A single polar flagellum and motility are potential virulence factors of *V. vulnificus*, a foodborne pathogen. In the present study, the functions of FlhF and regulatory characteristics of the *flhF* expression of *V. vulnificus* were investigated. A deletion mutation of FlhF abolished motility, flagella formation, and flagellin synthesis, and introduction of *flhF* in trans complemented the defects. The *flhF* mutant revealed decreased expression of the class III and IV flagella genes, indicating that FlhF is a key regulator for the flagella biogenesis of *V. vulnificus*. The influence of global regulatory proteins on the expression of *flhF* was examined, and SmcR, a LuxR homologue, was found to downregulate the *flhF* expression at the transcriptional level. SmcR represses the *flhF* expression only in the stationary phase of growth and exerts its effects by directly binding to the *flhF* promoter region. Finally, an SmcR binding site, centered at 22.5-bp upstream of the transcription start site, was identified by a DNase I protection assay. The combined results demonstrate that quorum sensing influences the motility and flagella biogenesis of *V. vulnificus* through modulating the expression of FlhF in a growth phase-dependent manner.