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A scoping review on the use of light therapy in the treatment of moderate to severe depression

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Abstract

This scoping review addresses the efficacy of light therapy for moderate to severe depression, a prevalent mental disorder affecting over 264 million people globally. Given the significant side effects associated with pharmacological treatments, such as low efficacy and adherence, non-pharmacological alternatives like light therapy are gaining prominence. Light therapy offers numerous advantages, including low cost, accessibility, and minimal side effects. Despite its promise, a comprehensive scoping review to identify knowledge gaps has been lacking. This review, therefore, aimed to explore the existing evidence on the efficacy of light therapy for moderate to severe depression and to identify methodological limitations within the literature.

A systematic search of databases including Science Direct, Google Scholar, PubMed, Medline, Web of Science, and Scopus was conducted for studies published between 2011 and 2021. The inclusion criteria encompassed cross-sectional, longitudinal, randomized controlled, and cohort designs, while case-control studies and editorials were excluded.

From the initial search, 16 studies were included in the final analysis. The findings indicate that both artificial and natural light therapy are effective in the short and medium term for treating moderate to severe depression, though long-term efficacy was not established. The review identified several methodological gaps, highlighting the need for more longitudinal and long-term cohort studies. Furthermore, it underscored the necessity of considering light therapy as a "complex intervention," standardizing reporting to address inconsistencies, and establishing a consensus on measurement methodologies to reduce heterogeneity.

1. Introduction

1.1 Background: The Severe Impact of Depression

Depression is a significant global health issue, affecting an estimated 264 million people worldwide (World Health Organisation, 2020a). As a mood disorder, it is characterized by persistent feelings of sadness, despair, and a diminished interest in daily activities, making it a severe mental disorder frequently associated with disability (Richards & O'Hara, 2014; Friedman et al., 2014).

The severity of depression stems from its detrimental impact across multiple domains of an individual's life. It elevates the risk of comorbidities, such as anxiety, and is linked to an increased risk of cardiovascular diseases (Lamers et al., 2011; Singh & Misra, 2009). Socially, it can lead to loneliness and isolation (Joynt et al., 2003). Furthermore, research has demonstrated a negative

correlation between depression and academic achievement (Andrews & Wilding, 2004). Most critically, depression significantly increases the risk of suicide (Wulsin et al., 1999). Given these profound consequences, the need for effective interventions is paramount to support the millions of patients vulnerable to the severe impact of this disorder (WHO, 2020b).

1.2 Limitations of Available Pharmacological Treatments

A wide range of treatments for depression exists, with pharmacological interventions often considered a first-line approach by therapists (Serani, 2011). However, the efficacy of these treatments is the subject of considerable debate (e.g., Krause et al., 2019; Ollendick et al., 2018). For instance, an early meta-analysis of 53 randomised controlled trials (RCTs) questioned the efficacy of Selective Serotonin Reuptake Inhibitors (SSRIs), one of the most prescribed classes of antidepressants (Song et al., 1993; Preskorn et al., 2012).

Further scrutiny comes from a large meta-analysis of 702 RCTs, involving 87,650 patients, which examined the association between pharmacological interventions and suicide (Fergusson et al., 2005). This extensive review concluded that the use of SSRIs is associated with an increased risk of suicide attempts, casting further doubt on their risk-benefit profile. Another significant issue is patient dropout due to a lack of efficacy. A meta-analysis of 63 RCTs comparing SSRIs with tricyclic antidepressants found that 15.4% of patients in the SSRI group and 18.8% in the tricyclic group discontinued treatment for this reason (Song et al., 1993). The authors concluded that while these pharmacological treatments are frequently prescribed, the high dropout rates necessitate the consideration of alternative therapies.

Beyond efficacy, SSRIs are associated with a wide range of side effects, including low energy, anxiety, weight loss, digestive issues, dry mouth, and blurred vision (Acton, 2012). A more serious adverse effect is treatment-emergent sexual dysfunction. A case study reported a 26-year-old man experiencing genital anaesthesia (GA) during treatment with Sertraline, a condition that persisted for six years after treatment termination (Bolton et al., 2006). While a single case study has limited generalisability (Yin, 2009), its findings provide valuable insight and are corroborated by larger-scale research.

A meta-analysis by Serretti & Chiesa (2009), which included primary outcome measures of total treatment-emergent sexual dysfunction, supported these concerns. The analysis found a significantly higher rate of sexual dysfunction for several antidepressants—including fluoxetine, paroxetine, sertraline, and others—compared to placebo, with rates ranging from 25.8% to 80.3%. Although this meta-analysis had limitations, such as varied assessment scales and the inclusion of open-label studies, it highlighted a serious issue associated with antidepressants. Consequently, many scholars argue that the low effectiveness and poor risk-benefit ratio (RBR) of antidepressants demand urgent research into more effective interventions with minimal side effects (Pigott et al., 2010; Richards & O'Hara, 2010).

1.3 Non-Pharmacological Treatments: A Promising Alternative

In response to the limitations of conventional treatments, many researchers have called for the exploration of non-pharmacological interventions, which often present with fewer side effects (Ripoll et al., 2015). Scholars like Walsh (2011) and Cooney et al. (2013) emphasize this need, particularly as first-line treatments like SSRIs have been reported as ineffective for many patients, including those under 18 (NHS, 2018). Furthermore, adherence to traditional medical and

behavioural interventions for depression can be low, especially among adolescents and young adults (Robertson et al., 2015; McQuaid, 2003).

Non-pharmacological treatments encompass a variety of psychosocial, behavioural, cognitive, and lifestyle interventions (Gotlib & Hammen, 2008). Among these, light therapy has emerged as a particularly promising lifestyle-based intervention (Even et al., 2008). In contrast to pharmacological treatments, light therapy is associated with a high adherence rate, largely due to its low cost, daily availability, and accessibility (DeRubeis & Strunk, 2017). While some studies have reported minor side effects such as headaches and eye strain (Terman & Terman, 2005), a randomised controlled trial by Crabtree et al. (2020) compared bright light therapy (n=26) to a dim red light control group (n=25). Using the modified Systematic Assessment for Treatment-Emergent Effects (SAFTEE) scale, the study concluded that bright light therapy did not lead to significant side effects, suggesting that previously reported issues may have been due to excessive, rather than moderate, exposure.

1.4 The Potential of Light Therapy for Depression

The evidence supporting light therapy is growing. An early study found that exposure to bright light for several hours a day for one week significantly reduced depressive symptoms (Kripke et al., 1992). Subsequent research has suggested that the efficacy of light therapy is comparable to that of antidepressants like imipramine and fluoxetine in treating both seasonal and non-seasonal depression (Kripke et al., 1998). Pail et al. (2011) and Niederhofer & von Klitzing (2012) further stressed the promise of bright light therapy for non-seasonal depression.

The mechanism of action is believed to be neurological. Kessler et al. (2003) used Magnetic Resonance Functioning (MRF) and found that light therapy increased neural activity, which is often low in individuals with depression (Quevedo et al., 2019). Evidence also shows a positive correlation between sunlight exposure and levels of 5-HT (serotonin) receptors in the brain, with the effect increasing with light brightness (Lambert et al., 2002; Praschak-Rieder et al., 2008). Since traditional antidepressants work by activating these same serotonin pathways, this provides a plausible biological basis for light therapy's effectiveness (Roth, 2008).

Two meta-analyses of 8 and 19 RCTs, respectively, confirmed that light therapy is an effective treatment for seasonal affective disorder (SAD), for which it is often considered a first-line treatment (Golden et al., 2005; Pjrek et al., 2020; Partonen & Pandi-Perumal, 2010). Its utility extends to non-seasonal affective disorders as well, including major depression, bipolar depression, senile depression, and postpartum depression (Corral et al., 2000; Forbes et al., 2002; Al-Karawi & Jubair, 2016; Kupeli et al., 2018; Zhao et al., 2018). For instance, a 60-day RCT with 122 individuals showed that light therapy significantly reduced symptoms of major depression (d=0.80) to a degree comparable with the antidepressant fluoxetine (Lam et al., 2016).

