Intervenciones no farmacológicas en demencia: desde la prevención al tratamiento

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Que el trabajo contenido en la presente memoria y titulado: ***"Intervenciones no farmacológicas en demencia: desde la prevención al tratamiento"*** que, para optar al grado de Doctora presenta **Dña. Nuria Cibeira González**, ha sido realizado bajo nuestra dirección y reúne los requisitos necesarios para su presentación y defensa pública como Tesis Doctoral.

En A Coruña, a 4 de marzo de 2024

Fdo. Dr. José Luis Rodríguez Villamil Fdo. Dra. Ana Maseda Rodríguez

En memoria de mis queridas Inesiña y Marisiña, mis segundas madres

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Prólogo

Esta tesis se presenta en la modalidad de "Compendio de artículos de investigación", cumpliendo con los requisitos exigidos en el artículo 41 del Reglamento de estudios de doctorado de la Universidade da Coruña, desarrollando un amplio trabajo de investigación sobre la aplicación de diferentes intervenciones no farmacológicas en personas sin deterioro, con deterioro cognitivo leve o demencia.

La presentación de la tesis se distribuye en cinco capítulos. El Capítulo 1 consiste en una introducción del trabajo, dividida en seis secciones en las que se describe la unidad temática fundamental de la investigación: la primera de ellas puntualiza la relación entre la demencia y las intervenciones no farmacológicas, y en las consiguientes se describe de forma individual cada una de las intervenciones estudiadas a lo largo del desarrollo de esta tesis (estimulación multisensorial, musicoterapia, luminoterapia, ajedrez terapéutico, y realidad virtual).

A continuación, el Capítulo 2 desarrolla la justificación y los objetivos del trabajo.

El Capítulo 3 recoge las publicaciones científicas resultado del desarrollo de esta tesis doctoral. Este capítulo se divide en cinco secciones, correspondiéndose a cada uno de los artículos del compendio de la tesis publicados en revistas indexadas en la base de datos *Journal Citation Reports* (JCR). Tras un breve resumen del contenido del artículo, se adjunta el documento publicado. A continuación, se presentan, por orden de aparición en este trabajo, las referencias de cada artículo con sus correspondientes índices de calidad:

1) Maseda, A., **Cibeira, N**., Lorenzo-López, L., González-Abraldes, I., Buján, A., de Labra, C., & Millán-Calenti, J.C. (2018) Multisensory stimulation and individualized music sessions on older adults with

severe dementia: effects on mood, behavior, and biomedical parameters. Journal of Alzheimer's Disease,63(4), 1415-1425. doi: 10.3233/JAD-180109. **[Indexada en Science Citation Index Expanded (SCIE), JCR ranking 2018: Neurosciences 99/267; Factor de Impacto 3,517; Q2]**

2) **Cibeira, N.,** Maseda, A., Lorenzo-López, L., Rodríguez-Villamil, J.L., López-López, R., & Millán-Calenti, J.C. (2020). Application of light therapy in older adults with cognitive impairment: A systematic review. *Geriatric Nursing, 41*(6), 970-983. doi: 10.1016/j.gerinurse.2020.07.005. **[Indexada en SCIE y Social Science Citation Index (SSCI), JCR ranking 2020: SCIE-Nursing 33/124, SSCI-Nursing 32/122; Factor de Impacto 2,361; Q2 en ambas categorías]**

3) **Cibeira, N.,** Maseda, A., Lorenzo-López, L., González-Abraldes, I., López-López, R., Rodríguez-Villamil, J.L., & Millán-Calenti, J.C. (2021). Bright light therapy in older adults with moderate to very severe dementia: immediate effects on behavior, mood, and physiological parameters. *Healthcare, 9*(8), 1065. doi: 10.3390/healthcare9081065. **[Indexada en SCIE y SSCI, JCR ranking 2021: SCIE-Health Care Sciences & Services 50/109, SSCI- Health Policy & Services 35/88; Factor de Impacto 3,160; Q2 en ambas categorías]**

4) **Cibeira, N.,** Lorenzo-López, L., Maseda, A., Blanco-Fandiño, J., López-López, R., & Millán-Calenti, J.C. (2021). Effectiveness of a chess-training program for improving cognition, mood, and quality of life in older adults: A pilot study. Geriatric *Nursing, 42*(4), 894-900. doi: 10.1016/j.gerinurse.2021.04.026. **[Indexada en SCIE y SSCI, JCR ranking 2021: SCIE-Nursing 36/125, SSCI-Nursing 34/123; Factor de Impacto 2,525; Q2 en ambas categorías]**

5) **Cibeira, N**., Lorenzo-López, L., Maseda, A., López-López, R., Moreno-Peral, P., & Millán-Calenti, J.C. (2020). Realidad virtual como herramienta de prevención, diagnóstico y tratamiento del deterioro cognitivo en personas mayores: revisión sistemática. Revista de *Neurología, 71*(6), 205-212. doi: 10.33588/rn.7106.2020258. **[Indexada en SCIE, JCR ranking 2020: Clinical Neurology 203/208; Factor de Impacto 0,870; Q4]**

En el Capítulo 4 estos resultados son interpretados y discutidos, dándole coherencia y cohesión al trabajo de investigación desarrollado, y mostrando también las principales limitaciones y fortalezas de los estudios realizados.

Por último, en el Capítulos 5 se enumeran las conclusiones obtenidas.

Adicionalmente, se presenta información complementaria al inicio del documento, en el que se pueden encontrar el listado de abreviaturas, y al final del documento, donde se recoge la bibliografía común, así como los documentos correspondientes a los informes favorables del comité de ética de cada proyecto (Anexos A, B y C) y el material suplementario de la segunda publicación científica del compendio (Anexos D y E).

RESUMEN

Resumen

La demencia requiere un abordaje integral que incluya prevención, diagnóstico correcto y temprano, tratamiento adecuado, y asignación eficiente de recursos. Para su manejo se recomienda priorizar inicialmente intervenciones no farmacológicas debido a la ausencia de efectos adversos y a la creciente evidencia de sus beneficios.

El objetivo general de esta tesis consiste en profundizar acerca del efecto de diferentes intervenciones no farmacológicas (estimulación multisensorial, musicoterapia, luminoterapia, ajedrez terapéutico y realidad virtual) sobre los síntomas psicológicos y conductuales (SPCD) y el funcionamiento cognitivo en personas mayores sin deterioro, con deterioro cognitivo leve o demencia.

Los estudios desarrollados consistieron en dos revisiones sistemáticas y tres estudios experimentales.

Los principales resultados obtenidos indican que la estimulación multisensorial, la musicoterapia y la luminoterapia proporcionan efectos positivos para controlar los SPCD, mientras que el programa de intervención con ajedrez reveló una mejora significativa del estado cognitivo. La realidad virtual mostró potencial como herramienta preventiva, diagnóstica y de tratamiento frente al deterioro cognitivo o demencia. Aunque son necesarias futuras investigaciones para reforzar estos resultados a fin de generalizar la aplicación de estas intervenciones en la práctica clínica, concluimos que las intervenciones estudiadas pueden ejercer efectos beneficios sobre los SPCD y el funcionamiento cognitivo en personas mayores.

Resumo

A demencia require un abordaxe integral que inclúa prevención, diagnóstico correcto e temperán, tratamento adecuado, e asignación eficiente de recursos. Para o seu manexo, recoméndase priorizar inicialmente intervencións non farmacolóxicas debido á ausencia de efectos adversos e á crecente evidencia dos seus beneficios.

O obxectivo xeral desta tese consiste en profundar acerca do efecto de diferentes intervencións non farmacolóxicas (estimulación multisensorial, musicoterapia, luminoterapia, xadrez terapéutico e realidade virtual) sobre os síntomas psicolóxicos e de conduta (SPCD) e o funcionamento cognitivo en persoas maiores sen deterioro, con deterioración cognitiva leve ou demencia.

Os estudios desenvolvidos consistiron en dúas revisións sistemáticas e tres estudos experimentais.

Os principais resultados obtidos indican que a estimulación multisensorial, a musicoterapia e a luminoterapia proporcionan efectos positivos para controlar os SPCD, mentres que o programa de intervención con xadrez revelou unha mellora significativa do estado cognitivo. A realidade virtual mostrou potencial como ferramenta preventiva, diagnóstica e de tratamento fronte á deterioración cognitiva ou demencia. Aínda que son necesarias futuras investigacións para reforzar estes resultados a fin de xeneralizar a aplicación destas intervencións na práctica clínica, concluímos que as intervencións estudadas poden exercer efectos beneficios sobre os SPCD e o funcionamento cognitivo en persoas maiores.

Abstract

Dementia requires a comprehensive approach that includes prevention, accurate and early diagnosis, appropriate treatment, and efficient allocation of resources. For its management, initially prioritizing non-pharmacological interventions is recommended due to the absence of adverse effects and the increasing evidence of their benefits.

The general objective of this thesis is to delve into the effect of different non-pharmacological interventions (multisensory stimulation, music therapy, light therapy, chess, and virtual reality) on behavioral and psychological symptoms (BPSD) and cognitive functioning in older adults without impairment, with mild cognitive impairment, or dementia.

The studies conducted consisted of two systematic reviews and three experimental studies.

The main results obtained indicate that multisensory stimulation, music therapy, and light therapy provide positive effects in the management of BPSD, while the chess intervention program revealed a significant improvement in cognitive status. Virtual reality showed potential as a preventive, diagnostic, and treatment tool against cognitive impairment or dementia. Although future research is needed to reinforce these results in order to generalize the application of these interventions in clinical practice, we concluded that the intervention studied can have beneficial effects on BPSD and cognitive functioning in older adults.

LISTADO DE ABREVIATURAS

AVD: Actividades de la Vida Diaria

BLT: Luminoterapia, por sus siglas en inglés *Bright Light Therapy*

BPSD: *Behavioral an Psychologial Symptoms of Dementia*

CdV: Calidad de Vida

CERAD: *Consortium to Establish a Registry for Alzheimer's Disease*

DCL: Deterioro cognitivo leve

DSAOA: *Depressive Symptom Assessment for Older Adults*

EA: *Enfermedad de Alzheimer*

EMS: Estimulación multisensorial

IACM: Inventario de Agitación de Cohen-Mansfield

JBI: Instituto *Joanna Briggs*

JCR: *Journal Citation Reports*

MMSE: *Mini-Mental State Examination*

MoCA: *Montreal Cognitive Assessment*

MT: Musicoterapia

NSQ: Núcleo supraquiasmático del hipotálamo

RV: Realidad virtual

SAD: trastorno afectivo estacional, por sus siglas en inglés *Seasonal Affective Disorder*

SNP: Síntomas neuropsiquiátricos

SPCD: Síntomas psicológicos y conductuales de la demencia

SpO2: Saturación de oxígeno en sangre

QUALID: *Quality of Life for Severe Dementia*

TMT: *Trail Making Test*

VFC: *Variabilidad de la frecuencia cardiaca*

ÍNDICE

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CAPÍTULO 1. INTRODUCCIÓN

Capítulo 1. Introducción

1.1. Demencia e intervenciones no farmacológicas

Una de las principales causas de discapacidad y dependencia entre las personas mayores es la demencia, constituyendo uno de los problemas de salud pública más importantes a los que se enfrenta nuestra sociedad (1). Tal y como se recoge en el Informe Mundial sobre el Alzheimer 2022 (2), se estima que en el mundo hay 55 millones de personas con demencia y esta cifra continúa aumentando cada año, esperándose que aumente a 139 millones en 2050, como consecuencia del progresivo envejecimiento poblacional y el incremento de la esperanza de vida (3). La demencia tiene un impacto físico, psicológico, social y económico tanto en las personas que la padecen, como en sus cuidadores, sus familias, y la sociedad en general (4). La investigación sobre los factores o intervenciones que pueden prevenir o retrasar el deterioro, el desarrollo de herramientas encaminadas al diagnóstico precoz, así como de intervenciones tanto en personas mayores sanas como en personas con deterioro cognitivo leve (DCL) o demencia, son elementos clave para su abordaje integral, mantener la calidad de vida y prevenir o retrasar la dependencia.

En las últimas décadas, ha crecido el interés por la investigación de los factores modificables del estilo de vida que pueden ser cruciales en las fases presintomáticas del DCL o la demencia, con la intención de desarrollar posibles estrategias preventivas (5). Estos factores modificables del estilo de vida incluyen la participación en actividades de ocio cognitivamente estimulantes, ya que existe evidencia de vínculos consistentes entre su práctica y la reducción del riesgo de desarrollar deterioro cognitivo y demencia en etapas posteriores de la vida (6,7) o el retraso en su aparición (8–10). Un ejemplo de estas actividades son los juegos de mesa, incluido el ajedrez, ya que algunos estudios (11–13) han demostrado que jugar a juegos de mesa tiene beneficios cognitivos. Por otro lado, además de

los efectos cognitivos, su práctica aporta beneficios sociales y psicológicos ya que la mayoría de ellos se llevan a cabo en contextos de relaciones sociales (14).

La progresión de la demencia conlleva, aparte del deterioro cognitivo, la aparición de al menos un síntoma neuropsiquiátrico en la mayoría de los individuos en algún momento del curso de su enfermedad (15,16). Los síntomas neuropsiquiátricos, también conocidos como síntomas psicológicos y conductuales de la demencia (SPCD) (17) se definen como una serie de signos y síntomas de alteración de la percepción, el contenido del pensamiento, el estado de ánimo y el comportamiento que aparecen con frecuencia en la demencia (18). Estos síntomas comprenden principalmente delirios, alucinaciones, agitación o agresividad, depresión, ansiedad, euforia, apatía, desinhibición, irritabilidad, labilidad emocional, conducta motora aberrante, alteraciones del sueño, y cambios en el apetito o conducta alimentaria (19,20).

El desarrollo de intervenciones para los SPCD incluye terapias farmacológicas y no farmacológicas. En el ámbito clínico, los agentes farmacológicos se utilizan con frecuencia para el tratamiento de la demencia, pero muestran una eficacia modesta y efectos secundarios graves significativos (21,22), incluido un mayor riesgo de hospitalización, caídas y mortalidad (23). Numerosas directrices y recomendaciones de expertos favorecen las intervenciones no farmacológicas para el tratamiento de los SPCD debido a su impacto significativo en las mediciones globales de los resultados de los SPCD y a la ausencia de efectos adversos (24). De hecho, el Panel de Expertos de la Sociedad Americana de Geriatría (*American Geriatrics Society Beers Criteria Update Expert Panel*) recomienda el uso de abordajes no farmacológicos como primera medida, a menos que hayan fracasado previamente, no sean viables o exista un riesgo sustancial de daño a sí mismo o a otros (25). Por lo tanto, las terapias no farmacológicas deben considerarse la primera opción de tratamiento de los SPCD.

Las intervenciones no farmacológicas incluyen estimulación cognitiva, terapia de reminiscencia, orientación a la realidad, terapia de validación, terapia asistida con animales, ejercicio o actividad física, Snoezelen/estimulación multisensorial, aromaterapia, musicoterapia y luminoterapia, entre otras (26,27). Otra intervención a tener en cuenta es la realidad virtual, que ha sido estudiada como una herramienta terapéutica de intervención, pero también de prevención, para mejorar los síntomas asociados a los trastornos neurológicos y existe evidencia de que produce mejoras cognitivas y motoras en diferentes fases de distintas enfermedades neurológicas, incluso en las etapas más avanzadas de las mismas (28).

Teniendo en cuenta lo anteriormente expuesto, esta tesis se centra en la utilización de 5 intervenciones no farmacológicas diferentes (estimulación multisensorial, musicoterapia, luminoterapia, ajedrez terapéutico y realidad virtual) aplicadas a personas mayores sin deterioro, deterioro cognitivo leve o demencia.

1.2. Estimulación multisensorial

Los entornos de estimulación multisensorial (EMS) se desarrollaron en los Países Bajos a finales de los años 70 y fueron introducidos inicialmente para trabajar con personas con discapacidad intelectual severa (29). Su aplicación se ha ido extendiendo a más colectivos y desde principios de la década de 1990 ha sido utilizada como intervención no farmacológica en personas con demencia (30), haciéndose cada vez más popular en las últimas décadas (31). Para la EMS suele utilizarse una sala específicamente diseñada para ello conocida como sala Snoezelen. Estas salas incluyen diversos objetos que permiten la estimulación de los 5 sentidos tales como cables de fibra óptica, columnas de agua, aromaterapia, diferentes sonidos o música, paneles táctiles y proyectores de imágenes, entre otros (32). Uno de los elementos distintivos de la EMS frente a otro tipo de

intervenciones es la atención personalizada hacia el paciente y la adopción de los terapeutas de un enfoque no directivo y facilitador, animando al paciente a interactuar con los estímulos sensoriales de su elección (33). La EMS pretende estimular los sentidos primarios mediante experiencias sensoriales agradables siendo necesarias pocas exigencias atencionales o intelectuales específicas, convirtiéndola en una de las pocas intervenciones que resultan adecuadas para las personas con demencia severa o muy severa, en donde las funciones cognitivas se encuentran muy mermadas (33,34).

La EMS ha demostrado efectos positivos para el control y estabilización de los SPCD en personas mayores con demencia desde estadios de leve a severo o muy severo, particularmente para el manejo de síntomas conductuales como la agitación (35,36) además de fomentar la interacción con el entorno y la comunicación (37,38). Por otro lado, aunque hay escasa bibliografía sobre su impacto en la cognición, las medidas psicofisiológicas (como frecuencia cardiaca y saturación de oxígeno (SpO2), la funcionalidad en la vida diaria y en la calidad de vida, este tipo de intervención parece contribuir a retrasar el empeoramiento de la gravedad de los trastornos neurocognitivos desde las fases más leves a las más graves (39).

1.3. Musicoterapia

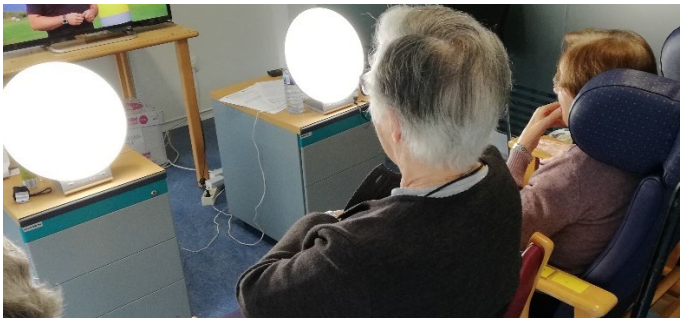
La musicoterapia (MT) es la aplicación de la música y/o sus elementos (melodía, ritmo, armonía, sonido) para favorecer y estimular diversos aspectos de las necesidades cognitivas, emocionales, y sociales (26), tales como promover la socialización, estimular la comunicación y la expresión verbal y no verbal, y ayudar a recuperar recuerdos evocando acontecimientos autobiográficos (40). La MT puede aplicarse de forma receptiva, es decir, escuchar música pasivamente, o participar activamente cantando, tocando un instrumento o moviéndose (26).

Además, la MT es una intervención no invasiva y poco costosa que puede ofrecerse fácilmente en entornos residenciales (41) , en parte gracias al desarrollo de protocolos como el de Linda A. Gerdner (42) basado en la evidencia de la intervención con música individualizada para el manejo de la agitación y la ansiedad en personas con demencia. La música individualizada se define como aquella música que se ha integrado en la vida de la persona y se basa en sus preferencias personales (43). En la bibliografía se recoge la importancia de la utilización de música individualizada cuando se utiliza la MT en personas con demencia, ya que se obtienen mayores beneficios cuando se tienen en cuenta los intereses musicales pasados y el origen sociocultural de la persona (43–45).

Se ha demostrado que la MT con música individualizada es una intervención adecuada para la reducción de los SPCD en personas con demencia (46,47), sobre todo con efectos positivos sobre la conducta disruptiva y la ansiedad (26,48). Por otro lado, el uso de música en personas mayores ha demostrado cambios sobre parámetros cardiovasculares relacionados con la relajación, observándose una disminución de la frecuencia cardíaca, la tensión arterial y frecuencia respiratoria (49), y un aumento de la saturación de oxígeno (50).

1.4. Luminoterapia

La luminoterapia (BLT, por sus siglas en inglés), consiste en la exposición controlada a determinados niveles de luz a fin de ayudar a establecer un ritmo circadiano saludable (51). Puede administrarse de diferentes formas, bien utilizando la luz solar exterior o bien a partir de fuentes de luz artificial como lámparas específicas colocadas a una distancia determinada dentro del campo visual de los sujetos, visores de luz colocados en la cabeza, o luces de techo, entre otros (52). En todos los casos, la luz debe ser captada por la retina del usuario para ser eficaz, no obstante, no es necesario mirar fijamente a la fuente de luz, incluso hacerlo no es recomendable con algunos dispositivos (53).



La descripción de la luminoterapia como opción terapéutica se mencionó por primera vez en la década de 1980 en relación con el trastorno afectivo estacional (SAD, por sus siglas en inglés) (54). El interés por la BLT rápidamente se extendió a otras afecciones, como los trastornos del estado de ánimo no estacionales, la enfermedad de Alzheimer (EA) y otras demencias, los trastornos del sueño relacionados con el sistema circadiano y otras alteraciones del comportamiento (55,56).

Los ciclos descanso-actividad y sueño-vigilia están controlados principalmente por el núcleo supraquiasmático (NSQ) del hipotálamo (57), y los cambios degenerativos en éste parecen ser la base biológica de las alteraciones circadianas en las personas con demencia, y podrían revertirse mediante la estimulación de dicho núcleo a través de la luz (52). Por tanto, la BLT ofrece una prometedora alternativa no farmacológica en personas con demencia para tratar los cambios fisiológicos asociados con las alteraciones del ritmo circadiano (52). Existe numerosa evidencia de que dosis efectivas de luz podrían estimular los ciclos circadianos, afectando a la eficiencia del sueño, los trastornos del estado de ánimo y las alteraciones de conducta en personas mayores con demencia (26,58–61).

1.5. Ajedrez terapéutico

El ajedrez se originó en la India en el siglo VII con el nombre de *chaturanga*. A lo largo de la historia, los nombres de las piezas y sus funciones han ido evolucionando hasta llegar a la estandarización actual, en la que cada jugador tiene ocho peones, una pareja de alfiles, de caballos y de torres, y un rey y una reina. El objetivo final del juego es capturar al rey adversario. El ajedrez es un juego exigente desde el punto de vista cognitivo, influyendo sobre todo la atención, la percepción, las funciones ejecutivas, las habilidades visuoespaciales y la memoria (62,63).

Se ha constatado que las actividades mentales estimulantes son una variable muy relevante en el mantenimiento de la función cognitiva durante el proceso de envejecimiento, ya que la realización de estas actividades contribuye a aumentar la reserva cognitiva (64). La reserva cognitiva, que hace referencia a la capacidad de resistir los cambios o lesiones que se van produciendo en el cerebro y en la función cognitiva con el avance de la edad (65), está influida por numerosos factores, como el nivel educativo, las demandas cognitivas de la

profesión principal, el coeficiente intelectual, las interacciones sociales, la actividad física o la participación en actividades cognitivamente estimulantes a lo largo de la vida (65,66). Por lo tanto, los cambios en el estilo de vida, incluso en edades avanzadas, pueden modificar la reserva cognitiva, lo que contribuiría a conseguir un envejecimiento más exitoso frente al deterioro cognitivo (67,68).

Un estilo de vida activo, incluyendo la práctica regular y frecuente de actividades cognitivamente estimulantes, parece retrasar la aparición del deterioro cognitivo o de la demencia (8–10). Un tipo de estas actividades son los juegos de mesa, incluido el ajedrez, ya que son una de las actividades de ocio más estimulantes que las personas mayores pueden practicar fácilmente (69). Algunos estudios (11–13) han demostrado que jugar a juegos de mesa tiene beneficios cognitivos, concretamente en lo que respecta a la memoria de trabajo, el razonamiento lógico, las funciones ejecutivas y la velocidad de procesamiento. Por otro lado, además de los efectos cognitivos, la práctica de actividades cognitivamente estimulantes aporta beneficios sociales y psicológicos ya que la mayoría de ellas se llevan a cabo en contextos de relaciones sociales (14,70).

1.6. Realidad virtual

La realidad virtual (RV) se puede definir como una aproximación a la interfaz usuario-ordenador que implica la simulación en tiempo real de un entorno, escenario o actividad que permite la interacción del usuario a través de múltiples canales sensoriales (71). La RV puede variar entre una modalidad no inmersiva hasta una modalidad totalmente inmersiva, dependiendo del grado en el que el usuario esté aislado del entorno físico cuando interactúa con el entorno virtual (28). La RV ha estado disponible comercialmente desde finales de los años 80, sin embargo, su mayor crecimiento se ha producido desde finales de los años 90, promovido en parte por el gran avance de las nuevas tecnologías (72), expandiéndose rápidamente su aplicación a una gran variedad de disciplinas (71). Actualmente, sus ámbitos de aplicación son muy numerosos, incluyéndose entre ellos el sanitario.

La RV ha sido estudiada como una herramienta terapéutica para intervenir sobre los síntomas asociados a los trastornos neurológicos y existe evidencia de que produce beneficios cognitivos y motores en diferentes fases de distintas enfermedades neurológicas, incluso en las etapas más avanzadas de las mismas (28). Existen numerosas publicaciones que evalúan la influencia de la RV sobre aspectos físicos (destacando la marcha y el equilibrio) en personas mayores con diferentes patologías neurológicas (72–74). En los últimos años, ha crecido la investigación acerca de su aplicación en el ámbito del deterioro cognitivo o demencia, y actualmente existen revisiones muy recientes sobre los beneficios de la RV en este campo como ayuda al diagnóstico precoz de DCL (75,76), como herramienta de evaluación (77), y sobre todo, en cuanto a su potencial como tratamiento (78–83).

CAPÍTULO 2. JUSTIFICACIÓN Y OBJETIVOS

Capítulo 2. Justificación y objetivos

2.1. Justificación

La demencia es una de las principales causas de discapacidad y dependencia entre los adultos mayores de todo el mundo, y constituye una prioridad de salud pública debido a los importantes costes humanos y económicos que implica para la sociedad (1). Para su abordaje integral es vital el apoyo y la investigación sobre programas relacionados con su prevención y envejecimiento activo, sobre herramientas encaminadas a su diagnóstico precoz, y sobre intervenciones para su tratamiento.

Con el presente trabajo de investigación se pretende impulsar diferentes intervenciones no farmacológicas como estrategia de prevención primaria y de tratamiento frente al desarrollo de deterioro cognitivo leve y/o demencia y, por ende, mejorar la calidad de vida de las personas mayores y su entorno. Se ha buscado abarcar un amplio campo de actuación, incluyendo intervenciones dirigidas a personas sin deterioro cognitivo, personas con deterioro cognitivo leve, y personas con demencia desde fase leve hasta las fases más avanzadas.

Existe cada vez más evidencia de los beneficios de las intervenciones no farmacológicas sobre el deterioro cognitivo y los SPCD (8,28,84,85). Dentro de estas intervenciones se incluyen la estimulación multisensorial, la musicoterapia, la luminoterapia, el ajedrez terapéutico y la realidad virtual, abordadas en esta tesis.

Tanto la EMS, como la musicoterapia, y la luminoterapia, permiten la estimulación de los sentidos primarios sin necesidad de actividad intelectual por parte del paciente por lo que resultan muy adecuadas para personas con capacidades comunicativas y de movilidad reducidas o limitadas (86), como son las personas con demencia en fase severa o muy severa. Es por ello por lo que la

EMS, la MT y la BLT son de las pocas intervenciones no farmacológicas existentes, apropiadas para estas personas en fases avanzadas de la demencia, donde las posibilidades de comunicación verbal se encuentras muy limitas y dificultan su participación en otro tipo de terapias. Además, las terapias sensoriales, como la EMS y la musicoterapia han demostrado proporcionar efectos positivos inmediatos sobre ciertos parámetros fisiológicos, como la frecuencia cardiaca o la saturación de oxígeno en sangre (87,88); por lo tanto, cabría esperar que la BLT, como terapia sensorial, también produjera mejoras en esos parámetros.

En cuanto a la EMS, hay que señalar la significativa inversión económica que requiere la adquisición del equipo necesario para montar una sala Snoezelen (89). Debido a este impacto económico, es necesario justificar los beneficios de la EMS en comparación con otras intervenciones no farmacológicas, ya que no existen pruebas suficientes sobre la mayor eficacia de la EMS en comparación con otras intervenciones individuales (33,87,90).

Por otro lado, aunque numerosos estudios (58–61) abordan los efectos de la luminoterapia como tratamiento de los SPCD en personas con deterioro cognitivo leve o demencia, la evidencia en cuanto a su efecto sobre la cognición y calidad de vida es limitada. Además, la bibliografía existente se centra en los efectos a corto y largo plazo de esta terapia, pero sus efectos inmediatos han sido escasamente investigados. Por tanto, es necesaria más investigación para examinar el impacto de la luminoterapia sobre estos aspectos. Asimismo, existe una gran variabilidad entre los protocolos de BLT empleados en los diferentes estudios en personas con demencia, no existiendo un consenso en el modo de aplicar esta terapia, principalmente en lo referido a la intensidad de la luz utilizada, frecuencia, momento del día, y duración de la intervención, por lo que es necesario investigar y proponer una guía de buenas prácticas para su uso.

En cuanto al ajedrez, partimos de la hipótesis de que la práctica regular de una actividad cognitivamente estimulante puede ayudar a mantener un estado cognitivo, social y psicológico saludable durante el proceso de envejecimiento (12–14). La investigación en esta línea específica apenas se ha desarrollado hasta la fecha, por lo que es necesario explorar este campo para profundizar en los efectos que la práctica regular de actividades cognitivamente estimulantes, tales como el ajedrez, pueden tener en edades avanzadas.

Finalmente, referente a la RV, en las últimas décadas, se ha incrementado exponencialmente el estudio de la RV sobre diferentes trastornos neurológicos con buenos resultados (72–74). Sin embargo, la bibliografía centrada en los beneficios de la RV sobre el deterioro cognitivo en personas mayores era limitada, si bien en los últimos años ha crecido la investigación en esta área. Aunque este auge ha dado lugar a que actualmente existan revisiones muy recientes sobre los beneficios de la RV en este campo (78–83), sigue siendo escasa la bibliografía sobre su uso como herramienta preventiva, y, además, hasta donde sabemos, todavía no existen revisiones que abarquen los tres ámbitos de aplicación en el deterioro cognitivo: prevención, diagnóstico y tratamiento.

2.2. Objetivos

El objetivo general del trabajo de investigación que se presenta es estudiar el efecto de diferentes intervenciones no farmacológicas sobre los síntomas psicológicos y conductuales y el funcionamiento cognitivo en personas mayores sin deterioro, con deterioro cognitivo leve o demencia.

Los objetivos específicos que surgen del objetivo general son los siguientes:

- Analizar y comparar los efectos de la estimulación multisensorial en sala Snoezelen vs sesiones de música individualizada, en relación al

estado de ánimo, conducta, y parámetros fisiológicos en una muestra de personas mayores institucionalizadas con demencia severa. (Estudio I)

- Revisión sistemática de la bibliografía existente para explorar la eficacia de la luminoterapia como abordaje no farmacológico de los SPCD, así como su efectividad sobre la cognición, estado funcional y calidad de vida en personas mayores con deterioro cognitivo. (Estudio II)

- Identificar las condiciones de la intervención con luminoterapia con mayor eficacia en personas mayores con deterioro cognitivo a fin de facilitar las guías para el establecimiento de un protocolo adecuado para la práctica clínica en esta población. (Estudio II)

- Explorar los efectos inmediatos de la luminoterapia sobre la conducta, el estado de ánimo y los parámetros fisiológicos en una muestra de personas mayores institucionalizadas con demencia de moderada a muy severa. (Estudio III)

- Evaluar los efectos de la participación en un programa de intervención basado en el entrenamiento de ajedrez sobre el estado cognitivo, el estado de ánimo y la calidad de vida en una muestra de personas mayores institucionalizadas y semiinstitucionalizadas. (Estudio IV)

- Revisión sistemática para explorar los posibles beneficios de la aplicación de la realidad virtual en la prevención, diagnóstico y tratamiento del deterioro cognitivo. (Estudio V)

CAPÍTULO 3. RESULTADOS

Capítulo 3. Resultados (Publicaciones científicas)

Este capítulo recoge los cinco trabajos de investigación que componen esta tesis doctoral. En conjunto, dan respuesta a los objetivos enumerados en el capítulo anterior. Cada sección corresponde a un artículo publicado en una revista científica indexada en JCR:

- *Multisensory stimulation and individualized music sessions on older adults with severe dementia: effects on mood, behavior, and biomedical parameters.* En *Journal of Alzheimer's Diasese*.
- *Application of light therapy in older adults with cognitive impairment: A systematic review*. En *Geriatric Nursing*.
- *Bright light therapy in older adults with moderate to very severe dementia: immediate effects on behavior, mood, and physiological parameters*. En *Healthcare*.
- *Effectiveness of a chess-training program for improving cognition, mood, and quality of life in older adults: A pilot study*. En *Geriatric Nursing*.
- *Realidad virtual como herramienta de prevención, diagnóstico y tratamiento del deterioro cognitivo en personas mayores: revisión sistemática*. En *Revista de Neurología*.

3.1. Estudio I: Estimulación multisensorial y sesiones de música individualizada en personas mayores con demencia severa: efectos sobre el estado de ánimo, conducta, y parámetros biomédicos (91)

Este estudio tenía como objetivo explorar los efectos de dos intervenciones no farmacológicas, la estimulación multisensorial (EMS) en una sala Snoezelen y sesiones de música individualizadas, sobre el estado de ánimo, la conducta y los parámetros biomédicos de personas mayores con demencia severa institucionalizadas.

Se llevó a cabo un ensayo aleatorizado de 21 pacientes con 65 o más años asignados aleatoriamente a dos grupos (EMS y música individualizada). Cada sesión de intervención era de 30 minutos, y administradas dos veces por semana, durante un periodo de 12 semanas. Se registraron los principales resultados antes, durante y al final de la intervención.

Los resultados mostraron que ambos grupos tuvieron efectos positivos inmediatos sobre el estado de ánimo y el comportamiento. Los participantes estaban más felices/más contentos ($p < 0,001$), hablaban con más espontaneidad ($p = 0,009$), se relacionaban mejor con la gente ($p = 0,002$), estaban más atentos y concentrados en su entorno ($p < 0,001$), se divertían ($p = 0,002$), estaban menos aburridos/inactivos ($p = 0,004$) y más relajados/contenidos ($p = 0,003$). El grupo EMS realizó un mejor seguimiento visual de los estímulos ($p = 0,044$), mientras que en el grupo de música estaba más relajados y contentos ($p = 0,003$). Se observó una disminución de la frecuencia cardíaca ($p = 0,013$) y un aumento de la saturación de oxígeno ($p = 0,011$) antes y después de las intervenciones en ambos grupos, sin diferencias significativas.

Se concluyó que ambas intervenciones parecen ser eficaces para controlar las alteraciones del estado de ánimo y del comportamiento a corto plazo y para mejorar los índices fisiológicos, lo que pone de relieve la eficacia de los tratamientos no farmacológicos en pacientes con demencia severa.

