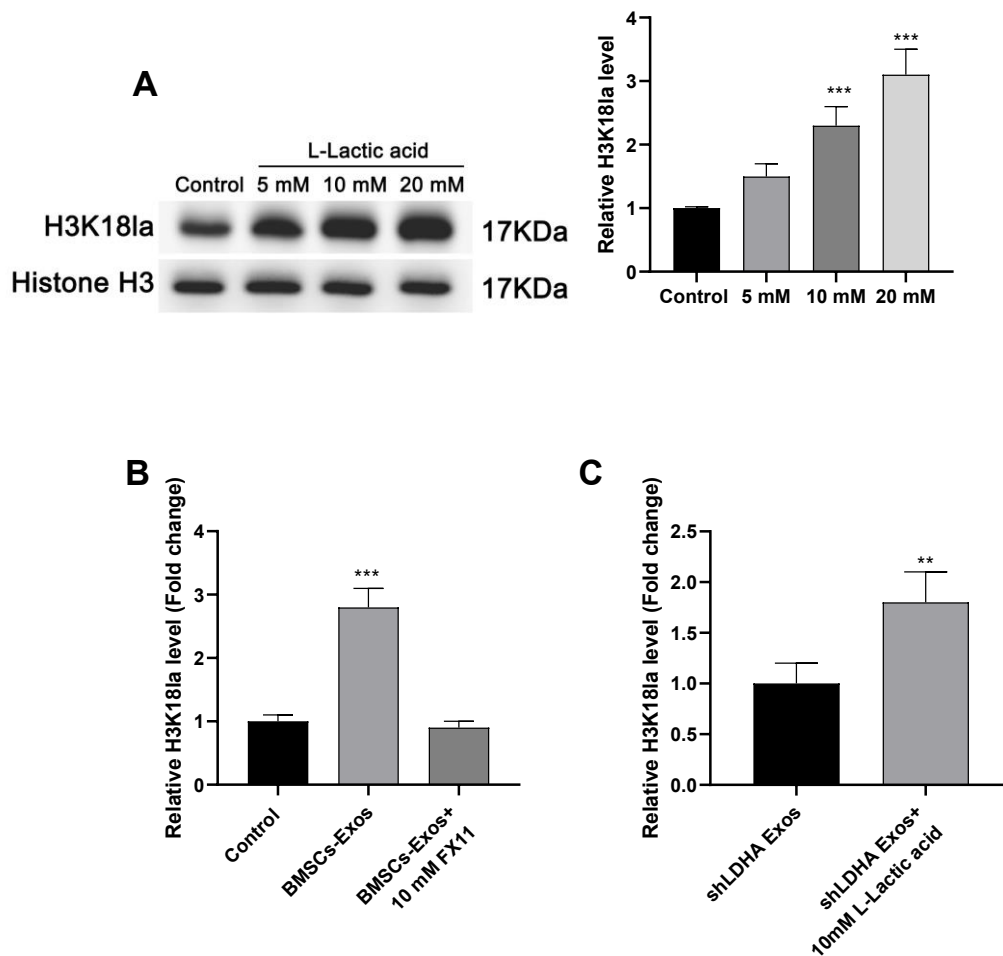
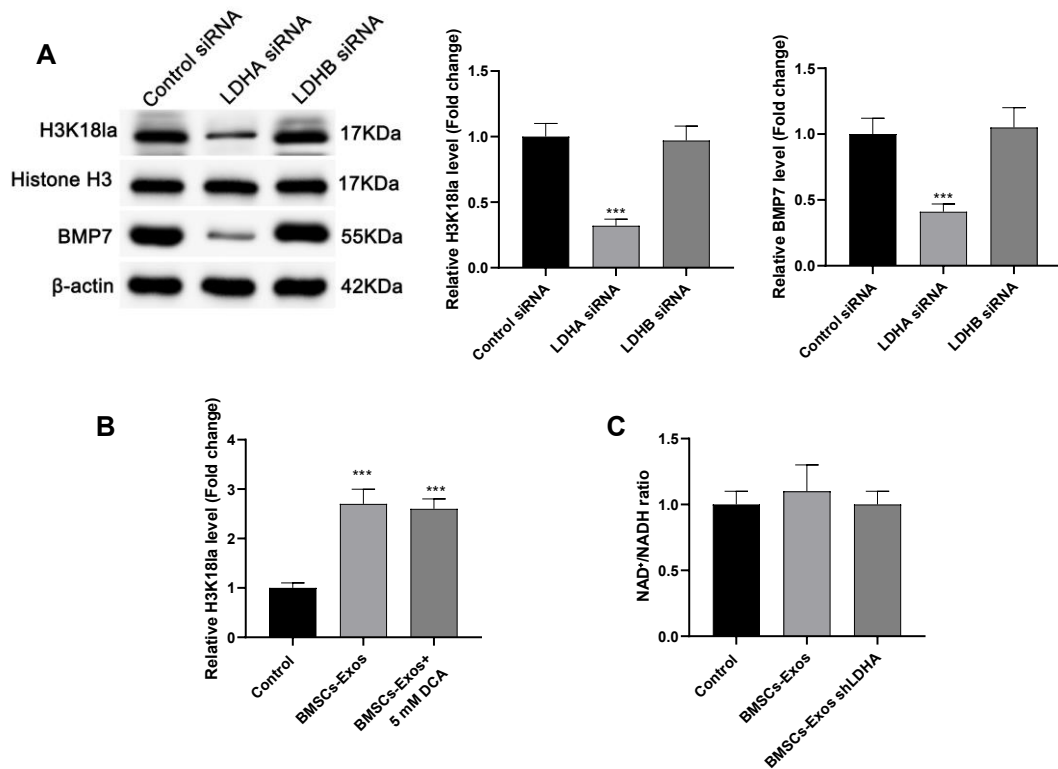