1.5 Rationale, Aims, and Objectives

The evidence for light therapy in treating depression is considerable and emerging. The field is broad, encompassing various forms of light therapy (e.g., bright light, sunlight, narrow-band blue light) and different types of depression (e.g., Major Depressive Disorder, Bipolar Depression, SAD). While a systematic review is essential for critically analysing evidence, the breadth of the literature suggests that such a review may be premature. A scoping review is a more appropriate initial step, as it serves to map and summarize the available evidence, which can then guide more focused systematic reviews in the future (Booth et al., 2016; Munn et al., 2018).

To our knowledge, no updated scoping review has comprehensively examined the different forms of light therapy for the treatment of depression. This study will fill that void by exploring and mapping the literature, which will help researchers undertake subsequent systematic reviews by providing a summary of existing evidence (Tricco et al., 2016). A primary goal of a scoping review is to identify gaps in the literature, thereby guiding future primary research (Pham et al., 2014). The findings will inform researchers about the depth and breadth of the evidence, clarify how research in this area is typically conducted, and provide an opportunity to make recommendations for future studies.

Therefore, this scoping review aims to explore, map, and summarise the available evidence on the use of different forms of light therapy for moderate to severe depression. It also seeks to identify unanswered questions, methodological gaps, and critically analyse the measures and methods used in previous research to provide valuable recommendations for future studies.

2. Introduction to Key Concepts and Definitions

2.1 Introduction

This chapter aims to familiarise the reader with the fundamental concepts central to this research. It will define depression, discuss its prevalence, and outline its classifications by severity and type. The chapter will also define light therapy, detail its various forms—including lightboxes, blue light, and green light technology—and explore its proposed mechanisms of action. Finally, it will touch upon previous studies to set the stage for the literature review that follows.

2.2 What is Depression?

Depression is a severe and common mental disorder that negatively impacts an individual's thinking, feelings, behaviour, and daily activities (Quevedo et al., 2019). According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), a diagnosis of depression requires a persistent depressed mood or a loss of interest or pleasure in activities, along with several other specific symptoms, for at least two weeks (American Psychiatric Association, 2013).

Clinical depression is distinct from normal sadness, which is a temporary reaction to adverse events. Depression persists for extended periods and impairs daily functioning far beyond the scope of an initial trigger (Gotlib & Hammen, 2008; Richards & O'Hara, 2014). Symptoms include persistent sadness, pessimism, and hopelessness; feelings of guilt, worthlessness, or helplessness; loss of interest in hobbies; fatigue; slowed movement or speech; restlessness and irritability; difficulty concentrating, remembering, or making decisions; sleep disturbances (oversleeping or insomnia); significant appetite or weight changes; unexplained aches and pains; and suicidal thoughts or attempts (Reynolds & Johnston, 2013).

Depression is the most prevalent psychiatric disorder worldwide and the second leading cause of years lived with a disability (YLDs) (Vos et al., 2013; Ferrari et al., 2013). In 2020, its prevalence among UK adults reached 21%, more than doubling since the start of the COVID-19 pandemic (Office for National Statistics, 2020). In the USA, 2017 data indicated a 7.1% prevalence among adults, with higher rates in females (8.7%) than males (5.3%), and the highest prevalence among young adults aged 18-25 (13.1%) (National Institute of Mental Health, 2017).

2.3 Mild, Moderate, and Severe Depression

Depression is clinically classified by severity into three main categories:

- **Mild Depression:** Symptoms are present but do not substantially interfere with daily activities. Individuals may experience a lack of motivation, feelings of hopelessness, irritability, and changes in appetite or sleep. Though symptoms are noticeable, diagnosis can be challenging, but it is generally easier to treat (Knaus, 2006; Wright & McCray, 2011).
- **Moderate Depression:** This level shares symptoms with mild depression but they are more pronounced and begin to cause clear problems at home and work. Additional symptoms can include excessive worry, feelings of worthlessness, and decreased productivity and self-esteem. Diagnosis is more straightforward than with mild depression (Richards & O'Hara, 2014; Gilson & Freeman, 2009).
- **Severe (Major) Depression:** This form includes the symptoms of mild and moderate depression, but they are significantly more intense, noticeable, and debilitating. Episodes can last for six months or longer and may be recurrent. Severe depression can lead to dangerous outcomes such as delusions, hallucinations, and suicidal ideation or behaviours, making rapid diagnosis and treatment critical (McIntyre, 2019; Alpert & Fava, 2014).

2.4 Forms of Depression

Understanding the different forms of depression is relevant as they may show varied responses to treatments like light therapy.

Major Depression

Also known as major depressive disorder (MDD) or classic depression, this form involves severe symptoms that persist for most of the day, nearly every day. These symptoms include gloom, fatigue, sleep disturbances, appetite changes, cognitive difficulties, and thoughts of self-harm, often lasting for weeks or months (National Institute of Mental Health, 2017; Kasper et al., 2003).

Persistent Depressive Disorder

Formerly known as dysthymia, this is a chronic form of depression lasting for at least two years (American Psychiatric Association, 2015). While symptoms may be less intense than in major depression, their persistence can severely disrupt relationships and daily life. Symptoms include deep sadness, low self-esteem, low energy, and social withdrawal. Some individuals experience major depressive episodes on top of dysthymia, a condition known as "double depression" (Beck et al., 2014; Quevedo et al., 2019).

Bipolar Depression, or Manic Depression

Bipolar disorder is a mood disorder defined by alternating episodes of mania or hypomania (elevated mood and energy) and depression (El-Mallakh & Ghaemi, 2007). The depressive episodes can be particularly severe. Manic phases can involve grandiosity, psychosis, and extreme sleeplessness. The disorder is complex, likely stemming from genetic and non-genetic factors (Zarate & Manji, 2009; McManamy, 2009). When four or more mood episodes occur within a year, it is termed rapid cycling (Guyol, 2009).

Depressive Psychosis

This condition occurs when an individual with major depression also experiences psychosis—a loss of contact with reality. It involves hallucinations (sensing things that are not there, such as

hearing voices) and/or delusions (firmly held false beliefs) (Badcock & Paulik, 2019; Waters & Stephane, 2014).

Perinatal Depression

This form of major depression occurs during pregnancy or within one month of childbirth. Postpartum depression specifically refers to the period after birth (Martin, 2012). Hormonal fluctuations during this time can alter brain chemistry, leading to severe symptoms such as anxiety, rage, exhaustion, and thoughts of harming oneself or the baby (Friedmann, 2018; Osmond et al., 2008).

Seasonal Depression

Officially known as major depressive disorder with a seasonal pattern, or seasonal affective disorder (SAD), this type of depression is tied to the seasons (Partonen & Pandi-Perumal, 2010). Symptoms typically begin in the fall and winter, when daylight is limited, and subside in the spring. The symptoms are similar to those of major depression (Muneer, 2018; Stein et al., 2007).

Situational Depression (SD)

Clinically known as adjustment disorder with depressed mood, SD is a short-term, stress-related type of depression triggered by a specific event or trauma, such as a death, divorce, or severe illness (Kohen, 2010). While sadness is a normal reaction to such events, SD occurs when the reaction is excessive and interferes with daily life. Symptoms typically begin within 90 days of the event (Cohen & Galea, 2011; Steen & Thomas, 2015).