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Multisensory Stimulation and Individualized Music Sessions on Older Adults with Severe Dementia: Effects on Mood, Behavior, and Biomedical Parameters

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Abstract.
Background: Multisensory stimulation and individualized music have shown to be good in handling the psychological and behavioral symptoms in people with severe dementia.
Objective: Explore the effects of two nonpharmacological interventions, multisensory stimulation environment (MSSE) in a Snoezelen room and individualized music sessions, on mood, behavior, and biomedical parameters of institutionalized elderly patients with severe dementia.
Methods: Randomized trial of 21 patients aged ≥65 years randomly assigned to two groups (MSSE and individualized music). Interventions administered in two-weekly sessions lasted 30 minutes for a period of 12 weeks. Main outcomes were recorded before, during, and at the end of the intervention.
Results: Both groups had immediate positive effects on mood and behavior. Participants were more happy/more content ($p < 0.001$), talked more spontaneously ($p = 0.009$), related to people better ($p = 0.002$), were more attentive to/focused on their environment ($p < 0.001$), enjoyed themselves ($p = 0.003$), were less bored/inactive ($p = 0.004$), and more relaxed/content ($p = 0.003$). The MSSE group performed a better visual follow-up of the stimuli ($p = 0.044$), and the music group were more relaxed and happy ($p = 0.003$). A decrease in heart rate ($p = 0.013$) and an increase in oxygen saturation ($p = 0.011$) were observed from before to after interventions in both groups, with no significant differences between them.
Conclusions: Both interventions seem to be effective at managing mood and behavioral disturbances in the short term and at improving physiological rates, highlighting the efficacy of nonpharmacological treatments in patients with severe dementia.

Keywords: Dementia, elderly, individualized music, randomized trial, Snoezelen

INTRODUCTION

Dementia is one of the most important public health problems that our society faces. Its high prevalence in the elderly, along with the lack of effective treatments and the high degree of functional and cognitive dependence experienced by patients carries

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great medical, personal, familiar, social and economic impacts [1]. In advanced stages of dementia, patients show a variety of disrepair, including cognitive, functional, behavioral, and social decline, and also a wide range of neuropsychiatric symptoms [2], with dementia one of the main causes of disability in the elderly [3]. Traditionally, these behavioral and mood disturbances have been managed with medication but these pharmacological approaches have shown limited efficacy and can have some important adverse effects [4]. That is why nonpharmacological treatments are used increasingly and can improve both neuropsychiatric symptoms of patients and quality of life of caregivers [5]. The classical nonpharmacological behavioral interventions are not suitable for patients with severe dementia because their verbal communication is generally impaired [6]; they need specific nonpharmacological therapies with an appropriate environmental structure and simulation [7], such as individualized music interventions and multisensory stimulation environment (MSSE).

Music intervention uses music, in a receptive or in a participate way ([8], see [9] for a review), to get multiple benefits such as promoting socialization, stimulating communication and verbal and nonverbal expression, and helping to recover memories by evoking autobiographical events [10]. Furthermore, music intervention is a non-invasive and inexpensive intervention that could be easily offered in residential settings [11], in particular thanks to the development of an evidence-based protocol of individualized music for the management of agitation in people with dementia to be implemented in healthcare facilities [12, 13]. Individualized music has been defined as music integrated into the person's life and is based on personal preference [14]. Music intervention reduces neuropsychiatric symptoms in people with dementia [15, 16], with positive effects in disruptive behavior and anxiety (see [9] for a review, [17]). The use of music in elderly patients has shown a decrease in respiratory rate and an increase in temperature and oxygen saturation [18, 19].

On the other hand, initially, MSSE was introduced as a nonpharmacological treatment for people with learning difficulties [20]; nowadays more and more collectives have taken this therapy. Since the beginning of the 1990 s, application of MSSE has been extended to the care of people with dementia, and in the last decades, it is becoming increasingly popular [21, 22]. This therapy is usually carried out in a pleasant and relaxing space known as a "Snoezelen room" [23]. MSSE involves the stimulation of the five senses by the patient's exploration of an environment, following a non-directive and facilitative approach [22], in which many objects such as fiber-optic cables, aromatherapy, light effects, calming sounds, water columns of different colors, and textured balls for tactile stimulation among others, are included [7, 24]. MSSE can be modified introducing only a single stimulation modality (i.e., individualized music) or even pairing individual elements (music, aroma, colored water columns) [25]. MSSE has demonstrated to be an effective intervention in the management of behavior and mood in short-term in elderly with dementia in a moderate and severe stage, in addition to encouraging interaction and communication ([21, 26], see [9] and [27] for reviews). The equipment required for setting up multisensory stimulation in a Snoezelen room may be easily acquired but is a fairly expensive investment [28]. That is why it is necessary to demonstrate the benefits of MSSE in comparison with other nonpharmacological interventions. However, there is insufficient evidence about the increased effectiveness of multisensory stimulation compared to other one-to-one interventions [29, 30]. Additionally, some studies [31, 32] report effects of MSSE on biomedical parameters, such as heart rate, blood hemoglobin, or salivary cortisol.

Both music therapy and MSSE have shown to be good in handling the psychological and behavioral symptoms in people with severe dementia, but there is limited evidence demonstrating which is more effective. For that reason, it is necessary to carry out studies including these two therapies to distinguish the potential benefits of each other.

Therefore, the main objective of the current study was to assess whether MSSE in a Snoezelen room is more effective than individualized music sessions in regards to the mood, behavior, and biomedical parameters of institutionalized elderly patients with severe dementia.

MATERIALS AND METHODS

Design

We conducted a randomized longitudinal trial where participants were stratified according to their cognitive status being afterward randomly assigned to one of the two study groups (MSSE and individualized music).

Participants

Patients were recruited from a specialized dementia Gerontological Complex sited in A Coruña (Spain), with capacity for 70 people in a day care-setting and 64 institutionalized people in a nursing home. 21 users fulfilled the inclusion criteria of having a diagnosis of dementia and the presence of severe or very severe cognitive decline (Global Deterioration Scale [33], GDS 6-7). Diagnosis of dementia had been made and entered into the medical records by a neurologist. GDS was applied by a clinical psychologist with experience in assessing people to assess severity of dementia: severe (GDS 6) or very severe (GDS 7) cognitive decline. The exclusion criteria were: the presence of hearing impairment or other sensory disorder that would adversely affect interactions with the multisensory stimulation objects (e.g., severe vision impairment) and be bedridden.

A computer-based random number generator was used to randomly allocate the participants into one of the two groups according to their GDS score. 11 subjects were assigned to individualized music group and 10 subjects were assigned to MSSE group. A control group was not included in this study because our previous work [6] had already shown better effects of MSSE in comparison with control or one-to-one activity sessions.

Approval was obtained from the Ethics Committee at the University of A Coruña and the study was in conformity with the principles embodied in the Declaration of Helsinki. Before beginning data collection, all participants' proxies were previously informed about the study. Informed consent was obtained from a key family member or legal representative of each older person.

Procedure

The MSSE group participated in one-to-one multisensory sessions in a Snoezelen room. This room included several elements such as alternating colors fiber-optic cables, two water bubble columns within 2 mirrors, a water bed, a rotating mirror ball with a color light projector, a video, an interactive projecting system, musical selections, aromatherapy equipment with fragrant oils, and a tactile board with various textures, among others. In this group, the intervention followed the characteristics that define the MSSE [29]: visual, auditory, tactile, and olfactory stimulation was offered to patients; the therapists adopted a non-directive, enabling approach, encouraging patients to engage with sensory stimuli of their choice; and the stimuli used were non-sequential and unpatterned, experienced moment by moment without relying on short-term memory to link them to previous events.

The individualized music group participated in music sessions according to their musical preferences. The intervention, including the main specifications of the guideline for individualized music proposed by Gerdner [12], occurred in a quiet room of the center, away from others. Subjects were familiarized with the room used for the intervention, which was also used by the professional staff for routine individual assessments and interventions, avoiding the agitation that could imply an unknown location. Each session of music intervention was presented "free field" on a computer and the volume or loudness of music was set at an appropriate level for each participant. In this group, the therapist (one for each session) followed a directive approach, selecting the music for each session, taking into account the preferences and interests of the participants.

Participants from both groups took part in two weekly sessions, for a period of 12 weeks, until they completed 24 sessions. Sessions lasted 30 minutes unless the participant expressed a desire to leave or if the patient exhibited a situation of increased agitation or confusion. In both groups the sessions followed an internal structure that involved an introduction to the session, carrying the session through, and winding the session down. However, in the MSSE group, there was some flexibility within the standardization, to address the singularity and individual needs/preferences of each patient, keeping with the traditional philosophy of multisensory stimulation.

The sessions were conducted by professionals in the field of psychology or occupational therapy, with equivalent education and training in the methodology used. To avoid the creation of positive or negative expectations, the MSSE and the individualized music sessions were presented to the staff and caregivers as two equally valid interventions. As a result of this design, the differences found between the two conditions could be specifically attributed to the multisensory stimulation rather than more general therapeutic effects, such as the one-to-one attention to the patients. The data collection and administration of the intervention were carried out by the same therapist.

Data on the participants' sensorial preferences and interests were previously collected to design the content of the sessions and minimize the behavioral

problems that some participants could present within the MSSE and the music contexts. In the MSSE group, sensorial preferences in the Snoezelen room were assessed based on the procedure suggested by Pace et al. [34]. In the individualized music group, the significance of music prior to the patient's onset of cognitive impairment was determined. Family members knowledgeable about the patient's music preference were interviewed to get information as specific as possible. The Assessment of Personal Music Preference (APMPQ) (family version) [35] was used to assist in the selection of their family member's music preference. This instrument has been developed and tested [36] to obtain detailed information regarding personal music preferences and to identify the importance of music in the person's life during her or his independent living. It comprises a series of questions about the favorite types of music, forms of music, favorite artists/performs, and specific song titles prior to the onset of the cognitive impairment. The family version of APMPQ is used when the participants are unable to answer the questions due to cognitive impairment. This version has been successfully used by family members of residents living in long-term care facilities [36]. In our study, some items were revised to include types of Spanish music to make this assessment tool relevant to collect information regarding music preferences of older adults in Spain. The entire list of preferred music by each participant was stored in MP3 format on the PC used for intervention.

Mood and behavior

The participants' mood and behavior were rated before (10 minutes immediately before), during and after (10 minutes immediately after) the MSSE and individualized music sessions using the Interact scale [37]. Interact is a rating scale developed specifically for evaluating the effects of MSSE in dementia care. An inter-rater reliability of $r = 0.99$ was found on a small sample [38]. In this study, 'Interact during' and 'Interact short' scales were used. 'Interact during' had a total of 22 items measured on a Likert scale and was scored according to the frequency of occurrence of each behavior, ranging from 1 (not at all) to 5 (nearly all the time). These data give an indication of the processes that occur within sessions.

'Interact short', a 12-item version of Interact, was used to record mood and behavior during the 10 minutes immediately before sessions and the 10 minutes immediately after sessions to measure any observable changes. A Likert scale was applied to each item ranging from 1 (not at all) to 5 (nearly all the time). This gives an indication of the amount of change that each session produces in the short term.

Therapists received training in the use of the Interact scale, rated the same participants and discussed discrepancies. In order to avoid behavioral changes due to social desirability effect, Interact short was administered by therapists who work with the participants daily.

Biomedical parameters

Two biomedical parameters, heart rate (beats per minute) and oxygen saturation (SpO_2), were recorded immediately before and after sessions in the MSSE and individualized music groups using mobile finger pulse oximeters (Riester, Germany).

Statistical analysis

The sample characteristics were summarized as frequencies and percentages for the categorical variables and as the means and standard deviations for the continuous variables. We used the Shapiro-Wilk test to evaluate the normality of the sample. This test is more appropriate for small sample sizes (<50 individuals).

Between-group comparisons were made using Chi-square test to test categorical variables and Student *t*-test for continuous variables.

The immediate effects of the MSSE and individualized music sessions on patients' mood and behavior as measured by 'Interact short' were analyzed using paired *t*-tests to compare the means of scores from before sessions to the means of scores after sessions for each of the 12 outcome measurements. Within each group, Cohen's d values were reported as indicators of effect size (ES) for comparing the mean values. We interpreted the importance of the ES using the benchmarks for "small ES" ($d = 0.2$), "medium ES" ($d = 0.5$), and "large ES" ($d = 0.8$) as defined by Cohen [39].

Differences in the mood and behavior of patients during the MSSE and individualized music sessions as measured by 'Interact during' were analyzed using unpaired *t*-tests.

To determine whether there were any differences in the 'Interact short' scores from before to after a session between the groups, a repeated-measures two-way analysis of variance (two-way mixed ANOVAs) was conducted. The within-participants

variable was the difference in measurements over time (before versus after), and the between-participants variable was the group (MSSE versus individualized music).

In addition, a repeated-measures two-way mixed ANOVA was used to determine whether there were any differences between the groups in the number of changes in biomedical parameters (heart rate and SpO_2) from before to after the sessions. The within-participants variable was the measure over time (before and after), and the between-participants variable was the group (MSSE versus individualized music).

Eta-squared values ($\eta 2$) were reported as indicators of effect size. Based on Cohen's recommendations [39], $\eta 2$ of 0.02, 0.13 and 0.26 indicate small, medium, and large effect sizes respectively. In all analysis, a p value of less than 0.05 was considered statistically significant. Statistical analyses were conducted using the IBM SPSS Statistics v.23.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Effects on mood and behavior

The baseline sociodemographic characteristics of the residents at week 0 can be found in Table 1. The mean age of the sample was 88.9 years (SD ± 6.69), 71.4% were women, 71.4% of the patients were widowed, and 33.3% had secondary education. The MSSE and the individualized music groups were homogeneous in age, gender, marital status, and educational level.

Table 2 shows the means and SDs for each group on each item of Interact short and the results of paired t-tests. Significant improvements were observed from before sessions to after sessions in the MSSE group in the following items: more happy/content ($p = 0.001$), related to people better ($p = 0.023$), more attentive/focused on their environment ($p = 0.005$), enjoying themselves, more active or alert ($p = 0.017$), less bored/inactive ($p = 0.026$), and more relaxed, content, or sleeping appropriately ($p = 0.021$). The individualized music group showed significant improvements from before sessions to after sessions in the following items: more happy/content ($p = 0.013$), related to people better ($p = 0.034$), and more attentive/focused on their environment ($p = 0.007$).

With regard to the repeated-measure ANOVA results, there were no significant differences between the groups from before to after sessions (group-time interactions).

Furthermore, there were significant time effects in 7 of the outcome measures: happy/content, talked spontaneously, related well, attentive to/focused on their environment, enjoying self, bored/inactive, and relaxed/content.

Participants in both groups were more happy/content ($F_{(1,19)} = 30.961$, $p < 0.001$), talked more spontaneously ($F_{(1,19)} = 8.417$, $p = 0.009$), related to people better ($F_{(1,19)} = 13.470$, $p = 0.002$), more attentive to/focused on their environment ($F_{(1,19)} = 25.402$, $p < 0.001$), enjoying themselves ($F_{(1,19)} = 11.825$, $p = 0.003$), less bored/inactive ($F_{(1,19)} = 10.932$, $p = 0.004$), and more relaxed/content ($F_{(1,19)} = 11.189$, $p = 0.003$), in the 10 minutes after the sessions compared to the 10 minutes before the sessions.

Regarding Interact during, there were differences between the groups during sessions in 'tracking observable stimuli' (Fig. 1) and in how 'relaxed/content' (Fig. 2) participants were. In the first case, the MSSE group was rated as more observant ($p = 0.044$) than the music group; while in the second one, music group participants were rated as more relaxed ($p = 0.003$) than MSSE group participants.

Effects on biomedical parameters

Regarding biomedical parameters, there were significant time effects on heart rate (Fig. 3). Both groups reflected a decrease in heart rate from before to after sessions ($F_{(1,19)} = 7.577$, $p = 0.013$), although no significant differences were found between the groups.

Significant time effects were also found in SpO_2 (Fig. 4). There was an increase in the mean SpO_2 values of both groups from before to after the sessions ($F_{(1,19)} = 8.025$, $p = 0.011$), with no significant differences between the groups.

DISCUSSION

Effects of the type of intervention on mood and behavior

Interact short

Results showed no significant differences between both the MSSE and the individualized music sessions when comparing the 10 minutes after the sessions with the 10 minutes before the sessions. However, both groups had immediate positive effects on mood

Table 1
Sociodemographic characteristics of the residents with dementia at week 0 (Baseline, Pretrial)[a]

	MSSE ($n=10$)	Music ($n=11$)	Total ($n=21$)	p
Age (y)				
Mean (SD)	89.10 (6.24)	88.73 (7.36)	88.90 (6.69)	0.902
Age range	81–102	77–97	77–102	
Gender, *n* (%)				
Female	6 (60.0)	9 (81.8)	15 (71.4)	0.269
Male	4 (40.0)	2 (18.2)	6 (28.6)	
Marital status, *n* (%)				
Single	2 (20.0)	2 (18.2)	4 (19.0)	0.465
Married/partner	1 (10.0)	0 (0)	1 (4.8)	
Widowed	6 (60.0)	9 (81.8)	15 (71.4)	
Separated/divorced	1 (10.0)	0 (0)	1 (4.8)	
Educational level, *n* (%)				
No formal education	2 (20.0)	3 (27.3)	5 (23.8)	0.912
Primary	3 (30.0)	3 (27.3)	6 (28.6)	
Secondary	3 (30.0)	4 (36.4)	7 (33.3)	
College or higher degree	2 (20.0)	1 (9.0)	3 (14.3)	

MSSE, multisensory stimulation environment group; SD, standard deviation. [a]Significance: p-value < 0.05.

Table 2
Means scores (SDs) for each group (MSSE, $n=10$ versus Music, $n=11$) on INTERACT SHORT (before and after sessions)

Construct	Item	Group	Before	After	p	d
Mood	Tearful/sad	MSSE	1.19 (0.34)	1.14 (0.22)	0.395	0.17
		Music	1.12 (0.09)	1.08 (0.07)	0.122	0.50
	Happy/content	MSSE	2.52 (0.71)	2.91 (0.70)	0.001*	–0.55
		Music	2.65 (0.55)	2.85 (0.46)	0.013*	–0.39
	Fearful/anxious	MSSE	1.21 (0.44)	1.13 (0.19)	0.364	0.24
		Music	1.06 (0.10)	1.10 (0.18)	0.533	–0.27
	Confused	MSSE	1.17 (0.14)	1.10 (0.12)	0.230	0.54
		Music	1.21 (0.17)	1.18 (0.12)	0.546	0.20
Speech	Talked spontaneously	MSSE	1.52 (0.71)	1.74 (0.81)	0.052	–0.29
		Music	1.50 (0.52)	1.71 (0.66)	0.084	–0.35
Relating to people	Related well	MSSE	2.16 (0.66)	2.45 (0.83)	0.023*	–0.39
		Music	1.98 (0.75)	2.13 (0.79)	0.034*	–0.19
Relating to environment	Attentive/focused on environment/objects	MSSE	2.44 (0.77)	2.91 (0.97)	0.005*	–0.54
		Music	2.18 (0.75)	2.44 (0.81)	0.007*	–0.33
Need for prompting	Did things from own initiative	MSSE	1.75 (0.68)	1.80 (0.73)	0.670	–0.07
		Music	1.68 (0.66)	1.65 (0.57)	0.759	0.05
Stimulation level	Wandering, restless or aggressive	MSSE	1.23 (0.53)	1.15 (0.27)	0.398	0.19
		Music	1.08 (0.10)	1.09 (0.22)	0.800	–0.06
	Enjoying self, active or alert	MSSE	1.75 (0.59)	2.13 (0.81)	0.017*	–0.54
		Music	1.76 (0.63)	1.86 (0.62)	0.136	–0.16
	Bored, inactive or sleeping inappropriately	MSSE	2.91 (0.68)	2.42 (0.89)	0.026*	0.62
		Music	2.79 (0.84)	2.59 (0.98)	0.094	0.22
	Relaxed, content or sleeping appropriately	MSSE	2.21 (0.41)	2.60 (0.55)	0.021*	–0.80
		Music	2.55 (0.45)	2.75 (0.59)	0.100	–0.38

MSSE, multisensory stimulation group; *Significant (p-value) < 0.05; d, effect size.

and behavior. Participants in both groups were more happy/content, talked more spontaneously, related to people better, were more attentive to/focused on their environment, enjoyed themselves, were less bored/inactive and more relaxed/content from before to after sessions. Two theories, namely the Kovach Model of Imbalance in Sensoristasis [40] and the Functional Analytic Multisensory Environmental Therapy (FAMSET) [25], could explain what occurs during sensory stimulation in our participants. The first one [40], from a neurobiological perspective, postulates the need of pacing of sensory-stimulating and sensory-calming activities in persons with dementia to avoid intrapsychic discomfort. Multisensory stimulation ameliorates such negative consequences of imbalances in sensoristasis,

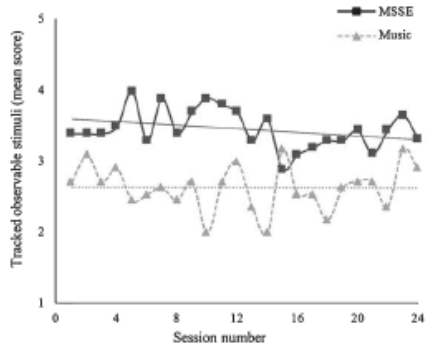

Fig. 1. Tracked observable stimuli. Interact during measurements at each session in two types of interventions—Multisensory Stimulation Environment (MSSE) and Individualized music—at sessions 0 (baseline) to 24 (post-trial). NOTE: 1 = Not at all, 2 = A bit of the time, 3 = Some of the time, 4 = Most of the time, 5 = Nearly all of the time.

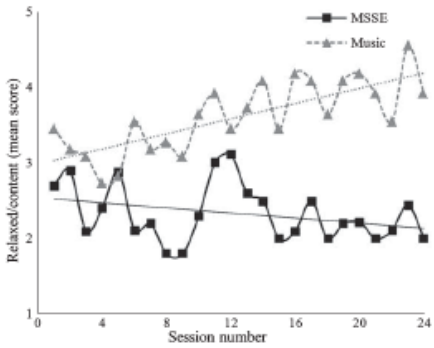

Fig. 2. Relaxed, content or sleeping appropriately. Interact during measurements at each session in two types of interventions—Multisensory Stimulation Environment (MSSE) and Individualized music—at sessions 0 (baseline) to 24 (post-trial). NOTE: 1 = Not at all, 2 = A bit of the time, 3 = Some of the time, 4 = Most of the time, 5 = Nearly all of the time.

providing stress-free and calming activities. On the other hand, the FAMSET theory [25] establishes that multisensory stimulation evokes states of reward and relaxation responses to reduce stress situations and to evoke well-being in people with dementia. Therefore, both interventions seem to be effective at managing mood and behavioral disturbances at the short term. Similar results were found in other studies [1, 31, 41] comparing MSSE in a Snoezelen room with other interventions, MSSE showed significant improvements in behavior immediately after the intervention but MSSE had no advantage over the other treatments. On the other hand, a study concluded that institutionalized people with dementia treated with MSSE had a significantly higher improvement in some of the neuropsychiatric symptoms than those who attended one-to-one activity sessions [42]. With similar findings, intervention with MSSE in a Snoezelen room improved significantly agitation levels compared to other recreational interventions [43]. A group of authors published a set of articles [44–47] showing that MSSE significantly improved mood and behavior of patients with moderate to severe dementia [44], and also the implementation of MSSE induced to a better quality of nurse-patient communication and better attendance in psychogeriatric care [45–47]. Regarding music intervention, several studies [48–54] evidenced the positive effects on the mood and behavior in patients with mild, moderate, or severe dementia after receiving individualized music sessions. However, previous studies [55, 56] have found opposite results, in which participation in music sessions did not improve levels of anxiety, depression, and agitation in older people with dementia. This lack of evidence may be reflective of measures coming from different respondents (carers/proxies versus the person with dementia) that would imply different results [55], or from the use of instruments with low sensitivity or randomization of participants without considering cognitive impairment level [56]. Another study [57] also concluded that individualized music did not have a significant effect on the behavioral and psychological symptoms of dementia (BPSD) in persons with moderate to severe dementia when compared with standard care received in their nursing homes. These authors explained the absence of statistically significant differences because the large number of participants who dropped out and the too small number of individualized music sessions.

Both interventions, MSSE and individualized music sessions, have shown some evidence for short-term improvement in mood and behavioral disturbances, but their long-term effectiveness has not been proven enough [21, 58].

Interact during

Regarding mood and behavior throughout the sessions, we found significant differences between the MSSE and music individualized groups in only two of the items analyzed with the Interact during scale: 'tracking observable stimuli' and 'relaxed/content'.

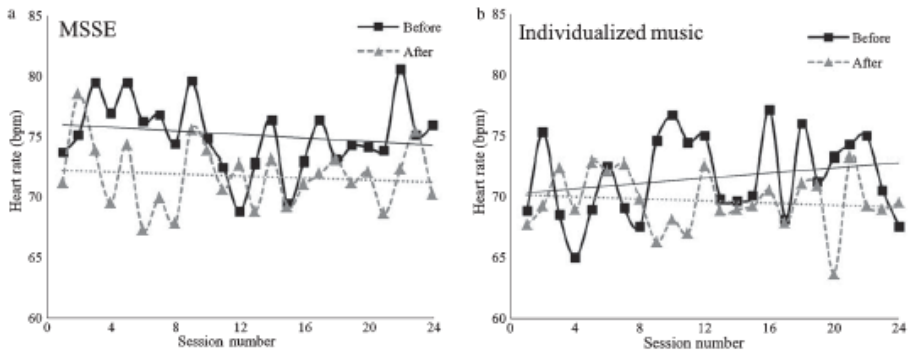

Fig. 3. Heart rate (beats per minute, bpm) before and after completion of two types of intervention—(a) Multisensory Stimulation Environment (MSSE) and (b) Individualized music —at sessions 0 (baseline) to 24 (post-trial).

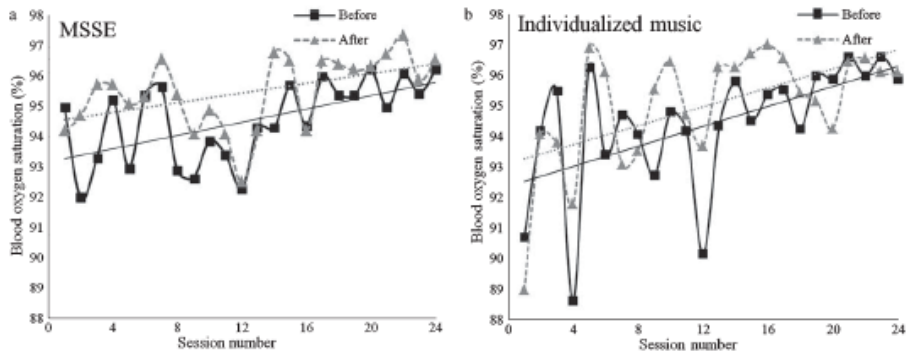

Fig. 4. Blood hemoglobin oxygen saturation (%) before and after completion of two types of intervention—(a) multisensory stimulation environment (MSSE) and (b) Individualized music —at sessions 0 (baseline) to 24 (post-trial).

Participants in the MSSE group performed a better visual follow-up of the stimuli, and participants in the music group were more relaxed and happy compared to participants in the MSSE group. Associated with the first point, other authors have found that visual sense is most likely to be stimulated in a MSSE [27]. With respect to the second aspect, unlike our results, a study [23] evaluating the effectiveness of MSSE in comparison to individualized music sessions, showed a positive effect on anxiety-related symptoms in people with dementia during MSSE intervention that was not shown in the participants of the music group. Besides, in a case study [59] with three subjects, a high level of looking was obtained during Snoezelen sessions, but not in music sessions. In contrast to previous findings [29, 30], no significant effects on mood and behavior during MSSE sessions in comparison to other activity sessions were found. In terms of music intervention in older adults with dementia, some studies [59–63] demonstrated a reduction of agitated behaviors either active (based on singing, dancing or playing instruments) or passive forms (based on listening to music) of music intervention. In addition, interactive music intervention results in a greater improvement in participant's mood and BPSD comparing to passive music intervention [64].

Effects on biomedical parameters

A decrease in heart rate and an increase in oxygen saturation were observed in MSSE and music sessions from before to after interventions, with no

significant differences between groups. This finding is consistent with previous studies [31, 65] in which no significant different effects of the MSSE compared to other one-to-one activities on the biomedical parameters in patients with mild, moderate or severe dementia, were found. However, a study analyzing heart rate and respiration in patients in the final stage of dementia, showed distinct reactions to music than to touch or object presentation [66].

Limitations and recommendations for future research

Several limitations should be noted when interpreting our findings. First, the relatively small sample size, with 11 individuals included in each group, which may account the no significant results found in some of the measured outcomes. Notably, it should be considered the difficulty of obtaining this specific type of older individuals with severe or very severe dementia for ensuring the homogeneity (same baseline characteristics) and randomization of both intervention groups. Future studies should address this limitation by including larger samples to confirm our findings. Second, the great economic investment that entails the use of a Snoezelen room compared to other therapies for people with dementia. Therefore, it is highly important to demonstrate in an empirical way that the benefits of MSSE in a Snoezelen room on mood and behavioral disturbances of people with severe dementia are better or greater than those provided by other sensory interventions that require minor economic resources such as music intervention or light therapy [7], especially since individualized music can be effectively implemented by nursing assistants, activity staff, or family members in a variety of settings [67].

Conclusions

This study evidences that both MSSE sessions and individualized music sessions are effective non-pharmacological treatments for the management of BPSD in people with severe dementia. MSSE sessions in Snoezelen room were found to be as effective as individualized music sessions, except during the intervention sessions, with differences in two of the analyzed parameters: 'tracking observable stimuli' and 'relaxed/content'; which means that participants in the MSSE group performed a better visual follow-up of the stimuli than the participants in the individualized music group, while participants in the music group were more relaxed and happy than those of the MSSE group. Regarding physiological rates, both groups exhibited an improvement in heart rate and oxygen saturation from before to after the sessions. Future empirical studies are needed to confirm our results and to examine the benefits of the MSSE in a room Snoezelen versus another type of interventions.

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3.2. Estudio II: Aplicación de la luminoterapia en personas mayores con deterioro cognitivo: Una revisión sistemática (92)

Esta revisión sistemática tuvo como objetivos evaluar la eficacia de la luminoterapia sobre los síntomas conductuales y psicológicos de la demencia (SPCD), la cognición, el estado funcional y la calidad de vida en personas mayores con deterioro cognitivo; e identificar las características óptimas de la luminoterapia para establecer un protocolo adecuado para su aplicación clínica.

Se realizaron búsquedas en las bases de datos Web of Science y Medline hasta diciembre de 2019, resultando en un total de 36 artículos incluidos, de los cuales, tres evaluaban de forma general los efectos sobre los SPCD, 25 sobre el sueño, 12 sobre la agitación, 10 sobre el estado de ánimo, 4 sobre los síntomas neuropsiquiátricos, 4 sobre la cognición, 2 sobre la calidad de vida y 2 sobre el estado funcional.

Los resultados de esta revisión han mostrado pruebas potenciales de los efectos positivos de la luminoterapia en el tratamiento de los trastornos del sueño, la conducta y el estado de ánimo en las personas con deterioro cognitivo, pero un efecto limitado sobre la cognición, la calidad de vida y el estado funcional. Además, esta revisión proporciona pautas para ayudar a definir un protocolo adecuado de intervención con luminoterapia en personas mayores con deterioro cognitivo, ya que se sintetizaron las condiciones más utilizadas en aquellos estudios con resultados positivos.

(El material suplementario al que se hace referencia en el artículo puedo encontrarse al final del presente trabajo, en el apartado de anexos – Anexos D y E).

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Feature Article

Application of light therapy in older adults with cognitive impairment: A systematic review

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ABSTRACT

This systematic review aims to assess the efficacy of light therapy on behavioural and psychological symptoms of dementia (BPSD), cognition, functional status, and quality of life in older adults with cognitive impairment; and secondarily, to identify the optimal characteristics of light therapy to establish an adequate protocol for its clinical application. We searched Web of Science and Medline databases through December 2019, resulting in 36 included articles: 3 evaluated the effects on BPSD, 25 on sleep, 12 on agitation, 10 on mood, 4 on neuropsychiatric symptoms, 4 on cognition, 2 on quality of life and 2 on functional status. Literature has shown potential evidence for positive effects of light therapy on managing sleep, behavioural and mood disturbances in people with cognitive impairment, but a limited effect on cognition, quality of life and functional status. This review provides guidelines for intervention protocols with light therapy in older people with cognitive impairment.

Introduction

The number of people affected by dementia worldwide is 50 million and will continue to increase dramatically in the next decades, representing one of the most important public health problems.[1] It is the main reason for the functional dependence and institutionalization of older adults, with a high economic impact on society.[2]

Dementia affects cognitive function and is usually accompanied by the presence of behavioural and psychological symptoms of dementia, BPSD,[3] which comprise four factors: a psychosis factor- irritability, agitation, hallucinations, and anxiety; a psychomotor factor- aberrant motor behaviour and delusions; a mood liability factor- disinhibition, elation and depression; and an instinctual factor- appetite disorders, sleep disorders and apathy.[4] The most prevalent BPSD are apathy, depression, irritability, agitation, and anxiety, while the less prevalent ones are euphoria, hallucinations, and disinhibition.[5] It is important to note that the prevalence of BPSD may vary in each subtype of dementia (see a review[5]), patients with vascular dementia have reported a higher prevalence and severity of depression and anxiety, or patients with dementia with Lewy bodies a higher prevalence of delusions and hallucinations, in comparison to Alzheimer's Disease, with a higher prevalence of aberrant motor behaviour.

BPSD are the most distressing symptoms of dementia for caregivers and contribute to institutionalization,[6] with agitation being one of the most relevant symptoms, affecting both formal and informal caregivers.[7] Sleep disturbances also represent an important clinical problem in dementia and are the main contributor to caregiver distress.[8]

Accurate BPSD characterization and intervention are key factors in the treatment of dementia, including a combination of pharmacological and non-pharmacological interventions.[5] BPSD management is a very difficult task for formal and informal caregivers due to possible adverse events or a lack of research supporting the use of different interventions.[3] Pharmacological and non-pharmacological interventions have been proposed for the treatment of both BPSD and cognitive impairment, and although the former (mainly antipsychotics) have demonstrated a slightly larger effect size, non-pharmacological strategies should be initially recommended to manage dementia (see a review[9]). In fact, the American Geriatrics Society Beers Criteria Update Expert Panel[10] recommends, *"antipsychotics must be avoided for BPSD unless nonpharmacological options have failed or are not possible and the older adult is threatening substantial harm to self or others"*. Therefore, alternative interventions are being used as a non-pharmacological approach to symptoms associated with dementia due to the lack of adverse events (see reviews[9,11] such as individualized music,[12]

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multisensory stimulation,[13] aromatherapy,[14] reminiscence therapy,[15] and light therapy[16,17]).

