

**Supplementary Table S4: Impact of Specific Sleep Abnormalities on Immune Function**

<b>Sleep Abnormality</b>	<b>Health Outcomes</b>	<b>Mechanisms</b>
Insomnia	Increased susceptibility to infections Chronic inflammation	Impaired cytokine production and immune cell function Altered regulation of inflammatory pathways (e.g., increased pro-inflammatory cytokines)
Obstructive Sleep Apnea (OSA)	Increased inflammation and autoimmune disorders Reduced vaccine response	Intermittent hypoxia triggering inflammatory cascades Impaired T-cell and B-cell responses to antigen exposure
Circadian Rhythm Disorders	Increased susceptibility to infections Chronic low-grade inflammation	Disruption of circadian immune function and impaired leukocyte trafficking Altered sleep-wake cycles affecting inflammatory gene expression
Sleep Deprivation	Increased risk of chronic inflammatory diseases	Elevated stress hormones and cytokine imbalances