2.5 Light Therapy: Definition and Types

Light therapy, or phototherapy, involves exposure to daylight or an equivalent artificial light source as a medical treatment (Sloan, 2020). It is a well-established intervention for seasonal depression and shows increasing promise for non-seasonal forms like major and bipolar depression (Terman & Terman, 2005; Pail et al., 2011).

Lightboxes

Lightboxes are devices that emit high-intensity light (up to 10,000 lux) to mimic daylight. The therapy works by delivering specific forms of artificial light to the retina, which can alter the timing and levels of melatonin (the sleep hormone) and serotonin (a mood-related neurotransmitter) **(Lazzerini et al., 2017).** While white light is common, some research has focused on specific wavelengths, particularly blue (460nm) and green (525nm) light (Wright et al., 2004). There is some debate over which color is most effective, with some studies suggesting green or white light may be preferable to blue light due to the potential role of cone photoreceptors in melatonin suppression (Gooley et al., 2010).

Dawn Simulators

Dawn simulators are devices, often integrated into alarm clocks, that mimic a natural sunrise by gradually increasing light levels for 30 to 120 minutes before waking (Callaghan & Gamble, 2015). They are effective because light signals received in the early morning are particularly potent for entraining the body's internal clock (Hamblin & Huang, 2013). Another related option is Natural Spectrum Light Bulbs (NSLBs), which provide full-spectrum light similar to daylight and can be used in standard lamps.

Blue Light Technology

Research suggests that blue light is superior to other wavelengths in regulating circadian rhythms and suppressing melatonin (Wang et al., 2017). A study on gerbils demonstrated that deprivation of blue light induced depression-like behaviours and reduced serotonin levels, indicating its critical role in mood regulation (Hu et al., 2020).

Green Light Therapy (GLT)

GLT uses green light, which is often associated with a calming, natural effect (Deppe, 2013). One study found that both green and white light therapy reduced depression ratings, although white light was superior for endogenous depression (Stewart et al., 1991). However, another study on older adults found that bright green light did not reduce depression, indicating that results are mixed and more research with diverse populations is needed (Loving et al., 2005).

2.6 The Mechanism of Light Therapy

While the efficacy of light therapy is increasingly recognized, its precise biological mechanism is still under investigation. The leading hypotheses focus on circadian rhythm regulation and Vitamin D production.

The primary theory involves the body's internal clock. Light signals are captured by retinal cells and sent to the suprachiasmatic nuclei (SCN), the brain's master clock that regulates our biologic rhythm (Martel, 2018; Hattar et al., 2003). The SCN is influenced by the timing and dose of light exposure, which in turn regulates the production of melatonin and interacts with serotonergic systems that are crucial for mood (Zeitzer et al., 2005; Stehle et al., 2003). By providing a strong light signal at a consistent time, light therapy can help correct a misaligned or delayed circadian rhythm, which is common in depression.

A second explanation relates to Vitamin D, a nutrient produced by the body in response to sunlight (Feldman et al., 2017). A deficiency in Vitamin D has been linked to depression, and some research suggests that its production is a key mechanism of light therapy (Parker et al., 2017). One meta-analysis found a significant association between Vitamin D supplementation and improved depression scores, with an effect size similar to antidepressants. However, the evidence is not conclusive. Another study found that the link between Vitamin D levels and depression disappeared after accounting for sun exposure, suggesting a complex relationship that requires further study (Knippenberg et al., 2014).

2.7 Conclusion

This chapter has introduced the core concepts necessary to understand the research topic. It has defined depression, outlined its prevalence, and detailed its different classifications by severity and type. The various forms and mechanisms of light therapy—a promising non-pharmacological intervention—have also been explained. This foundational knowledge will provide the context for the methods and findings discussed in the subsequent chapters of this scoping review

3 Methods

3.1 Introduction

The purpose of this chapter is to provide a detailed account of the methods used to conduct the current scoping review. This chapter will elucidate the review questions, protocol, eligibility

criteria, information sources, search strategy, the process for screening and selecting evidence, data charting, and the method of analysis. Furthermore, it will explore the key concepts related to the scoping review design, including its inherent strengths and limitations. A rationale for employing a qualitative/narrative synthesis approach will also be provided. The structure and execution of this review were guided by the methodological framework for scoping reviews established by Arksey and O'Malley.(2005)

3.2 Review Question

Formulating the research question for a scoping review requires careful consideration of its focus, direction, and clarity (Levac et al., 2010). The question must be broad enough to capture the wide range of literature characteristic of this review type (Arksey & O'Malley, 2005). Therefore, this scoping review was guided by two primary research questions designed to comprehensively map the field:

1. What is the available evidence on the use of different forms of light therapy in treating moderate to severe depression, and what are the corresponding unanswered questions and potential gaps in the literature?
2. What are the methods used to conduct research in this area, and what methodological gaps and limitations can be identified from the current body of studies to provide recommendations for future research?

3.3 Protocol

This scoping review meticulously followed the five-stage methodological framework proposed by Arksey and O'Malley (2005). This structured process involved: (1) identifying the research question; (2) identifying relevant studies; (3) study selection; (4) charting the data; and (5) collating, summarising, and reporting the results.

3.4 Design of the Study (Scoping Review)

A scoping review was the chosen research method for this study. A scoping review is a form of knowledge synthesis that aims to map the key concepts underpinning a research area, the main sources and types of available evidence, and the gaps in the literature to inform research, policymaking, and practice (Daudt et al., 2013). This design is exceptionally well-suited to the research questions, which seek to map the evidence on light therapy for depression, identify literature gaps, and explore how research is conducted in this domain (Arksey and O'Malley, 2005).

One of the principal strengths of a scoping review is its capacity to cover a wide range of studies, thereby revealing the scope, breadth, and nature of evidence on a topic (Munn et al., 2018). This contrasts with systematic reviews, which typically have a much narrower and more focused scope (Garrard, 2020). Scoping reviews are more appropriate for the stated research questions because they can accommodate a diversity of study methodologies and designs (Arksey and O'Malley, 2005). In contrast, systematic reviews employ reproducible methods to identify, select, and critically appraise relevant literature to synthesise data from a smaller, more homogenous set of included studies (Chandler et al., 2019).

Moreover, scoping reviews aim to provide a descriptive overview of the included articles without critically appraising individual studies or synthesising evidence from different studies into a single statistical result (Levac et al., 2010; Arksey and O'Malley, 2005). Instead, they critically analyse

the literature as a whole, focusing on identifying overarching methodological gaps and unanswered questions, which directly aligns with the objectives of this study. The scoping review method is also advantageous as it can explore the nature and volume of available evidence, thereby informing researchers about areas where further primary research is needed (Pham et al., 2014; Munn et al., 2018).

Colquhoun et al. (2014) argued that a scoping review is the preferred approach when a research area is vast, and the available studies are heterogeneous in their design or findings. They also stressed that this methodology is particularly beneficial when there is a lack of comprehensive reviews on a topic. To our knowledge, no scoping reviews have specifically addressed the use of light therapy for moderate to severe depression, making this study a timely and necessary contribution.

However, the use of a scoping review is not without limitations. This approach can be demanding in terms of time and resources due to its characteristically broad inclusion criteria (Tricco et al., 2016). The wide range of sources and information can also make it challenging to access and synthesise information in a fully systematic manner, particularly when covering multiple facets of a topic, such as the various forms of light therapy and depression (Munn et al., 2018). Despite these challenges, a scoping review remains the most effective approach for identifying gaps in the literature, exploring the current state of knowledge, and examining the different methods used across studies in a complex field (Oliver, 2012; Garrard, 2020).