Light therapy offers a promising non-pharmacological alternative in people with dementia to treat the physiological changes associated with alterations of circadian rhythm.[18] Older adults with dementia have a decreased general sensory input, low sensitivity to the light effect on the suprachiasmatic nucleus (SCN) and less exposure to bright environmental light.[18] Light therapy might reverse the degenerative changes in the SCN, which are the biological basis for circadian (rest-activity and sleep-wake cycles) disturbances in people with dementia.[18] Most institutional settings maintain consistent low light levels, which may not be sufficient to enable the circadian clock to entrain to the 24-hour day.[19] There is evidence that effective light doses would stimulate the circadian cycles, affecting sleep efficiency (see a review[20]), depression,[21] functional status[22] or behavioural problems[23,24] in older adults with dementia. Light therapy involves exposure under controlled conditions to certain levels of light. There are different forms of administering light therapy, using outdoor sunlight or artificial indoor light sources. Different light sources or devices can provide it: light boxes placed approximately one meter away from the subjects at a height within their visual fields; a light visor worn on their heads; or a more acceptable 'naturalistic' light therapy, known as a dawn-dusk simulation that mimics outdoor twilight transitions.[25] In all cases, light needs to enter the user's eyes to be effective, however it is not necessary to stare at the light source, even looking at lights is not recommended with some devices.[26] People may do other activities while receiving the light stimulation in their visual field, such as eating, watching television or reading, being easily implementable either in institutions or in dwellings. Additionally, there is wide methodological heterogeneity with regard to the light intensity, frequency, interval, time of the day, and length of the intervention among the studies.[18]

Importantly, limited research has been conducted to examine the efficacy of light therapy in managing BPSD in older adults with cognitive impairment. In fact, in the most recent review[17] examining light therapy, the authors did only involve participants with Alzheimer's disease. Therefore, this systematic review differs from others in providing an overview of the existing literature to date that examine the effect of light on BPSD, cognition, functional status, and quality of life in participants with all degrees of cognitive impairment. Moreover, this review pursues to provide a more practical point of view in order to facilitate the implementation of light therapy protocols in daily clinical practice.

The aim of the present systematic review is to assess studies exploring the efficacy of light therapy as a non-pharmacological approach to manage BPSD, as well as its effectiveness in cognition, functional status, and quality of life in people with cognitive impairment (not necessarily with a diagnosis of dementia). Additionally, we aim to identify the light therapy conditions with the highest efficacy for older adults with cognitive impairment in order to facilitate the establishment of an adequate protocol for the clinical application of light therapy in this population.

Materials and methods

The Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used for reporting of this systematic review.[27]

Search strategy

We identified articles that assessed the effect of light therapy for older adults with cognitive impairment by searching the Web of Science and Medline databases. The search included articles published until December 2019. Search terms included ("light therapy" or "light treatment" or "light exposure" or "bright light" or "effect of light"), and ("elder*" or "old*" or "dement*" or "Alzheimer" or "nursing home" or "day care"). Combinations of these terms were used for the title search (see search strategy in Appendix A published as supplementary material online). All possible articles were merged into a single file, and duplicate records were removed after they were checked manually. Two of the investigators independently evaluated the appropriateness of inclusion, and discrepancies were discussed and solved to reach a consensus. If disagreements arose, a third investigator was included in the discussion to reach the final consensus.

Study selection

The following inclusion criteria were established to select articles for this systematic review. Regarding participants: individuals with a mean age of 65 years or older with cognitive impairment (mild cognitive impairment and mild, moderate or severe dementia). In terms of the intervention: any type of light therapies, with specific information about duration and frequency. As regards the outcome measures: the effect on BPSD (especially with regard to sleep and agitation), cognitive status, functional status or quality of life as the primary outcome. Finally, with regard to language: only full-text articles written in English or Spanish were eligible. As exclusion criteria: reviews, letters, editorials, conference abstracts or papers, corrections or book chapters were excluded.

Quality assessment and data extraction

This systematic review adheres to the guidelines detailed on the PRISMA protocol.[27] The quality of the selected papers was assessed by two independent researchers, using two Critical Appraisal Tools provided by the Joanna Briggs Institute (JBI) ,[28] with a third investigator in case of any disagreements, likewise done for the included studies. JBI Critical Appraisal Checklist for Randomized Controlled Trials, with 13 items, was used to assess 18 articles. The other 18 articles were evaluated by JBI Critical Appraisal Checklist for Quasi-Experimental Studies (non-randomized experimental studies), with 9 items. At the end of the quality assessment of each article, an overall score of appraisal is determined based on the criteria number ranked as "Yes".

Data of each article included were collected according to the following characteristics: authors and year of publication, study design and intervention setting (gerontological complex, community-dwelling, hospital…), sample characteristics (age and sex), cognitive status, intervention characteristics (intensity, frequency, and duration), assessed outcomes, measurement tools, and main findings.

This systematic review did not require ethics approval from an ethics committee.

Due to the heterogeneity of the results, the measures and the design, a meta-analysis was not appropriate in this case.

Results

Fig. 1 includes the PRISMA flow chart of the study selection process. The search of Web of Science produced 208 results and of Medline produced 152 results. Moreover, 4 additional records were identified through the bibliography of some of the analysed articles. Of the 246 studies identified after removing duplicates, 101 remained as potentially relevant and were analysed in terms of their eligibility. Of these studies, 35 were excluded for the setting, 5 for not being focused on BPSD, cognitive status or quality of life, 9 for insufficient reporting of light therapy and 16 for not being original research (see Appendix B published as supplementary material online). Finally, 36 articles met the inclusion criteria for this review.

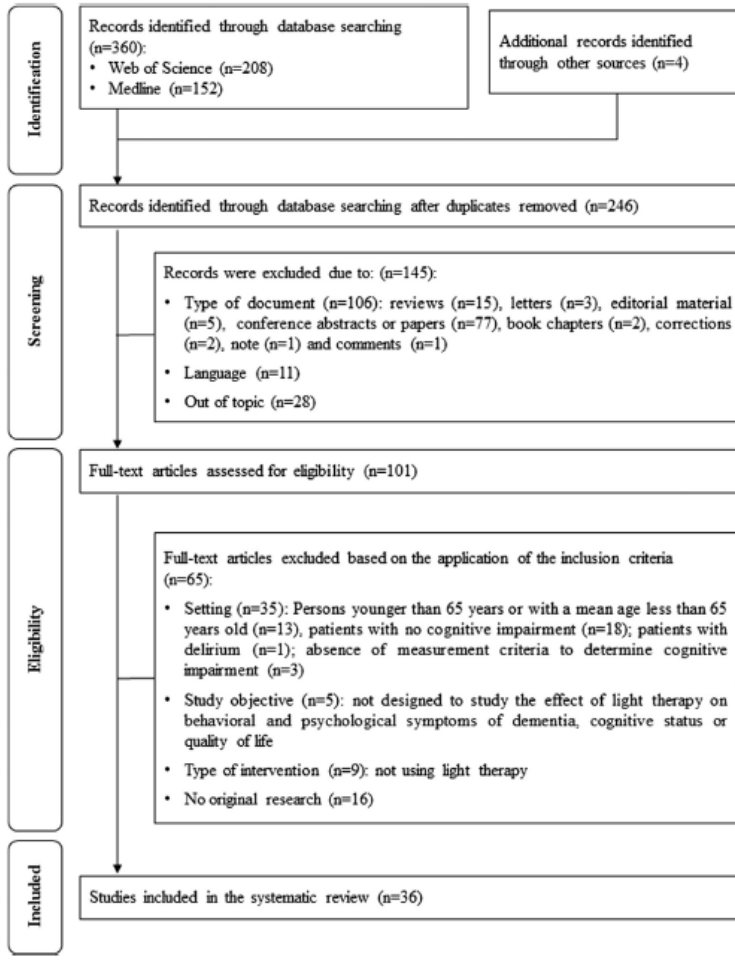

Fig 1. PRISMA Flow Diagram of literature search and selection process of the current systematic review.

Table 1 summarizes the characteristics of the included studies. As can be seen in the table, multiple articles, based on the same study sample, but describing different outcomes, were included in this systematic review.

In this systematic review, the mean sample size was 42.5 ± 42.5 in 29 studies (36 articles), with a minimum of 5 individuals[29] and a maximum of 189.[30] For all studies included in the analysis, the total sample size was 1233 older adults (66.1% women). Only nine articles contained a greater number of men than women.[31–39] The mean age of the included participants was 81.3 ± 4.5 years, ranging from 70.1 ± 5.1[37] to 89.2 ± 3.4 years.[24] Most of the articles assessed the effect of light therapy in older adults within the residential/nursing home setting, excluding three that also combined participants from hospitals,[31,40,41] seven that only involved a hospital setting[29,35–38,42,43] and four that included community-dwelling older adults.[32,33,44,45] Twenty of the articles identified in the search were from the USA, 4 from Norway,[39,46–48] three from Japan,[35,36,38] three from the Netherlands,[30,42,43] two from Austria,[29,34] two from Switzerland,[49,50] one from the United Kingdom,[51] and one from Canada.[52]

The results are grouped into six subsections: the first one includes the methodological quality assessment of included articles. The following 4 subsections present the main outcomes (light therapy and

Table 1
Characteristics of the included studies in the systematic review.

Author (year)	Study design/ Setting	Sample	Cognitive status	Intervention characteristics	Outcome measured	Measurement tools	Main findings
Ancoli-Israel (2002)[54]	RCT Nursing home	n = 77 (58 women) Mean age = 85. 7 ± 7.3	Mean MMSE = 12. 8 ± 8. 8 (range =0 – 30)	Four conditions: EBL, MBL, daytime sleep restriction, DRL. Procedure: BL (2500 lux), DRL (<50 lux); 18 d; 2 h/d	Sleep, Circadian rhythm	Actigraphy	No improvements in night-time sleep or daytime alertness. Morning bright light: a delayed peak of the activity rhythm, increased mean activity level and improved activity rhythmicity
Ancoli-Israel (2003a)[55,*]	RCT Nursing home	n = 92 (63 women) Mean age = 82. 3 ± 7.6	Probable or possible AD, mean MMSE = 5. 7 ± 5. 6 (range =0 – 22)	Three conditions: MBL, morning DRL, EBL. Procedure: BL (2500 lux), DRL (<300 lux); 10 d; 2 h/d	Agitation	CMAI, ABRS	CMAI: significant improvement in physical, verbal and overall agitation caregiver ratings of three treatment groups; ABRS: no significant changes
Ancoli-Israel (2003b)[56,*]	RCT Nursing home	n = 92 (63 women) Mean age = 82. 3 ± 7.6	Probable or possible AD, mean MMSE = 5. 7 ± 5. 6 (range =0 – 22)	Three conditions: MBL, morning DRL, EBL. Procedure: BL (2500 lux), DRL (<300 lux); 10 d; 2 h/d	Sleep	Actigraphy	Increased MBL or EBL consolidates night-time sleep by lengthening the maximum sleep bouts during the night. Time asleep did not vary as there were longer but fewer sleep bouts
Barrick (2010)[31,†]	Cluster-unit crossover design Psychiatric hospital and nursing home	n = 66 (31 women) Mean age = 79	Dementia, MDS-COGS/ MMSE: Mild: n = 3; Moderate: n = 18; Severe: n = 31; Very severe: n = 14	Four conditions: MBL, EBL; all day BL, STL. Procedure: BL (2000–3000 lux), STL (500–600 lux); 3 weeks; MBL EBL: 4 h/d, all day BL: 13 h/d	Agitation	CMAI	BL was not effective in reducing agitation under any intervention condition, even exacerbating it
Burns (2009)[51]	RCT Nursing home	n = 48 (32 women) Mean age = 83,5 ± 1,6	Dementia diagnosis, mean MMSE: STL group = 5. 1 ± 5. 6; BL group = 6. 9 ± 5. 3	Two conditions: MBL and STL. Procedure: MBL (10,000 lux), STL (100 lux); 2 weeks; 2 h/d	Agitation, Cognition, Mood, Sleep	CMAI, MMSE, CRBRS, CSDD, MOUSEPAD, Sleep charts, Actigraphy	Limited evidence of a reduction in agitation. Sleep and diurnal rhythm are improved, suggesting greater efficacy during the winter season
Dowling (2005a)[19]	RCT Nursing home	n = 46 (36 women) Mean age = 84. 0 ± 10. 0	AD diagnosis, mean MMSE = 6. 7 ± 6. 8	Two conditions: MBL and STL. Procedure: MBL (≥2500 lux), STL (150–200 lux); 10 weeks; 1 h/d	Sleep	Actigraphy	Significant improvement in rest-activity rhythms only in subjects with the most impaired rest-activity rhythms
Dowling (2005b)[57,†]	RCT Nursing home	n = 70 (57 women) Mean age = 84. 0 ± 10. 0	AD diagnosis, mean MMSE = 7. 0 ± 7. 0	Three conditions: MBL, EBL, STL. Procedure: BL (≥2500 lux), STL (150–200 lux); 10 weeks; 1 h/d	Sleep	Actigraphy	No significant differences in night-time sleep or daytime wakefulness. MBL implies a significantly more stable rest-activity rhythm
Dowling (2007)[58,†]	RCT Nursing home	n = 70 (57 women) Mean age = 84. 0 ± 10. 0	AD diagnosis, mean MMSE = 7. 0 ± 7. 0	Three conditions: MBL, EBL, STL. Procedure: BL (≥2500 lux), STL (150–200 lux); 10 weeks; 1 h/d	NPS	NPI – NH	Significant differences in depression/dysphoria, aberrant motor behaviour, and eating disorders, but with a small change, not indicative of a clinical effect

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Table 1 (*Continued*)

Author (year)	Study design/ Setting	Sample	Cognitive status	Intervention characteristics	Outcome measured	Measurement tools	Main findings
Dowling (2008)[93]	RCT Nursing home	*n* = 50 (43 women) Mean age = 86. 0 ± 8. 0	AD diagnosis, mean MMSE = 9. 3 ± 7. 9	Three conditions: MBL + melatonin, MBL + placebo, STL. Procedure: MBL (≥2500 lux), STL (150–200 lux); 10 weeks; 1 h/d	Sleep	Actigraphy	MBL plus melatonin significantly improves day-time somnolence, reduces the duration of day-time sleep, increases day-time activity, and improves the day: night sleep ratio
Fetveit (2003) [95]§	Repeated measures design Nursing home	*n* = 11 (10 women) Mean age = 86. 1 ± 8. 9	Moderate to severe dementia, mean MMSE = 11. 7 ± 4. 2; Mean CDR = 2. 5 ± 0. 5	One condition: MBL. Procedure: 6000–8000 lux; 2 weeks; 2 h/d	Sleep	Actigraphy, Own scale of sleep-wake disturbances	Significant improvements in nocturnal sleep, sleep maintenance and sleep efficiency
Fetveit (2004) [47]§	Repeated measures design Nursing home	*n* = 11 (10 women) Mean age = 86. 1 ± 8. 9	Moderate to severe dementia, mean MMSE = 11. 7 ± 4. 2; Mean CDR = 2. 5 ± 0. 5	One condition: MBL. Procedure: 6000–8000 lux; 2 weeks; 2 h/d	Sleep	Actigraphy	Significant positive effects on sleep disturbances (sleep onset latency, nocturnal wake time and efficiency), even at the 12-week follow-up
Fetveit (2005) [48]§	Repeated measures design Nursing home	*n* = 11 (10 women) Mean age = 86. 1 ± 8. 9	Moderate to severe dementia, mean MMSE = 11. 7 ± 4. 2; Mean CDR = 2. 5 ± 0. 5	One condition: MBL. Procedure: 6000–8000 lux; 2 weeks; 2 h/d	Sleep	Actigraphy, Own scale of sleep-wake disturbances	Significant positive effect on daytime wakefulness, decreasing daytime sleep
Figueiro (2014)[94]	Repeated measures Nursing home	*n* = 14 (9 women) Mean age = 86. 9 ± 4. 4	Mild-moderate dementia, mean BIMS = 7. 7 ± 2. 3	One condition: Bluish-white light. Procedure: 324±190 lux; 4 weeks; 8 – 10 h/d	Sleep, Circadian rhythm, Mood, Agitation, ADL	Daysimeter, PSQI, MSD-ADL, CSDD, CMAI	Significant increase in total sleep time and sleep efficiency. Significant improvement in sleep, depression and agitation scores from the standardized questionnaires applied
Figueiro (2015)[92]	Repeated measures Community-dwelling	*n* = 35 (9 women) and 34 caregivers (27 women) Mean age = 80. 8 ± 7. 9	Mild-moderate dementia, MMSE = range 12–24; CDR = range 1–2	One condition: Bluish-white light. Procedure: 350–400 lux; 4 weeks; 8 – 10 h/d	Circadian rhythm, Sleep, Mood	Daysimeter, Actigraphy, Sleep diary, PSQI, CSDD, GDS-SF	Significant increase in circadian entrainment in both, participants with dementia and their caregivers. Participants with dementia also showed an improvement in sleep efficiency and depressive symptoms
Fontana Gasio (2003)[91]	RCT Nursing home	*n* = 13 (12 women) Mean age = 84,9 ± 4,8	Diagnosis of dementia, mean MMSE: DDS group = 13. 8 ± 5. 9; placebo group = 14. 3 ± 4. 1	Two conditions: DDS and placebo (DRL). Procedure: DDS (max. 400 lux), DRL (<5 lux); 3 weeks; per day: dawn time and dusk time	Circadian rhythm, Sleep, Cognition, NPS	Actigraphy, MMSE, CERAD, NPI-NH, GDS-SF	DDS group presented shortened sleep latency, longer sleep duration, more nocturnal immobility and less nocturnal activity than the DRL group. No significant effects of either condition in the neuropsychological evaluations
Friedman (2012)[33]	Parallel group design Community-dwelling	*n* = 54 (23 women) Mean age = 77. 9 ± 8. 1	Mild cognitive impairment to dementia, mean MMSE = 22. 1 ± 4. 7; CERAD = 1. 3 ± 1. 8	Two conditions: MBL and DRL Procedure: MBL (4200± 1600 lux), DRL (90± 96 lux); 2 weeks; 30 min/d	Sleep	Actigraphy, ESS, Daily sleep reports	30-min MBL is not sufficient for improving sleep

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Table 1 (*Continued*)

Author (year)	Study design/ Setting	Sample	Cognitive status	Intervention characteristics	Outcome measured	Measurement tools	Main findings
Graf (2001)[34]	Parallel group design Nursing home	$n = 23$ Mean age = 82. 1 ± 6. 4	AD or VD, mean MMSE: MBL group = 15. 2 ± 4. 8; MDL group = 17. 1 ± 7. 1	Two conditions: MBL and MDL. Procedure: MBL (3000 lux), MDL (100 lux); 10 d; 2 h/d	Cognition	MMSE	Significant beneficial effects on cognitive functioning
Haffmans (2001)[62]	Crossover design Hospital	$n = 10$ (7 women) Mean age = 72. 1	Dementia diagnosis	Two conditions: MBL + melatonin and MBL + placebo. Procedure: 10,000 lux; 2 periods of 2 weeks; 30 min/d	Agitation	CGI, GIP, SDAS	Positive effects for the MBL combined with placebo. Patients were less restless and more co-operative. The condition with melatonin showed no additional positive effects
Hickman (2007) [40],†	Cluster-unit crossover design Psychiatric hospital and nursing home	$n = 66$ (31 women) Mean age = 79	Dementia, MDS-COGS/ MMSE: Mild to moderate: $n = 21$; severe: $n = 31$; and very severe: $n = 14$	Four conditions: MBL, EBL, all day BL, STL. Procedure: BL (2000–3000 lux), STL (500–600 lux); 3 weeks; MBL and EBL: 4 h/d, all day BL: 13 h/d	Mood	CSDD	MBL significantly decreases depressive symptoms in some people but may worsen symptoms in others. Individual more than unit-level BL interventions would be a more effective strategy
Lovell (1995)[24]	ABABA design Nursing home	$n = 6$ (5 women) Mean age = 89. 2 ± 3. 4	Moderate to severe dementia, mean MMSE = 8. 7 ± 5. 2	One condition: MBL. Procedure: 2500 lux; two 10 d MBL periods; 2 h/d	Agitation	ABRS	Agitation is significantly lower on light treatment days
Lyketsos (1999)[63]	RCT Nursing home	$n = 15$ (14 women) Mean age = 80. 8 ± 8. 7	Dementia, mean MMSE = 6. 4 ± 6. 8	Two conditions: MBL and STL. Procedure: MBL (10,000 lux); 4 weeks; 1 h/d	Agitation, Sleep, Mood	BEHAVE-AD, CSDD, Sleep logs	No effect on agitation or depression. Significant improvement in nocturnal sleep
McCurry (2011)[64]	RCT Community-dwelling	$n = 132$ (73 women) Mean age = 81. 0 ± 8. 0	Probable or possible AD diagnosis, mean MMSE = 18. 7 ± 6. 9	Four conditions: 1–walking, 2-EBL, 3–walking + light + sleep education, 4–control. Procedure: EBL (2500 lux); 8 weeks; 1 h/d	Sleep	Actigraphy, SDI	Light therapy and walking, singly or in combination, significantly improve night-time sleep in individuals with sleep problems
Mishima (1994)[35]	Two-group pretest-posttest design Hospital	$n = 24$ Mean age = 75	Moderate and severe dementia, VD or AD diagnosis	Two conditions: MBL and control. Procedure: 3000–5000 lux; 4 weeks; 2 h/d	Sleep, BPSD	Sleep diary by nursing staff	Significant increase in total and nocturnal sleep time and a significant decrease in daytime sleep time. The presence of behaviour disorders during the intervention period was significantly lower than at baseline
Mishima (1998)[36]	Crossover design Hospital	$n = 22$ (9 women) Mean age = 79. 5	VD or AD diagnosis, mean MMSE: VD group = 8. 0 (range 3 – 14); AD group = 9.0 (range 3 – 17)	Two conditions: MBL and MDL. Procedure: MBL (5000–8000 lux), MDL (300 lux); 4 weeks; 2 h/d	Sleep	Actigraphy	Significant improvement of MBL in nocturnal sleep, reducing night-time activity, but only in the VD group
Münch (2017)[50]	Between-subject study design Nursing home	$n = 89$ (58 women) Mean age = 78. 4 ± 9. 0	Severe cognitive impairment, mean S-MMSE = 8. 8 ± 10. 2	Two conditions: Low and high light. Procedure: Low (<417. 24 lux), high (>417. 24 lux); 8 weeks; 10 h/d	Emotions, Agitation, QoL, Activity, Sleep	OERS, CADS, CMAI, QUALID, Wrist-worn activity watch	Higher light exposure results in an increase in positive emotions, greater general alertness and better quality of life

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Table 1 (Continued)

Author (year)	Study design/ Setting	Sample	Cognitive status	Intervention characteristics	Outcome measured	Measurement tools	Main findings
Onega (2016) [36] ¶	RCT Nursing home	n = 60 (43 women) Mean age = 82. 6 ± 9. 6	Dementia diagnosis, Mild: n = 7; Moderate: n = 11; Severe: n = 42. ; mean MMSE = 7.2 ± 6. 9	Two conditions: MBL+EBL and STL. Procedure: BL (10, 000 lux), STL (250 lux); 8 weeks; 30 min twice a day; 5 d/ week	Mood, Agitation	DSAOA, DMAS-17, CSDD, PAS BARS, CMAI-F, CMAI-D	Significant improvement in all three measures of depression and all four measures of agitation
Onega (2018) [37] ¶	Mix-model repeated measures Nursing home	n = 60 (43 women) Mean age = 82. 6 ± 9. 6	Dementia diagnosis, Mild/ moderate: n = 18; Severe: n = 42; mean MMSE = 7. 2 ± 6. 9	Two conditions: MBL+EBL and STL. Procedure: BL (10, 000 lux), STL (250 lux); 8 weeks; 30 min twice a day; 5 d/ week	Mood	DSAOA, CSDD (Analysis of the total scores and their individual subscales)	Total scores: equally effective at mild/moderate and severe stages of dementia. Subscales: greater benefits for severe dementia than mild/moderate in two DSAOA subscales (disagreeable behaviour and sleep impairment)
Riemersma-van der Lek (2008) [33]	RCT Assisted care facilities	n = 189 (170 woman) Mean age = 85. 5 ± 5. 5	Dementia diagnosis, mean MMSE = 16. 4 ± 5. 6	Four conditions: 1-BL, 2-Melatonin, 3-BL + Melatonin, 4-DL. Procedure: BL (± 1000 lux), DL (± 300 lux); 15±12 months; 9 h/d.	Cognition, Mood, Sleep, Agitation, NPS, ADL	MMSE, CSDD, PCCMS, PCCARS, MOSES, CMAI, NI-ADL, NPI-Q Actigraphy	BL ameliorated cognition and depressive symptoms and also attenuated the increase in functional limitations over time. Melatonin + LB improved agitation, nocturnal restlessness, sleep efficiency, duration and fragmentation
Satlin (1992) [37]	Open clinical trial Hospital	n = 10/1 woman) Mean age = 70. 1 ± 5. 1	Moderate to severe dementia, mean MMSE = 0. 6 ± 1. 1	One condition: MBL Procedure: 1500–2000 lux; 2 weeks; 2 h/d	Agitation, Sleep	Daily ratings by nursing staff	Improvements in sleep-wakefulness, nocturnal activity decreased and the relative amplitude of circadian rhythm increased. No effects on agitation
Schindler (2002) [29]	Case series Hospital	n = 5(4 women) Mean age = 81. 8 ± 6. 3	Dementia diagnosis	One condition: MBL Procedure: 2500 lux; 2 weeks; 2 h/d	NPS	CRS	Delusions slightly improved in three of the participants, another did not show them neither before or during MBL, and another developed delirious symptomatology
Sekiguchi (2017) [38]	Case series Hospital	n = 17 (6 women) Mean age = 75. 5 ± 6. 2	Dementia diagnosis, mean MMSE = 12. 1 ± 8. 2	One condition: MBL Procedure: 5000 lux; 2 weeks; 1 h/d	Sleep	NPI-NH (Sleep disturbances)	Improvement of sleep disturbance in four AD patients. No significant values provided
Skjerve (2004) [30]	Open clinical trial Nursing home	n = 10 (3 women) Mean age = 79.4	VD or AD diagnosis, Median MMSE = 0 (range = 0–11)	One condition: MBL Procedure: 5000–8000 lux; 4 weeks; 45 min/d	BPSD, Sleep	CMAI, BEHAVE-AD, Own scale for sleep-wake disturbances, Actigraphy	Significant reduction of BPSD. No effect on sleep-wake measures but an improvement of activity rhythm disturbances
Sloane (2007) [41] †	Cluster-unit crossover design Psychiatric hospital and nursing home	n = 66 (31 women) Mean age = 79	Dementia, MDS-COGS/ MMSE: Mild to moderate: n = 21; severe: n = 31; and very severe: n = 14	Four conditions: MBL, EBL, all day BL, STL. Procedure: BL (2000–3000 lux), STL (500–600 lux); 3 weeks; MBL and EBL: 4 h/d, all day BL: 13 h/d	Sleep, Circadian rhythm	Actigraphy	Night-time sleep increased significantly in participants exposed to morning and all-day light with the increase most prominent in participants with severe or very severe dementia

(continued on next page)

Table 1 (*Continued*)

Author (year)	Study design/ Setting	Sample	Cognitive status	Intervention characteristics	Outcome measured	Measurement tools	Main findings
Sloane (2015)[48]	RCT Community-dwelling	*n* = 17 (11 women); Age: 65–79 = 6; ≥80 = 11	Dementia diagnosis; mean MMSE = 12.7 ± 9.1	Two conditions: BWL and RYL. Procedure: BWL (300–400 lux), RYL (mean = 118 lux); 6 weeks; fi on awakening time until 18:00	Sleep, Mood, QoL	Actigraphy, PSQI, MOS, ESS, CSDD, PHQ-9, QOL-AD	No significant evidence of sleep improvement or other outcomes in people with dementia. For caregivers, a significant improvement in sleep was observed
Thorpe (2000)[52]	ABA repeated measures Long term care facility	*n* = 16 (13 women) Mean age = 80.3	Dementia diagnosis; mean GDS = 6 (range 5–7)	One condition: MBL Procedure: 10,000 lux; 1 week; 90 min/d (Monday to Friday)	Agitation, BPSD	CMAI, EBC	CMAI: a significant decrease in agitation during MBL compared with the post-therapy week. EBC: MBL showed a trend to increase positive behaviours and to decrease disruptive behaviours
Van Someren (1997)[43]	ABA Repeated measures Psychogeriatric ward	*n* = 22 (15 women) Mean age = 79±2	Dementia diagnosis; mean GDS = 6. 3 ± 0. 13 (range 5–7)	Two condition: BL and baseline. Procedure: BL(mean = 1136± 89 lux), baseline (mean = 458±90 or 372± 89 lux); 4 weeks; all-day	Circadian rhythm	Actigraphy	BL improves the circadian rest-activity rhythm disturbances in severely demented patients with intact vision, but not in those with visual impairment

Note. *, †, ‡, §, ¶: Articles with the same symbol report data from the same study sample but describe different outcomes. Abbreviations: ABA: baseline with no treatment (A) and treatment (B); ABABA: Alternating baseline (A) and treatment (B) conditions; ABRS: Agitated Behaviour Rating Scale; AD: Alzheimer's Disease; ADL: Activities of Daily Living; BARS: Brief Agitation Rating Scale; BEHAVE-AD: The Behavioural pathology in Alzheimer's Disease; BMS: Brief Interview for Mental Status; BL: Bright Light; BPSD : Behavioural and Psychological Symptoms of Dementia; BWL: Blue-White Light; CADS: Change in Advanced Dementia Score; CDR: Clinical Dementia Rating; CERAD: Consortium to Establish a Registry for Alzheimer's Disease; CGI: Clinical Global Impression; CMAI: Cohen-Mansfield Agitation Inventory; CMAI-D: Cohen-Mansfield Agitation Inventory-Disruptiveness; CMAI-P: Cohen-Mansfield Agitation Inventory-Frequency; CRBRS: Crichton Royal Behaviour Rating Scale; CRS: Confusion Rating Scale; CSDD: Cornell Scale for Depression in Dementia; DDS: Dawn-Dusk Simulation; DL: Dim light; DMAS-17 : Dementia Mood Assessment Scale-17 item; DRL: Dim Red Light; DSAOA: Depressive Symptom Assessment in Older Adults; EBC: Environment-Behaviour Interaction Code; EBL: Evening Bright Light; ESS: Epworth Sleepiness Scale; GDS: Global Deterioration Scale; GDS-SF: Geriatric Depression Scale – Short Form; GIP: Gedragsobservatieschaal voor Intramurale Psychogeriatrie; MBL: Morning Bright Light; MD: Mixed Dementia; MDL: Morning Dim Light; MDS-ADL: Minimum Data Set – Activities of Daily Living Scale; MDS-COGS: Minimum Data Set - Cognition Scale; MMSE: Mini- Mental State Examination; MOS: Medical Outcomes Study sleep scale; MOSSS: Multi Observation Scale for Elderly Subjects; MOUSEPAD: Manchester and Oxford Universities Scale for the Psychopathological Assessment of Dementia; NI-ADL: Nurse-informant activities of daily living scale; NPI-NH: Neuropsychiatric Inventory Nursing Home Version; NPS: Neuropsychiatric Symptoms; OERS: Observed Emotion Rating Scale; PAS: Pittsburgh Agitation Scale; NPI-Q: Questionnaire format of Neuropsychiatric Inventory; PCOARS: Philadelphia Geriatric Centre Affect Rating Scale; PGCMS: Philadelphia Geriatric Center Morale Scale; PHQ-9: Patient Health Questionnaire; PSQI: Pittsburgh Sleep Quality Index; QoL: Quality of Life; QOL-AD: Quality of Life in Alzheimer's Disease; QoLLID : Quality of Life for Severe Dementia; RCT: Randomized Controlled Trial; RYL: Red-Yellow Light; SDAS: Social Dysfunction and Aggression Scale; SDI: Sleep Disorders Inventory; S-MMSE: Severe Mini- Mental State Examination; STL: Standard light; VD: Vascular Dementia.

Table 2
Methodological quality assessment using The Joanna Briggs Institute Critical Appraisal Checklist for Randomized Clinical Trials.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Score (/13)
Ancoli-Israel et al.[54]	Y	U	N	U	U	N	Y	N	N	Y	U	N	Y	4
Ancoli-Israel et al.[55]	Y	U	N	U	N	N	Y	N	U	Y	Y	N	Y	5
Ancoli-Israel et al.[56]	Y	U	N	U	N	N	Y	Y	U	Y	Y	N	Y	6
Burns et al.[51]	Y	U	Y	U	U	Y	Y	Y	Y	Y	Y	N	Y	9
Dowling et al.[19]	Y	U	Y	N	N	N	Y	Y	N/A	Y	U	N	Y	6
Dowling et al.[57]	Y	U	Y	N	N	N	Y	Y	U	Y	U	N	Y	6
Dowling et al.[58]	Y	U	Y	N	N	N	Y	U	U	Y	Y	N	Y	6
Dowling et al.[59]	Y	U	N	Y	Y	Y	Y	Y	N/A	Y	U	Y	Y	9
Fontana Gasio et al.[49]	Y	U	Y	U	U	U	U	Y	U	Y	U	Y	Y	6
Friedman et al.[33]	Y	U	Y	U	U	U	Y	Y	U	Y	U	N	Y	6
Graf et al.[34]	Y	U	U	U	U	Y	U	Y	U	Y	U	N	Y	5
Haffmans et al.[42]	Y	U	U	Y	Y	Y	U	Y	U	Y	Y	N	Y	8
Lyketsos et al.[53]	Y	U	Y	U	U	Y	Y	Y	Y	Y	U	N	Y	8
McCurry et al.[44]	Y	Y	Y	U	U	Y	Y	Y	Y	Y	Y	Y	Y	11
Onega et al.[53]	Y	U	Y	Y	N	Y	Y	Y	U	Y	Y	Y	Y	10
Onega et al.[67]	Y	U	N	Y	N	Y	Y	Y	U	Y	Y	N	Y	9
Riemersma van der Lek et al.[30]	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	U	Y	Y	11
Sloane et al.[45]	Y	U	U	U	U	U	U	Y	U	Y	U	N	Y	4

Note: Q1: Randomization; Q2: Concealed allocation; Q3: Groups similar at baseline; Q4: Participants blinded; Q5: Allocator blinded; Q6: Assessors blinded; Q7: Groups treated equally; Q8: Follow-up complete; Q9: Participants analysed in original group; Q10: Outcomes measured in the same way in groups; Q11: Outcomes measured reliably; Q12: Appropriate statistical analysis; Q13: Appropriate trial design. Abbreviations: Y: Yes; N: No; U: Unclear; N/A: not applicable.