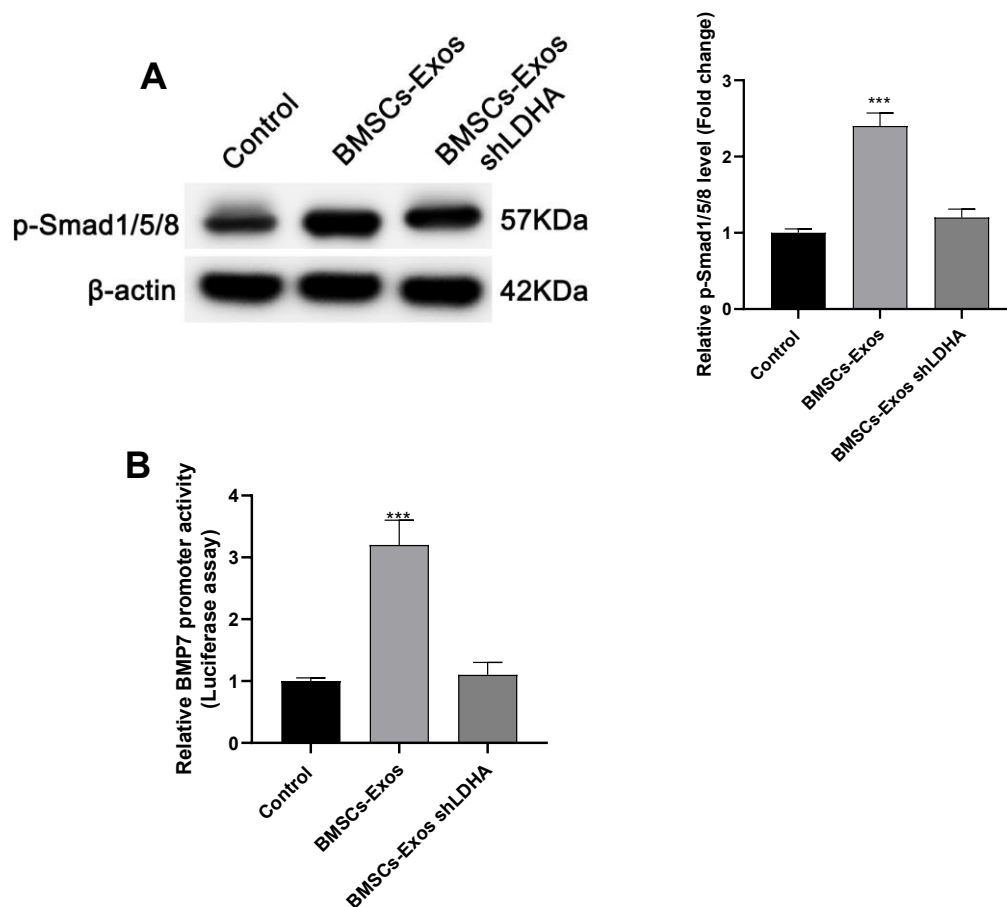
Supplementary Figure 1 Characterization of BMSCs-Exos. A: Western blot analysis of exosomal markers (CD63, CD81, TSG101) and negative control (Calnexin) in BMSCs whole cell lysate and BMSCs-Exos; B: Nanoflow cytometry scatter plot showing CD63+/CD81+ double-positive particles in BMSCs-Exos (89.7%) versus PBS control. Data are mean $\pm$ SD (n=3). *** P < 0.001.



Supplementary Figure 2 LDHA-driven lactate directly regulates H3K18 lactylation. **A:** Dose-dependent increase in H3K18la levels with lactate supplementation (0-20 mM); **B:** Inhibition of H3K18la by oxamate (10 mM); **C:** Rescue of H3K18la in LDHA-knockdown CSPCs with 10 mM lactate. Data are mean $\pm$ SD (n=3). *** P < 0.001 vs control; ** P < 0.01 vs shLDHA Exos.



Supplementary Figure 3 Specificity validation of LDHA-lactate axis. A and B: No effect of LDHB knockdown on H3K18la and BMP7; C: Pyruvate metabolism inhibitor (DCA) did not alter H3K18la. NAD⁺/NADH ratio remained unchanged. Data are mean $\pm$ SD (n=3). *** P < 0.001 vs control.



Supplementary Figure 4 BMP7 acts through the Smad pathway. A: Western blot of p-Smad1/5/8 in CSPCs; B: Luciferase assay showing Smad1/5/8-dependent BMP7 promoter activity. Data are mean $\pm$ SD (n=3). *** $P < 0.001$ vs control.