3.5 Qualitative/Narrative Synthesis Approach

This scoping review employed a qualitative/narrative approach for data synthesis. This means that while studies with qualitative, quantitative, and mixed-methods designs were included, their findings were discussed and summarised narratively rather than being combined through statistical analysis. This approach, which draws on interpretivist methods, allows for a rich and explanatory exploration of concepts, ideas, and phenomena, which can result in a deeper understanding of the research area (Maxwell, 2012; McCusker & Gunaydin, 2015.(

Furthermore, a qualitative synthesis allows for the exploration of the research area within its context, increasing the relevance of the findings (Ritchie et al., 2012). Given that depressive symptoms are a profoundly personal experience, a narrative design that can capture this nuance is highly appropriate for this scoping review (Merriam & Tisdell, 2015). On the other hand, this approach has limitations; it may involve a subjective interpretation of findings, which could potentially affect the reliability and validity of the review (Silverman, 2017.(

Eligibility Criteria

In accordance with best practice, the eligibility criteria were designed to be as unambiguous and transparent as possible and are consistent with the research questions (Peters et al., 2020). The PCC (Population, Concept, and Context) framework, recommended by the Joanna Briggs Institute, was used to structure these criteria (Peters et al., 2015).

- Population :The population for this review comprised patients with any form of moderate to severe depression, including bipolar disorder, perinatal depression, seasonal affective disorder (SAD), and major depression. While studies on bipolar depression were included, the primary focus remained on depressive symptoms rather than manic or hypomanic states. Studies focusing exclusively on mild or subthreshold depression were excluded.

This decision was made because treatments effective for mild depression are not necessarily effective for more severe forms, given the difference in symptom intensity (Tacchi & Scott, 2017). This exclusion also served to sharpen the focus of the review (Garrard, 2020). There were no restrictions based on age or gender, except for the exclusion of studies focused on children younger than 11 years, which was a practical step to narrow the scope.

- Concept :The central concept was light therapy. To ensure the review captured the full breadth of evidence, all forms of light therapy were included, such as bright white light therapy, sunlight therapy, blue narrow-band light-emitting diodes (LEDs), and infrared radiation (Booth et al., 2016). This broad definition aligns with the primary purpose of a scoping review, which is to explore the full scope of evidence rather than maintaining a narrow focus (Munn et al., 2018).
- Context :There were no restrictions on context. Studies conducting light therapy in natural or artificial settings, in hospitals or at home, were included. Similarly, there were no restrictions on geographic location or socioeconomic status. This approach helps to explore the full breadth and width of the evidence on the topic (Aveyard, 2018).

Regarding the forms of evidence, both primary and secondary research were included. Primary research designs such as qualitative, quantitative, mixed-methods, cohort, randomised controlled trials, longitudinal, and cross-sectional studies were eligible. These designs were prioritised as they generally offer higher quality evidence and a lower risk of bias compared to editorials, case series, case reports, or expert opinions, which were excluded (Hoffmann et al., 2013). Secondary research, such as systematic reviews, was also included, as these can help inform future updates to outdated reviews (Garrard, 2020).

Grey literature (e.g., theses, dissertations, reports) was not included due to constraints on time and effort, as well as the fact that such findings are often not peer-reviewed (Bonato, 2018; Efron & Ravid, 2018). Books were also excluded as they fell outside the scope of this review and are not typically peer-reviewed (Oliver, 2012).

The review was limited to studies published in the English language. This was a practical necessity, as the researcher does not have proficiency in other languages, and the cost of translation services was prohibitive. This is a recognised limitation of the current study (Hart, 2018).

Exclusion	Inclusion	Criteria
Mild depression (subthreshold depression).	Patients with moderate to severe depression. Participants aged 11 years and older.	Population
Other treatments for depression.	Any form of light therapy.	Concept

No restrictions.	All contexts are included (hospital or home setting).	Context
Studies published before 2011.	.2021–2011	Year of Publication
Grey literature, books, editorials, case series.	Quantitative, qualitative, mixed-method design, cohorts, observational studies, longitudinal studies, cross-sectional studies, case-control studies, and systematic reviews.	Study Design
Studies published in other languages.	English language.	Language
Available only in the abstract, or the full content is unavailable.	Available in full content.	Content

Information Sources and Identification of Relevant Papers

To ensure a comprehensive search of the relevant evidence, a wide range of information sources and databases was utilised (Arksey & O'Malley, 2005). Scoping reviews must balance breadth with feasibility (Courtney & McCutcheon, 2010). This review used several data sources, including Google Scholar, the Bangor University library, PsycInfo, Web of Science, Science Direct, Wiley Online Library, and Scopus. Databases such as Science Direct, PubMed, and Scopus were chosen for their extensive libraries and their use of MeSH (Medical Subject Headings), which facilitates systematic and efficient searching by categorising articles with defined labels (Aveyard & Payne, 2016; Harpring, 2010). Although a large scoping review often benefits from an experienced team (Thomas et al., 2017), this research was conducted solely by the author, who consulted with a librarian and supervisor as needed, per the recommendation of Pham et al. (2014). In addition, the reference lists of all retrieved papers were hand-searched to increase familiarity with the evidence and identify any additional relevant studies (Arksey & O'Malley, 2005.(

3.6 Search Strategy

Essential synonyms and keywords were used in the search process. Database filters were set for studies published in English between 2011 and 2021. The search was further restricted to peer-reviewed papers available in full text. Search terms were organised into two groups and combined using Boolean operators.

Group 2 (Condition)	Group 1 (Intervention)

depression OR depressive symptoms OR bipolar depression OR Persistent depression OR perinatal depression OR Major depression OR seasonal depression OR non-seasonal depression OR Moderate depression OR severe depression	Light therapy OR blue light therapy OR bright light therapy OR sunlight exposure OR narrow-band blue-light therapy OR Infrared light OR Red light therapy OR Green light OR Bright green light

The search process involved picking and combining a keyword from the first group with one from the second group (e.g., “light therapy” AND “depression”; “light therapy” AND “bipolar depression”), and this was repeated for all relevant combinations.

3.7 Selection of Source of Evidence

A two-phase screening process was used to select the final studies (Dawidowicz, 2010). In the first phase, the titles and abstracts of all retrieved papers were screened against the inclusion criteria. If a paper seemed to meet the criteria, it moved to the second phase, which involved a full-text screening to make a final determination of eligibility. Studies had to meet all eligibility criteria to be included. Although a two-reviewer process is recommended to minimise bias (Peters et al., 2017), this was not feasible. To ensure transparency, the reasons for excluding papers at the full-text stage were documented, and the entire screening process was summarised using a PRISMA flow diagram (Moher et al., 2009).

3.8 Charting the Data

Charting the data is an iterative process that involves extracting key characteristics from the included studies and summarising the relevant data narratively (Peters et al., 2015; Levac et al., 2010). For this review, data from the included papers were extracted manually into an Excel spreadsheet. Manual extraction was chosen over software packages to enhance the researcher's familiarity with the retrieved studies (Boland et al., 2014). The extracted data included: first author and year of publication, study design, sample characteristics (population, gender, age, country ,and setting), study objectives, intervention details, comparison group (if any), outcomes, research implications, and conclusions. For studies with a longitudinal design, the length of the follow-up period was also recorded.

3.9 Collation, Synthesis, and Reporting of Results

A thematic analysis was used to summarise and interpret the findings from the included studies. Thematic analysis is a flexible and accessible method suitable for providing a rich, detailed account of data from large and diverse datasets, making it an appropriate choice for a qualitative synthesis of both quantitative and qualitative evidence (Guest et al., 2011; Braun & Clarke, 2006). This method is particularly useful for identifying commonalities and differences across studies and generating unexpected insights (Gavin, 2008).

The analysis followed the six stages outlined by Braun and Clarke:(2014)

1. Familiarisation with data :Reading and re-reading the findings of the included studies to become deeply familiar with the content.
2. Generating initial codes :Systematically identifying and coding interesting features of the data.
3. Searching for themes :Collating codes into potential themes.
4. Reviewing themes :Checking if the themes work in relation to the coded extracts and the entire data set.
5. Defining and naming themes :Ongoing analysis to refine the specifics of each theme and the overall story the analysis tells.
6. Producing the report :The final analysis, which involves writing a scholarly report of the findings.