BPSD, light therapy and cognition, light therapy and quality of life, and light therapy and activities of daily living) described in Table 1. As observed, three of the articles examined the effect of light treatment on BPSD as a whole, regarding effects on specific BPSD: 25 of the articles examined the effect of light on sleep, 12 on agitation, 10 on mood and 4 on neuropsychiatric symptoms. Additionally, four articles assessed the effect on cognition, two on quality of life and two on functioning in activities of daily living. A final sixth subsection was included to compare the intervention conditions of light therapy among the studies analysed in this review.

Quality assessment

Regarding quality assessment, studies were analysed using the corresponding form of JBI appraisal tool according to the type of design used in each article: checklist for Randomized Controlled Trials - RCT (Table 2) and checklist for Quasi-Experimental Studies - QES (Table 3). In Table 2, only three[30,44,53] of the 18 included studies met 10 or more (80%) of the 13 criteria on the JBI for RCT. A lack of quality was observed in most of the 18 studies, 10 (55.6%) of them[19,33,34,45,49,54–58] had equal or below six scores (less than half of the defined appraisal criteria). Category 12 (appropriate statistical analysis) was the most unfulfilled item, no power analysed or effect sizes were estimated. In category 9 (participants analysed in the original group) was rated as not applicable (N/A) in two of the included studies[19,59] since their follow-up was complete, so the intention-to-treat analysis was not used in these cases. Randomization (Q1), identical group treatment (Q7), complete follow-up (Q8), outcomes measured (Q10), and trial design (Q13) were the best methodological standards. Methodological quality was better in those non-randomized studies (Table 3), all 18 studies met at least 5 (50%) of the defined appraisal criteria. Four[31,40,41,50] of the 18 assessed articles met 7 or more (80%) of the 9 criteria of the JBI for QES. Categories 4 (presence of a control group) and 9 (appropriate statistical analysis) was the most unfulfilled item, no power analysed or effect sizes were estimated. A clear cause/effect (Q1), identical compared groups (Q2), pre- and post-measures (Q5), complete follow-up (Q6), and outcomes measured (Q7) were the most covered items for non-randomized experimental studies.

Table 3
Methodological quality assessment using The Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Score (/9)
Barrick et al.[31]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Fetveit et al.[46]	Y	Y	U	N	Y	Y	Y	U	N	5
Fetveit and Bjorvatn[47]	Y	Y	U	N	Y	Y	Y	Y	N	6
Fetveit and Bjorvatn[48]	Y	Y	U	N	Y	Y	Y	Y	N	6
Figueiro et al.[64]	Y	Y	U	N	Y	N	Y	Y	N	5
Figueiro et al.[32]	Y	Y	U	N	Y	N	Y	Y	Y	6
Hickman et al.[40]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Lovell et al.[24]	Y	Y	U	N	Y	Y	Y	U	N	5
Mishima et al.[35]	Y	N	U	Y	Y	Y	Y	Y	N	6
Mishima et al.[36]	Y	N	U	N	Y	Y	Y	Y	N	5
Münch et al.[50]	Y	Y	U	Y	N	Y	Y	Y	Y	7
Satlin et al.[37]	Y	Y	U	N	Y	Y	Y	U	N	5
Schindler et al.[29]	Y	Y	U	N	Y	Y	Y	U	N	5
Sekiguchi et al.[38]	Y	Y	U	N	Y	Y	Y	U	N	5
Skjerve et al.[39]	Y	Y	U	N	Y	Y	Y	U	N	5
Sloane et al.[41]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Thorpe et al.[52]	Y	Y	U	N	Y	Y	Y	Y	N	6
van Someren et al.[43]	Y	Y	U	N	Y	Y	Y	U	N	5

Note: Q1: Clear cause and effect; Q2: Participants included in comparison similar; Q3: Any comparison other than intervention of interest; Q4: Control group; Q5: Multiple measurements pre and post-intervention; Q6: Follow-up complete; Q7: Outcomes measured in the same way in groups; Q8: Outcomes measured reliably; Q9: Appropriate statistical analysis. Abbreviations: Y: Yes; N: No; U: Unclear; N/A: not applicable.

Light therapy and BPSD

Three studies[35,39,52] analysing the effect of light therapy on BPSD as a whole found improvements on BPSD. Two of these[35,52] showed a substantial reduction in the frequency of behaviour disorders, and in one of them,[52] it was also reported a mean decrease of total disruptive behaviours during the light intervention.

In the following subsections, our results are presented classified according to the effect of light therapy on specific BPSD: sleep, agitation, mood, and neuropsychiatric symptoms.

Light therapy and sleep

Of the 25 articles assessing the effect of light therapy on sleep disorders, 19 utilized actigraphy. Actigraphy is a reliable technique to study the effect of treatments on sleep and circadian rhythm disorders in people with dementia.[60] In addition to using actigraphy, six articles complemented the evaluation of sleep with subjective measures; three of them incorporated an own questionnaire of sleep-wakefulness disturbances,[39,46,48] and the other three[32,33,51] included daily sleep reports, plus the Pittsburgh Sleep Quality Index (PSQI)[61] in one case[32] and the Epworth Sleepiness Scale, ESS[62] in another one.[33] Other three articles[35,37,63] only used daily ratings by nursing staff, two articles[45,64] included only the PSQI, in one study the assessment was made by the Neuropsychiatric Inventory, Nursing Home version (NPI-NH)[65] and finally, one article used the Sleep Disorders Inventory (SDI).[66]

Only three of the 25 articles reviewed[33,45,50] found no significant improvement in sleep disturbances. Sekiguchi et al.[38] found evidence only in 4 out of 17 patients, those with mild to moderate Alzheimer's disease and a shorter duration of illness.

Light therapy and agitation

Seven[24,30,42,52,53,55,64] of the 12 articles evaluating the effect of light therapy on agitation provided significant evidence of potential beneficial effects on this symptom. Three[37,50,63] found no significant improvement in behavioural symptoms in people with dementia, one[51] reported only limited evidence of a reduction in agitation, and finally, in the study of Barrick et al.[31] light therapy resulted in an exacerbation of agitation levels during treatment periods.

Light therapy and mood

Five out of 10 articles focused on evaluating the use of light therapy for improving mood found a significant decrease in depressive symptoms[30,32,53,64,67] and another one found more positive emotions, with greater general alertness.[50] Moreover, Hickman et al.[40] found limited evidence since depressive symptomatology only decreased in some people with dementia, while other patients showed a worsening of such symptoms. The remaining three articles[45,51,63] found no benefits of light therapy on mood.

Light therapy and neuropsychiatric symptoms

Three of the four articles that evaluate the impact of light therapy on neuropsychiatric symptoms (NPS) use the Neuropsychiatric Inventory, two of them[49,58] use the Nursing Home version (NPI-NH)[65] and the other one[30] utilizes the questionnaire format.[68] In two of these articles,[30,49] no significant effects were found neither in the severity of the symptoms either in distress of the caregivers. Conversely, Dowling et al.[58] found significant ameliorations in depression/dysphoria, aberrant motor behaviour, and appetite/eating disorders, but pointing out the low clinical meaning of the outcomes, with no clinical effect on the agitation/aggression of patients with dementia. The fourth of the articles[29] on neuropsychiatric symptoms specifically addresses delusions and hallucinations in a small group of patients with Alzheimer's disease. These authors found contradictory results, during the intervention, three of the participants slightly improved the delusional symptoms that they presented before, and another participant did not show delusions neither before nor during the treatment. Conversely, one participant without previous delusional symptomatology developed paranoid delusions and visual hallucinations during the intervention, disappearing one day after the end of the treatment.

Light therapy and cognition

Only four studies were included in this review. Two of them[30,34] found significant beneficial effects on cognition decline with increasing Mini-Mental State Examination (MMSE) de Folstein[69] total scores after light treatment. Nevertheless, other authors[48,50] found no significant differences in MMSE scores after treatment, nor in the neuropsychological tests developed for the Consortium to Establish a Registry for Alzheimer's Disease (CERAD)[70] for the measurement of memory, cognitive impairment and the progression of dementia.[49]

Light therapy and quality of life

Münch et al.[50] reported better quality of life of severely demented patients after light exposure, with better scores using the Quality of Life for Severe Dementia instrument (QUALID).[71] However, a previous study[45] reported no significant differences in Quality of Life in Alzheimer's Disease scores (QOL-AD).[72]

Light therapy and activities of daily living

Two of the articles[30,64] included in this review addressed, among others, the effect of light therapy on the functioning of the activities of the participant's daily life,. In one of these studies,[64] it was used the Minimum Data Set Activities of Daily Living Scale (MDS-ADL)[73] to measure the dependence in the performance of activities of daily living (ADL), showing a decrease in the scores over time without significant differences. In the other study,[30] it was found evidence that light therapy attenuated the gradual increase in functional limitations over time in patients with dementia.

Intervention characteristics

The characteristics of the intervention protocol varied among the studies regarding the type and intensity of the light as well as the duration and frequency of the intervention (see Table 1). In the majority of the articles included in this review, older adults with cognitive impairment were exposed to white bright light, with a high variability of light intensities consisting of doses ranging from 417.24 lux[50] to 10,000 lux.[51–53,63,67] The most repeated intensity value of the treatment light, appearing in eleven of the 36 selected articles, was a light intensity of 2500 lux,[19,24,29,41,44,54–59] followed by the value of 10,000 lux, which was shown in 6 of the articles. On the other hand, four studies used a different type of light treatment. In three[32,45,64] of them, participants were exposed to a bluish-white light as the treatment condition, and in the other one,[49] it was used as a naturalistic form of light therapy called dawn-dusk simulation (DDS).

With respect to the time of day, excluding McCurry et al.[44] who provided evening bright light sessions, and Fontana Gasio et al.[49] who used a special application that includes exposure at dawn and dusk time, all the articles included light intervention in the morning. Ten out of the articles[31,40,41,53–58,67] established experimental designs including both morning and evening bright light, with more

Table 4
The most repeated characteristics of light therapy in the included studies providing positive results.

Intervention characteristics				
Type of light	Intensity	Time of day	Frequency (time/day)	Total duration
White bright light	2500–10,000 lx	Morning	30 min–2 h	2–4 weeks

significant effects in the morning sessions. Six of the studies[30,32,43,45,50,64] reported a combined design, with bright light sessions from the time of awakening until 18:00.

Diversity across the studies was also observed in terms of the frequency and duration of light therapy, ranging from 30 min[33,42] to 8–10 h[32,64] per day, with two hours per day being the most frequent intervention duration,[24,29,34–37,46–48,51,54–56] followed by one hour per day present in seven of the articles.[19,38,44,57–59,63] Two of the studies[31,40] included an experimental group that was exposed to all-day bright light from 7 a.m. to 8 p.m., but a longer exposure time to the lighting conditions did not demonstrate improved effects. There was also a variety in the light intervention duration, with a minimum of 5 days[52] and a maximum of 15±12 months.[30] The most common duration of light treatment were periods time of two weeks[29,33,37,38,46–48,51] and four weeks,[32,35,36,39,42,43,63,64] each period being used respectively in eight of the articles analysed.

Table 4 includes the most repeated characteristics of light therapy used only in the studies with positive results in any of their outcomes measures.

Discussion

This systematic review aimed to analyse studies exploring light therapy in people with cognitive impairment to assess its efficacy as a non-pharmacological approach to manage BPSD, cognition, functional status and quality of life. The current review provides potential evidence that light therapy has positive effects on BPSD, but limited evidence of its effectiveness on cognition, quality of life and functioning in activities of daily living. The secondary objective was to identify the light therapy conditions with the highest benefits for older adults with cognitive impairment, seeking to define guidelines for an adequate protocol in order to facilitate its clinical application with this population. There were great differences between the characteristics of the intervention protocols of the analysed studies, so we synthetized the conditions most commonly used in those studies with positive results.

The articles analysed yielded findings of positive effects of light therapy on BPSD in people with dementia. There is numerous research addressing the effects of light therapy on this symptomatology, especially regarding sleep, agitation and mood.

Most of the publications focus on sleep, reporting significant improvements after or during the intervention, except from four out of the 25 included articles, which found ameliorations only in some of the participants[38] or no significant changes in sleep disturbances.[33,45,50] Additionally, better effects on rest-activity rhythms were observed in older people with vascular dementia than those with dementia of Alzheimer's type, probably due to the higher desynchronization of the circadian rhythm in those with vascular dementia.[36]

The second most reported symptom is agitation, with the majority of the publications analysed showing a reduction in it after the intervention with light therapy. Bright light therapy improved agitation symptoms, with a significant decrease in caregiver ratings of physical, verbal and total agitation measured with the Cohen-Mansfield Agitation Inventory (CMAI)[24] from baseline to the end of the treatment, delaying acrophase of the agitation rhythm; however, it had little effect on observational ratings of agitation.[55] These authors also concluded that this therapy is more adequate in older people with milder forms of dementia since those with severe dementia possess an SCN that is too degenerated to benefit from light treatment. In contrast to this study, Skjerve et al.[39] showed improved behavioural symptoms in people with severe dementia, also suggesting a delay in activity rhythms. Other authors[30,52,64] also used the CMAI for the measurement of agitated behaviours, showing a significant decrease of agitation; in one of these articles,[30] the positive effects were found only in the condition of light exposure combined with melatonin administration. Additionally, in another study,[42] bright light therapy showed a positive effect on motor restless behaviour after treatment, with patients being less restless and more cooperative. A potential effect, albeit with limited evidence, was also observed for agitation in severely cognitively impaired patients.[51] Light therapy is a treatment that may be used at home to reduce agitation.[24] The effectiveness of light therapy to reduce agitation (with significant effects on four measures of agitation) provides a non-pharmacological alternative to pharmacological treatment,[53] in which serious side effects are uncommon.[39] In contrast to this effect of light therapy, other authors[31] even observed a worsening of behavioural symptoms. Nevertheless, this study includes among its limitations that those patients who responded favourably to the light treatment were discharged because of their decreased agitation level. Lyketsos et al.[63] explain the lack of effect on agitation due to the use of a short-term intervention (4 weeks) or to the absence of a sleep/wake cycle disorder in their study sample. These different outcomes are in conjunction with the different instruments used to measure agitation, the different levels of dementia severity of the patients or the lack of controlling important parameters, as medication consumption or changes before and during the light intervention, among the studies.

Regarding mood, six out of ten articles showed an improvement in depressive symptomatology. In one of these articles,[57] the effect of light therapy was compared between two groups of participants assigned to them based on their stage of dementia (mild to moderate dementia vs severe dementia). Both groups showed an improvement in total scores, but differences in two subscales of the Depressive Symptom Assessment for Older Adults (DSAOA),[75] where patients at severe stages of dementia showed greater benefits of the intervention. As opposed to these results, no positive effect of light therapy on mood was found in three articles.[45,51,63] Moreover, Hickman et al.[40] found positive effects in some of the participants after the light therapy intervention, but conversely other participants showed a worsening of their depressive symptoms. Circadian disruption increases the likelihood of depressive symptoms, which are also linked to the sleep disturbances[76] since alterations of rest-activity rhythm contribute to depressive episodes.[77] Light treatment is also a non-pharmacological option to reduce depression and depressive symptomatology in older adults with dementia,[53] although the magnitude of the effect may not always be clinically significant.[58] This effect is large if the efficacy of bright light therapy on depressive symptoms is studied in people with depression or depressive symptomatology at baseline.[40] These findings are not consistent with those of Burns et al.[50] who showed no significant differences in Cornell scores,[78] or those of Lyketsos et al.[63] who reported no significant changes after bright light exposure in people with dementia. Differences between the methods used to measure depressive symptoms in people with dementia or the collection of information from the caregivers also influence outcomes on the effect of the lighting intervention.[40]

The BPSD with the least research is the neuropsychiatric symptoms, having found only four articles to include in the current review. Three of the articles[30,49,50] evaluated the impact of light therapy on general NPS, with significant improvements in only one of them.[58] The fourth article was focus on delusional symptomatology, finding conflicting results among participants of the study: three slightly improved, one showed no change, and another participant began to experience hallucinations and delusions during the intervention.[29] There is a lack of research regarding the effects of light therapy on psychotic symptoms associated with dementia. Taguchi et al.[79] examined the use of bright light therapy as a prevention tool of postoperative delirium in a sample of middle-aged and aged hospitalized patients. These authors found that the hallucinations disappeared at the first or second day of the intervention in the experimental group, but they persisted in the control group for several days. Therefore, bright light therapy seems to be useful in the management of NPS, but its application requires caution, as it has been suggested that it may have a significant impact on the onset of delusional symptomology in the course of Alzheimer's disease.[29]

Respecting cognition, we found limited and conflicting evidence for the effects of light therapy. In two of the articles analysed,[30,34] participants showed an increase in MMSE total scores after the intervention, by contrast in the other two studies,[48,50] no significant changes were shown in either the MMSE or CERAD scores. Importantly, neuroimaging studies have shown that light regulates cognitive brain activity, which affects cognition and alertness, contributing to sleep and circadian rhythms.[80] Thus, the potential effect of light on brain functioning must be further explored.

Although the direct effect on the quality of life is not usually considered in the studied articles and is even controversial, improvement of sleep disturbances would also indirectly improve the quality of life of people with dementia.[76] Thus, increased light exposure is associated with significant differences in quality of life in older community-dwelling people.[81]

Likewise, research on the impact of light therapy on functional status in people with cognitive impairment is also scarce, having found for this review only two articles on this topic. The existing studies[30,64] showed potential benefits of light therapy on the functioning of the participants in their activities of daily living. It is important to promote future research addressing the effects of light therapy on functional status due to its high importance in the field of gerontology and geriatrics.

Finally, regarding the intervention characteristics, it was found high heterogeneity among the protocols of the studies included in the current review. This lack of homogeneity can affect the different outcomes found in the analysed articles. In general, including all the literature addressed, treatment sessions can last from 30 min to 13 h depending on the equipment used, dosing 2500–10,000 lux, once or twice a day, for a total intervention period time ranging from 10 days to 10 weeks. With the purpose of providing guidelines for future research in this area, as observed in Table 4, we synthetized the most used characteristics among the studies that resulted in positive effects on the outcome measures. Lastly, the application of light therapy does not require a prescription, but it is important that clinical staff who are familiar with this intervention explain and supervise its application both in institutions and at home. Likewise, although contraindications for light therapy are few,[82] following up once the intervention has begun is essential to control changes, paying particular attention to the development or increase of neuropsychiatric symptoms,[29] making adjustments to the intervention protocol if necessary.

Strengths and limitations

This review should be understood considering some limitations. First, the limited number of people participating in some studies and the heterogeneity of the methodological aspects for light intervention can affect the robustness and clinical relevance of some of the described outcomes and conclusions. In contrast, we carry out an evaluation of the methodological quality for each included study in order to strengthen our results. Additionally, the main strength of this review is the absence of a limit on search years. In addition, we required validated instruments criteria to analyse the effect on BPSD, quality of life and cognitive status in older people, and we presented well-defined aims and explicit inclusion criteria. Besides, we pursued to know the effect of light therapy in older adults (aged 65 years or older) with cognitive impairment, having or no having dementia diagnosis.

Conclusions

This systematic review showed potential evidence for positive effects of light therapy on managing sleep, behavioural and mood disturbances in people with cognitive impairment, but more research is needed to support these results. A limited effect was found respecting cognition, quality of life and functional status. Despite the great heterogeneity found in the studies, this review reported the most commonly repeated parameters of light therapy used in older adults with cognitive impairment with positive results throughout the literature, thus offering a guide for the design of future studies in this field. Therefore, future studies should be designed to determine the optimal intensity, frequency and duration of the intervention as well to assess its effectiveness.

Declaration of Competing Interest

None

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi: 10.1016/j.gerinurse.2020.07.005.

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3.3. Estudio III: Luminoterapia en personas mayores con demencia de moderada a muy severa: efectos inmediatos sobre la conducta, el estado de ánimo y parámetros fisiológicos (93)

En este estudio nos propusimos explorar los efectos inmediatos de la BLT sobre el comportamiento, el estado de ánimo y los parámetros fisiológicos (saturación de oxígeno y frecuencia cardiaca) en una muestra de personas mayores institucionalizadas con demencia de moderada a muy grave.

El protocolo BLT consistió en sesiones matinales de 30 minutos con una intensidad de 10.000 lux, de lunes a viernes, durante 4 semanas. Los parámetros fisiológicos se registraron inmediatamente antes y después de cada sesión mediante pulsioximetría. El estado de ánimo y el comportamiento se evaluaron antes, después y durante las sesiones mediante la escala Interact.

Las puntuaciones de Interact después de las sesiones mostraron una disminución significativa en los ítems de *Llanto/tristeza* y *Habla espontánea*, y un aumento significativo en los ítems *Disfrutando de sí mismo, activo o alerta*, y *Relajado, contento o durmiendo adecuadamente.* Las puntuaciones de Interact durante las sesiones reflejaron una disminución significativa en los ítems relacionados con el habla. Ambos parámetros fisiológicos cambiaron positivamente de antes a después de las sesiones.

Nuestros resultados sugieren que la BLT proporciona efectos positivos inmediatos sobre el estado de ánimo, el nivel de estimulación y los parámetros fisiológicos, así como una tendencia a la disminución del habla. Se necesitan investigaciones más sólidas para explorar más a fondo el impacto inmediato de BLT.

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Bright Light Therapy in Older Adults with Moderate to Very Severe Dementia: Immediate Effects on Behavior, Mood, and Physiological Parameters

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Abstract: Bright light therapy (BLT) has demonstrated positive short- and long-term effects in people with cognitive impairment or dementia; however, the immediate impact of BLT sessions has been scarcely investigated. In this study, we aimed to explore the immediate effects of BLT on behavior, mood, and physiological parameters (oxygen saturation/heart rate) in a sample of institutionalized older adults with moderate to very severe dementia, with a median age of 85.0 (interquartile range, IQR, 82.0–90.0), being higher in men (87.0 years, IQR 80.0–94.0) than in women (84.5 years, IQR 82.0–89.5). The BLT protocol consisted of 30-min morning sessions of 10,000 lux, Monday through Friday, for 4 weeks. The physiological parameters were recorded immediately before and after each session by pulse oximetry. Mood and behavior were assessed before, after, and during the sessions using the Interact scale. Post-session Interact scores showed a significant decrease in the items *Tearful/sad* and *Talked spontaneously*, and a significant increase in the items *Enjoying self, active or alert*, and *Relaxed, content or sleeping appropriately*. Interact scores during the sessions reflected a significant decrease in the speech-related items. Both physiological parameters changed positively from before to after sessions. Our results suggest that BLT provides immediate positive effects on mood, stimulation level, and physiological parameters, as well as a trend toward decreased speech. More robust research is needed to further explore the immediate impact of BLT. This study is registered with Clinicaltrials.gov (NCT04949984).

Keywords: bright light therapy; dementia; mood; behavior; oxygen saturation; heart rate

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1. Introduction

Dementia is one of the main causes of disability and dependence among older adults worldwide, constituting a public health priority due to its significant human and financial costs to society [1]. Oxidative stress, mitochondrial damage, and synaptic damage are all implicated in dementia pathogenesis, playing an important role in the cognitive impairment and memory loss of older individuals with Alzheimer's disease (AD) [2–4]. Neurotransmitters are essential to maintain synaptic and cognitive function, and are also involved in altering the mood, depression, or anxiety of AD patients [5,6]. Aside from cognitive decline, dementia progression leads to the appearance of at least one neuropsychiatric symptom (NPS) in most individuals at some point during the course of their disease [7,8]. NPS, also known as behavioral and psychological symptoms of dementia (BPSD) [9], are defined as a series of signs and symptoms of disturbed perception, thought content, mood, and behavior that frequently occur in dementia and constitute part of the expression of the disease [10]. These symptoms mainly comprise delusions, hallucinations, agitation, depression, anxiety, apathy, irritability, euphoria, disinhibition, aberrant motor

behavior, sleep and nighttime behavior disturbances, and changes in appetite and eating behaviors [11,12].

Treatment development for BPSD includes both pharmacological and nonpharmacological therapies. In clinical settings, pharmacological agents are frequently used in the management of these symptoms but show modest efficacy and significant serious side-effects [13,14], including increased risks of hospitalization, falls, and mortality [15]. Numerous guidelines and expert recommendations favor nonpharmacological interventions for the treatment of BPSD due to their significant impact on global BPSD outcome measurements and the lack of adverse events [16]. In fact, the American Geriatrics Society Beers Criteria Update Expert Panel recommends the use of nonpharmacological approaches as the first course of action, unless they have previously failed, are not feasible, or there is a substantial risk of harm to self or others [17]. Therefore, nonpharmacological therapies should be considered to be the first choice of treatment. Nonpharmacological interventions include cognitive stimulation, reminiscence therapy, reality orientation, validation therapy, animal-assisted therapy, exercise or physical activity, Snoezelen/multisensory stimulation, aromatherapy, music therapy, and light therapy, among others [18,19]. It is necessary for further research to continue to strengthen the evidence of their effectiveness [16].

In this study, we focus on bright light therapy (BLT). This therapy consists of the controlled application of certain levels of light that can be administered in different ways, including outdoor sunlight, light boxes, light visors worn on the head, ceiling lights, or dawn-dusk simulation [20]. BLT is reported to have positive effects in the management of BPSD, sleep disturbances, and circadian rhythms (see recent reviews [21,22]). Although numerous studies address the short- and long-term effects of this therapy in people with cognitive impairment or dementia, there is little research on its immediate effects. Furthermore, other sensory therapies—such as multisensory stimulation in a Snoezelen room or music therapy—are shown to provide immediate positive effects on measures of behavior and mood disturbances, as well as on certain physiological parameters such as heart rate or blood oxygen saturation [23–25]. Thus, it could be expected that BLT, as a sensory therapy, would also lead to improvements in mood, behavior, and physiological parameters. Therefore, the main objective pursued in this study was to explore the immediate effects of bright light therapy on behavior, mood, and physiological parameters (oxygen saturation and heart rate) in a sample of institutionalized older people with moderate to very severe dementia.

2. Materials and Methods

2.1. Design

This study was designed as a randomized controlled trial. Participants were stratified according to their cognitive status and were subsequently randomly assigned to the experimental group (BLT) or control group. In the analysis and exploitation of results, we only considered the response of the BLT group with regard to the stated objective since the control group did not undergo the intervention needed to complete Interact assessment during the study.

2.2. Participants

Participants were recruited from among the residents of a gerontological complex specializing in dementia (78.7% with cognitive impairment) and located in A Coruña, Spain. The gerontological complex has 70 older people in a day care-setting and 64 institutionalized older people in a nursing home. We selected all institutionalized participants (n = 64, with a mean age of 88.4 ± 8.0 years and a median age of 89.0 (interquartile range, IQR, 84.0–94.0)); 29.7% were men, with a mean age of 88.5 ± 9.4 years and a median age of 91.0 (interquartile range, IQR, 84.5–94.0), and 70.3% were women, with a mean age of 88.4 ± 7.5 years and a median age of 88.0 (interquartile range, IQR, 84.0–94.0). To delimit the sample, before the recruitment process, inclusion and exclusion criteria were established according to the existing literature. As inclusion criteria, participants were required

to satisfy the conditions of being 65 years or older, diagnosed with dementia, scoring ≥4 points on the global deterioration scale (GDS) [26], and having signed the informed consent (directly or through their legal guardians). Based on a recent systematic review on the ocular safety of light therapy [27], individuals with increased ocular sensitivity to light (photosensitivity) or those with preexisting ocular abnormalities were excluded from the study. Residents who had any severe eye disorder that did not allow them to open their eyes, or involved very low visual acuity, were also excluded since light needed to enter the participant's eyes to achieve the desired effects [28].

2.3. Procedure

The research protocol (code 2017/408) received favorable authorization from the Galician Research Ethics Committee of Xunta de Galicia, Spain, and was developed in accordance with the Declaration of Helsinki. The participants and their legal guardians were informed about the study and signed the corresponding informed consent. All the information transmitted was adapted to the level of comprehension of the participants to facilitate their understanding and comfort throughout the study.

The study was retrospectively registered with ClinicalTrials.gov (NCT04949984) on 2 July 2021. The study protocol was based on the implementation guidelines that we described in a recent review [22]. The BLT sessions were carried out in a quiet room of the gerontological complex especially enabled for their proper implementation and were conducted by two research psychologists specialized in gerontology. The devices used for the intervention were bright white light lamps providing an intensity of 10,000 lux. Four users participated in each session, with two users per lamp, seated in a comfortable chair with armrests which was 70 cm from the lamp. The sessions were 30 min/day, between 10:30 a.m. and noon, 5 days a week (Monday to Friday), for 4 weeks (total 20 sessions). During the sessions, while exposed to light, participants watched documentaries on neutral topics. Each session lasted 30 min, unless the participant expressed the desire to leave the room and could not be convinced to remain without generating agitation. Participants who responded negatively to light exposure were immediately withdrawn from the intervention. Only those sessions in which the participant remained for at least 80% of the expected time (≥22.5 min) were considered as sessions performed.

In every session, the researchers supervised the participants to ensure full compliance with the treatment and evaluated the physiological parameters, mood, and behavior of the participants. Once in the room, the investigators measured the heart rate (beats per minute) and blood oxygen saturation (SpO2) of each participant using a mobile finger pulse oximeter before and after the session.

Mood and behavior were assessed during the sessions and in the 10 min periods immediately before and after each session using the Interact scale [29] and its shortened version, named Interact short. The Interact scale, hereinafter referred to as Interact during, is made up of 22 Likert-scale items that score the frequency of occurrence (ranging from 1 (Not at all) to 5 (Nearly all the time)) of each type of mood and behavior during the sessions. Additionally, as qualitative information, any comments made by the participants about their session were recorded, as well as the sensation that the researchers believe the participants experienced during the session (relaxing, stimulating, leisure, improving communication, arousing curiosity, or unpleasant). The Interact short includes 12 Likert-scale items, with the same range as in the Interact during, recording the occurrence of each type of mood and behavior of the participants in the 10 min periods immediately preceding and following the session to measure any observable change.

2.4. Statistical Analysis

All data were analyzed using the SPSS statistical software package (version 26.0) (IBM, Armonk, NY, USA) and statistical significance was set at $p < 0.05$. The normal distribution of the variables was tested using the Shapiro–Wilk test. For subsequent analyses, we applied parametric or nonparametric tests depending on whether the assumption of normality was

met or not for each measured variable. The Wilcoxon signed-rank test or paired *t*-test were employed to measure significant changes between the Interact short scores before and after the intervention sessions for each of the assessed mood and behavior items. Likewise, these same tests were used to analyze the evolution of the Interact during scores by comparing the average scores of the first week with those of the fourth week. In addition, the evolution of mood and behavior scores throughout the four weeks of treatment was analyzed with the Friedman test for related samples. The paired *t*-test was also used to determine the existence of any differences between before and after the sessions in the physiological parameters investigated. In the variables in which statistically significant differences were found, Cohen's d or r values were used to report the effect size (ES) of these changes. The interpretation of the importance of the ES was made according to the benchmarks defined by Cohen [30] as follows: small ES (d = 0.2 or r = 0.1), medium ES (d = 0.5 or r = 0.3), and large ES (d = 0.8 or r = 0.5).

3. Results

3.1. Sample Characteristics

After applying inclusion and exclusion criteria, the total sample was reduced from 64 to 39 institutionalized older people (20 participants assigned to the control group and 19 to the BLT group). Table 1 shows their sociodemographic characteristics and their level of cognitive decline based on the scores obtained in the GDS. The categorical variables (gender, marital status, educational level, level of cognitive impairment) are expressed in terms of frequency and percentage, and age, as a continuous variable, is presented as the mean plus standard deviation (SD), along with the range of minimum and maximum values. The mean age of the participants was 86.3 ± 6 years, ranging from 75 to 98, with a median age of 85.0 (interquartile range, IQR, 82.0–90.0), being higher in men (87.0 years, IQR 80.0–94.0) than in women (84.5 years, IQR 82.0–89.5). The group was composed mostly of women (73.7%), and most participants were widowed (68.4%). Concerning educational level, few of the participants had higher education since most of them had received formal education for eight or fewer years (73.7%). Regarding the cognitive impairment measured by GDS, 31.6% of the sample presented moderate decline, 26.3% presented moderate to severe decline, another 26.3% presented severe decline, and finally, 15.8% of the participants presented very severe decline.

Table 1. Sociodemographic characteristics of the study population.

Characteristics of the Participants—*n* (%)		Total Sample (*n* = 19)
Gender	Female	14 (73.7)
	Male	5 (26.3)
Age	Mean age ± SD	86.3 ± 6.0
	Age range	75–98
Marital status	Single	2 (10.5)
	Married	3 (15.8)
	Widower	13 (68.4)
	Others	1 (5.3)
Educational level	Years of education ≤ 8	14 (73.7)
	Years of education 9–17	2 (10.5)
	Years of education > 17	3 (15.8)
Cognitive impairment—GDS [1]	Stage 4. Moderate decline	6 (31.6)
	Stage 5. Moderate-severe decline	5 (26.3)
	Stage 6. Severe decline	5 (26.3)
	Stage 7. Very severe decline	3 (15.8)

[1] GDS: global deterioration scale.

3.2. Mood and Behavior

Significant effects were detected between before and after the intervention sessions in 4 of the 12 items evaluated in the Interact short (see Table 2). The results of the Wilcoxon signed-rank test showed a significant reduction in the prevalence of the *Tearful/sad* item ($p = 0.044$) with a medium effect size ($r = -0.32$). The results of the paired *t*-test showed significant changes in the score of the *Talked spontaneously* item ($p = 0.035$) with a medium effect size ($d = 0.52$). Moreover, two items of the *Stimulation level* construct showed a significant increase in scores: *Enjoying self, active or alert* ($p = 0.034$) and *Relaxed, content or sleeping appropriately* ($p = 0.001$), with medium ($d = -0.52$) and large ($d = -0.94$) effect sizes, respectively.

Table 2. Means (SDs) of Interact short scores before and after light therapy sessions.

Construct	Item	Before	After	*p*-value	ES
Mood	Tearful/sad [a]	1.29 (0.46)	1.23 (0.43)	0.044 *	r = −0.32
	Happy/content [b]	2.42 (0.88)	2.57 (0.97)	0.052	
	Fearful/anxious [a]	1.20 (0.38)	1.08 (0.17)	0.069	
	Confused [a]	1.21 (0.38)	1.17 (0.38)	0.128	
Speech	Talked spontaneously [b]	2.67 (0.79)	2.53 (0.85)	0.035 *	d = 0.52
Relating to others	Related well to other staff/patients [a]	3.86 (0.62)	3.84 (0.69)	0.717	
Relating to environment	Attentive/responsive/focused on environment [a]	4.01 (0.61)	4.09 (0.56)	0.305	
Need for prompting	Did things from own initiative [b]	1.88 (0.46)	1.86 (0.44)	0.707	
Stimulation level	Wandering, restless or aggressive [a]	1.10 (0.18)	1.04 (0.07)	0.185	
	Enjoying self, active or alert [b]	3.70 (0.64)	3.87 (0.60)	0.034 *	d = −0.52
	Bored, inactive or sleeping inappropriately [a]	1.62 (0.66)	1.49 (0.64)	0.052	
	Relaxed, content or sleeping appropriately [b]	3.57 (0.55)	3.87 (0.48)	0.001 **	d = −0.94

[a] Wilcoxon signed-rank test; [b] paired *t*-test; * significant (p-value < 0.05); ** significant (p-value < 0.01); ES: effect size (Cohen's d or r values).

