

## Optimal Laser Phototherapy Parameters for Pain Relief

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### Abstract

**Background and objective:** Studies on laser phototherapy for pain relief have used parameters that vary widely and have reported varying outcomes. The purpose of this study was to determine the optimal parameter ranges of laser phototherapy for pain relief by analyzing data aggregated from existing primary literature. **Materials and methods:** Original studies were gathered from available sources and were screened to meet the pre-established inclusion criteria. The included articles were then subjected to meta-analysis using Cohen's *d* statistic for determining treatment effect size. From these studies, ranges of the reported parameters that always resulted into large effect sizes were determined. These optimal ranges were evaluated for their accuracy using leave-one-article-out cross-validation procedure. **Results:** A total of 96 articles met the inclusion criteria for meta-analysis and yielded 232 effect sizes. The average effect size was highly significant:  $d = +1.36$  [confidence interval (95% CI) = 1.04–1.68]. Among all the parameters, total energy was found to have the greatest effect on pain relief and had the most prominent optimal ranges of 120–162 and 15.36–20.16 J, which always resulted in large effect sizes. The cross-validation accuracy of the optimal ranges for total energy was 68.57% (95% CI = 53.19–83.97). Fewer and less-prominent optimal ranges were obtained for the energy density and duration parameters. None of the remaining parameters was found to be independently related to pain relief outcomes. **Conclusions:** The findings of meta-analysis indicate that laser phototherapy is highly effective for pain relief. Based on the analysis of parameters, total energy can be optimized to yield the largest effect on pain relief.

**Keywords:** laser phototherapy, meta-analysis, pain relief, parameters

### Introduction

SINCE THE BENEFITS of laser phototherapy for pain relief were first reported more than four decades ago,<sup>1</sup> numerous studies have shown that phototherapy ameliorates pain of various etiologies, including rheumatoid arthritis,<sup>2,3</sup> osteoarthritis,<sup>4</sup> tendinopathies,<sup>5,6</sup> carpal tunnel syndrome,<sup>7</sup> neck pain,<sup>8</sup> low back pain,<sup>9</sup> and Raynaud syndrome.<sup>10</sup> Although the underlying mechanisms for phototherapy-induced pain relief are now clearer,<sup>11–15</sup> the ideal parameters to ensure efficacy of this form of treatment are unclear. A major reason for this lack of clarity is that available studies have used a variety of parameters and reported a wide range of outcomes, including positive and negative results, making it difficult not only to compare studies but also to relate the parameters studied to treatment outcomes. The wide range of parameters and outcomes reported in literature leave the practitioner without a clear knowledge and understanding of effective treatment parameters.

Meta-analysis, a well-established statistical procedure for systematically combining the results of multiple studies to determine an overall treatment effect,<sup>16</sup> has been used to analyze the literature and determine the overall effect of phototherapy on pain.<sup>8,17</sup> Compared with individual studies, combining the results of multiple studies provides a more robust and precise estimate of the true treatment effect size. As an objective statistical procedure, meta-analysis is also more powerful than a simple review of the literature, systematic review, or subjective assessment from multiple studies. Consequently, it has been used to resolve controversies concerning the efficacy of laser phototherapy in clinical practice.<sup>8,17–20</sup>

Even though available meta-analysis studies offer convincing evidence that laser phototherapy is effective for tissue repair and pain relief, further analysis showing therapeutic parameters that could optimize the effect of treatment has not been explored. Consequently, the treatment parameters that could potentially yield the best therapeutic

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