While the flexibility of thematic analysis can be challenging for novice researchers, this was mitigated by adhering to established guidelines and maintaining a clear epistemological perspective to ensure coherence (Willig, 2013; Holloway & Todres, 2003.(

3.10 Consultation

The consultation stage, which can involve engaging with stakeholders to inform or validate the review's findings, is considered optional in the Arksey and O'Malley (2005) framework. Given the limited resources available for this project, this stage was not conducted.

3.11 Conclusion

In conclusion, this study employed a scoping review methodology to map the available literature on the use of light therapy for moderate to severe depression and to identify gaps in current research. A qualitative approach to synthesis, specifically thematic analysis, was used to interpret the findings from the included studies. The entire process was structured according to the guide provided by Arksey and O'Malley (2005) and reported with the aid of the PRISMA statement to ensure a rigorous and transparent methodological approach.

4. Results

4.1 Search and Selection of Studies

The initial database search identified a total of 426 records. After the removal of 156 duplicates, 270 unique studies were advanced to the screening stage. During the initial screening of titles and abstracts, 130 papers were excluded as they did not meet the eligibility criteria. This left 140 studies for full-text eligibility assessment. Following a thorough review of the full-text articles, an additional 122 papers were excluded for various reasons, such as focusing on mild depression, examining other treatments, or not being available in full text. Ultimately, 16 studies met all eligibility criteria and were included in the final qualitative synthesis.

4.2 Key Characteristics of Included Studies

The 16 included studies focused on the use of light therapy for moderate to severe depression, demonstrating significant heterogeneity in design, population, and intervention protocols.

Focus of Research :The studies covered a range of depressive disorders. Five studies examined the efficacy of bright light therapy for bipolar depression (Dauphinais et al., 2012; Sit et al., 2018; Esaki et al., 2019; Kupeli et al., 2018; Zhou et al., 2017). Two studies focused on seasonal affective disorder (SAD) (Uzoma et al., 2015; Reeves et al., 2012), while five investigated non-seasonal major depression (Demirkol et al., 2019; Lam et al., 2016; Lieverse et al., 2011; Kirschbaum-Lesch et al., 2018; House & Walton, 2018). Several studies explored light therapy in combination with other treatments; four examined it as an adjunctive therapy to pharmacological treatment (Kupeli et al., 2018; Zhou et al., 2017; Demirkol et al., 2019; Lam et al., 2016), and three investigated its combination with wake therapy (Danilenko et al., 2019; Kirschbaum et al., 2018; Kragh et al., 2017a, 2017b). Other specific areas of focus included the impact of light therapy on sleep patterns (Sit et al., 2018; Kirschbaum et al., 2018), its efficacy in a naturalistic setting (Esaki et al., 2019), its immediate effects (Reeves et al., 2012), and a comparison of its efficacy between Caucasian and African American populations (Uzoma et al., 2015).

Study Design and Location :The methodological approaches were diverse. The review included eight randomised controlled trials (RCTs), with some being double-blind and placebo-controlled (Sit et al., 2018; Lieverse et al., 2011) or single-blind (Zhou et al., 2017). Other designs included a cross-sectional study (Esaki et al., 2019), a mixed-method design (Uzoma et al., 2015), a qualitative study (Kragh et al., 2017a), a cross-over design (Reeves et al., 2012), and several prospective or non-randomised trials. Geographically, the research was predominantly conducted in developed countries, with five studies from the USA, two from Germany, two from Denmark, two from Turkey, two from Japan, and one each from Russia, the Netherlands, and Canada.

Participant Characteristics :The sample sizes of the included studies ranged from 27 (Uzoma et al., 2015) to 181 participants (Esaki et al., 2019). The majority of studies (n=11) recruited adults aged 18 or older. However, the review also captured research on specific age groups, including two studies with adolescents (Kirschbaum et al., 2018; Kirschbaum-Lesch et al., 2018), one with young adults aged 19-21 (House & Walton, 2018), and one exclusively with older adults aged 60 and above (Lieverse et al., 2011). Studies were conducted in both inpatient (e.g., Kirschbaum et al., 2018) and outpatient settings (e.g., Esaki et al., 2019.(

Intervention and Outcome Measures :There was significant heterogeneity in the intervention protocols. The intensity of bright light therapy varied from 1,000 lux in a natural light study (Esaki et al., 2019) to a standard 10,000 lux in several others (e.g., Kragh et al., 2017b; Reeves et al., 2012). Treatment durations ranged from a single one-hour session (Reeves et al., 2012) to nine weeks (e.g., Kragh et al., 2017a).

A wide array of outcome measures was used to assess depression. The Hamilton Depression Rating Scale (HDRS) was the most frequently used tool (n=6), followed by the Montgomery–Åsberg Depression Rating Scale (MADRS) (n=3) and the Beck Depression Inventory (BDI), which was used alone or in combination with other scales in several studies. Some studies also incorporated objective measures, such as melatonin and cortisol levels (Lieverse et al., 2011) or actigraphy for sleep patterns (Kirschbaum et al., 2018), as well as measures for quality of life (Dauphinais et al., 2012) and side effects.

4.3 Thematic Analysis of Findings

The synthesis of the 16 included studies yielded nine prominent themes related to the efficacy, application, and experience of light therapy for moderate to severe depression.

Artificial Light Therapy is an Effective Treatment in the Short and Medium Term

The majority of the reviewed studies concluded that light therapy is an effective intervention for depression. Its efficacy was demonstrated across various forms, including bipolar depression (Sit et al., 2018; Kupeli et al., 2018; Zhou et al., 2017), unipolar depression (Danilenko et al., 2019), seasonal depression (Uzoma et al., 2015; Reeves et al., 2012), and non-seasonal depression (Demirkol et al., 2019; Lam et al., 2016; Lieverse et al., 2011). Only one study reported a lack of statistically significant findings, which the authors attributed to a high placebo effect (Dauphinais et al., 2012). A key finding was the rapid onset of the antidepressant effect, with some studies noting improvements after just one hour (Reeves et al., 2012), four hours (Danilenko et al., 2019), or a single night of treatment (Kirschbaum et al., 2018). However, the long-term efficacy of light therapy was questionable. For instance, Kragh et al. (2017b) found that the initial antidepressant effect failed to persist throughout the nine-week study period, suggesting that benefits may wane over time.

Natural and Real-Life Light Therapy Can Also Be Effective

Only one study in this review examined the efficacy of natural, real-life light exposure. This cross-sectional study found that exposure to daytime light of at least 1,000 lux was an effective treatment for bipolar depression (Esaki et al., 2019). This finding is particularly significant as it suggests a highly accessible and low-cost alternative to formal lightbox therapy.

Light Therapy May Be Effective for Different Levels of Depression

The evidence suggests that light therapy is effective for both moderate and severe depression. For example, Zhou et al. (2017) demonstrated its effectiveness in treating severe forms of depression, although their follow-up was only two weeks. Similarly, Kragh et al. (2017b) showed that a combination of wake and light therapy could be effective for both moderate and severe depression. However, the lack of long-term follow-up in most studies means that the sustained efficacy for severe depression remains an area needing further investigation.

Light Therapy is an Effective Adjunctive Treatment

Several studies highlighted the value of light therapy as an adjunctive or add-on treatment. It was shown to be effective when used alongside pharmacological treatments for non-seasonal depression (Demirkol et al., 2019; Lam et al., 2016) and bipolar depression (Zhou et al., 2017; Kupeli et al., 2018). This suggests that light therapy can be successfully integrated into existing treatment plans to enhance therapeutic outcomes.