To analyze the significance of the changes in the evolution of behavioral and psychological symptoms during the sessions, a comparison was made between the mean/median scores of the Interact during items of the four weeks of intervention. As can be seen in Table 3, scores reflected a significant decrease in the speech-related items, with large effect sizes. Scores were significantly lower for the *Comments or questions about activities/objects* item of the *Relating to the environment* construct. The results did not differ when analyzing the evolution of the four weeks versus the evolution between only the first and last week, with the same variables being significant in both comparisons.

Regarding the type of experience felt by the participants during the sessions, the evaluators recorded most of the sessions as leisure (32.98%), followed by relaxing (34.23%), stimulating (23.35), arousing curiosity (16.18%), and improving communication (6.43%). The researchers only perceived 6.32% of the sessions as unpleasant for the participants.

3.3. Physiological Parameters

There were significant changes between before and after the sessions in both physiological parameters (see Figure 1). Participants demonstrated an increase in mean SpO2 values ($p < 0.001$, Figure 1A) and a decrease in mean heart rate ($p < 0.001$, Figure 1B) at the end of the sessions, with a large effect size of both changes measured ($d = -1.33$ and $d = 1.10$, respectively).

Table 3. Means (SDs) of Interact during session scores for each week.

Construct	Item	Week 1	Week 2	Week 3	Week 4	*p*-Value	ES
Mood	Tearful/sad	1.40 (0.16)	1.27 (0.15)	1.16 (0.08)	1.12 (0.08)	0.675	
	Happy/content	2.41 (0.25)	2.11 (0.20)	2.15 (0.19)	2.05 (0.22)	0.425	
	Fearful/anxious	1.16 (0.05)	1.19 (0.15)	1.03 (0.07)	1.08 (0.09)	0.222	
	Confused	1.06 (0.04)	1.20 (0.08)	1.11 (0.08)	1.03 (0.05)	0.194	
Speech	Talked spontaneously	2.42 (0.13)	2.12 (0.29)	2.11 (0.24)	1.96 (0.27)	0.035 *	r = −0.43
	Recalled Memories	1.04 (0.07)	1.13 (0.12)	1.07 (0.11)	1.05 (0.12)	0.828	
	Spoke clearly	2.39 (0.14)	2.00 (0.37)	1.85 (0.22)	1.76 (0.06)	<0.001 ***	d = 0.95
	Spoke sensibly	2.39 (0.23)	1.94 (0.34)	1.84 (0.22)	1.76 (0.06)	0.001 **	d = 0.93
	Normal length sentences	2.37 (0.13)	1.95 (0.32)	1.85 (0.22)	1.76 (0.06)	<0.001 ***	d = 0.87
Relating to person	Held eye contact appropriately	3.36 (0.18)	3.35 (0.39)	3.22 (0.22)	3.16 (0.25)	0.729	
	Touching	3.03 (0.20)	3.17 (0.29)	3.23 (0.18)	3.04 (0.31)	0.923	
	Relating well	3.28 (0.24)	3.47 (0.41)	3.55 (0.15)	3.34 (0.20)	0.820	
	Co-operated	3.46 (0.19)	3.66 (0.45)	3.74 (0.13)	3.57 (0.18)	0.987	
Relating to environment	Tracked Observable Stimuli	3.43 (0.22)	3.51 (0.40)	3.35 (0.21)	3.27 (0.31)	0.907	
	Touched objects/equipment appropriately	3.37 (0.20)	3.55 (0.25)	3.45 (0.14)	3.37 (0.23)	0.674	
	Attentive to/responsive/focused on activity/objects	3.65 (0.27)	3.68 (0.19)	3.32 (0.32)	3.46 (0.15)	0.220	
	Comments/questions about activities/objects	2.13 (0.14)	1.57 (0.16)	1.59 (0.28)	1.42 (0.16)	<0.001 ***	r = −0.52
Need for prompting	Did things from own initiative	1.99 (0.10)	2.05 (0.19)	1.83 (0.07)	1.97 (0.17)	0.752	
Stimulation level	Wandering, restless or aggressive	1.20 (0.11)	1.05 (0.04)	1.11 (0.06)	1.12 (0.09)	0.204	
	Enjoying self, active or alert	3.57 (0.23)	3.56 (0.28)	3.33 (0.35)	3.50 (0.10)	0.526	
	Bored, inactive or sleeping inappropriately	2.18 (0.18)	2.09 (0.28)	2.43 (0.24)	2.12 (0.28)	0.439	
	Relaxed, content or sleeping appropriately	3.54 (0.15)	3.57 (0.13)	3.33 (0.24)	3.61 (0.19)	0.478	

* Significant (*p*-value < 0.05); ** significant (*p*-value < 0.01); *** significant (*p*-value < 0.001); ES: effect size (Cohen's d or r values).

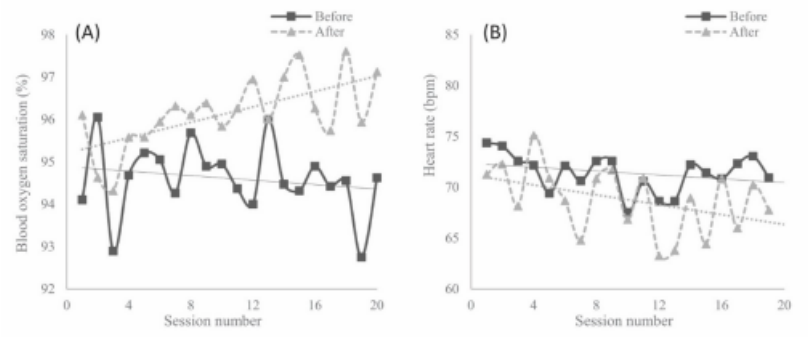

Figure 1. Records of biomedical parameters before and after light therapy intervention from session 0 (baseline) to 20 (post-trial): (**A**) blood hemoglobin oxygen saturation (%); (**B**) heart rate—beats per minute (bpm).

4. Discussion

The purpose of this study was to examine the immediate effects of a four-week BLT intervention program on the behavior, mood, oxygen saturation, and heart rate of institutionalized older patients with moderate to very severe dementia. The main results revealed promising evidence of the benefits of BLT on specific aspects of mood and behavior in participants both during and after the sessions, as well as positive effects on the physiological parameters analyzed.

As previously stated, mood and behavior were assessed using the Interact scale [29]. Although this scale was initially developed for the assessment of mood and behavior of patients with dementia during multisensory stimulation sessions in a Snoezelen room, its use has been extended to other nonpharmacological interventions such as music [24], art [31], and reminiscence therapies [32,33]. On this basis, the Interact scale was chosen for this study since its structure and form of application are also appropriate and compatible with the procedure of light therapy sessions.

The Interact short scores obtained by the participants before and after BLT sessions revealed, on the one hand, a significant decrease in the items of *Tearful/sad* and *Talked spontaneously*, and, on the other hand, a significant change in their stimulation level—specifically in the items *Enjoying self, active or alert*, and *Relaxed, content or sleeping appropriately*. Therefore, participants were less sad and less spontaneously talkative immediately after BLT sessions, which in turn could be related to the fact that they were also more relaxed, content, or sleeping appropriately. Concurring with some of these findings, other authors [34] investigating the immediate effects of BLT versus dim red light sessions found an immediate decrease in sleepiness and a tendency for mood improvement upon exposure to bright light. Other studies using 30-min BLT sessions found short-term positive effects on mood and agitation in people with dementia [35–37], with greater benefits observed in patients with severe dementia than in those with mild/moderate dementia [36].

The Interact during showed a significant decrease in the score of the *Making comments or asking questions about the activity* item, which makes sense due to the habituation of the participants to the intervention program as it progressed. Scores on the Interact during also reflected that as the weeks of intervention progressed, the participants talked less clearly, sensibly, and spontaneously and with shorter sentences, i.e., an overall decrease in speech during the sessions. These results may also be linked to the lower post-session scores on the *Talked spontaneously* item of the Interact short. None of the existing studies on BLT in the literature address the immediate effects that occur within sessions, so we cannot discuss our results from the perspective of previous studies.

Regarding physiological parameters, the measurements showed positive changes between before and after the sessions in the two analyzed parameters, with a significant increase in mean SpO2 and a significant reduction in mean heart rate. These changes may be related to the fact that participants were more relaxed, as shown by the Interact scores, since these biological responses are considered physiological indicators of a relaxation response [38,39]. Consistent with our findings, Choi et al. [40], who studied the immediate influence of different dim-colored lights—white, red, and blue—in healthy adults, also found a decrease in heart rate after exposure to the illumination. In the existing literature, another physiological parameter that has been studied with respect to light therapy is heart rate variability (HRV). A group of authors [41,42] found immediate positive effects of evening BLT on HRV in a sample of healthy young women. Similar findings were reported by Rechlin et al. [43] in patients diagnosed with major depression. Our results differ from another previous study in which no immediate effects of morning BLT on any of the physiological parameters analyzed were found [34]. Following the initial hypothesis of this study, our findings on the effects of BLT on the physiological parameters analyzed coincide with the positive effects of other sensory interventions reported in the existing literature, such as music therapy [24,25,44,45] and multisensory stimulation [23,24].

To the best of our knowledge, the immediate impact of BLT sessions on mood and behavior has been virtually unexamined previously, so the present study provides novel and relevant data for clinical practice. However, the results of this work should be regarded as preliminary and interpreted with caution due to certain existing limitations. This study is one part of a larger and more comprehensive BLT investigation. The current study only analyzed the immediate effects during and after BLT sessions, and the long-term effects should be further established. Therefore, these limitations stem mainly from the small sample size and the use of a single-arm intervention with no control group, both of which limit the generalizability of the results found. Additionally, mood and behavior

were measured based on the observations of unblinded researchers, which may have resulted in researcher bias. Future research should address these limitations by employing a double-blind design in controlled studies with larger sample sizes. Another physiological parameter (determination of blood pressure at least three times during the sessions) could also be used to further assess the impact of bright light therapy.

5. Conclusions

The results of the present study suggest that a bright light therapy intervention program of 30-min sessions provides promising outcomes and immediate positive effects on mood, stimulation level, blood oxygen saturation, and heart rate. On the other hand, there was a tendency for a decrease in speech both during and after the intervention sessions. Further research is needed to strengthen these findings and to explore in depth the possible immediate effects of BLT.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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3.4. Estudio IV: Efectividad de un programa de entrenamiento de ajedrez para mejorar la cognición, el estado de ánimo, y la calidad de vida en personas mayores: Un estudio piloto (94)

Este estudio tuvo como objetivo evaluar los efectos de un programa de entrenamiento de ajedrez sobre el estado cognitivo, el estado de ánimo y la calidad de vida (CdV) en una muestra de personas mayores institucionalizadas y semi-institucionalizadas.

Se realizó un estudio piloto controlado, no aleatorizado, con medidas repetidas (pre y post intervención). Los análisis revelaron un impacto positivo del programa de ajedrez en el estado cognitivo general ($p < 0,001$) y evidencia prometedora ($p < 0,043$) de beneficios sobre la atención, la velocidad de procesamiento y las funciones ejecutivas. Los participantes del grupo de intervención también mostraron una mejora significativa en las puntuaciones de calidad de vida ($p < 0,021$).

A partir de los resultados obtenidos, se concluyó que un protocolo de entrenamiento de ajedrez de 12 semanas con dos sesiones semanales de 60 minutos mejoró el estado cognitivo y la CdV en una muestra de personas mayores institucionalizadas y semiinstitucionalizadas. Son necesarias más investigaciones para explorar sus efectos en profundidad.

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Effectiveness of a chess-training program for improving cognition, mood, and quality of life in older adults: A pilot study

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ABSTRACT

Background: Regular practice of a cognitively stimulating activity, such as chess, can help maintain a healthy cognitive, social, and psychological state during the aging process.
Objective: To evaluate the effects of a chess-training program on cognitive status, mood, and quality of life (QoL) in a sample of institutionalized and semi-institutionalized older adults.
Method: A nonrandomized, controlled pilot study with repeated measures (pre- and post-intervention) was conducted.
Results: Analyses revealed a positive impact of the chess program on general cognitive status ($p < 0.001$) and promising evidence ($p < 0.043$) of an impact on attention, processing speed, and executive functions. The participants in the intervention group also showed significant improvement in QoL scores ($p < 0.021$).
Conclusions: A 12-week chess-training protocol with two 60-minute sessions per week improved cognition and QoL in a sample of institutionalized and semi-institutionalized older adults. Further research with larger samples is needed to explore its effects in depth.

Introduction

The World Alzheimer Report 2018[1] reported that dementia is one of the most important health problems in our society, with 50 million people affected by dementia worldwide. In recent decades, there has been growing interest in the investigation of modifiable lifestyle factors that may be crucial in the presymptomatic phases of mild cognitive impairment (MCI) or dementia, with the intention of developing potential preventive strategies.[2] These modifiable lifestyle factors include participation in cognitively stimulating leisure activities, since existing evidence from a meta-analysis reported consistent links between their practice and reductions in the risk of developing cognitive impairment and dementia in later life.[3] Numerous international investigations have reported that stimulating mental activities are a highly relevant variable in the maintenance of cognitive function during the aging process since engaging in these activities contributes to increasing cognitive reserve. Cognitive reserve is a hypothetical construct referring to the adaptability of cognitive processes that may explain the differential susceptibility of cognitive abilities to brain aging or pathological changes such as those occurring in Alzheimer's disease (AD).[4,5] High lifespan cognitive reserve has been associated with reductions in the risk of MCI and delays in its progression to dementia.[6] Cognitive reserve is influenced by numerous factors, such as level of education, occupational attainment, intelligence, changes in life situations (divorce, retirement, etc.), social interactions, physical activity, or participation in cognitively stimulating activities across the lifespan.[7–10] Therefore, changes in lifestyle, even in later life, might modify cognitive reserve, which could help individuals achieve more successful aging against age-related cognitive decline or the possible development of MCI or dementia.[5,6]

An active lifestyle with regular and frequent practice of mentally stimulating activities appears to delay the onset of pathologies associated with cognitive decline.[5,11,12] Furthermore, some investigations have reported social and psychological benefits derived from the practice of cognitively stimulating leisure activities, since the vast majority of these activities tend to take place in the context of social relationships.[10,13] One type of these activities is board games, including chess, as they are one of the most stimulating leisure activities that older people can easily practice.[14] Some studies[15,16] have shown that playing board games has cognitive benefits, specifically in terms

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of working memory, logical reasoning, executive functions, and processing speed. An article published by Coyle[17] showed a significant relationship between effortful mental activities, including chess practice, and a reduced probability of developing dementia; however, research along this specific line has scarcely been developed to date, and most of the published studies have been correlational, which precluded making causal inferences. More investigation in this field is needed to further explore the effects that regular practice of cognitively stimulating activities, such as playing chess, can have in advanced age stages.

The main objective of this study was to evaluate the effects of participating in an intervention program based on chess training on cognitive status, mood, and QoL in a sample of institutionalized and semi-institutionalized older adults. The proposed chess-training protocol could be easily implemented as a nonpharmacological intervention in diverse care institutions for older adults.

Our study was based on the hypothesis that the regular practice of stimulating cognitive activities, such as chess, can reduce the risk of developing cognitive impairment and dementia and contribute to maintaining a healthy cognitive status. Considering that chess is an activity that involves high mental and social components,[18] we expected to obtain cognitive, social, and psychological benefits, thus positively influencing the quality of life (QoL) of older people.

Material and methods

Design

This study was designed as a nonrandomized, controlled pilot study with repeated measures (pre- and post-intervention). Thus, outcomes of interest were assessed before and after administering the program in both the experimental and control groups.

The research protocol (code 2019/582) was reviewed and approved by the Autonomic Research Ethics of Galicia Committee (Spain), and the study was developed following the ethical standards embodied in the Declaration of Helsinki. Written informed consent was obtained from all participants or proxies in case of cognitive decline.

Participants

The sample was obtained from among the users of a gerontological complex located in A Coruña (Spain). This complex is composed of two institutionalization modalities: a daycare center and a nursing home. As a function of the setting, the participants were considered institutionalized (residents of the nursing home) or semi-institutionalized (users attending daycare center).

Participants were selected based on the following inclusion criteria: (a) subjects aged ≥60 years; (b) visual and auditory function intact or corrected; and (c) agreement to participate in the study. As a criterion of exclusion, individuals in advanced stages of dementia (moderately severe, severe, and very severe) measured by a score greater than 4 on the Global Deterioration Scale (GDS)[19] were not included in the study. The legal decisional capacity of the participants was confirmed by the physicians and clinicians of the center based on their clinical judgment and the GDS scores of the patients, assuring their capacity to understand the research protocol and to decide to participate in the study. Additionally, individuals were not eligible for the study if they presented any disorder or disease that precluded the development of the necessary manipulative actions for the practice of chess that could have interfered with participation in the training program.

At the end of the recruitment process, 32 subjects met the inclusion and exclusion criteria described above, although only 22 participants completed the entire study (see Fig. 1).

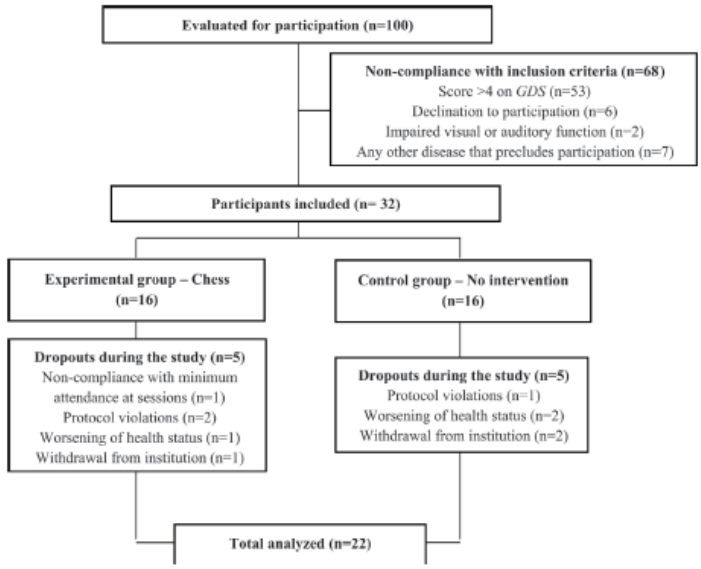

Fig. 1. Flowchart of study participants. Recruitment, sampling, and dropouts throughout the study.

Procedure

An informative talk was held at the gerontological complex addressed to potential study participants, in which they were informed about the nature and objectives of the study. Once informed consent was obtained, the sample was selected based on the inclusion and exclusion criteria described above, and individuals were assigned to groups. The assignment of participants to each group was made by convenience based on their interest in receiving chess training.

The participants were assessed during a baseline neuropsychological evaluation lasting 45–60 min, depending on the level of cognitive impairment of each participant. The subjects in both groups were subsequently evaluated after completing the chess program and this evaluation was identical to the initial evaluation.

The chess-training program was conducted in group sessions taught by two expert chess trainers and supervised by one of the researchers together with a therapist from the center. The sessions were held in a specially designed room within the gerontological complex itself, mixing institutionalized and semi-institutionalized participants. The participants in the experimental group were trained for 12 weeks in two weekly sessions of 1 h. The program consisted of 24 sessions, and it was established that participants needed to attend at least 80% of the training sessions to be able to ensure results. The subjects in the control and experimental groups continued with the routine daily activities of the gerontological complex.

The set of classes ranged from the most basic knowledge (introduction of the chessboard and the pieces and basic game rules) to the most complex (specific tactics), encompassing all the specific concepts necessary to acquire the basic knowledge and skills to play chess. The same structure was used in all the sessions, which began with a brief theoretical explanation followed by practical exercises. Practice and repetition were essential, and the fact that the participants could progress at different rates was considered. The level of these exercises was adjusted based on each participant with a consideration of both their cognitive state and their ability to follow the sessions. A single concept was addressed in each session, and each session included a review of what had been learned in the previous one, until the participants were able to independently play basic games.

Instruments and outcomes measures

As previously stated, the participants in both groups were assessed at two time points, i.e., before and after the intervention program. All instruments were administered by two gerontologists with experience in neuropsychological assessments. The primary outcome measures were the assessment of cognition, mood, and QoL. Moreover, in the post-intervention assessment of the experimental group, two additional questions were included: a five-point Likert scale question about their level of satisfaction with the chess program and a dichotomous question (yes/no) about their motivation to continue if the program were offered again.

Cognition

The neuropsychological evaluation of cognition included measures of general cognitive status, as well as more specific assessments of particular cognitive domains. The Montreal Cognitive Assessment test (MoCA)[20] is a screening instrument used to evaluate general cognitive status covering 8 domains of cognition: attention, executive functions, memory, language, visuospatial abilities, abstract thinking, calculation, and orientation. The MoCA standardization for the Spanish population[21] was taken into account to adjust the total score based on the age and years of formal education of each participant.

Regarding the evaluation of specific cognitive domains, we used the Trail Making Test (TMT)[22] and the Visual Benton Retention Test (VBRT).[23] TMT[22] evaluates attention, processing speed, and executive functions. This test has two different parts (A and B), both consisting of a sheet of paper with 25 circles randomly distributed over it. In Part A, the subject must draw lines to connect numbers in ascending order; Part B includes numbers and letters, and the subject must join them following an ascending pattern and alternating between numbers and letters. The VBRT[23] contains three sets of ten geometric figures, and four alternative methods of assessment (A, B, C, and D); we used application methods A and C. Method C allows the evaluation of visuoperceptual and visuospatial abilities and consists of copying the figures from each card without a time limit. Method A was used to assess visual memory: each stimulus was shown for 10 s, the card was then removed, and the subject was asked to reproduce the design by immediate recall.

Mood

The mood of participants was assessed using the Geriatric Depression Scale Short Form (GDS-SF)[24] to detect the presence of depressive symptoms. The GDS-SF is made up of 15 items with a yes/no dichotomous answer about how the person has been feeling in the last two weeks.

Quality of life

QoL of the participants was evaluated with the WHOQOL-OLD,[25] an additional module on the WHOQOL scale,[26] specifically developed for the evaluation in older adults of their subjective perception about their QoL. The WHOQOL-OLD module contains 24 five-point Likert-scale items organized into six facets, covering the main aspects of QoL in old age: 1) sensory abilities, 2) autonomy, 3) past, present, and future activities, 4) social participation, 5) death and dying and 6) intimacy. The questionnaire asks the patients for their thoughts and feelings about these aspects of their QoL in the last two weeks. The six facets contain four items each, and for all facets, the possible scores can range from 4 to 20. The total score is based on the summation of all 24 items in the module, with higher scores representing higher QoL.

Statistical analysis

Before all the analyses, the Shapiro-Wilk test was used to assess normality of the distribution of the variables. For subsequent analyses, we applied nonparametric tests since the normality assumption was not met and the sample size was small ($n < 30$).

The baseline characteristics of the sample were analyzed using descriptive statistics and frequency distributions (see Table 1). Considering the small sample size of the groups, these sociodemographic characteristics were compared using nonparametric tests to analyze between-group differences at baseline, namely, Mann-Whitney U tests were used for quantitative variables, and chi-square tests were used for categorical variables.

Brunner-Langer mixed nonparametric ANOVA[27] following an F1-LD-F1 design where the group was the whole-plot factor and time the subplot factor was used to test the effects of the intervention (chess program vs. control) and its interaction with time on MoCA, VBRT, TMT, GDS-SF, and WHOQOL-OLD scores. Pairwise comparisons were made with the Wilcoxon signed-rank and Mann-Whitney U tests. Wilcoxon signed-rank tests were used to compare the test scores before and after the intervention in each group, and Mann-Whitney U tests was used to compare the scores between the control and intervention groups at each of the two time points. A p-value < 0.05 was set to define statistical significance. All statistical analyses were performed with the statistical software IBM SPSS Statistics v.25.0 and the statistical software R v.3.6.1 (using R packages Rcmdr, MASS, and nparLD).

Table 1
Sociodemographic characteristics of the study population.

	Total sample (n = 22)	Control group (n = 11)	Chess group (n = 11)	p-value
Gender, n (%) [a]				0.006**
Female	15 (68.2)	11 (100)	4 (36.4)	
Male	7 (31.8)	0 (0.0)	7 (63.6)	
Age [b]				0.263
Mean age ± SD	83.05 ± 8.19	85.73 ± 5.61	80.36 ± 9.68	
Age range	64 – 94	76 – 94	64 – 93	
Setting, n (%) [a]				0.669
Daycare center	10 (45.5)	4 (36.4)	6 (54.5)	
Nursing home	12 (54.5)	7 (63.6)	5 (45.5)	
Marital status, n (%) [a]				0.133
Single	1 (4.5)	0 (0.0)	1 (9.1)	
Married	6 (27.3)	1 (9.1)	5 (45.4)	
Widower	13 (59.1)	9 (81.8)	4 (36.4)	
Divorced/Separated	2 (9.1)	1 (9.1)	1 (9.1)	
Years of formal education [b]				0.484
Mean ± SD	8.86 ± 3.63	8.91 ± 3.45	8.82 ± 3.97	
Range of years	0 – 17	0 – 13	3 – 17	
Level of cognitive impairment[†]**, n (%)** [a]				0.801
Severe	12 (54.6)	7 (63.6)	5 (45.4)	
Moderate	3 (13.6)	1 (9.1)	2 (18.2)	
Mild	4 (18.2)	2 (18.2)	2 (18.2)	
No impairment	3 (13.6)	1 (9.1)	2 (18.2)	

[a] Chi-square test.
[b] Mann–Whitney U test.
** $p<0.01$.
[†] Level of cognitive impairment established based on the cutoff points for the Montreal Cognitive Assessment Test (MoCA) in the Spanish population.

Results

Sample characteristics

The final sample consisted of 22 subjects, with 11 individuals per group. Table 1 shows the baseline sociodemographic characteristics and the level of cognitive impairment of the participants. The mean age of the participants was 83.05 ± 8.19 years, and 68.2% of the sample were women. The marital status of most of the participants was widowhood (59.1%). Regarding educational level, the average number of years of formal education completed was 8.86 ± 3.63, ranging from 0 to 17 years. Finally, concerning the level of cognitive impairment, slightly more than half of the sample (54.6%) presented severe cognitive impairment at the beginning of the study based on the MoCA cutoff points adjusted for age and education.

At baseline, there were no significant differences between chess and control groups for these characteristics, with the exception of gender since the control group was entirely composed of women.

Table 2 shows the medians, interquartile ranges, means, and SDs for each group on every instrument used at the evaluations as well as the results of the Wilcoxon signed-rank and Mann-Whitney U tests. We decided to include both medians and means: medians due to the nonparametric analyses utilized and means to facilitate the interpretation of the test scores.

Effects of the chess-training program on cognition

The mixed nonparametric ANOVA results showed that the group-time interaction effect was significant ($p < 0.001$) only with the MoCA scores. Pairwise comparisons showed significant improvements in the MoCA scores ($p = 0.003$) in the chess group from before to after the intervention program as well as significant differences ($p = 0.006$) between groups with the post-intervention scores being higher in the chess group.

Regarding the TMT-Part A, for both groups, the task execution time decreased in the post-intervention compared to the baseline assessment, without significant differences between groups or over time. On the other hand, Part B was not fully completed in 15 cases due to comprehension difficulties, so only seven participants (two from the control group and five from the chess group) completed TMT-Part B in both assessments. The participants in the chess group who completed TMT-Part B showed improved performance, with significantly lower execution time ($p = 0.043$) after the intervention program.

Regarding the VBRT, when comparing the two evaluation time points, the scores hardly varied in both groups. The VBRT, with its two methods of application, did not show significant intergroup differences or significant time effects.

Effects of the chess-training program on mood

Depressive symptomatology measured by GDS-SF was significantly lower in the patients in the chess group at both evaluation time points (before: $p = 0.048$; after: $p = 0.023$) than in the control group participants. No significant effects were observed within each group over time.

Effects of the chess-training program on quality of life

The Wilcoxon signed-rank test showed significant differences ($p = 0.021$) in the WHOQOL-OLD scores from before to after the intervention program in the participants who received the chess sessions. The WHOQOL-OLD scores remained stable in the comparison of pre- and post-intervention evaluations, and no significant differences were found between the groups.

Acceptability, feasibility, and perceived satisfaction with the chess-training program

Our findings demonstrate the preliminary acceptability and feasibility of the chess-training program with some positive impacts on general cognition and QoL. Regarding acceptability, the mean number of attended classes was 22.73 ± 1.27 out of 24 sessions across 12 weeks, showing adequate adherence. The reason for not attending a class was always due to medical reasons. To assess overall chess skill acquisition, a test was individually administered to each participant

Table 2
Comparisons of intragroup and between group test scores at baseline and post-intervention.

	Control group (n = 11)			Intervention - chess group (n = 11)			Control vs chess group (p-value[b], between groups)	
	Before	After	p-value[a] (intragroup)	Before	After	p-value[a] (intragroup)	Before	After
MoCA score			0.670			0.003**	0.130	0.006**
Median (IQR)	8.0 (7.0–15.0)	9.0 (6.0–14.0)		13.0 (10.0–18.0)	16.0 (14.0–23.0)			
Mean±SD	11.1 ± 6.0	10.7 ± 5.6		13.9 ± 5.4	18.3 ± 5.7			
TMT-A score			0.260			0.091	0.158	0.094
Median (IQR)	265.4 (178.6–295.1)	193.4 (148.7–311.3)		156.4 (78.2–255.1)	109.0 (67.8–195.4)			
Mean±SD	248.4 ± 121.3	216.9 ± 94.1		180.3 ± 113.5	162.2 ± 147.7			
TMT-B score[†]			0.655			0.043*	1.000	0.699
Median (IQR)	386.2 (133.3–386.2)	284.1 (135.6–284.1)		348.5 (183.2–436.4)	253.0 (165.0–379.4)			
Mean±SD	386.2 ± 357.6	284.1 ± 210.0		317.5 ± 132.2	268.3 ± 115.9			
VBRT-A score			0.317			0.287	0.206	0.082
Median (IQR)	1.0 (0.0–2.0)	0.0 (0.0–2.0)		2.0 (1.0–2.0)	2.0 (0.0–5.0)			
Mean±SD	1.3 ± 1.3	1.0 ± 1.4		1.9 ± 1.6	2.6 ± 2.2			
VBRT-C score			0.607			0.206	0.319	0.083
Median (IQR)	7.0 (2.0–8.0)	6.0 (2.0–8.0)		8.0 (5.0–9.0)	8.0 (5.0–9.0)			
Mean±SD	5.8 ± 3.1	5.6 ± 2.7		7.0 ± 2.5	7.4 ± 2.1			
GDS-SF score			0.483			0.549	0.048*	0.023*
Median (IQR)	3.0 (2.0–8.0)	5.0 (2.0–9.0)		2.0 (1.0–4.0)	2.0 (1.0–3.0)			
Mean±SD	4.73±3.2	5.6 ± 3.9		2.7 ± 2.1	2.4 ± 2.4			
WHOQOL-OLD			0.594			0.021*	0.869	0.429
Median (IQR)	88.0 (75.0–92.0)	86.0 (79.0–101.0)		87.0 (82.0–90.0)	95.0 (90.0–98.0)			
Mean±SD	86.6 ± 8.4	89.5 ± 15.8		86.8 ± 6.8	95.3 ± 7.4			

[a] Wilcoxon signed-rank test.
[b] Mann–Whitney U test.
* $p < 0.05$.
** $p < 0.01$.
[†] The number of participants completing this test was 7 (2 in the control group and 5 in the intervention group).Abbreviations: GDS-SF= Geriatric Depression Scale; IQR= interquartile range; MoCA= Montreal Cognitive Assessment; TMT-A= Trail Making Test-Part A; TMT-B= Trail Making Test-Part B; VBRT-A= Visual Benton Retention Test, Administration A (immediate memory); VBRT-C= Visual Benton Retention Test, Administration C (copy).

by the trainers at the end of the program. The test assessed learning the position and basic moves of each piece on the chessboard and the capacity to identify check or checkmate positions with no assistance. A total of 90.9% of the participants learned the correct position of the pieces on the chessboard. Regarding the basic moves of the pieces, all the participants learned how to correctly move the pawns, 90.9% learned how to move the bishops and the queen, and 81.8% learned how to move the rooks, the knights, and the king. Finally, 81.8% learned to identify check and checkmate tactics. The other participants were able to perform the moves after initial guidance from the teachers. Finally, satisfaction with the program was evaluated with a five-point Likert scale (very satisfied, satisfied, neither satisfied nor dissatisfied, dissatisfied and very dissatisfied) at the end of the program. A total of 72.7% of the participants were very satisfied or satisfied with the chess program, and 27.3% were neither satisfied nor dissatisfied. Importantly, all the participants expressed their intention and motivation to continue playing chess, and the program was implemented as a nonpharmacological treatment for dementia in the gerontological complex.

Discussion

This study examined the effects of a chess intervention program on cognition, mood, and QoL in institutionalized or semi-institutionalized older people. The analysis showed that the chess program had a positive impact on general cognitive status. Regarding specific cognitive domains, our results showed promising improvements on attention, processing speed, and executive functions and no effect on visuospatial abilities and visual memory. Regarding mood, we cannot draw firm conclusions, as there were existing differences between the groups at baseline. Regarding QoL, the intervention group showed improvement after the chess program.

Our results in terms of general cognition were in line with those provided in a recent review,[28] which stated that regular chess practice could be considered a protective factor against cognitive decline in older people. Our outcomes also concur with other existing studies that reported that regular practice of cognitively stimulating activities, such as playing board games, was associated with a decreased risk of dementia[3,11,14,18,29–34] and MCI.[2,11,35,36] Likewise, some studies have shown that frequent participation in cognitive activities is related to attenuated cognitive decline.[3,12,37,38] Other authors have also reported that engaging in hobbies in later life, including board games such as Japanese chess, contributed to the preservation of cognitive function.[39]

Regarding specific cognitive domains, in our study, attention, processing speed, and executive functions showed significant improvements in the chess group measured as a decrease in execution time on the TMT-Part B during the post-intervention assessment. The TMT-Part B results were only analyzed with seven individuals owing to missing data because of the inability of some participants to complete this part due to their level of cognitive impairment. Despite not including these data in the analysis of results, we consider it important to note that two participants in the control group showed a tendency to worsen since they had been able to complete the task during the baseline assessment but not in the post-intervention assessment. Likewise, in the experimental group, one of the participants showed a trend for improvement. This participant had not been able to complete TMT-Part B in the initial assessment, but she completed it in the post-intervention evaluation, and achieved adequate execution with values above the cutoff point established as deficient by Reitan.[22] Other studies have also supported the idea that chess practice leads to improvements in specific cognitive domains. A resistance training program combined with chess playing in a group of older women[40] resulted in better spatial orientation, attention, calculation, recall, and language on the Mini-Mental State Examination.[41] The results of a recent meta-analysis[42] revealed a significant

positive correlation between chess skills and processing speed, short-term memory, fluid reasoning, and comprehension. Another study using the Ska game revealed improvements in memory, attention, and executive function after an intervention program.[43] Another study[44] also concluded that greater participation in leisure activities, including playing chess, lessened the decline in processing speed. Moreover, a recent systematic review and meta-analysis[3] reported that engagement in mentally stimulating leisure activities was associated with better processing speed and executive functioning in later life. Regarding the memory domain, we did not find significant effects of chess practice on visual memory. In contrast, Yates et al. [3] reported that regular practice of mentally stimulating activities was related to better memory function. Furthermore, some studies [29,32] have found that more practice with board games was related to an attenuation in memory decline rates, especially in terms of episodic memory [29,32] and working memory.[32,45] Regarding visuospatial abilities, our outcomes were consistent with previous findings on the absence of changes in this domain related to the practice of cognitive activities.[32]

Regarding mood, some studies have reported its positive relationship with the practice of cognitively stimulating activities.[46–48] Lin et al.[46] analyzed the effects of the game GO, a kind of Chinese chess, on depression in people with AD, concluding that an intervention involving the game GO for 6 months ameliorated depressive symptomatology. Engagement with Making Memories Together, a therapeutic board game specifically designed for people with AD, has been shown to be associated with a significant reduction in signs of depression in patients in advanced stages of dementia.[47] However, we cannot draw definitive conclusions from our results since there were differences between the groups before the start of the intervention in terms of the presence of depressive symptoms, which were higher in the control group in both evaluations. The nonrandomized sampling nature of our study could explain this baseline heterogeneity.

Regarding QoL, in addition to the objective improvement measured by the WHOQOL-OLD, it is also worth noting that some social behaviors were observed over the course of chess classes, such as helping each other, socially participating to a greater extent, and creating social ties. These social behaviors derived from the chess intervention program revealed an important factor to consider since previous research has demonstrated that an extensive social network and a socially integrated lifestyle seem to have a protective effect against dementia.[49,50] Additionally, playing face-to-face board games, such as chess, has been demonstrated to be more effective for cognitive function than playing alone.[45] Research on the effects of the practicing cognitively stimulating activities by older people with cognitive impairment or dementia has shown a significant relationship between regularly playing board games and presenting a better QoL.[46] Additionally, a study with healthy older women also showed improvements in their perception of QoL after an intervention program combining chess classes with resistance training.[40]

Finally, it is important to highlight the high level of satisfaction and motivation reported by the participants in the intervention group in the post-evaluation, consistent with the good adherence to the chess program. These results are a helpful indicator of good acceptability and the feasibility of implementing a chess-intervention program in care centers with the same characteristics.

In response to the secondary objective proposed in this study, our results indicated that a chess-training protocol consisting of two weekly sessions of one hour for 12 weeks was effective in improving the cognition and QoL of a sample of institutionalized and semi-institutionalized older people. No existing research has applied a specific chess protocol as an intervention in older adults. Therefore, we recommend our chess-training protocol as a guideline for implementation in all care institutions directed to this sector of the population.

This pilot study includes some limitations that should be taken into account when considering our preliminary results. The assignment of patients based on their preferences restricts the generalization of the findings and may weaken the external validity of the results. Additionally, the sample size was small, including 11 participants in each group. Larger studies with more robust randomized designs are warranted to determine the efficacy of chess-based interventions. The possibility of continuing to play chess and the long–term effects of the program were not assessed. Thus, it would be interesting to conduct follow–up assessments to determine the possibility and the rate of continuation and potential related changes in cognition, mood, and QoL. Finally, the influence of the intervention period on the efficacy of the program should also be further explored.

Despite these limitations, our research also has some strengths. First, we incorporated the evaluation of multiple factors (cognition, mood, and QoL) which allowed us to obtain as much information as possible about the benefits of this type of intervention in senior care centers. Another important strength is that our outcomes have implications for clinical practice since they provide guidelines for professionals to develop an inexpensive and easy-to-implement intervention.

Conclusions

A chess intervention program with 60-minute sessions twice a week for 12 weeks improved general cognitive status, attention, processing speed, executive functions, and QoL in a sample of semi-institutionalized and institutionalized older people. Further research with larger and randomized samples is necessary to provide a more in-depth exploration of the effects of a chess intervention program in older adults with and without cognitive impairment.

Declarations of competing interest

None.

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3.5. Estudio V: Realidad virtual como herramienta de prevención, diagnóstico y tratamiento del deterioro cognitivo en personas mayores: revisión sistemática (95)

Esta revisión sistemática tenía como objetivo explorar la aplicación de la RV como herramienta preventiva, diagnóstica y/o de tratamiento del deterioro cognitivo en personas mayores.

Se llevó a cabo una búsqueda bibliográfica en las bases de datos Medline y Web of Science, incluyendo toda la literatura publicada desde sus inicios hasta diciembre de 2019. De las 270 publicaciones encontradas, 15 cumplieron los criterios de inclusión: 2 examinaron el efecto de la RV como herramienta de prevención del deterioro cognitivo, 6 su aplicabilidad diagnóstica y 7 su efectividad como tratamiento.

Los resultados de esta revisión indican que existe evidencia del potencial efecto de la RV como estrategia preventiva frente al desarrollo de deterioro cognitivo en personas mayores. Existe también evidencia tanto de su aplicabilidad como herramienta diagnóstica de detección de desarrollo de deterioro cognitivo leve (DCL) o demencia, así como de su efectividad como tratamiento, ya que mejora el funcionamiento cognitivo de personas mayores con deterioro cognitivo. Son necesarios futuros estudios metodológicamente más robustos y con amplios tiempos de seguimiento, a fin de examinar el impacto real de la RV y poder generalizar su aplicación en los diferentes ámbitos de manejo del deterioro cognitivo.

ORIGINAL

Realidad virtual como herramienta de prevención, diagnóstico y tratamiento del deterioro cognitivo en personas mayores: revisión sistemática

Nuria Cibeira, Laura Lorenzo-López, Ana Maseda, Rocío López-López, Patricia Moreno-Peral, José C. Millán-Calenti

Introducción. En las últimas décadas, se ha incrementado exponencialmente la investigación sobre los efectos de la realidad virtual en diferentes trastornos neurológicos. Sin embargo, la bibliografía centrada en los beneficios de la realidad virtual sobre el deterioro cognitivo en personas mayores es limitada.

Objetivo. Explorar la aplicación de la realidad virtual como herramienta preventiva, diagnóstica o de tratamiento del deterioro cognitivo en personas mayores.

Pacientes y métodos. Se llevó a cabo una búsqueda bibliográfica en las bases de datos Medline y Web of Science, incluyendo toda la bibliografía publicada desde sus inicios hasta diciembre de 2019.

Resultados. De las 270 publicaciones encontradas, 15 cumplieron los criterios de inclusión: dos examinaron el efecto de la realidad virtual como herramienta de prevención del deterioro cognitivo; seis, su aplicabilidad diagnóstica; y siete, su efectividad como tratamiento.

Conclusiones. Existe evidencia del potencial efecto de la realidad virtual como estrategia preventiva frente al desarrollo de deterioro cognitivo en personas mayores. Existe también evidencia de su aplicabilidad como herramienta diagnóstica de detección de desarrollo de deterioro cognitivo leve o demencia, y de su efectividad como tratamiento, ya que mejora el funcionamiento cognitivo de personas mayores con deterioro cognitivo. Son necesarios futuros estudios metodológicamente más robustos y con amplios tiempos de seguimiento para examinar el impacto real de la realidad virtual y poder generalizar su aplicación en los diferentes ámbitos de manejo del deterioro cognitivo.

Palabras clave. Deterioro cognitivo. Diagnóstico. Personas mayores. Prevención. Realidad virtual. Revisión sistemática. Tratamiento.

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Introducción

Tal y como se recoge en el Informe Mundial del Alzheimer de 2018 [1], el número de personas afectadas por demencia en el mundo es de 50 millones y esta cifra continuará aumentando en las próximas décadas como consecuencia del progresivo envejecimiento poblacional y el incremento de la esperanza de vida [2]; representa uno de los problemas de salud pública más importantes a los que se enfrenta la sociedad actual, con importantes repercusiones personales, familiares, sociales y económicas [3]. La prevención, el diagnóstico correcto y temprano, y el tratamiento, tanto farmacológico como no farmacológico, son elementos clave para el abordaje integral de la demencia.

Entre los cambios cognitivos asociados al envejecimiento normativo y los que definen las características clínicas tempranas de la demencia, se sitúa una fase clínica intermedia o precursora conocida como deterioro cognitivo leve (DCL) [4-6]. El DCL se correspondería con el denominado trastorno neurocognitivo menor del *Manual diagnóstico y estadístico de los trastornos mentales, quinta edición* (DSM-5) [7], caracterizado por un declive en uno o más dominios cognitivos, pero sin llegar a interferir con la capacidad de desarrollo de las actividades de la vida diaria de la persona. La investigación sobre los factores o intervenciones que pueden prevenir o retrasar el declive cognitivo y el desarrollo de herramientas encaminadas al diagnóstico precoz, así como de intervenciones tanto en personas mayores sanas como en personas con DCL o demencia, son elementos clave para mantener la calidad de vida y prevenir o retrasar la dependencia.

En relación con estos factores, la realidad virtual se ha estudiado como una herramienta terapéutica para mejorar o prevenir los síntomas asociados a los trastornos neurológicos, y existe evidencia de que produce mejoras cognitivas y motoras en diferentes fases de distintas enfermedades neurológicas, incluso en sus etapas más avanzadas [8].

La realidad virtual se puede definir como una aproximación a la interfaz usuario-ordenador que implica la simulación en tiempo real de un entorno, escenario o actividad que permite la interacción del usuario a través de múltiples canales sensoriales [9]. La realidad virtual puede variar entre una modalidad no inmersiva hasta una modalidad totalmente inmersiva, dependiendo del grado en el que el usuario esté aislado del entorno físico cuando interactúa con el entorno virtual [8]. La realidad virtual ha estado disponible comercialmente desde finales de los años ochenta; sin embargo, su mayor crecimiento se ha producido desde finales de los años noventa del siglo pasado, promovido en parte por el gran avance de las nuevas tecnologías [10], y su aplicación se ha expandido rápidamente a una gran variedad de disciplinas [9]. Actualmente, sus ámbitos de aplicación son muy numerosos, y entre ellos se incluye el sanitario.

En las últimas décadas, se ha incrementado exponencialmente la investigación sobre los efectos de la realidad virtual en diferentes trastornos neurológicos. Existen numerosas y recientes publicaciones que evalúan la influencia de la realidad virtual sobre aspectos físicos (destacan la marcha y el equilibrio) en personas mayores con diferentes patologías neurológicas (véanse revisiones) [11-13]; sin embargo, la bibliografía centrada en los beneficios de la realidad virtual sobre el deterioro cognitivo en personas mayores es más escasa. Aunque existen algunos estudios que han encontrado beneficios de la aplicación de la realidad virtual sobre la cognición en personas con deterioro cognitivo e incluso demencia [14,15], desde nuestro conocimiento no existen revisiones sistemáticas sobre el uso de la realidad virtual para la prevención, el diagnóstico y el tratamiento del deterioro cognitivo en personas mayores.

Teniendo en cuenta lo expuesto, se planteó como objetivo realizar una revisión sistemática para explorar los posibles beneficios de la aplicación de la realidad virtual en la prevención, el diagnóstico y el tratamiento del deterioro cognitivo.

Pacientes y métodos

Se llevó a cabo una revisión sistemática siguiendo las directrices de la guía PRISMA para revisiones sistemáticas y metaanálisis [16].

Procedimiento de búsqueda

La búsqueda se realizó en las bases de datos Medline y la colección principal de Web of Science, incluyendo toda la bibliografía publicada desde sus inicios hasta la actualidad (diciembre de 2019), tanto en español como en inglés. La búsqueda se realizó utilizando una combinación de los términos en inglés *'virtual reality', 'elder*', 'old* adults'* u *'old* people', 'cognitive impair*'* o *'dement*'*. Todos los registros obtenidos como resultado de dicha búsqueda se fusionaron en un solo documento, con el objetivo de eliminar los duplicados después de comprobarlos manualmente. Una vez eliminados los duplicados, se procedió a la evaluación de la idoneidad de inclusión de cada uno de los restantes artículos.

Criterios de selección

Como hemos mencionado, todos los registros identificados se unificaron en un solo documento para proceder a su revisión manual y poder eliminar los duplicados. A continuación, se analizaron por título y resumen, y se excluyeron todos aquéllos con idioma o tipo de documentos diferentes a los establecidos en el objeto de estudio de la presente revisión, manteniendo los restantes como potencialmente relevantes, que se analizaron a texto completo en términos de su elegibilidad.

La selección de los artículos para esta revisión bibliográfica se estableció teniendo en cuenta los siguientes criterios de inclusión:

- *Participantes:* estudios llevados a cabo en poblaciones con una media de edad de 60 años o más.
- *Variable independiente/intervención:* intervenciones llevadas a cabo con realidad virtual.
- *Ámbito de estudio:* estudios dirigidos a examinar la utilización de la realidad virtual en los distintos ámbitos de aplicación del deterioro cognitivo (prevención, diagnóstico y tratamiento).
- *Resultados medidos:* estudios cuya variable resultado sea el deterioro cognitivo/funcionamiento cognitivo.
- *Idioma:* artículos a texto completo escritos en inglés o castellano.

Como criterio de exclusión se estableció el tipo de publicación, incluyendo únicamente estudios originales. No se tuvieron en cuenta revisiones, cartas al editor, resúmenes de congresos que no abordaran estudios originales, material editorial, capítulos de libro o correcciones.

En la figura se muestra el diagrama de flujo correspondiente al proceso de selección.

Codificación de variables

La información de cada artículo incluido en la pre-

sente revisión se sintetizó según las siguientes características: autor y año de publicación, diseño del estudio, ámbito de aplicación (prevención, diagnóstico, tratamiento), características de la muestra, modalidad de intervención y principales hallazgos.

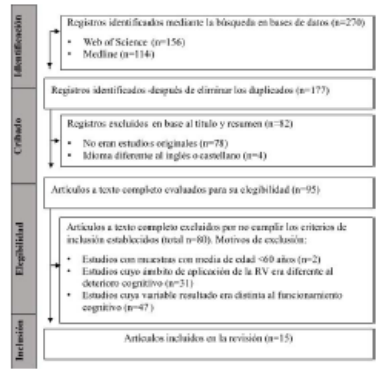
Resultados

Tras el proceso de búsqueda en las bases de datos se obtuvieron un total de 270 registros, de los cuales 156 (57,8%) correspondieron a la colección principal de Web of Science y 114 (42,2%) a Medline. Tras eliminar los 93 duplicados de los registros inicialmente identificados, se procedió a analizar por título y resumen los 177 registros restantes, y 95 estudios permanecieron como potencialmente relevantes. De estos estudios, 80 se excluyeron considerando los criterios de inclusión previamente establecidos. Finalmente, el proceso de revisión dio lugar a la inclusión de un total de 15 artículos (Figura).

En la tabla se recogen las principales características y resultados de las 15 publicaciones analizadas en esta revisión agrupadas en tres subapartados (realidad virtual como herramienta de prevención, realidad virtual como instrumento diagnóstico y realidad virtual como tratamiento del deterioro cognitivo en personas mayores) de acuerdo con los objetivos establecidos. De los 15 artículos analizados, dos examinaban el efecto de la realidad virtual como prevención del deterioro cognitivo; seis, su aplicabilidad para el diagnóstico del deterioro cognitivo; y siete, su efectividad como tratamiento del deterioro cognitivo. Como puede observarse, dos artículos [17,18] están basados en el mismo estudio, pero describen resultados diferentes, por lo que ambos fueron incluidos para su análisis en la presente revisión. Todos los artículos incluidos están publicados entre los años 2010 y 2019 (hay que señalar que el artículo de Liao et al [18] tiene su edición impresa en febrero de 2020, pero cumplió los criterios de inclusión porque en el momento de la búsqueda se accedió a su versión electrónica, publicada en octubre de 2019).

En la presente revisión, el tamaño muestral medio fue de 58,7 ± 50,4 individuos, con un mínimo de 10 participantes [19] y un máximo de 205 [20]. Teniendo en cuenta los artículos incluidos, el tamaño muestral total fue de 880 individuos (68,4% mujeres), y fue mayor el número de mujeres que de hombres en todos ellos. La media de edad de los participantes fue de 73,4 ± 4,4 años, que varió en un rango de 63,7 ± 2,2 [21] hasta 80,3 ± 7,9 años [22].

Figura. Diagrama de flujo del proceso de selección de estudios.



Realidad virtual como herramienta de prevención del deterioro cognitivo en personas mayores

Solo se encontraron dos estudios [23,24] que examinaban, con un diseño de medidas pretest-postest, el efecto preventivo de la realidad virtual en el deterioro cognitivo de personas mayores. En ambos se observaron mejorías en el funcionamiento cognitivo tras el entrenamiento con realidad virtual.

En uno de ellos [23] se analizó el efecto de la estimulación cognitiva con realidad virtual basada en actividades instrumentales de la vida diaria, diseñadas para entrenar múltiples funciones cognitivas en un grupo de personas mayores sanas, sin deterioro cognitivo ni diagnóstico de trastorno neurológico o psiquiátrico. Tras un entrenamiento de 12 sesiones, los participantes mostraron una mejora significativa en la atención, la memoria visual y la flexibilidad cognitiva. En el otro estudio [24] se utilizó un programa de entrenamiento cognitivo basado en realidad virtual utilizando el juego GRADYS [25], consistente en cuatro módulos (atención, memoria, lenguaje y procesamiento visuoespacial) de tareas inspiradas en la vida diaria, para analizar sus efectos en un grupo de personas mayores sin deterioro cognitivo y en otro con demencia leve. Ambos grupos mostraron progreso en el entrenamiento, aunque los cambios positivos se produjeron casi exclusivamente en el grupo sin demencia. Basándose en sus resultados, Zajac-Lamparska et al [24] reco-

Tabla. Características principales de los artículos incluidos.

	Diseño	Ámbito	Participantes	Intervención	Principales hallazgos
Gamito et al [23]	Diseño de medidas pretest-postest	Prevención	*n* = 25 (21 mujeres) Edad: 74 ± 5,3 años Sin deterioro cognitivo	RV: entrenamiento cognitivo basado en AVD	El programa de RV dio lugar a mejoras significativas en el funcionamiento cognitivo en diferentes dominios: atención, memoria visual y flexibilidad cognitiva
Zajac-Lamparska et al [24]	Diseño de medidas pretest-postest	Prevención	*n* = 99 (76 mujeres) Edad: 69,9 ± 6,6 años Dos grupos: demencia leve y sin deterioro	RV: entrenamiento cognitivo (juego GRADYS)	Mejoras significativas en el funcionamiento cognitivo en el grupo sin demencia. El juego GRADYS se muestra como una herramienta útil para la prevención del deterioro cognitivo en el envejecimiento normal
Howett et al [26]	Estudio transversal	Diagnóstico	*n* = 86 (59 mujeres) Edad: 70,5 ± 7,9 años	RV: tarea de navegación	Los resultados mostraron que esta tarea de navegación basada en la tecnología de realidad virtual puede diferenciar entre bajo y alto riesgo de desarrollar demencia en los pacientes con DCL
Mohammadi et al [28]	Estudio transversal	Diagnóstico	*n* = 110 (65 mujeres) Edad: 70,9 ± 1,8 años	RV: tarea de navegación	Se concluyó que esta tarea de navegación con RV puede distinguir sujetos con DCLm de personas mayores sin deterioro, pero no sujetos con DCL
Plancher et al [29]	Estudio transversal	Diagnóstico	*n* = 51 (38 mujeres) Edad: 77,2 ± 5,7 años	RV: coche virtual	Los grupos con DCLa y EA mostraron peor ejecución que el grupo sin deterioro. Las diferencias en las puntuaciones de memoria espacial alocéntrica fueron especialmente útiles para discriminar a los pacientes con DCLa de los que no presentaban deterioro cognitivo
Tarnanas et al [20]	Estudio transversal	Diagnóstico	*n* = 205 (117 mujeres) Edad: 72,7 ± 6,9 años	RV: evacuación por incendio (VR-DOT)	La tarea VR-DOT se mostró como una herramienta efectiva para discriminar DCLa y EA leve de la ausencia de deterioro
Zygouris et al [27]	Estudio transversal	Diagnóstico	*n* = 55 (45 mujeres) Edad: 68,9 ± 1,2 años	RV: supermercado virtual	La tarea de supermercado virtual resultó un método válido para la detección del DCL en una población mayor, pero no para evaluar subtipos de DCL
Zygouris et al [21]	Estudio transversal	Diagnóstico	*n* = 12 (9 mujeres) Edad: 63,7 ± 2,2 años	RV: supermercado virtual remoto	Se mostró evidencia preliminar de la factibilidad de la aplicación de RV para la detección remota de DCL
Hsieh et al [30]	Ensayo clínico cuasi experimental	Tratamiento	*n* = 60 (43 mujeres) Edad: 78,2 ± 7,5 años DCL	RV: taichí	El programa de ejercicio RV: taichí produjo mejoras cognitivas (pensamiento abstracto y razonamiento) tras el entrenamiento
Hwang y Lee [31]	Ensayo clínico controlado aleatorizado	Tratamiento	*n* = 24 (17 mujeres) Edad: 72,2 ± 5,7 años DCL	Programa de RV	El funcionamiento cognitivo del grupo experimental tras el entrenamiento mejoró en comparación con el grupo control, mostrando diferencias significativas
Liao et al [17][a]	Ensayo clínico controlado aleatorizado	Tratamiento	*n* = 34 (23 mujeres) Edad: 74,3 ± 6 años DCL	Programa de RV combinado físico y cognitivo	El grupo de RV y el de control mejoraron significativamente en funciones ejecutivas. El grupo de RV mostró mejoras mayores en atención dividida y rendimiento de la marcha en tareas duales cognitivas
Liao et al [18][a]	Ensayo clínico controlado aleatorizado	Tratamiento	*n* = 34 (23 mujeres) Edad: 74,3 ± 6 años DCL	Programa de RV combinado físico y cognitivo	El grupo de RV y el de control mejoraron en funciones ejecutivas y memoria verbal inmediata. Sin embargo, solo el grupo de RV mejoró significativamente en cognición global (MoCA), memoria verbal demorada y AIVD
Man et al [22]	Diseño de medidas pretest-postest	Tratamiento	*n* = 44 (39 mujeres) Edad: 80,3 ± 1,3 años Demencia cuestionable	RV: entrenamiento de memoria	Efectos positivos del entrenamiento de memoria en ambos grupos. El grupo de RV obtuvo mayores ganancias en el rendimiento objetivo de la memoria (recuerdo inmediato y demorado) y el grupo sin RV mostró mejores resultados en subpruebas de memoria subjetiva
Mrakic-Sposta et al [19]	Ensayo clínico controlado aleatorizado	Tratamiento	*n* = 10 (6 mujeres) Edad: 73,3 ± 5,7 años DCL	Programa de RV combinado físico y cognitivo	El grupo de RV mostró una mayor mejoría que el grupo control en las pruebas de funciones ejecutivas, memoria, fluidez verbal, atención visuoespacial y pruebas visuoconstructivas. Estas diferencias no fueron significativas
Optale et al [32]	Ensayo clínico controlado aleatorizado	Tratamiento	*n* = 31 (21 mujeres) Edad = 80,1 ± 7,9 años Deterioro de la memoria	Programa combinado de RV + musicoterapia	El grupo de RV + musicoterapia mostró mejoras significativas en las pruebas de memoria, especialmente en el recuerdo a largo plazo, además de mejoras en otros aspectos de la cognición. Contrariamente, el grupo de musicoterapia mostró un deterioro cognitivo progresivo

AIVD: actividades instrumentales de la vida diaria; AVD: actividades de la vida diaria; DCL: deterioro cognitivo leve; DCLa: deterioro cognitivo leve amnésico; DCLm: deterioro cognitivo leve multidominio; EA: enfermedad de Alzheimer; MoCA: evaluación cognitiva de Montreal; RV: realidad virtual. [a]Artículos pertenecientes al mismo estudio.

mendaron el juego GRADYS como una posible contramedida para el deterioro cognitivo experimentado en el envejecimiento cognitivo normal.

Realidad virtual como instrumento diagnóstico del deterioro cognitivo en personas mayores

De los seis estudios que analizaban el uso de la realidad virtual para el diagnóstico del deterioro cognitivo en personas mayores, todos ellos eran estudios transversales correlacionales: tres [21,26,27] compararon un grupo con DCL con un grupo sin deterioro cognitivo, y los otros tres [20,28,29], además de un grupo sin deterioro y un grupo con DCL, también incluyeron un grupo con enfermedad de Alzheimer. En todos ellos se mostró evidencia de la utilidad de la realidad virtual como herramienta diagnóstica o diferenciadora de DCL.

En dos de los estudios [26,28] se utilizó una tarea de navegación mediante realidad virtual para comparar la ejecución entre grupos. En uno de ellos [26], tras la realización de 27 sesiones, se concluyó que la tarea de navegación mediante realidad virtual puede diferenciar entre pacientes con DCL con bajo o con alto riesgo de desarrollar demencia. El otro estudio [28] comparó cuatro grupos con enfermedad de Alzheimer leve, DCL amnésico puro, DCL multidominio y participantes sin deterioro, y concluyó que la tarea de navegación utilizada permitió distinguir a los sujetos con DCL multidominio de los participantes sin deterioro, pero no a los que tienen DCL amnésico puro.

En otros dos estudios [20,29] se observó que las tareas basadas en realidad virtual permitieron discriminar a pacientes con DCL amnésico puro de población sin deterioro. Plancher et al [29] mostraron evidencias que permitieron diferenciar a pacientes con DCL amnésico puro de aquellos sin deterioro mediante la valoración en una sesión de realidad virtual basada en la interacción con un coche virtual, y se obtuvieron diferencias en las puntuaciones de memoria espacial alocéntrica. En Tarnanas et al [20], la tarea utilizada de realidad virtual simuladora de una evacuación por incendio se mostró efectiva para discriminar a pacientes con DCL amnésico puro o con enfermedad de Alzheimer leve de los participantes sin deterioro.

Por último, en los otros dos estudios de Zygouris et al [21,27], se utilizó un entrenamiento cognitivo basado en la misma tarea de realidad virtual (supermercado virtual), y en uno de ellos se usó de manera remota [21]. En ambos casos, la tarea de realidad virtual se mostró como un método válido para la detección de DCL en población mayor.

Realidad virtual como tratamiento del deterioro cognitivo en personas mayores

Los siete estudios incluidos en la presente revisión sobre el uso de la realidad virtual para el tratamiento del deterioro cognitivo [17-19,22,30-32] mostraron resultados positivos sobre el funcionamiento cognitivo de los participantes tras la intervención. Un aspecto a destacar es la gran variabilidad en las características de los programas de intervención utilizados en cada estudio en cuanto a la duración de la sesión, la duración total y el tipo de tarea de realidad virtual. La duración de cada sesión varió entre un mínimo de 30 [22,31,32] y un máximo de 60 minutos [17,18,30], y fue de 40-45 minutos en el estudio de Mrakic-Sposta et al [19]. En cuanto a la duración total de la intervención, también se observaron diferencias: el estudio [32] que presentaba la duración más amplia era de un total de 60 sesiones divididas en dos fases de intervención, la primera con 36 sesiones, y la segunda con 24. Le sigue el estudio de Hsieh et al [30] con 48 sesiones; el de Liao et al, notificado en dos publicaciones [17,18], con 36 sesiones; el de Hwang y Lee [31] con 20 sesiones; el de Mrakic-Sposta et al [19] con 18, y finalmente la duración menor fue de 10 sesiones [22].

El tipo de tareas de realidad virtual usadas como tratamiento también varió entre los estudios incluidos. En tres de los estudios [17-19], ensayos clínicos controlados aleatorizados, se utilizó un programa de realidad virtual que combinaba tareas físicas y cognitivas, y todos ellos presentaron mejoras en las funciones ejecutivas y de memoria. En otro estudio [30], con un diseño de ensayo clínico cuasi experimental, se utilizó como intervención un programa de ejercicio físico de realidad virtual basado en el taichí, que dio lugar a mejoras en el pensamiento abstracto y el razonamiento tras seis meses de entrenamiento. Otro estudio [31] analizó las diferencias entre un programa de entrenamiento de memoria mediante realidad virtual frente a un programa de entrenamiento de memoria dirigido por un terapeuta, siguiendo un diseño de medidas pretest-postest, y consiguió una consecución de efectos positivos en ambas modalidades. No obstante, fueron mayores las ganancias en memoria inmediata y demorada en el grupo de realidad virtual, mientras que en el grupo dirigido por un terapeuta se obtuvieron mejores resultados en las pruebas de memoria subjetiva. Otros autores [32], siguiendo un diseño controlado aleatorizado simple ciego, utilizaron un programa de realidad virtual combinado con musicoterapia, comparando su efectividad frente a un programa único de musicoterapia, y obtuvieron co-

mo resultado una mejora significativa en el grupo de realidad virtual, especialmente en la memoria a largo plazo. Finalmente, en el estudio de Hwang y Lee [31], un ensayo clínico controlado aleatorizado, se mostraron diferencias significativas entre el grupo experimental, sometido a un programa de intervención con realidad virtual, y el grupo de control. En la publicación de este estudio no se especificaron las características del programa de realidad virtual.

Discusión

El objetivo de esta revisión sistemática fue explorar la bibliografía publicada hasta la actualidad sobre los efectos de la aplicación de la realidad virtual en diferentes ámbitos del deterioro cognitivo en personas mayores, y se obtuvieron resultados positivos de la aplicación de la realidad virtual en cuanto a prevención, diagnóstico y tratamiento del deterioro cognitivo en personas mayores. Desde nuestro conocimiento, es la primera revisión sistemática que abarca todos los posibles ámbitos de aplicación de la realidad virtual sobre el deterioro cognitivo.

De manera general, incluyendo los tres ámbitos de aplicación abordados en esta revisión, los sistemas de realidad virtual permiten a los usuarios interactuar en diversos entornos y obtener retroalimentación en tiempo real sobre su rendimiento sin estar expuestos a riesgos [33]. El uso de la realidad virtual presenta un gran número de ventajas, entre las que destaca la posibilidad de que los pacientes pueden realizar tareas de realidad virtual de manera remota [34], proveer un aprendizaje activo durante una actividad motivante, la capacidad de controlar el grado de dificultad de la tarea aumentando gradualmente su nivel, así como la posibilidad de adaptarla a objetivos específicos individuales [35]. Además, existen numerosos estudios que describen la factibilidad de aplicación y buena aceptación de la realidad virtual por parte de las personas mayores tanto con deterioro cognitivo [36-38] como sin deterioro [39-41].

Con respecto al efecto de la realidad virtual como herramienta de prevención del deterioro cognitivo, la bibliografía es escasa. Los dos estudios identificados [23,24] en la presente revisión mostraron efectos positivos de la realidad virtual como estrategia preventiva, aunque sin realizar un seguimiento a largo plazo. Estos hallazgos concuerdan con los recogidos en otros estudios con población mayor sin deterioro [42,43] que mostraban beneficios del uso de la realidad virtual sobre su funcionamiento cognitivo, pero sin analizar los resultados a largo plazo, por lo que no se puede establecer el efecto preventivo de la realidad virtual. Son necesarias más investigaciones de carácter longitudinal centradas en el análisis de los potenciales beneficios de la realidad virtual como contramedida frente al posible desarrollo posterior de deterioro cognitivo en personas mayores.

En esta última década, se ha observado un creciente interés en la investigación sobre las nuevas tecnologías para el desarrollo de paradigmas capaces de detectar cambios en las capacidades cognitivas [29] con el objetivo de conseguir un diagnóstico más adecuado y precoz de pacientes con DCL o enfermedad de Alzheimer. Nuestros resultados, en concordancia con los recogidos en otra revisión actual [44], muestran que la investigación sobre la aplicación de la realidad virtual como herramienta diagnóstica está en auge y proporciona evidencias significativas para la detección de signos de DCL o enfermedad de Alzheimer tempranos en población mayor sin deterioro cognitivo, así como para discriminar entre sus diferentes etapas [34]. Es necesario continuar con la investigación en esta línea con el fin de aumentar la evidencia en este ámbito, diseñar instrumentos diagnósticos de realidad virtual estandarizados e introducirlos en la práctica clínica habitual para contribuir al diagnóstico precoz.

En los últimos años, la realidad virtual ha ido ganando reconocimiento como una herramienta útil para el tratamiento o rehabilitación del deterioro cognitivo [33], incluso algunos autores estudian los efectos de sistemas de realidad virtual integrada junto con intervenciones tradicionales, como la terapia de reminiscencia, que muestran resultados beneficiosos [45]. Los principales hallazgos de nuestra revisión son positivos en cuanto al uso de la realidad virtual como herramienta efectiva para mejorar la función cognitiva en sujetos con presencia de deterioro cognitivo. Estos resultados concuerdan con los recogidos en otras revisiones [44,46,47] sobre el efecto de la realidad virtual en el deterioro cognitivo, donde se observaron mejorías en la cognición en personas mayores con deterioro cognitivo o incluso demencia [48].

Aunque los resultados obtenidos son interesantes de cara a la aplicación de la realidad virtual en el campo del deterioro cognitivo, es necesario tener en cuenta ciertas limitaciones observadas en la presente revisión. En primer lugar, hay que señalar que el número de personas que participaron en algunos de los estudios fue muy reducido. Otra de las limitaciones fue la escasa identificación de estudios, sobre todo en el ámbito de la prevención. Por último, es importante señalar la heterogeneidad entre estudios

en cuanto a los protocolos de intervención empleados, lo que dificulta el establecimiento de conclusiones específicas respecto a la estandarización de protocolos de aplicación clínica. Por otro lado, serían elementos que habría que valorar como fortalezas la ausencia de un límite temporal en la búsqueda, que abarcó toda la bibliografía existente, la utilización de diferentes bases de datos complementarias y el amplio enfoque utilizado al abordar tanto la prevención como el diagnóstico y el tratamiento.

En conclusión, los resultados obtenidos en esta revisión sistemática proporcionan evidencia de la aplicabilidad de la realidad virtual como herramienta diagnóstica, así como de su efectividad como propuesta de intervención mejorando el funcionamiento cognitivo en personas mayores con presencia de deterioro cognitivo. También se muestran resultados prometedores en cuanto al efecto protector de la realidad virtual como estrategia preventiva frente al posible desarrollo de deterioro cognitivo. Son necesarios futuros estudios metodológicamente más robustos y con amplios tiempos de seguimiento a fin de examinar el impacto real de la realidad virtual y poder generalizar su aplicación en los diferentes ámbitos de manejo del deterioro cognitivo, contribuyendo así a mejorar la salud y la calidad de vida de las personas mayores y su entorno.

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Virtual reality as a tool for the prevention, diagnosis and treatment of cognitive impairment in the elderly: a systematic review

Introduction. In recent decades, research into the effects of virtual reality on different neurological disorders has increased exponentially. Yet, the literature focused on the beneficial effects of virtual reality on cognitive impairment in elderly people is limited.