The Combination of Wake Therapy and Light Therapy is Promising in the Short Term

Three studies investigated the combination of wake therapy (sleep deprivation) with light therapy and found it to be an effective intervention for depression in the short term (Danilenko et al., 2019; Kirschbaum et al., 2018; Kragh et al., 2017a). The antidepressant effect of this combination therapy was often rapid, with improvements seen after the first night or within the first week (Kirschbaum et al., 2018; Kragh et al., 2017b). However, one study noted that this initial improvement was not

maintained beyond the first week, again raising questions about the long-term sustainability of the effects (Kragh et al., 2017b).

Light Therapy is a Safe, Acceptable, and Feasible Treatment

A consistent theme across the reviewed literature was that light therapy is a safe, well-tolerated, and highly acceptable treatment for patients with moderate to severe depression (Uzoma et al., 2015). It is considered inexpensive and feasible to implement. Kragh et al. (2017a), in their qualitative study, found that patients firmly accepted and supported the treatment. While some studies noted high remission rates, such as Sit et al. (2018) where 68.2% of participants in the bright light group achieved remission, others found more modest rates, highlighting variability in outcomes.

Light Therapy is Effective Across Different Age Groups

The reviewed studies suggest that light therapy is an effective treatment for patients of different ages. While the majority of research focused on adults aged 18 and older, specific studies successfully demonstrated its efficacy in adolescent populations (House & Walton, 2018; Kirschbaum et al., 2018; Kirschbaum-Lesch et al., 2018) and in older adults (Lieverse et al., 2011). This broad applicability enhances its potential as a widely applicable intervention.

Light Therapy Can Improve Sleep and Endocrine Function

Several studies indicated that light therapy has a positive impact on sleep and related biological markers. Lieverse et al. (2011) found that light therapy improved sleep efficiency and increased melatonin levels. The combination of light and wake therapy was also shown to improve sleep efficacy (Kirschbaum et al., 2018; Kragh et al., 2017a; House & Walton, 2018), suggesting that its mechanism may be partly mediated through the regulation of sleep-wake cycles and associated hormones.

Social Support is Important for Adherence

One qualitative study provided unique insight into the psychosocial factors influencing treatment success. Kragh et al. (2017a) found that social support from family, friends, and peers was an essential determinant of adherence to light therapy. This suggests that the context in which light therapy is administered can significantly impact its effectiveness.

Critical Analysis of Included Studies

A critical analysis of the included studies reveals several overarching strengths and limitations within the body of evidence.

Strengths : A significant portion of the evidence base is built on RCTs, many of which employed robust methodological features such as randomisation, blinding, and allocation concealment to reduce bias (e.g., Sit et al., 2018; Lieverse et al., 2011). The use of validated and reliable measures for depression, such as the HDRS and BDI, was common, lending credibility to the findings (Trajković et al., 2011). Some studies enhanced their rigour by using objective measures like actigraphy or hormonal assays (Esaki et al., 2019; Lieverse et al., 2011), and a few used a naturalistic approach, which increases the real-world applicability of the findings (Kirschbaum-Lesch et al., 2018).

Limitations : Despite these strengths, several methodological limitations were prevalent. Small sample sizes were a common issue, potentially reducing the statistical power of some studies and limiting their ability to detect true effects (e.g., Kupeli et al., 2018; Danilenko et al., 2019). Several studies were open-label or single-blind, increasing the risk of experimenter bias or placebo effects (e.g., Kupeli et al., 2018; Uzoma et al., 2015).

A major limitation across the board was the short duration of both the interventions and the follow-up periods. Most studies lasted for only a few weeks, with the longest follow-up being nine weeks. This makes it impossible to draw firm conclusions about the long-term efficacy of light therapy. Additionally, some studies had high dropout rates or did not adequately control for confounding variables, such as changes in medication during the trial period, which could affect the validity of the results (Kragh et al., 2017a). The reliance on self-reported data in some studies also introduces the potential for response bias (House & Walton, 2018). Finally, the lack of control groups in some prospective trials makes it difficult to draw meaningful conclusions about the intervention's specific effects (Kirschbaum-Lesch et al., 2018).

5 Discussion

5.1 Introduction

The primary objective of this scoping review was to explore the current state of evidence regarding the use of light therapy for moderate to severe depression. In doing so, it aimed to identify unanswered research questions, map the scope of the existing literature, and examine the methodologies employed in this field. This chapter discusses the key findings synthesised from the included studies, addresses the review's main aims by interpreting these findings in the context of the broader literature, and identifies critical methodological gaps that can inform future research.

5.2 Light Therapy as an Effective Short-Term Treatment

A central finding of this scoping review is that light therapy is an effective treatment for moderate to severe depression, particularly in the immediate and short term. The evidence synthesised from the included studies demonstrates that light therapy can significantly reduce depressive symptoms across a range of conditions, including unipolar depression (Danilenko et al., 2019), bipolar depression (Kupeli et al., 2018; Zhou et al., 2017; Sit et al., 2018), seasonal depression (Reeves et al., 2012; Uzoma et al., 2015), and non-seasonal depression (Lam et al., 2016; Lieverse et al., 2011; Demirkol et al., 2019). This conclusion is consistent with a broader body of literature, including other reviews and meta-analyses that have affirmed the efficacy of light therapy for both seasonal and non-seasonal depressive disorders (**Martensson et al., 2015;** Baxendale et al., 2013; Chojnacka et al., 2016).

Further supporting these findings, a meta-analysis by Tseng et al. (2016), which included 489 patients with bipolar depression, reported that light therapy resulted in a significant reduction in depression severity, both with and without concomitant medication or total sleep deprivation. The review also found that augmentation with light therapy significantly reduced depression severity compared to treatment without it ($p=0.024$).

Particularly noteworthy is the rapid onset of the antidepressant effect. Several studies included in this review reported a noticeable improvement in symptoms after very short exposure times, such as a single hour (Reeves et al., 2012), four hours (Danilenko et al., 2019), or one night of treatment (Kirschbaum et al., 2018). This aligns with earlier research suggesting that the antidepressant

impact of bright light therapy can emerge within the first few days of treatment and is often clearly observable within the first week (**Tuunainen et al., 2004;** Terman & Terman, 2005; Golden et al., 2005). This rapid action represents a significant clinical advantage, particularly for patients in acute distress.

5.3 The Gap in Long-Term Efficacy and the Need for Longitudinal Studies

Despite the robust evidence for its short-term effectiveness, a significant gap exists regarding the long-term efficacy of light therapy. This review found a conspicuous lack of studies with extended follow-up periods. The longest treatment and follow-up duration among the included studies was nine weeks (Kragh et al., 2017a, 2017b; Kirschbaum-Lesch et al., 2018), which is insufficient to draw conclusions about long-term outcomes.

Critically, the limited evidence available raises questions about the sustainability of the treatment effects. Kragh et al. (2017b) reported that the initial benefits of a combined wake and light therapy intervention could not be maintained throughout the nine-week study period. This finding suggests that the antidepressant effects may wane over time. This aligns with the argument put forward by Rohan et al. (2007) that light therapy may function as a palliative treatment—one that effectively relieves symptoms but does not cure the underlying disorder. For conditions like SAD, this implies that depressive symptoms are likely to recur each winter, thereby questioning the long-term curative power of the intervention. The potential for light therapy to precipitate hypomania is another long-term consideration that requires further investigation (Tuunainen et al., 2004; Sit et al., 2007).

This lack of long-term data represents a major gap in literature. There is an urgent need for more studies with longer follow-up periods (e.g., one, two, or more years) to determine if the benefits of light therapy can be sustained. Such studies should also examine factors that might enhance long-term impact, such as the total length of the intervention period and the intensity of the light used.

5.4 The Potential of Natural and Lower-Intensity Light Therapy

An important and promising finding from this review was that exposure to uncontrolled, natural daytime light could significantly reduce depressive symptoms (Esaki et al., 2019). In this study, the light intensity was approximately 1,000 lux, which is considerably lower than the 10,000 lux standard used in many clinical trials (e.g., Kragh et al., 2017b; House & Walton, 2018). This suggests that effective treatment may not require high-intensity, artificial light sources, which has significant implications for accessibility and cost.

This finding is consistent with other research exploring the benefits of natural sunlight. A single-blind RCT by Wang & Chen (2020) found that daily sunlight exposure for one month reduced depression, enhanced mood, and increased daily activity in post-stroke patients. This raises the possibility that the antidepressant effect of natural light may be mediated not only by the light itself but also by the accompanying increase in physical activity. A meta-analysis by Rebar et al. (2015) found that physical activity has a medium effect on decreasing depressive symptoms, suggesting that it could be a confounding or mediating variable in studies of natural light exposure. The finding that lower-intensity light may be effective also reveals a gap in the literature regarding the

optimal dose of light therapy. Further research is needed to explore the efficacy of intensities both lower than 1,000 lux and potentially higher than 10,000 lux.

5.5 Mechanisms of Action: A Complex and Multifaceted Picture

The exact mechanism by which light therapy exerts its antidepressant effect remains largely unknown and is likely multifaceted. One of the leading theories centres on the regulation of circadian rhythms. The response to morning light therapy in non-seasonal depression (Lam et al., 2016) and SAD (Lewy et al., 2009) is often attributed to a corrective phase shift in the body's internal clock. The finding from this review that light therapy can improve sleep efficacy and increase melatonin levels supports this hypothesis (Lieverse et al., 2011; Kirschbaum et al., 2018).

However, the mechanism in bipolar depression appears more complex. While morning light is effective, some research suggests that midday light therapy can also yield strong antidepressant effects, possibly with a milder impact on the circadian system, which may reduce the risk of inducing hypomania or mixed states (Sit et al., 2018; Hashimoto et al., 1997). This suggests that the timing of the intervention may need to be tailored to the specific type of depression.

Other proposed mechanisms involve various neurobiological systems. Some researchers have linked the effect to changes in glucose metabolism in the brain (Hirakawa et al., 2018) or to increased serotonin turnover, which is known to be lower in winter and higher on sunny days (Lambert et al., 2002). There is also growing interest in the role of dopamine, particularly in depression with seasonal patterns, where links have been found between dopamine receptors and symptoms like binge eating (Levitan et al., 2004). The diversity of these proposed mechanisms suggests that light therapy likely acts on multiple pathways, and it remains unclear which of these is the primary driver of its antidepressant effect. Future research is needed to disentangle these mechanisms and determine how they might differ across various forms of depression.

5.6 Efficacy Across Different Age Groups

This scoping review found that light therapy is an effective intervention for patients across different age groups. While the majority of the included studies focused on adults, several demonstrated its efficacy in young people and adolescents (Kirschbaum et al., 2018; House & Walton, 2018; Kirschbaum-Lesch et al., 2018). Importantly, one study specifically recruited older adults and also found the treatment to be effective (Lieverse et al., 2011). This broad applicability is a significant strength of the intervention. However, the limited number of studies focusing exclusively on older adults represents a gap in the literature, and more research is needed in this specific population.

5.7 Safety, Acceptability, and Adherence

A consistent finding across the reviewed studies was that light therapy is a safe, well-tolerated, and acceptable treatment for most patients with moderate to severe depression (Uzoma et al., 2015; Kragh et al., 2017a). Compared to pharmacological antidepressants, light therapy is associated with more benign side effects, which may contribute to higher levels of adherence (Lam et al., 2006). While some side effects like autonomic hyperactivation or emergent hypomania have been reported, particularly in the initial days of treatment, they are generally minimal (Terman & Terman, 2005.(

Remission rates reported in the included studies were variable but often substantial. For example, Sit et al. (2018) found that 68.2% of patients with bipolar depression achieved remission with bright light therapy, while Kupeli et al. (2018) reported an 81% response rate. These high response and remission rates, combined with its safety profile, make light therapy an attractive treatment option.

5.8 The Importance of Social Support and Combination Therapies

One of the unique findings of this review was the identification of social support as a critical factor for maximising the efficacy of light therapy. The qualitative study by Kragh et al. (2017a) revealed that support from friends, family, and peers was a powerful motivator for treatment compliance. This highlights the importance of considering the psychosocial context in which light therapy is delivered. This finding can be understood through the lens of the Theory of Planned Behaviour, where subjective norms—the perceived social pressure to perform a behaviour—strongly influence behavioural intentions (Ajzen, 2011). Similarly, the therapeutic alliance between the patient and the therapist is a known predictor of treatment adherence and outcomes in psychotherapy (Sharf et al., 2010), and it is likely a crucial, though under-studied, factor in light therapy as well.

This review also found that combination therapies may be particularly promising. The combination of light therapy with wake therapy was shown to be effective in the short term, although its long-term benefits are questionable (Kirschbaum et al., 2018; Kragh et al., 2017b). The use of light therapy as an adjunctive treatment with medication also demonstrated strong results. This suggests that light therapy can be effectively integrated into a multi-modal treatment plan.

5.9 Conclusion

In conclusion, this scoping review demonstrates that light therapy is an effective, safe, and well-tolerated treatment for moderate to severe depression in the immediate and short term. Its rapid onset of action and applicability across various depression subtypes and age groups make it a valuable clinical tool. The findings also highlight the potential of lower-intensity, natural light exposure as a highly accessible intervention. However, the evidence base is marked by a significant lack of long-term studies, which is a critical gap that must be addressed to understand the sustainability of its effects. The mechanisms of action are complex and likely involve a combination of circadian, neuroendocrine, and neurotransmitter system modulation. Future research should focus on conducting longitudinal studies, standardising intervention protocols and outcome measures, and exploring the efficacy of light therapy in diverse populations and for under-researched forms of depression. By addressing these gaps, the full potential of light therapy as a mainstream, evidence-based treatment for depression can be realised.

6 Conclusion

6.1 Introduction

This final chapter provides the concluding remarks of the scoping review, with a primary focus on presenting the key research implications and recommendations for future studies that have emerged from the synthesis of evidence. It also offers a transparent assessment of the strengths

and limitations of this review, situating its findings within a clear methodological context. Finally, it presents an overall conclusion, summarising the current state of knowledge on the use of light therapy for moderate to severe depression and its place within the broader landscape of mental health treatment.

6.2 Research Implications and Recommendations for Future Research

This scoping review has successfully mapped the existing literature on light therapy for moderate to severe depression, and in doing so, has revealed several critical gaps and methodological shortcomings. These findings give rise to a wide range of recommendations and research implications designed to guide the next phase of inquiry in this promising field.

The Imperative for Longitudinal Research

A primary and urgent recommendation is the need for studies with significantly longer follow-up periods. The current evidence base, as synthesised in this review, is heavily weighted towards short-term outcomes. The longest follow-up period identified was only nine weeks (Kragh et al., 2017a; Kragh et al., 2017b; Kirschbaum-Lesch et al., 2018), with most other studies having even shorter durations. Consequently, while the efficacy of light therapy in the short term is well-supported, its effectiveness in the long term cannot be guaranteed. According to Menard (2007), studies with longer follow-ups are of higher quality as they can determine whether an intervention's impact is sustained over time. Therefore, future research must incorporate longer follow-up periods (e.g., one, three, or five years) to ascertain the durability of light therapy's antidepressant effects. This would also allow researchers to examine whether extending the duration of the treatment itself influences long-term outcomes.