Aim. To explore the application of virtual reality as a preventive, diagnostic or therapeutic tool for cognitive impairment in elderly people.

Patients and methods. A literature search was conducted in the Medline and Web of Science databases, including all the literature published from their inception up until December 2019.

Results. Of the 270 publications found, 15 met the inclusion criteria: two examined the effect of virtual reality as a tool for the prevention of cognitive impairment, six looked at its possible applications in diagnosis, and seven explored its effectiveness as a form of treatment.

Conclusions. There is evidence of the potential effect of virtual reality as a preventive strategy against the development of cognitive impairment in elderly people. There is also evidence of its applicability as a diagnostic tool for detecting the development of mild cognitive impairment or dementia, and of its effectiveness as a treatment, since it improves the cognitive functioning of elderly people with cognitive impairment. Further studies are needed that are more methodologically robust and have long follow-up times in order to examine the real impact of virtual reality and to be able to generalise its application in different areas of the management of cognitive impairment.

Key words. Cognitive impairment. Diagnosis. Elderly persons. Prevention. Systematic review. Treatment. Virtual reality.

CAPÍTULO 4. DISCUSIÓN

Capítulo 4. Discusión

En esta tesis doctoral por compendio se presentan cinco artículos que, en conjunto, forman parten de una línea de investigación enfocada en profundizar sobre el conocimiento acerca de las intervenciones no farmacológicas en demencia. En concreto, el objetivo general de esta tesis fue estudiar el efecto sobre los síntomas psicológicos y conductuales y el funcionamiento cognitivo en personas mayores sin deterioro, con deterioro cognitivo leve o demencia mediante diferentes intervenciones: estimulación multisensorial en sala Snoezelen, musicoterapia, luminoterapia, ajedrez terapéutico y realidad virtual.

Cronológicamente, este compendio comienza con un estudio iniciado en el año 2015 que analizaba y comparaba el efecto de la estimulación multisensorial y la musicoterapia en una muestra de personas institucionalizadas con demencia, incluyéndose en el presente trabajo uno de los artículos resultado de esa investigación (91). En cuanto a la luminoterapia, se desarrolló un proyecto de investigación durante 2017 a fin de estudiar sus efectos inmediatos (93), a corto y largo plazo en personas con demencia en fases de moderada a muy severa. Para el desarrollo de este proyecto se realizó previamente una revisión sistemática acerca de esta intervención con el objetivo de identificar las características de aplicación con mejores resultados (92). Posteriormente, en el año 2019 se llevó a cabo un estudio piloto acerca de los beneficios que el ajedrez puede aportar a nivel cognitivo, psicológico y social en personas mayores tanto con presencia de deterioro cognitivo leve o moderado, como sin deterioro (94). Por último, se realizó una revisión sistemática referente a la aplicación de la realidad virtual como herramienta preventiva, diagnóstica y de tratamiento del deterioro cognitivo en personas mayores a fin de ampliar el conocimiento acerca de sus beneficios en este campo de cara al futuro desarrollo de estudios con esta actual herramienta (95).

A continuación, en esta sección se presentan los resultados interpretados y discutidos de cada una de las publicaciones incluidas en esta tesis por compendio, así como las principales limitaciones y fortalezas de la investigación.

4.1. Efectos de la estimulación multisensorial y la musicoterapia sobre el estado de ánimo, la conducta, y los parámetros biomédicos en personas mayores con demencia severa (Estudio I)

Efectos inmediatos a corto plazo sobre el estado de ánimo y la conducta

Los resultados obtenidos en nuestro estudio muestran que los dos grupos de intervención tuvieron efectos positivos inmediatos sobre el estado de ánimo y el comportamiento al comparar los 10 minutos posteriores a las sesiones con los 10 minutos anteriores a las mismas. Sin embargo, los resultados obtenidos no mostraron diferencias significativas entre la EMS y las sesiones de música individualizada. Al finalizar las sesiones, en base a la información recogida mediante la escala *Interact* (96), los participantes de ambos grupos se mostraban más contentos/alegres, hablaban más espontáneamente, se relacionaban más con el personal u otros usuarios, estaban más atentos o centrados en relación con su entorno, estaban menos aburridos/inactivos y más relajados/alegres. Por lo tanto, ambas intervenciones parecen ser eficaces para controlar las alteraciones del estado de ánimo y del comportamiento a corto plazo.

Se encontraron resultados similares en otros estudios (97–99) que comparaban los efectos de la EMS en sala Snoezelen con otras terapias, donde la EMS mostró mejoras significativas en la conducta tras la intervención; sin embargo, coincidiendo con nuestros resultados, la EMS no tuvo ninguna ventaja sobre las otras intervenciones. Por otro lado, otros dos estudios (100,101) sí hallaron diferencias a favor de la EMS frente a otras actividades; uno de ellos concluyó que las personas institucionalizadas con demencia tratadas con EMS presentaban una mejora significativamente mayor en algunos de los síntomas

neuropsiquiátricos que las que simplemente asistieron a sesiones de actividades individuales (100), y en el otro, la intervención con EMS mejoró significativamente los niveles de agitación en comparación con sesiones individuales de actividades lúdicas (101). Un grupo de autores publicó un conjunto de artículos (102–105) en los que se demostraba que la EMS mejoraba significativamente el estado de ánimo y el comportamiento de los pacientes con demencia en fases de moderada a severa (102), y también que la aplicación de la EMS inducía a una mejor calidad de la comunicación enfermera-paciente y a una mejor asistencia en la atención psicogeriátrica (103–105).

En cuanto a la musicoterapia, numerosos estudios (44,106–111) han mostrado evidencia de sus efectos positivos sobre el estado de ánimo y el comportamiento en pacientes con demencia leve, moderada o grave tras recibir sesiones de música individualizada. En contraposición, existen algunos estudios anteriores (112,113) que han hallado resultados opuestos, en los que la participación en sesiones de música no mejoró los niveles de ansiedad, depresión y agitación en personas mayores con demencia. Los autores justifican esta falta de evidencia en base a varias limitaciones metodológicas explicadas en los propios artículos tales como la distinta procedencia de las medidas analizadas (cuidadores o familiares en el caso de la agitación, y la persona con demencia en el caso de la ansiedad), lo que implicaría resultados diferentes (112), o el uso de instrumentos con baja sensibilidad y la aleatorización de los participantes sin tener en cuenta su nivel de deterioro cognitivo (113). En esta línea, otro estudio (114) concluyó que la musicoterapia individualizada no tuvo un efecto significativo sobre los SPCD en personas con demencia de moderada a grave en comparación con la atención estándar recibida en sus residencias. Estos autores justifican la ausencia de diferencias estadísticamente significativas por la gran cantidad de participantes que abandonaron el estudio y el número demasiado reducido de sesiones de música individualizadas.

Efectos sobre el estado de ánimo y la conducta durante las sesiones de intervención

En cuanto al estado de ánimo y el comportamiento durante las sesiones, en nuestro estudio encontramos diferencias significativas entre los grupos de EMS y MT solo en 2 de los ítems analizados con la escala *Interact during* (96): "seguimiento visual de estímulos" y "relajado, contento o descansando adecuadamente". Los participantes del grupo EMS realizaron un mejor seguimiento visual de los estímulos, mientras que los participantes del grupo música se mostraron más relajados y contentos en comparación con los participantes del grupo EMS.

En relación con el primer hallazgo, otros autores han constatado que el sentido de la vista es el más susceptible de ser estimulado mediante la EMS (115). En consonancia con nuestros resultados, en un estudio de caso con tres sujetos también se obtuvo un alto nivel de estimulación visual durante las sesiones de Snoezelen, pero no en las sesiones de música (116).

Con respecto al segundo aspecto, a diferencia de nuestros resultados, un estudio (117) que evaluaba la eficacia de EMS en comparación con sesiones de música individualizada en personas con demencia, mostró un efecto positivo sobre los síntomas relacionados con la ansiedad durante la intervención de EMS que no se mostraba durante las sesiones de música. En contraposición, otros estudios no han encontraron efectos significativos durante las sesiones de EMS sobre el estado de ánimo y el comportamiento, en comparación con otras sesiones de actividad (33,90).

Por otro lado, otras investigaciones (116,118–121) demostraron una reducción de las conductas agitadas durante las sesiones de intervención tanto mediante la forma activa de la intervención musical (basada en cantar, bailar o tocar instrumentos) como la pasiva (basada en escuchar música).

Efectos sobre los parámetros biomédicos

En nuestra investigación se observó una disminución de la frecuencia cardiaca y un aumento de la saturación de oxígeno en sangre tanto en las sesiones de EMS como de música desde antes hasta después de las intervenciones, sin diferencias significativas entre los grupos. Este hallazgo es coherente con estudios anteriores (87,97) en los que no se encontraron efectos significativamente diferentes del EMS en comparación con otras actividades individuales sobre los parámetros biomédicos en pacientes con demencia leve, moderada o severa. Sin embargo, un estudio que analizó la frecuencia cardiaca y respiratoria en pacientes en la fase final de la demencia, mostró que reaccionaban de forma diferente a la música que al tacto o a la presentación de objetos (122).

4.2. Aplicación de la luminoterapia en personas mayores con deterioro cognitivo (Estudio II)

El objetivo principal de la revisión sistemática llevada a cabo fue analizar los estudios existentes en la bibliografía disponible hasta la fecha, que explorasen la luminoterapia como enfoque no farmacológico para el tratamiento de los SPCD, así como sus efectos sobre la cognición, el estado funcional y la calidad de vida en personas con deterioro cognitivo. El resultado de dicha revisión proporciona evidencia de que la luminoterapia tiene efectos positivos sobre los SPCD, pero pruebas limitadas de su eficacia sobre la cognición, la calidad de vida y la funcionalidad en las actividades de la vida diaria.

El objetivo secundario fue identificar las condiciones de luminoterapia con mayor eficacia en personas mayores con deterioro cognitivo, a fin de facilitar una guía para el establecimiento de un protocolo adecuado para su aplicación clínica con esta población. Se observaron grandes diferencias entre los protocolos de intervención de los estudios analizados, por lo que se sintetizaron las condiciones más utilizadas en aquellos con resultados positivos.

Efectos sobre los SPCD

Los artículos analizados aportaron hallazgos de efectos positivos de la luminoterapia sobre los SPCD en personas con demencia. Existen numerosas investigaciones que abordan los efectos de la luminoterapia sobre esta sintomatología, especialmente en lo que respecta al sueño, la agitación y el estado de ánimo.

La mayoría de las publicaciones se centran en el sueño, presentando mejoras significativas después o durante la intervención, excepto en cuatro de los 25 artículos incluidos en la revisión, que encontraron mejoras solo en algunos de los participantes (123) o ningún cambio significativo en las alteraciones del sueño (124–126). Es importante señalar que se observaron mejores efectos sobre los ritmos de descanso-actividad en la demencia vascular que en la enfermedad de Alzheimer, probablemente debido a la mayor desincronización del ritmo circadiano en las personas con demencia vascular (127).

El segundo síntoma más descrito es la agitación, mostrando la mayoría de las publicaciones analizadas una reducción de ésta tras la intervención con luminoterapia. La BLT se asoció con una mejora significativa en las puntuaciones de la agitación física, verbal y total medida por parte de los cuidadores mediante el *Inventario de Agitación de Cohen-Mansfield (IACM)* (128), pero tuvo poco efecto en las calificaciones observacionales de la agitación (129). En esta misma publicación, los autores también concluyeron que la BLT es más adecuada en personas mayores con formas más leves de demencia, ya que aquellos con demencia severa poseen un NSQ demasiado degenerado para beneficiarse del tratamiento con luz. En contraste con este estudio, otros autores (130) mostraron una mejoría de los síntomas conductuales en personas con demencia severa, sugiriendo también un retraso en los ritmos de actividad. En otros estudios (131–133) también utilizaron el *IACM* para la evaluación de conductas agitadas tras intervención con BLT, mostrando una disminución

significativa de la agitación; aunque en uno de estos artículos (131) los efectos positivos se encontraron solo en la condición de exposición a la luz combinada con la administración de melatonina. Otra investigación (134) mostró beneficios de la BLT sobre la conducta motora inquieta, mostrándose los participantes menos inquietos y más cooperativos tras la intervención. En la bibliografía analizada también se recoge un efecto potencial, aunque con evidencia limitada (135), de la BLT para el manejo de la agitación en pacientes con deterioro cognitivo severo. En contraposición a los efectos positivos previamente comentados, en dos de los estudios analizados no se hallaron beneficios (136,137). En uno de ellos (136), incluso se observó un empeoramiento de los síntomas conductuales; no obstante, ese estudio presenta una importante limitación para tener en cuenta a la hora de interpretar sus resultados, ya que aquellos pacientes que respondieron favorablemente al tratamiento lumínico fueron dados de alta por haber disminuido su nivel de agitación. Estos resultados dispares entre los estudios están en conjunción con los diferentes instrumentos utilizados para medir la agitación, los distintos niveles de severidad de la demencia de los participantes o la falta de control de parámetros importantes, tales como el consumo de medicación o los cambios antes y durante la intervención lumínica.

En cuanto al estado de ánimo, seis de los diez artículos analizados en la revisión mostraron mejoría de la sintomatología depresiva. En uno de estos artículos (138) se comparó el efecto de la luminoterapia entre dos grupos de participantes clasificados en función de su estadio de demencia: demencia leve a moderada frente a demencia severa. Ambos grupos mostraron una mejora en las puntuaciones totales, pero diferencias en dos subescalas de la *Depressive Symptom Assessment for Older Adults (DSAOA)* (139), donde los pacientes en fases severas de la demencia mostraron mayores beneficios de la intervención. En contraposición a estos resultados, en tres artículos no se encontró ningún efecto positivo de la luminoterapia sobre el estado de ánimo (125,135,137). En

esta línea, otros autores (140) observaron incluso un empeoramiento de los síntomas depresivos en algunos de los participantes tras la intervención con BLT.

El impacto de la BLT para el manejo de los síntomas neuropsiquiátricos (SNP) generales, se evaluó en cuatro de los artículos incluidos en nuestra revisión, hallándose mejoras significativas en solo en uno de ellos (141). Uno de los artículos se centró en la sintomatología delirante, encontrando resultados contradictorios entre los participantes en el estudio: tres mejoraron, uno no mostró ningún cambio y otro participante empezó a experimentar alucinaciones y delirios durante la intervención (142). Es escasa la investigación acerca del efecto de la luminoterapia sobre los síntomas psicóticos asociados a la demencia. Existe un estudio (143) en el que se examinó el uso de la BLT como herramienta de prevención del delirio postoperatorio en una muestra de pacientes hospitalizados de mediana y avanzada edad, descubriendo que las alucinaciones desaparecían al primer o segundo día de la intervención con BLT en el grupo experimental pero persistían en el grupo de control durante varios días. Por lo tanto, la BLT parece ser útil en el tratamiento de los SNP, pero su aplicación requiere precaución, ya que se ha sugerido que puede tener un impacto significativo en la aparición de la sintomatología delirante en el curso de la enfermedad de Alzheimer (142).

Efectos sobre el estado cognitivo

Con respecto a la cognición, se encontraron pruebas limitadas y contradictorias de los efectos de la luminoterapia. En dos de los artículos analizados (131,144), los participantes mostraron un aumento en las puntuaciones totales en el *Mini-Mental State Examination* (MMSE) (145) después de la intervención, pero por el contrario, otros dos estudios (135,146) no mostraron cambios significativos ni en las puntuaciones del MMSE ni en las pruebas neuropsicológicas del *Consortium to Establish a Registry for Alzheimer's Disease* (CERAD) (147).

Es importante destacar que los estudios de neuroimagen han demostrado que la actividad cerebral cognitiva está regulada por la luz, que es un potente modulador de la cognición y del estado de alerta, influyendo directamente en el sueño y en los ritmos circadianos (148). Por lo tanto, se debe seguir explorando el efecto potencial de la luz sobre el funcionamiento cerebral.

Efectos sobre la calidad de vida

La efectividad de la BLT sobre la CdV apenas se ha estudiado, presentando además resultados controvertidos. En uno de los estudios analizados en la revisión no se obtienen diferencias significativas tras la intervención (125), mientras que en otra investigación (126) sí se observa una mejor CdV en los pacientes en fases avanzadas de la demencia obteniendo mejores puntuaciones mediante la escala *Quality of Life for Severe Dementia* (QUALID) (149).

Aunque el efecto directo sobre la calidad de vida no suele considerarse en los artículos e incluso es controvertido, la mejora de las alteraciones del sueño también mejoraría indirectamente la calidad de vida de las personas con demencia (150). El aumento de la exposición a la luz ha sido asociado con diferencias significativas en la calidad de vida de las personas mayores que viven en la comunidad (151).

Efectos sobre la funcionalidad en Actividades de la Vida Diaria (AVD)

Asimismo, la investigación sobre el impacto de la luminoterapia en el estado funcional de las personas con deterioro cognitivo también es escasa, habiéndose encontrado para nuestra revisión solo dos artículos sobre este tema. Los estudios existentes (131,133) mostraron beneficios potenciales de la BLT sobre el funcionamiento de los participantes en sus AVD.

Es importante promover futuras investigaciones que aborden los efectos de la luminoterapia sobre el estado funcional debido a su gran importancia en el campo de la gerontología y la geriatría.

Características de la intervención con luminoterapia

En cuanto a las características de la intervención con BLT, se encontró una gran heterogeneidad entre los protocolos de los estudios analizados. Esta falta de homogeneidad puede afectar a los diferentes resultados encontrados. En general, incluyendo toda la literatura abordada, las sesiones de tratamiento pueden durar entre 30 minutos y 13 horas dependiendo del equipo utilizado, con una dosis entre 2.500-10.000 lux, aplicada una o dos veces al día, y con un tiempo total de intervención que oscila entre 10 días y 10 semanas. Con el objetivo de proporcionar directrices para futuras investigaciones en este campo, se sintetizaron las características más utilizadas entre los estudios que resultaron tener efectos positivos. Los parámetros más repetidos en los protocolos de BLT con buenos resultados han sido: luz blanca brillante, con una intensidad entre 2.500 – 10.000 lux, aplicada por la mañana, con una frecuencia de entre 30 minutos a 2 horas por día, y una duración total del programa de intervención de entre 2 y 4 semanas.

La aplicación de la luminoterapia no requiere prescripción médica, pero es importante que personal clínico familiarizado con esta intervención explique y supervise su aplicación tanto en instituciones como en el domicilio. Asimismo, aunque las contraindicaciones de la luminoterapia son escasas (152) es fundamental realizar un seguimiento una vez iniciada la intervención para controlar los cambios, prestando especial atención al desarrollo o aumento de síntomas neuropsiquiátricos (142) y realizando ajustes en el protocolo de intervención si fuera necesario.

4.3. Efectos inmediatos de la luminoterapia sobre la conducta, el estado de ánimo y los parámetros fisiológicos en personas mayores con demencia de moderada a muy severa (Estudio III)

El propósito del tercer estudio fue examinar los efectos inmediatos sobre el comportamiento, el estado de ánimo, la saturación de oxígeno y la frecuencia cardíaca en una muestra de adultos mayores institucionalizados con demencia de moderada a muy grave que se sometieron a un programa de intervención con BLT durante cuatro semanas. Los principales resultados revelaron pruebas prometedoras de los beneficios del BLT en aspectos específicos del estado de ánimo y del comportamiento de los participantes, tanto durante como después de las sesiones, así como efectos positivos en los parámetros fisiológicos analizados.

Efectos inmediatos a corto plazo sobre el estado de ánimo y la conducta

Al igual que en el Estudio I, en esta investigación el estado de ánimo y el comportamiento también fueron evaluados mediante la escala *Interact* (96). Aunque esta escala se desarrolló inicialmente para la evaluación del estado de ánimo y el comportamiento de pacientes con demencia durante sesiones de estimulación multisensorial en una sala Snoezelen, su uso se ha extendido a otras intervenciones no farmacológicas, como la musicoterapia (91), la terapia artística (153) o la terapia de reminiscencia (97,154). Partiendo de esta base, se eligió la escala *Interact* para este estudio, ya que su estructura y forma de aplicación son también adecuadas y compatibles con el procedimiento de las sesiones de luminoterapia.

Las puntuaciones obtenidas por los participantes entre antes y después de las sesiones de BLT revelaron, por un lado, una disminución significativa en dos ítems relativos al humor (“Compungido/triste”) y al lenguaje (“Hablar espontáneamente”), y, por otro lado, un cambio significativo en su nivel de estimulación, concretamente en los ítems de “Pasarlo bien, activo y alerta”, y

"Relajado, contento o descansando adecuadamente". Por lo tanto, inmediatamente después de las sesiones de BLT, los participantes estaban menos tristes y hablaban menos de forma espontánea, lo que a su vez podría estar relacionado con el hecho de que también se mostraban más relajados, contentos o descansando adecuadamente. Coincidiendo con algunos de estos hallazgos, otros autores (155) que analizaron los efectos inmediatos de las sesiones de BLT frente a sesiones de luz roja tenue, descubrieron una disminución de la somnolencia y una tendencia a la mejora del estado de ánimo inmediatamente después de la exposición a la BLT. Otros estudios que aplicaban sesiones de BLT de 30 minutos encontraron efectos positivos a corto plazo sobre el estado de ánimo y la agitación en personas con demencia (134,138,156), observándose mayores beneficios en la demencia grave que en la demencia leve/moderada (138).

Efectos sobre el estado de ánimo y la conducta durante las sesiones de intervención

Los resultados recogidos durante las sesiones mostraron un descenso significativo en la puntuación del ítem "Hacer comentarios o formular preguntas sobre la actividad", lo que tiene sentido debido a la habituación de los participantes al programa de intervención a medida que éste avanzaba. Las puntuaciones también reflejaron que a medida que avanzaban las semanas de intervención los participantes hablaban menos espontáneamente, con frases más cortas y con menos claridad o sensibilidad, es decir, una disminución general del habla durante las sesiones. Estos resultados pueden estar vinculados con los hallazgos obtenidos en relación con la disminución del habla espontánea tras las sesiones de BLT. Ninguno de los estudios existentes sobre BLT en la literatura aborda los efectos inmediatos que se producen dentro de la sesión, por lo que no podemos discutir nuestros resultados desde la perspectiva de los estudios anteriores.

Efectos sobre los parámetros fisiológicos

En este estudio se analizaron los parámetros fisiológicos de frecuencia cardíaca y SpO_2. Las mediciones mostraron cambios positivos entre antes y después de las sesiones en los dos parámetros, con un aumento significativo de la SpO_2 media y una reducción significativa de la frecuencia cardiaca media. Estos cambios pueden estar relacionados con el hecho de que los participantes estaban más relajados, como muestran las puntuaciones de la escala Interact, ya que estas respuestas biológicas se consideran indicadores fisiológicos de una respuesta de relajación (157,158). En consonancia con nuestros hallazgos, en otro estudio que investigaba la influencia inmediata de diferentes luces de colores tenues -blanca, roja y azul- en adultos sanos, también se observó una disminución de la frecuencia cardiaca tras la exposición (159). Por el contrario, nuestros resultados difieren de los de otro estudio previo en el que no se hallaron efectos inmediatos de la BLT matutina sobre ninguno de los parámetros fisiológicos analizados (155).

En la bibliografía existente, otro parámetro fisiológico que se ha estudiado con respecto a la luminoterapia es la variabilidad de la frecuencia cardiaca (VFC). Un grupo de autores (160,161) halló efectos positivos inmediatos de la BLT vespertina sobre la VFC en una muestra de mujeres jóvenes sanas. En otra investigación se encontraron resultados similares en pacientes diagnosticados de depresión mayor (162).

Siguiendo la hipótesis inicial de nuestro estudio, nuestros resultados sobre los efectos del BLT en los parámetros fisiológicos analizados coinciden con los efectos positivos obtenidos en la literatura existente sobre otras intervenciones sensoriales, como la musicoterapia (88,91,163,164) y la estimulación multisensorial (87,91).

4.4. Efectos del ajedrez terapéutico sobre la cognición, el estado de ánimo, y la calidad de vida en personas mayores (Estudio IV)

Este estudio examinó los efectos de un programa de intervención de ajedrez sobre la cognición, el estado de ánimo y la calidad de vida en personas mayores institucionalizadas o semiinstitucionalizadas. Los análisis mostraron que el programa de ajedrez tuvo un impacto positivo sobre el estado cognitivo general medido mediante el test *Montreal Cognitive Assessment* (MoCA) (165). En cuanto a dominios cognitivos específicos, nuestros resultados mostraron mejoras prometedoras en la atención, la velocidad de procesamiento y las funciones ejecutivas, pero ningún efecto en las habilidades visoespaciales y la memoria visual. Referente al estado de ánimo, no podemos extraer conclusiones firmes, ya que existían diferencias entre los grupos al inicio del estudio. Con relación a la calidad de vida, el grupo de intervención mostró mejoras tras el programa de ajedrez.

Efectos sobre el estado cognitivo

Nuestros resultados en cuanto a la cognición general coinciden con los proporcionados en una revisión (166) que afirmaba que la práctica regular del ajedrez podía considerarse un factor protector contra el deterioro cognitivo en personas mayores. Nuestros resultados también coinciden con los de múltiples estudios que señalan que la práctica regular de actividades cognitivamente estimulantes, como los juegos de mesa, se asocia a un menor riesgo de demencia (9,64,69,167–173) y de DCL (5,9,174,175). Asimismo, se ha demostrado que la participación frecuente en actividades cognitivas se relaciona con la mitigación del deterioro cognitivo (10,64,176,177). También ha señalado que la práctica de actividades en edades avanzadas, incluyendo los juegos de mesa como el ajedrez japonés, contribuye a preservar la función cognitiva (178).

Con respecto a los dominios cognitivos específicos, en nuestro estudio, la atención, la velocidad de procesamiento y las funciones ejecutivas mostraron mejoras significativas en el grupo de ajedrez, objetivadas con una disminución del tiempo de ejecución de la Parte B del *Trail Making Test* (TMT) (179) en la evaluación posterior al programa de intervención. Los resultados del TMT-Parte B solo se analizaron en siete individuos debido a que faltaban datos por la incapacidad de alguno*s participantes para completar esta prueba debido a su nivel de deterioro cognitivo. A pesar de no incluir estos datos en el análisis de los resultados, consideramos importante señalar que dos participantes del grupo control mostraron una tendencia a empeorar, ya que habían sido capaces de completar la tarea durante la evaluación basal, pero no en la evaluación posterior a la intervención. Asimismo, en el grupo experimental, uno de los participantes mostró una tendencia a la mejora, ya que esta participante no había sido capaz de completar el TMT-Parte B en la evaluación inicial, pero lo completó en la evaluación post-intervención, y logró una ejecución adecuada con valores por encima del punto de corte establecido como deficiente por Reitan (179).

Estudios previos, también han respaldado la teoría de que la práctica del ajedrez produce mejoras en dominios cognitivos específicos. Los resultados de un metaanálisis exhaustivo acerca de la relación entre la capacidad cognitiva y la habilidad ajedrecística (62) revelaron una correlación positiva significativa entre las habilidades ajedrecísticas y la velocidad de procesamiento, la memoria a corto plazo, el razonamiento fluido y la comprensión. Un programa de entrenamiento de resistencia combinado con la práctica del ajedrez en un grupo de mujeres mayores (13) dio como resultado una mejora de la orientación espacial, la atención, el cálculo, el recuerdo y el lenguaje en el MMSE (145).

En otro estudio (180) se concluyó que una mayor participación en actividades de ocio, entre ellas jugar al ajedrez, disminuía el descenso de la velocidad de procesamiento en el proceso de envejecimiento. En esta misma línea, recientes revisiones sobre este tema (8,64) advirtieron que la participación

en actividades de ocio mentalmente estimulantes como los juegos de mesa, se asociaba con una mejor velocidad de procesamiento y funcionamiento ejecutivo.

Referente a la memoria, en nuestro estudio no se hallaron efectos significativos de la práctica del ajedrez sobre la memoria visual. Por el contrario, Yates *et al*. (64) alegaron que la práctica regular de actividades mentalmente estimulantes estaba relacionada con una mejor función de la memoria. Además, algunos estudios (167,170) han constado que una mayor práctica con juegos de mesa estaba relacionada con una atenuación de los índices de deterioro de la memoria, especialmente en términos de memoria episódica (167,170) y de memoria de trabajo (170,181).

Con relación a las capacidades visoespaciales, nuestros resultados fueron congruentes con hallazgos previos sobre la ausencia de cambios en este dominio relacionados con la práctica de actividades cognitivas (170).

Efectos sobre el estado de ánimo

Algunos estudios han determinado una relación positiva entre el estado de ánimo y la práctica de actividades cognitivamente estimulantes (182–184). En uno de estos estudios, se analizaron los efectos sobre la depresión en personas con EA del juego GO, denominado ajedrez chino, concluyendo que una intervención que incluía el juego GO durante 6 meses mejoraba la sintomatología depresiva (182). En otro de estos estudios se evaluaba la utilización del *Making Memories Together*, que se trata de un juego de mesa terapéutico diseñado específicamente para personas con EA, y se demostró estar asociado a una reducción significativa de los signos de depresión en pacientes con demencia avanzada (184). A partir de nuestro estudio no podemos extraer conclusiones definitivas de nuestros resultados, ya que existían diferencias previas entre los grupos antes de la intervención en cuanto a la presencia de síntomas depresivos, siendo mayores en el grupo control en ambas valoraciones. La naturaleza no aleatoria del muestreo podría explicar esta heterogeneidad basal.

Efectos sobre la calidad de vida

En nuestro estudio se objetiva una mejora en la CdV en los participantes del grupo de ajedrez mediante la escala WHOQOL-OLD (185). Además, también cabe destacar que se observaron comportamientos sociales adecuados en el transcurso de las clases de ajedrez, tales como ayudarse unos a otros, mayor participación social y creación de vínculos. Estos comportamientos derivados del programa de intervención de ajedrez revelan un factor importante a tener en cuenta, ya que investigaciones anteriores han demostrado que poseer una amplia red social y un estilo de vida socialmente integrado parece tener un efecto protector contra la demencia (186,187). Además, se ha demostrado que jugar entre dos personas a juegos de mesa, como el ajedrez, es más eficaz para la función cognitiva que jugar solo (181). Las investigaciones sobre los efectos de la práctica de actividades cognitivamente estimulantes por parte de personas mayores con deterioro cognitivo o demencia han mostrado una relación significativa entre jugar regularmente a juegos de mesa y presentar una mejor CdV (182). Por otro lado, un estudio con mujeres mayores sanas también mostró mejoras en su percepción de la CdV tras un programa de intervención que combinaba clases de ajedrez con entrenamiento de resistencia (13).

Aceptación, viabilidad y satisfacción con el programa de ajedrez

En cuanto a la aceptabilidad del programa cabe destacar que el número medio de clases a las que se asistió fue de 22,73 ± 1,27 sobre el total de las 24 sesiones del programa, lo que muestra una adherencia adecuada. Además, los motivos para no asistir se debieron siempre a razones médicas o de salud.

En relación con la adquisición de conocimientos sobre el ajedrez, prácticamente todos los participantes aprendieron la posición correcta de las piezas en el tablero y sus movimientos básicos, siendo la gran mayoría (82-91%) capaces de moverlas sin ayuda y el resto capaces de realizar los movimientos tras orientaciones iniciales por parte de los monitores.

Finalmente, es importante destacar el alto nivel de satisfacción y motivación expresado por los participantes del grupo de intervención en la evaluación final, consistente con la buena adherencia al programa de ajedrez.

Estos resultados son un indicador útil de la buena aceptabilidad y la viabilidad de implementar un programa de ajedrez-intervención en centros asistenciales con las mismas características.

4.5. Aplicación de la realidad virtual como herramienta preventiva, diagnóstica y de tratamiento del deterioro cognitivo en personas mayores (Estudio V)

El objetivo de esta revisión fue explorar la bibliografía publicada hasta ese momento sobre los efectos de la aplicación de la realidad virtual en diferentes ámbitos del deterioro cognitivo en personas mayores, obteniéndose resultados positivos de su aplicación en cuanto a prevención, diagnóstico y tratamiento. Según nuestros conocimientos, esta es la primera revisión sistemática que abarca todos los posibles ámbitos de aplicación de la RV sobre el deterioro cognitivo.

De manera general, incluyendo los tres ámbitos de aplicación abordados en esta revisión, los sistemas de RV permiten a los usuarios interactuar en diversos entornos y obtener retroalimentación en tiempo real sobre su rendimiento sin estar expuestos a riesgos (188). El uso de la RV presenta un gran número de ventajas, entre las que destaca la posibilidad de que los pacientes pueden realizar tareas de RV de manera remota (189), el proveer un aprendizaje activo durante una actividad motivante, la capacidad de controlar el grado de dificultad de la tarea aumentando gradualmente su nivel, así como la posibilidad de adaptarla a objetivos específicos individuales (190). Además, existen numerosos estudios que reportan la factibilidad de aplicación y buena aceptación de la RV por parte de las personas mayores tanto con deterioro cognitivo (191–193) como sin deterioro (194–196).

Realidad virtual como herramienta de prevención del deterioro cognitivo

Con respecto al efecto de la RV como herramienta de prevención del deterioro cognitivo, la literatura es escasa. Los dos estudios identificados (197,198) en la presente revisión mostraron efectos positivos de la RV como estrategia preventiva, aunque sin realizar un seguimiento a largo plazo. En base a sus resultados, los autores de uno de estos estudios (198) recomendaron el juego GRADYS (199), consistente en cuatro módulos (atención, memoria, lenguaje y procesamiento visoespacial) de tareas inspiradas en la vida diaria, como una posible contramedida para el deterioro cognitivo experimentado en el envejecimiento cognitivo normal.

Los hallazgos de los estudios previamente comentados concuerdan con los recogidos en otros estudios con población mayor sin deterioro (200,201) que mostraban beneficios del uso de la RV sobre su funcionamiento cognitivo, pero sin analizar los resultados a largo plazo, por lo que no se puede establecer el efecto preventivo de la RV.

Son necesarias más investigaciones de carácter longitudinal centradas en el análisis de los potenciales beneficios de la RV como medida preventiva frente al posible desarrollo posterior de deterioro cognitivo en personas mayores.

Realidad virtual como instrumento diagnóstico del deterioro cognitivo

En esta última década, se ha observado un creciente interés en la investigación sobre las nuevas tecnologías para el desarrollo de paradigmas capaces de detectar cambios en las capacidades cognitivas (202) con el objetivo de conseguir un diagnóstico más adecuado y precoz de pacientes con DCL o EA.

Todos los estudios incluidos en el análisis de esta revisión mostraron evidencia de la utilidad de la RV como herramienta diagnóstica o diferenciadora

de DCL (202–207). Nuestros resultados, en concordancia con los recogidos en otras revisiones (75,76,208) muestran que la investigación sobre la aplicación de la RV como herramienta diagnóstica está en auge, y proporciona evidencias significativas para la detección de signos de DCL o EA tempranos en población mayor sin deterioro cognitivo, así como para realizar evaluaciones o discriminar entre las diferentes etapas del mismo (77,189).

Es necesario continuar con la investigación en esta línea con el objetivo de aumentar la evidencia en este ámbito, diseñar instrumentos diagnósticos de RV estandarizados e introducirlos en la práctica clínica habitual para contribuir al diagnóstico precoz.

Realidad virtual como herramienta de tratamiento del deterioro cognitivo

Los principales hallazgos de nuestra revisión son positivos en cuanto al uso de la RV como herramienta efectiva para mejorar la función cognitiva en sujetos con presencia de deterioro cognitivo. Un aspecto a destacar es la gran variabilidad en las características de los programas de intervención utilizados en cada estudio en cuanto a la duración de la sesión, la duración total, y el tipo de tarea de RV. Nuestros resultados concuerdan con los recogidos en otras revisiones (208–210) sobre el efecto de la RV en el deterioro cognitivo, donde se observaron mejorías en la cognición en personas mayores con deterioro cognitivo o incluso demencia (211). Por otro lado, algunos autores incluso estudiaron los efectos de sistemas de RV integrada junto con intervenciones tradicionales, como la terapia de reminiscencia, mostrando resultados beneficiosos (212).

En los últimos años, la RV ha ido ganando reconocimiento como una herramienta útil y adecuada para el tratamiento o rehabilitación del deterioro cognitivo. En la actualidad existen numerosas revisiones que fundamentan su potencial como tratamiento (78–83,188).

4.6. Limitaciones y fortalezas de la investigación

Como limitaciones del estudio I, podemos indicar en primer lugar, el tamaño relativamente pequeño de la muestra, con 11 y 10 individuos incluidos en cada grupo, lo que puede explicar la ausencia de resultados significativos en algunos de los resultados medidos. Debe tenerse en cuenta la dificultad de obtener este tipo específico de individuos con demencia grave o muy grave para garantizar la homogeneidad (mismas características basales) y la aleatorización de ambos grupos de intervención. Futuros estudios deberían abordar esta limitación incluyendo muestras más amplias para confirmar nuestros hallazgos. En segundo lugar, otra de las limitaciones es la gran inversión económica que supone el uso de una sala Snoezelen en comparación con otras terapias. Por ello, es muy importante demostrar de forma empírica que los beneficios de la EMS en una sala Snoezelen sobre el estado de ánimo y las alteraciones conductuales de las personas con demencia severa son mejores o mayores que los proporcionados por otras intervenciones sensoriales que requieren menores recursos económicos como la musicoterapia o la luminoterapia.

La revisión de la BLT (estudio II) debe entenderse teniendo en cuenta algunas limitaciones. En primer lugar, el número limitado de personas que participaron en algunos estudios y la heterogeneidad de los aspectos metodológicos para la intervención pueden afectar a la solidez y la relevancia clínica de algunos de los resultados y conclusiones descritos. En contraposición, se realizó una evaluación de la calidad metodológica para cada estudio incluido mediante el *JBI Critical Appraisal Checklist for Randomized Controlled Trials* y el *JBI Critical Appraisal Checklist for Quasi-Experimental Studies* proporcionados por el *Instituto Joanna Briggs* (JBI) con el fin de fortalecer nuestros resultados. Como fortalezas de esta revisión, cabe destacar la ausencia de un límite en los años de búsqueda y, el establecimiento del criterio de uso de instrumentos validados para la evaluación de los efectos de la BLT, y criterios de inclusión explícitos. Además, se buscó conocer el efecto de la luminoterapia

en adultos mayores (de 65 años o más) con deterioro cognitivo, con o sin diagnóstico de demencia.

En cuanto al estudio III, aporta datos novedosos y relevantes para la práctica clínica ya que, hasta donde sabemos, el impacto inmediato de las sesiones de BLT sobre el estado de ánimo y el comportamiento prácticamente no se ha examinado anteriormente. No obstante, los resultados de este trabajo deben considerarse preliminares e interpretarse con cautela debido a ciertas limitaciones existentes. Este estudio es parte de una investigación más amplia y exhaustiva sobre BLT, y en este artículo solo se analizaron los efectos inmediatos después y durante las sesiones de BLT. Por tanto, las limitaciones de este estudio se derivan principalmente del pequeño tamaño de la muestra y del uso de una intervención de un solo brazo sin grupo control, lo que limita la generalización de los resultados. Por otra parte, el estado de ánimo y el comportamiento se midieron basándose en las observaciones de investigadores no cegados, lo que puede haber dado lugar a un sesgo del investigador. Las futuras investigaciones deberían abordar estas limitaciones empleando un diseño doble ciego en estudios controlados y con muestras de mayor tamaño.

El estudio IV presenta algunas limitaciones que deben tenerse en cuenta. En primer lugar, la asignación de los pacientes en función de sus preferencias restringe la generalización de los resultados y puede debilitar la validez externa de los mismos. En segundo lugar, el tamaño de la muestra fue pequeño, con 11 participantes en cada grupo. Estas dos limitaciones podrían solventarse en futuras investigaciones utilizando muestras más amplias con diseños aleatorios más sólidos. Por otro lado, no se evaluaron los efectos a largo plazo del programa; por lo tanto, sería interesante realizar evaluaciones de seguimiento para determinar la tasa de continuación de los posibles cambios relacionados en la cognición, el estado de ánimo y la calidad de vida. Por último, la influencia del período de intervención en la eficacia del programa también debería explorarse más a fondo. A pesar de estas limitaciones, este estudio también engloba algunos

puntos fuertes. En primer lugar, incorporamos la evaluación de múltiples factores (cognición, estado de ánimo y calidad de vida), lo que nos permitió obtener la máxima información posible sobre los beneficios de este tipo de intervención en los centros de atención a personas mayores. Otro punto fuerte importante es que nuestros resultados tienen implicaciones para la práctica clínica, ya que proporcionan directrices para que los profesionales puedan desarrollar una intervención barata y fácil de implementar.

Por último, en el estudio V también es necesario tener en cuenta ciertas limitaciones. Principalmente, el tamaño muestral en algunos de los estudios incluidos en la revisión fue muy reducido. Otra de las limitaciones fue la escasa identificación de estudios, sobre todo en el ámbito de la prevención. Por último, es importante señalar la heterogeneidad entre estudios en cuanto a los protocolos de intervención empleados, lo que dificulta el establecimiento de conclusiones específicas respecto a la estandarización de protocolos de aplicación clínica. Por otro lado, serían elementos a valorar como fortalezas, la ausencia de un límite temporal en la búsqueda, abarcando toda la bibliografía existente; la utilización de diferentes bases de datos complementarias; y el amplio enfoque utilizado al abordar tanto la prevención, como el diagnóstico y el tratamiento.

CAPÍTULO 5. CONCLUSIONES

Capítulo 5. Conclusiones

Conforme a los objetivos planteados y a los resultados obtenidos, el desarrollo de la presente tesis ha permitido formular las siguientes conclusiones:

De acuerdo al primer estudio, se evidencia que tanto las sesiones de EMS y las sesiones de música individualizadas son tratamientos no farmacológicos eficaces para el tratamiento de los SPCD en personas con demencia severa. Las sesiones de EMS en sala Snoezelen resultaron ser tan efectivas como las sesiones de música individualizada, excepto durante las sesiones de intervención, con diferencias en dos de los parámetros analizados: los participantes del grupo EMS realizaron un mejor seguimiento visual de los estímulos que los participantes del grupo de música individualizada, mientras que los participantes del grupo de música se mostraron más relajados y contentos que los del grupo EMS. En cuanto a los parámetros fisiológicos, ambos grupos mostraron una mejora de la saturación de oxígeno antes y después de las sesiones.

Con la revisión sistemática sobre luminoterapia, se muestra evidencia potencial de sus efectos positivos para el tratamiento de los trastornos del sueño, el comportamiento y el estado de ánimo en las personas con deterioro cognitivo. Se encontró un efecto limitado con respecto a la cognición, la calidad de vida y el estado funcional. A pesar de la gran heterogeneidad encontrada en los estudios, esta revisión presenta los parámetros de la luminoterapia más frecuentemente repetidos en toda la bibliografía, con resultados positivos en personas mayores con deterioro cognitivo, ofreciendo así una guía para el diseño de futuros estudios en este campo.

Con respecto a los resultados del tercer estudio, concluimos que un programa de intervención de luminoterapia de sesiones de 30 minutos, proporciona efectos positivos inmediatos sobre el estado de ánimo, el nivel de

alerta, la saturación de oxígeno en sangre y la frecuencia cardiaca. Además, se observó una tendencia a la disminución del habla tanto durante como después de las sesiones de intervención.

Del cuarto estudio, se concluye que un programa de intervención de ajedrez con sesiones de 60 minutos dos veces por semana durante 12 semanas mejora el estado cognitivo general, la atención, la velocidad de procesamiento, las funciones ejecutivas y la CdV en una muestra de personas mayores semiinstitucionalizadas e institucionalizadas.

Los resultados obtenidos en la revisión sistemática sobre RV proporcionan evidencia de su aplicabilidad como herramienta diagnóstica, así como de su efectividad como propuesta de intervención mejorando el funcionamiento cognitivo en personas mayores con presencia de deterioro cognitivo. También se muestran resultados prometedores en cuanto al efecto protector de la RV como estrategia preventiva frente al posible desarrollo de deterioro cognitivo.

Por tanto, y de acuerdo al objetivo principal, las intervenciones no farmacológicas analizadas en esta tesis demuestran beneficios tanto sobre los síntomas psicológicos y conductuales en personas mayores con DCL o demencia (estimulación multisensorial, sesiones de música individualizada y luminoterapia), como sobre el funcionamiento cognitivo en personas mayores con deterioro cognitivo o en aquellas sin él (ajedrez y realidad virtual). En todo caso, son necesarias futuras investigaciones metodológicamente más robustas y con muestras más amplias, a fin de profundizar en los efectos identificados y poder generalizar la aplicación de estas intervenciones en la práctica clínica, contribuyendo así a mejorar la salud y calidad de vida de las personas mayores y su entorno.

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ANEXOS

Anexos

Anexo A. Informe favorable Comité de ética (Estudio I)

UNIVERSIDADE DA CORUÑA

COMITÉ DE ÉTICA DA INVESTIGACIÓN

COMITÉ DE ÉTICA DA INVESTIGACIÓN
UNIVERSIDADE DA CORUÑA
18 DIC. 2013
SALIDA Nº CE 19/2013

CE 19/2013

INFORME
DEL COMITÉ DE ÉTICA DE LA UNIVERSIDAD DE A CORUÑA

El Comité de Ética de la Universidad de A Coruña (CE-UDC), reunido en sesión ordinaria de 18 de diciembre de 2013 y una vez estudiada la documentación presentada por D. José Carlos Millán Calenti, Investigador del estudio titulado "*Efectos de la estimulación multisensorial en personas mayores con y sin deterioro cognitivo*" estima que el mencionado estudio respeta las exigencias y los principios éticos y la normativa jurídica aplicables.

Por todo lo anterior, acordó por unanimidad, en el ámbito de sus competencias,

INFORMAR FAVORABLEMENTE

La viabilidad del estudio presentado por el investigador D. José Carlos Millán Calenti.

El Comité de Ética de la Universidad de A Coruña velará por el respeto de las exigencias y los principios éticos y la normativa jurídica aplicables durante el desarrollo del correspondiente estudio.

Y para que conste a los efectos oportunos, firma el presente informe en A Coruña, a 18 de diciembre de 2013.

Comité de Ética
UNIVERSIDADE DA CORUÑA

Fdo.: Rafael Colina Garea
Presidente del CE-UDC

Anexo B. Informe favorable Comité de ética (Estudio III)

XUNTA DE GALICIA
CONSELLERÍA DE SANIDADE
Secretaría Xeral Técnica

Secretaría Técnica
Comité Autonómico de Ética da Investigación de Galicia
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DICTAMEN DEL COMITÉ DE ÉTICA DE LA INVESTIGACIÓN DE A CORUÑA-FERROL

Carlos Rodríguez Moreno, Secretario del Comité de Ética de la Investigación de A Coruña-Ferrol

CERTIFICA:

Que este Comité evaluó en su reunión del día 24/10/2017 el estudio:

Título: Luminoterapia en personas con demencia: ensaio clínico aleatorizado
Promotor: Ana Belén Maseda Rodríguez
Tipo de estudio: Outros
Version:
Código del Promotor:
Código de Registro: 2017/408

Y, tomando en consideración las siguientes cuestiones:

- La pertinencia del estudio, teniendo en cuenta el conocimiento disponible, así como los requisitos legales aplicables, y en particular la Ley 14/2007, de investigación biomédica, el Real Decreto 1716/2011, de 18 de noviembre, por el que se establecen los requisitos básicos de autorización y funcionamiento de los biobancos con fines de investigación biomédica y del tratamiento de las muestras biológicas de origen humano, y se regula el funcionamiento y organización del Registro Nacional de Biobancos para investigación biomédica, la ORDEN SAS/3470/2009, de 16 de diciembre, por la que se publican las Directrices sobre estudios Posautorización de Tipo Observacional para medicamentos de uso humano, y el la Circular nº 07 / 2004, investigaciones clínicas con productos sanitarios.
- La idoneidad del protocolo en relación con los objetivos del estudio, justificación de los riesgos y molestias previsibles para el sujeto, así como los beneficios esperados.
- Los principios éticos de la Declaración de Helsinki vigente.
- Los Procedimientos Normalizados de Trabajo del Comité.

Emite un INFORME FAVORABLE para la realización del estudio por el/la investigador/a del centro:

Centros	Investigadores Principales
UDC, Facultad de Ciencias de la Salud	Ana Belén Maseda Rodríguez

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Y hace constar que:

7. El Comité Territorial de Ética de la Investigación de A Coruña-Ferrol cumple los requisitos legales vigentes (R.D 223/2004 de ensayos clínicos, y la Ley 14/2007 de Investigación Biomédica).
8. El Comité Territorial de Ética de la Investigación de A Coruña-Ferrol tanto en su composición como en sus PNTs cumple las Normas de Buena Práctica Clínica (CPMP/ICH/135/95).
9. La composición actual del Comité Territorial de Ética de la Investigación de A Coruña-Ferrol es:

Salvador Pita Fernández (Presidente). Médico especialista en Medicina Familiar y Comunitaria. Área de Gestión Integrada A Coruña.
Lucía Fuster Sanjurjo (Vicepresidenta). Farmacéutica. Especialista en Farmacia Hospitalaria. Área de Gestión Integrada Ferrol
Carlos Rodríguez Moreno (Secretario). Médico especialista en Farmacología Clínica. Área de Gestión Integrada Santiago
Natalia Cal Purriños (Vicesecretaria). Licenciada en derecho. Fundación "Profesor Nóvoa Santos". A Coruña
Juana Mª Cruz del Río. Trabajadora social. Consellería de Sanidad
Begoña Graña Suárez. Médica especialista en Oncología Médica. Área de Gestión Integrada A Coruña
Angel Lopez-Silvarrey Varela. Médico especialista en Pediatría. Área de Gestión Integrada A Coruña
Alejandro Pazos Sierra. Médico. Universidad de A Coruña
Gonzalo Peña Pérez. Médico especialista en Cardiología. Hospital de San Rafael. A Coruña
José Mª Rumbo Prieto. Diplomado en enfermería. Área de Gestión Integrada Ferrol
María Isabel Sastre Gervás. Farmacéutica Atención Primaria. Área de Gestión Integrada A Coruña

Para que conste donde proceda, y a petición del promotor / investigador, en Santiago de Compostela,

El secretario

Anexo C. Informe favorable Comité de ética (Estudio IV)

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DICTAMEN DEL COMITÉ DE ÉTICA DE LA INVESTIGACIÓN DE A CORUÑA - FERROL

Sonia Pértega Díaz, Vicesecretaria del Comité de Ética de la Investigación de A Coruña-Ferrol

CERTIFICA:

Que este Comité evaluó en su reunión del día 16/12/2019 el estudio:

Título: Análisis del efecto neuroprotector del ajedrez en personas mayores
Versión: v01
Promotor/a: José Carlos Millán Calenti
Investigador/a: José Carlos Millán Calenti
Código de Registro:2019/582

Y que este Comité, tomando en consideración la pertinencia del estudio, el conocimiento disponible, los requisitos éticos, metodológicos y legales exigibles a los estudios de investigación con seres humanos, sus muestras o registro y los Procedimientos Normalizados de Trabajo del Comité, emite un dictamen **FAVORABLE** para la realización del citado estudio.

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Y HACE CONSTAR QUE:

1. El Comité Territorial de Ética de la Investigación de A Coruña-Ferrol cumple los requisitos legales vigentes

2. La composición actual del Comité Territorial de Ética de la Investigación de A Coruña-Ferrol es:

Carmen Mella Pérez (Presidenta). Médica especialista en Medicina Interna. Área de Gestión Integrada Ferrol.
Angel Lopez-Silvarrey Varela. (Vicepresidente). Médico especialista en Pediatría. Área de Gestión Integrada A Coruña.
Natalia Cal Purriños. (Secretaria). Licenciada en Derecho. Fundación "Profesor Novoa Santos". A Coruña.
Sonia Pértega Díaz. (Vicesecretaria). Matemática. Área de Gestión Integrada A Coruña.
Juana Mª Cruz del Rio. Trabajadora social. Consellería de Sanidad.
María Ángeles Freire Fojo. Farmacéutica. Especialista en Farmacia Hospitalaria. Área de Gestión Integrada Ferrol.
Portal González Lorenzo. Médica especialista en Medicina Familiar y Comunitaria. Área de Gestión Integrada Ferrol.
Isaac Martínez Bendayán. Médico especialista en Cardiología. Área de Gestión Integrada A Coruña.
María Otero Santiago. Médica especialista en Medicina Preventiva y Salud Pública. Área de Gestión Integrada A Coruña.
Alejandro Pazos Sierra. Médico. Universidad de A Coruña.
Gonzalo Peña Pérez. Médico especialista en Cardiología. Hospital de San Rafael. A Coruña.
Carlos Rodríguez Moreno. Médico especialista en Farmacología Clínica. Área de Gestión Integrada Santiago.
José Mª Rumbo Prieto. Diplomado en Enfermería. Área de Gestión Integrada Ferrol.
María Isabel Sastre Gervás. Farmacéutica Atención Primaria. Área de Gestión Integrada A Coruña.

Para que conste donde proceda, y a petición de quien corresponda, en A Coruña.

La Vicesecretaria del Comité Territorial de Ética de la Investigación de A Coruña – Ferrol,

Sonia Pértega Díaz

Xacobeo 2021

Anexo D. Material suplementario artículo revisión luminoterapia - estrategia de búsqueda (Estudio II)

1. WEB OF SCIENCE (Results: 208)

Title: (Light therapy OR Light treatment OR Light exposure OR Bright light OR "Effect of light") AND (elder* OR old* OR dement* OR Alzheimer OR nursing home OR day care)

Timespan: 1900-2019

Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI, CCR-EXPANDED, IC

2. MEDLINE (Results: 152)

Title: (Light therapy OR Light treatment OR Light exposure OR Bright light OR "Effect of light") AND (elder* OR old* OR dement* OR Alzheimer OR nursing home OR day care)

Timespan: 1950-2019

Indexes= MEDLINE.

Anexo E. Material suplementario artículo revisión luminoterapia – motivos de exclusión de artículos a texto completo (Estudio II)

Citation	Reason for exclusion
A. RESULTS FROM THE WEB OF SCIENCE	
1. Alparslan GB, Özkaraman A, Özbabalik D, Colak E. The effect of light on daily activities and sleep in patients with Alzheimer's Disease. J Turk Sleep Med. 2019;3:59-64.	Absence of measurement criteria to determine cognitive impairment
2. Missotten P, Farag L, Delye S, Muller A, Grotz C, Adam S. Place des therapies lumiere aupres des personnes agees souffrant de pathologie dementielle: etat des lieux et perspectives futures. (Role of "light therapy" among older adults with dementia: an overview and future perspectives). Geriatrie et psychologie neuropsychiatrie du vieillissement. 2019;17(1):83-91.	No original research
3. Scheuermaier K, Lee JH, Duffy JF. Phase Shifts to a Moderate Intensity Light Exposure in Older Adults: A Preliminary Report. J Biol Rhythms. 2019;34(1):98-104.	Persons younger than 65 years or with a mean age less than 65 years old
4. Scheuermaier K, Münch M, Ronda JM, Duffy JF. Improved cognitive morning performance in healthy older adults following blue-enriched light exposure on the previous evening. Behav Brain Res. 2018;348:267-275.	Patients with no cognitive impairment

5. Nioi A, Roe J, Gow A, McNair D, Aspinall P. Seasonal Differences in Light Exposure and the Associations With Health and Well-Being in Older Adults: An Exploratory Study. Herd-Health Env Res. 2017;10(5):64-79.	Not using light therapy
6. Wu M, Sung H, Lee W, Smith GD. The effects of light therapy on depression and sleep disruption in older adults in a long-term care facility. Int J Nurs Pract. 2015;21(5):653-659.	Patients with no cognitive impairment
7. Obayashi K, Saeki K, Kurumatani N. Light exposure at night is associated with subclinical carotid atherosclerosis in the general elderly population: The HEIJO-KYO cohort. Chronobiol Int. 2015;32(3):310-317.	Not designed to study the effect of light therapy on BPSD or cognitive impairment
8. Obayashi K, Saeki K, Tone N, Iwamoto J, Miyata K, Ikada Y, et al. Lower melatonin secretion in older females: Gender differences independent of light exposure profiles. J Epidemiol. 2015;25(1):38-43.	Not designed to study the effect of light therapy on BPSD or cognitive impairment
9. Obayashi K, Saeki K, Kurumatani N. Association between light exposure at night and insomnia in the general elderly population: The HEIJO-KYO cohort. Chronobiol Int. 2014;31(9):976-982.	Patients with no cognitive impairment
10. Obayashi K, Saeki K, Iwamoto J, Ikada Y, Kurumatani N. Association between light exposure at night and nighttime blood pressure in the elderly independent of nocturnal urinary melatonin excretion. Chronobiol Int. 2014;31(6):779-786.	Not using light therapy

11. Obayashi K, Saeki K, Iwamoto J, Okamoto N, Tomioka K, Nezu S, et al. Effect of exposure to evening light on sleep initiation in the elderly: A longitudinal analysis for repeated measurements in home settings. Chronobiol Int. 2014;31(4):461-467.	Not using light therapy
12. Obayashi K, Saeki K, Iwamoto J, Ikada Y, Kurumatani N. Independent associations of exposure to evening light and nocturnal urinary melatonin excretion with diabetes in the elderly. Chronobiol Int. 2014;31(3):394-400.	Not designed to study the effect of light therapy on BPSD or cognitive impairment
13. van der Ploeg ES, O'Connor DW. Methodological challenges in studies of bright light therapy to treat sleep disorders in nursing home residents with dementia. Psychiatry Clin Neurosci. 2014;68(11):777-784.	No original research
14. Chong MS, Tan KT, Tay L, Wong YM, Ancoli-Israel S. Bright light therapy as part of a multicomponent management program improves sleep and functional outcomes in delirious older hospitalized adults. Clin Interv Aging. 2013;8:565-572.	Patients with delirium
15. Kretschmer V, Schmidt K, Griefahn B. Bright-light effects on cognitive performance in elderly persons working simulated night shifts: Psychological well-being as a mediator? Int Arch Occup Environ Health. 2013;86(8):901-914.	Persons younger than 65 years or with a mean age less than 65 years old

16. Akyar I, Akdemir N. The effect of light therapy on the sleep quality of the elderly: An intervention study. Aust J Adv Nurs. 2013;31(2):31-38.	Patients with no cognitive impairment
17. Obayashi K, Saeki K, Iwamoto J, Ikada Y, Kurumatani N. Exposure to light at night and risk of depression in the elderly. J Affect Disord. 2013;151(1):331-336.	Not using light therapy
18. Obayashi K, Saeki K, Iwamoto J, Okamoto N, Tomioka K, Nezu S, et al. Exposure to light at night, nocturnal urinary melatonin excretion, and obesity/dyslipidemia in the elderly: A cross-sectional analysis of the HEIJO-KYO study. J Clin Endocrinol Metab. 2013;98(1):337-344.	Not designed to study the effect of light therapy on BPSD or cognitive impairment
19. Kretschmer V, Schmidt K-, Griefahn B. Bright light effects on working memory, sustained attention and concentration of elderly night shift workers. Light Res Technol. 2012;44(3):316-333.	Persons younger than 65 years or with a mean age less than 65 years old
20. Figueiro MG, Hamner R, Higgins P, Hornick T, Rea MS. Field measurements of light exposures and circadian disruption in two populations of older adults. J Alzheimers Dis. 2012;31(4):711-715.	Not using light therapy
21. Kretschmer V, Griefahn B, Schmidt K. Bright light and night work: Effects on selective and divided attention in elderly persons. Light Res Technol. 2011;43(4):473-486.	Persons younger than 65 years or with a mean age less than 65 years old
22. Lieverse R, van Someren EJW, Nielen MMA, Uitdehaag BMJ, Smit JH, Hoogendijk WJG. Bright light treatment in elderly patients with nonseasonal major depressive disorder A randomized placebo-controlled trial. Arch Gen Psychiatry. 2011;68(1):61-70.	Patients with no cognitive impairment

23. Muench M, Scheuermaier KD, Zhang R, Dunne SP, Guzik AM, Silva EJ, et al. Effects on subjective and objective alertness and sleep in response to evening light exposure in older subjects. Behav Brain Res. 2011;224(2):272-278.	Persons younger than 65 years or with a mean age less than 65 years old
24. Scheuermaier K, Laffan AM, Duffy JF. Light exposure patterns in healthy older and young adults. J Biol Rhythms. 2010;25(2):113-122.	Patients with no cognitive impairment
25. van Hoof J, Aarts MPJ, Rense CG, Schoutens AMC. Ambient bright light in dementia: Effects on behaviour and circadian rhythmicity. Build Environ. 2009;44(1):146-155.	Absence of measurement criteria to determine cognitive impairment
26. Staples VSL, Archer SN, Arber S, Skene DJ. Daily light exposure profiles in older non-resident extreme morning and evening types. J Sleep Res. 2009;18(4):466-471.	Not using light therapy
27. Figueiro MG, Bierman A, Bullough JD, Rea MS. A personal light-treatment device for improving sleep quality in the elderly: Dynamics of nocturnal melatonin suppression at two exposure levels. Chronobiol Int. 2009;26(4):726-739.	Persons younger than 65 years or with a mean age less than 65 years old
28. Friedman L, Zeitzer JM, Kushida C, Zhdanova I, Noda A, Lee T, et al. Scheduled bright light for treatment of insomnia in older adults. J Am Geriatr Soc. 2009;57(3):441-452.	Persons younger than 65 years or with a mean age less than 65 years old

29. Tsai S, Barnard KE, Lentz MJ, Thomas KA. Twenty-four hours light exposure experiences in postpartum women and their 2-10-week-old infants: An intensive within-subject design pilot study. Int J Nurs Stud. 2009;46(2):181-188.	Persons younger than 65 years or with a mean age less than 65 years old
30. Lieverse R, Nielen MMA, Veltman DJ, Vitdehaag BMJ, van Someren EJW, Smit JH, et al. Bright light in elderly subjects with nonseasonal major depressive disorder: A double blind randomised clinical trial using early morning bright blue light comparing dim red light treatment. Trials. 2008;9:48.	Patients with no cognitive impairment
31. Gammack JK. Light therapy for insomnia in older adults. Clin Geriatr Med. 2008;24(1):139-149.	No original research
32. García-Corpas JP, Amariles P, Faus MJ. Light therapy: Its effectiveness in treating insomnia in elderly patients. Aten Prim. 2008;40(2):101-103.	No original research
33. Grandner M, Kripke D, Langer R. Light exposure is related to social and emotional functioning and to quality of life in older women. Psychiatry Res. 2006;143(1):35-42.	Patients with no cognitive impairment
34. Loving RT, Kripke DF, Knickerbocker NC, Grandner MA. Bright green light treatment of depression for older adults [ISRCTN69400161]. BMC Psychiatry. 2005;5:42.	Patients with no cognitive impairment
35. Loving RT, Kripke DF, Elliott JA, Knickerbocker NC, Grandner MA. Bright light treatment of depression for older adults [ISRCTN55452501]. BMC Psychiatry. 2005;5:41.	Patients with no cognitive impairment

36. Tsai YF, Wong TKS, Juang YY, Tsai HH. The effects of light therapy on depressed elders. Int J Geriatr Psychiatry. 2004;19(6):545-548.	Patients with no cognitive impairment
37. Skjerve A, Bjorvatn B, Holsten F. Light therapy for behavioural and psychological symptoms of dementia. Int J Geriatr Psychiatry. 2004;19(6):516-522.	No original research
38. Chikamori F, Kuniyoshi N, Shibuya S, Takase Y. Perioperative music therapy with a key-lighting keyboard system in elderly patients undergoing digestive tract surgery. Hepatogastroenterology. 2004;51(59):1384-1386.	Not using light therapy
39. Harrison Y. The relationship between daytime exposure to light and night-time sleep in 6-12-week-old infants. J Sleep Res. 2004;13(4):345-352.	Persons younger than 65 years or with a mean age less than 65 years old
40. Kirisoglu C, Guilleminault C. Twenty minutes versus forty-five minutes morning bright light treatment on sleep onset insomnia in elderly subjects. J Psychosom Res. 2004;56(5):537-542.	Persons younger than 65 years or with a mean age less than 65 years old
41. Sumaya IC, Rienzi BM, Deegan JF, Moss DE. Bright light treatment decreases depression in institutionalized older adults: A placebo-controlled crossover study. J Gerontol A Biol Sci Med Sci. 2001;56(6):M356-M360.	Patients with no cognitive impairment
42. Klerman EB, Duffy JF, Dijk DJ, Czeisler CA. Circadian phase resetting in older people by ocular bright light exposure. J Invest Med. 2001;49(1):30-40.	Patients with no cognitive impairment

43. Mishima K, Okawa M, Hozumi S, Hishikawa Y. Supplementary administration of artificial bright light and melatonin as potent treatment for disorganized circadian rest-activity and dysfunctional autonomic and neuroendocrine systems in institutionalized demented elderly persons. Chronobiol Int. 2000;17(3):419-432.	No original research
44. Van Someren E, Swaab D, Colenda C, Cohen W, McCall W, Rosenquist P. Bright light therapy: Improved sensitivity to its effects on rest-activity rhythms in Alzheimer patients by application of nonparametric methods. Chronobiol Int. 1999;16(4):505-518.	No original research
45. Koyama E, Matsubara H, Nakano T. Bright light treatment for sleep-wake disturbances in aged individuals with dementia. Psychiatry Clin Neurosci. 1999;53(2):227-229.	Absence of measurement criteria to determine cognitive impairment
46. Ohashi Y, Okamoto N, Uchida K, Iyo M, Mori N, Morita Y. Daily rhythm of serum melatonin levels and effect of light exposure in patients with dementia of the Alzheimer's type. Biol Psychiatry. 1999;45(12):1646-1652.	Not designed to study the effect of light therapy on BPSD or cognitive impairment
47. Kohsaka M, Fukuda N, Honma H, Kobayashi R, Sakakibara S, Koyama E, et al. Effects of moderately bright light on subjective evaluations in healthy elderly women. Psychiatry Clin Neurosci. 1999;53(2):239-241.	Patients with no cognitive impairment

48. Sakakibara S, Kohsaka M, Kobayashi R, Honma H, Fukuda N, Koyama T. Effects of morning bright light in healthy elderly women: Effects on wrist activity. Psychiatry Clin Neurosci. 1999;53(2):235-236.	Persons younger than 65 years or with a mean age less than 65 years old
49. Kobayashi R, Kohsaka M, Fukuda N, Sakakibara S, Honma H, Koyama T. Effects of morning bright light on sleep in healthy elderly women. Psychiatry Clin Neurosci. 1999;53(2):237-238.	Persons younger than 65 years or with a mean age less than 65 years old
50. Cooke K, Kreydatus M, Atherton A, Thoman E. The effects of evening light exposure on the sleep of elderly women expressing sleep complaints. J Behav Med. 1998;21(1):103-114.	Patients with no cognitive impairment
51. Ancoli-Israel S, Klauber MR, Jones DW, Kripke DF, Martin J, Mason W, et al. Variations in circadian rhythms of activity, sleep, and light exposure related to dementia in nursing-home patients. Sleep. 1997;20(1):18-23.	Not using light therapy
52. Murphy PJ, Campbell SS. Enhanced performance in elderly subjects following bright light treatment of sleep maintenance insomnia. J Sleep Res. 1996;5(3):165-172.	Patients with no cognitive impairment
53. Genhart MJ, Kelly KA, Coursey RD, Datiles M, Rosenthal NE. Effects of bright light on mood in normal elderly women. Psychiatry Res. 1993;47(1):87-97.	Patients with no cognitive impairment
54. Campbell SS, Kripke DF, Gillin JC, Hrubovcak JC. Exposure to light in healthy elderly subjects and Alzheimers patients. Physiol Behav. 1988;42(2):141-144.	Not using light therapy

B. RESULTS FROM MEDLINE	
55. Martiny K. Bright light treatment is effective in treating older patients with non-seasonal major depression. Evid Based Nurs. 2011;14(4):117-118.	No original research
56. Kripke DF. Bright light treatment reduces symptoms in older adults with non-seasonal major depression. Evid Based Nurs. 2011;14(3):75.	No original research
57. Figueiro MG, Lesniak N, Rea MS. Implications of controlled short-wavelength light exposure for sleep in older adults. BMC Res Notes. 2011;4:334.	Persons younger than 65 years or with a mean age less than 65 years old
58. Anonymous. Brighter daytime lighting may improve dementia. Mayo Clin Health Lett. 2008;26(11):4.	No original research
59. Anonymous. Bright lights may improve dementia symptoms. Harv Ment Health Lett. 2008;25(3):7.	No original research
60. Sloane PD, Figueiro M, Cohen L. Light as therapy for sleep disorders and depression in older adults. Clin Geriatr. 2008;16(3):25-31.	No original research
61. Goldberg DJ, Hussain M, Fazeli A, Berlin AL. Treatment of skin laxity of the lower face and neck in older individuals with a broad-spectrum infrared light device. J Cosmet Laser Ther. 2007;9(1):35-40.	No original research
62. Anonymous. Conquering insomnia helps people with Alzheimer's. Sleep hygiene programs, exercise and daytime exposureto light can alleviate sleep disturbances. Health News. 2006;12(3):9-10.	No original research

63. Sutherland D, Woodward Y, Byrne J, Allen H, Burns A. The use of light therapy to lower agitation in people with dementia. Nurs Times. 2004;100(45:32-34.	No original research
64. Wakamura T, Tokura H. Influence of bright light during day time on sleep parameters in hospitalized elderly patients. J Physiol Anthropol Appl Human Sci. 2001;20(6):345-351.	Patients with no cognitive impairment
65. Dawson P. Bright light treatment for people with Alzheimer's disease. Perspectives. 1999;23(1):25-26.	No original research