Enhancing Methodological Rigour: Sample Size, Design, and Diversity

Several aspects of study design require attention to advance the field. First, future research must consider the optimal sample size. This review found that the majority of studies on light therapy for depression have recruited small samples, with the largest being 181 participants (Esaki et al., 2019). Studies with small samples have low statistical power, which reduces their ability to detect a true effect and increases the risk of a Type II error—a false negative conclusion (Blumberg et al., 2014; Mackey & Gass, 2011). While excessively large samples can also be problematic, wasting resources and potentially inflating the significance of minuscule differences (Pajo, 2017; Zikmund et al., 2013), a well-justified, larger sample size allows for a more accurate estimation of the treatment effect and enhances the generalisability of the findings (Tracy, 2019; Chapman et al., 2005). Researchers should therefore strive for a balance, ensuring their samples are large enough to detect clinically meaningful differences without being unnecessarily large (Sekaran & Bougie, 2019.(

Second, there is a need for greater diversity in research designs. This review identified only one qualitative study (Kragh et al., 2017a) and one mixed-methods study (Uzoma et al., 2015). Qualitative research is highly relevant for this topic, as it can illuminate patients' lived experiences, attitudes, and preferences regarding light therapy through methods like open-ended interviews (Merriam & Tisdell, 2015; Maxwell, 2012). This can provide a deeper understanding of the human experience of the treatment (Creswell & Creswell, 2017). Similarly, mixed-methods designs offer a holistic approach by combining the strengths of both qualitative and quantitative methods, allowing researchers to counter the limitations of each and compare results for a more comprehensive understanding (Tashakkori & Teddlie, 2010; Clark & Ivankova, 2015.(

Third, the efficacy of light therapy needs to be examined in more diverse populations. The majority of studies were conducted in the USA and Germany. There is a pressing need for research in other regions, such as the Middle East and Africa, as cultural factors, such as openness to experience, may influence adherence to and acceptance of a novel treatment like light therapy (Leary & Hoyle, 2009; Fischer, 2017). Furthermore, the natural intensity of sunlight varies significantly across a "sunshine belt" in these regions compared to many Western countries, which could have profound implications for the efficacy of natural light interventions. The evidence base must also be expanded to better understand the effects of treatment in specific age groups. While this review found that light therapy is effective in adolescents and older adults, more studies focusing exclusively on these populations are needed to account for potential differences in acceptance and biological response, such as the age-related decline in openness to experience (Schwaba et al., 2018.(

Addressing Gaps in the Scope of Research

This review revealed that the current research has predominantly focused on bipolar depression, seasonal depression, and non-seasonal major depression. There is a significant lack of studies examining the efficacy of light therapy for other individual types of depression, such as postpartum depression, persistent depressive disorder (dysthymia), psychotic depression, situational depression, and treatment-resistant depression. Future research should aim to fill these gaps to build a more comprehensive evidence base. It would also be beneficial to conduct studies that separately analyse the efficacy of light therapy for moderate versus severe depression to understand if the treatment effect varies by baseline severity. Furthermore, while most studies focused on efficacy, there is a need for more research dedicated to examining other important factors, such as acceptability, feasibility, safety, and the impact of the therapeutic alliance and social support on treatment outcomes.

Recognising Light Therapy as a Complex Intervention

An important implication from this review is that light therapy should be understood and studied as a complex intervention. Unlike simple interventions with a linear causal pathway, complex interventions involve multiple interacting components, and their outcomes are influenced by a range of factors, including individual patient characteristics, social context, and the therapeutic alliance (Petticrew, 2011; Richards & Hallberg, 2015). The finding that social support impacts adherence highlights this complexity (Kragh et al., 2017a). Therefore, researchers must be cautious in their interpretation of findings; a lack of a positive result does not necessarily mean the intervention is ineffective but could indicate that its effect was influenced by a complex array of unmeasured factors (Greenhalgh, 2014; Straus et al., 2013). Future studies should employ robust theoretical frameworks and appropriate research designs for complex interventions, such as stepped-wedge or cluster-randomised trials, to better account for these interacting components (Das-Munshi et al., 2020.(

The Need for Standardised Outcome Measures

Finally, this review identified significant heterogeneity in the outcome measures used across studies. Different studies employed the Hamilton Depression Rating Scale, the Montgomery–Åsberg Depression Rating, the Beck Depression Inventory, or a combination thereof. This clinical heterogeneity makes it difficult to compare findings across studies and limits the potential for future meta-analyses (Littell et al., 2008; Thyer, 2009). The use of 33 different outcome measures

in a meta-analysis of 198 depression trials by Barth et al. (2016) underscores the scale of this problem. To address this, it is strongly recommended that the field moves towards the development and adoption of "Core Outcome Sets" (COS). A COS establishes a minimum, standardised set of outcomes that should be measured and reported in all trials for a specific condition (Williamson et al., 2012). The use of a COS for light therapy research would enhance consistency, make comparison across studies easier, and facilitate more robust evidence synthesis in future systematic reviews (Grobbee & Hoes, 2014; Sethi et al., 2019.(

6.3 Strengths and Limitations of the Review

This scoping review possesses several strengths. First, a comprehensive search strategy was employed across multiple databases, which is a key practice for conducting a thorough literature review (Ridley, 2012). Second, the use of strict eligibility criteria—such as a ten-year publication window and the exclusion of lower-quality evidence like editorials—resulted in a focused and manageable number of high-quality studies, which improved the focus of the research (Efron & Ravid, 2018). The specific focus on moderate to severe depression also enhanced the quality and clinical relevance of the review's findings (Richards & O'Hara, 2014). Finally, the use of the structured framework by Arksey and O'Malley (2005) provided a clear and rigorous process for conducting the review.

However, the review is not without limitations. The exclusion of studies published in languages other than English introduces a potential language bias and means that relevant studies may have been missed (Oliver, 2012). Similarly, limiting the search to the last ten years, while necessary for focus, may have excluded older, seminal studies (Hart, 2018). The exclusion of certain study designs, such as case-control studies, may have limited the review's ability to capture evidence related to rare conditions that could affect the response to light therapy (Borgan et al., 2018). The very nature of a scoping review, which aims to cover a broad and heterogeneous body of literature, means that it is always possible that some relevant studies were missed (Munn et al., 2018). Finally, the potential for publication bias, where studies with positive findings are more likely to be published, is a limitation inherent in all literature reviews (Rothstein et al., 2006). This was mitigated by actively searching for studies with negative findings, but the risk cannot be eliminated entirely.

6.4 Overall Conclusion

This scoping review has shown that light therapy is an effective, safe, acceptable, and feasible treatment for moderate to severe depression in the short term. Its efficacy is supported across a range of depressive disorders and age groups, and it shows promise both as a monotherapy and as an adjunctive treatment with medication or wake therapy. The finding that natural, lower-intensity light can also be effective is particularly promising for its accessibility.

However, the review has also highlighted critical gaps in the literature. The lack of long-term data is the most significant of these, and future research must prioritise longitudinal studies to establish the sustainability of the treatment's effects. Methodological improvements are needed, including larger sample sizes, more diverse research designs (particularly qualitative and mixed-methods), and research in a wider range of cultural and geographic contexts. The field would also benefit immensely from the standardisation of outcome measures through the development of a core outcome set.

In summary, for the treatment of moderate to severe depression, several evidence-based options exist, including pharmacotherapy and various forms of talking therapy. This review has demonstrated that light therapy is a promising and valuable addition to this therapeutic arsenal. It can be considered a viable alternative or adjunctive treatment, particularly for patients who have not benefited from other treatments or who are concerned about the side effects of medication. By addressing the research gaps identified in this review, the scientific community can further solidify the evidence base and help integrate light therapy more fully into mainstream clinical practice.

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