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General

Virtual Reality as an Innovative Tool for Eating Disorders Psychological Treatment

Abdulnaser Fakhrou[1], Gabriele Avincola[2], Giorgia Farruggio[3], Idria Verduzzo[3], Pasquale Caponnetto[3,4]

[1] Department of Psychological Science, College of Education, Qatar University, [2] Department of Clinical and Experimental Medicine, Psychiatry Unit, University of Catania, [3] Department of Educational Sciences, Section of Psychology, University of Catania, [4] Center of Excellence for the Acceleration of Harm Reduction (CoEHAR), University of Catania

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Background

This review aims to examine scientific evidence, therapeutic approaches, and outcomes achieved through the use of Virtual Reality (VR) in the context of Eating Disorders.

Method

We conducted a systematic search (PRISMA) and selected articles published in databases such as PubMed, Health and Medical Collection, and Science Direct Elsevier Journal.

Results

Numerous pieces of evidence demonstrate that VR is a valuable tool in treating anorexia nervosa, bulimia nervosa, and binge eating disorder. Additionally, it proves effective in addressing components of Eating Disorders (EDs), such as attentional bias related to body image and Body Image Disturbance. Specifically, the following treatments have emerged: VR Cue Exposure, Body Swapping, AB Modification Training via VR, and repeated Transcranial Magnetic Stimulation combined with VR. Virtual environments and embodiment in virtual bodies also allow for the assessment of variables related to EDs.

Conclusion

This review highlights how VR, with its specific characteristics, serves as an excellent ally to enhance both assessment and treatment for EDs. Future research should focus on filling existing gaps and delving into aspects not yet explored. One potential development could involve creating guidelines for VR use in EDs.

1. INTRODUCTION

Eating Disorders (EDs) are characterized by dysfunctional eating behaviors.[1] The DSM-5-TR distinguishes them as Anorexia Nervosa (AN), Bulimia Nervosa (BN), Binge Eating Disorder (BED), Avoidant/Restrictive Food Intake Disorder (ARFID), Pica, Rumination Disorder, Other Specified Feeding or Eating Disorder (OSFED), and Unspecified Feeding or Eating Disorder. Specifically, Anorexia Nervosa is characterized by restrictive eating behaviors leading to significant weight loss, intense fear of gaining weight, and distorted body image perception. Bulimia Nervosa involves recurrent episodes of binge eating followed by compensatory behaviors (e.g., self-induced vomiting, laxative use). Binge Eating Disorder manifests through recurrent episodes of binge eating without compensatory behaviors. ARFID involves food avoidance based on three fundamental criteria (lack of interest, sensory characteristics, fear of consequences) but is not associated with concerns about weight or body image.[1]

EDs have a relatively low prevalence; in European women, the prevalence of AN is 1-4%, BN 1-2%, BED 2-3% (with variations based on region, age, and ethnicity). Prevalence is much lower in men, partly because they develop these disorders to a lesser extent and also because they report symptoms much less due to cultural biases.[2,3]

The major risk factors include attentional and behavioral biases related to eating behaviors and body image.[4] Specifically, Body Image Disturbance (BID) is a common symptom of EDs and is elicited by attentional biases related to body image. BID can be divided into two dimensions: body image distortion (perceptual dimension) and body image dissatisfaction (cognitive-affective dimension).[5,6] These elements result in a discrepancy between perceived and ideal body size, leading to negative consequences on the individual's mental health.

Furthermore, according to literature, it is pertinent to reference a neuroscientific theory: Allocentric Lock Theory.[7,8] This theory highlights the role of spatial representations in influencing how the body is experienced and remembered. There are two spatial representations, interacting with each other: egocentric and allocentric representations. The egocentric representation encodes and updates information in relation to the body taken as a prospective reference point, while the allocentric representation encodes and stores long-term information independently of the individual, with environmental elements as reference points. These two representations interact because the egocentric representation allows the allocentric representation to update.[8,9]

Therefore, considering the numerous psychological variables involved, the high comorbidity, and the challenging prognosis of EDs, research should explore new treatment perspectives, even moving away from what are considered Gold Standards (e.g., CBT, IPT, CET).[10] Indeed, a new frontier in ED treatment, showing promising results, is the use of Virtual Reality (VR).[11] This form of immersive technology, which allows the senses (particularly vision and hearing) to interact with a virtual environment, seems to meet the clinical needs demonstrated by patients with EDs.[11] In accordance with a recent narrative review,[12] there are VR-mediated treatments that have shown efficacy in treating EDs: (1) VR cue exposure, for reducing craving and anxiety responses to food; (2) Reference frame-shifting approach, for modifying negative body-related memories and reorganizing multisensory integration processes; (3) Body illusions, for reducing attentional biases related to body stimuli.

This review aims to provide a comprehensive overview of the new treatment approaches that VR can offer in the clinical management of the core symptoms of EDs. When used judiciously, VR proves to be an excellent ally in enhancing both assessment and treatments for such disorders. The objective is to examine the scientific evidence, therapeutic approaches, and outcomes achieved through the use of this immersive technology. Additionally, it is interesting to explore VR's influence on attitudes towards food, body perception, and eating behaviors.

2. MATERIALS AND METHODS

2.1. SEARCH STRATEGIES

Articles published in PubMed, Health and Medical Collection, and ScienceDirect Elsevier Journal databases were analyzed and selected through a systematic search using the following search string format: "Eating Disorder Virtual Reality." This search string was chosen to align with the paper's objective of analyzing the new frontiers of assessment and treatment of Eating Disorders (EDs) using VR technology.

This review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 flow-diagram[13] to describe the methodology of article search and selection for inclusion.

2.2. INCLUSION CRITERIA

Articles were included according to the following criteria:

1. Database: studies published in PubMed, Health and Medical Collection, ScienceDirect Elsevier Journal were included.
2. Timeframe: studies from 2015 onwards were included, considering developments in VR research.
3. Topic: only articles consistent with the research objective were included.
4. Sample: studies with a sample size greater than 12 were included to ensure reliability and validity.

2.3. EXCLUSION CRITERIA

Articles were excluded according to the following criteria:

1. Database: Studies not published in PubMed, Health and Medical Collection, ScienceDirect Elsevier Journal were excluded.
2. Timeframe: All studies prior to 2015 were excluded.
3. Topic: All articles inconsistent with the research objective were excluded.
4. Sample: Studies with a sample size of less than 12 were excluded.

2.4. RISK OF BIAS

The Cochrane Risk of Bias tool V2 [RoB2] [14] was used to assess the risk of bias of all included studies (see Figure 1) as recommended in the Cochrane Handbook for Systematic Reviews of Interventions [15]. All studies were ranked in five different domains yielding results of low risk of bias (green), some concerns of bias (yellow), or high risk of bias (red). Types of bias may include selection bias (random sequence generation and allocation concealment), performance bias (blinding of patients/research team), detection bias (blinding of outcome assessment), attrition bias (incomplete outcome data/lost to follow-up), and reporting bias (selective outcome reporting).

3. RESULTS

3.1. CHARACTERISTICS OF THE STUDIES

In this review, a total of fifteen articles were included to analyze recent developments in the use of Virtual Reality (VR) for the assessment and treatment of Eating Disorders (EDs). The studies were selected based on their relevance to the objective of this review, with a specific focus on Anorexia Nervosa, Bulimia Nervosa, and Binge Eating Disorder. The selected studies, published from 2015 onwards, allowed for the analysis of available and diversified treatments for each eating disorder. Overall, these articles provide an overview of VR applications not only for treatment but also for assessment, contributing to early diagnosis. The PRISMA flow-diagram is reported in Figure 2.

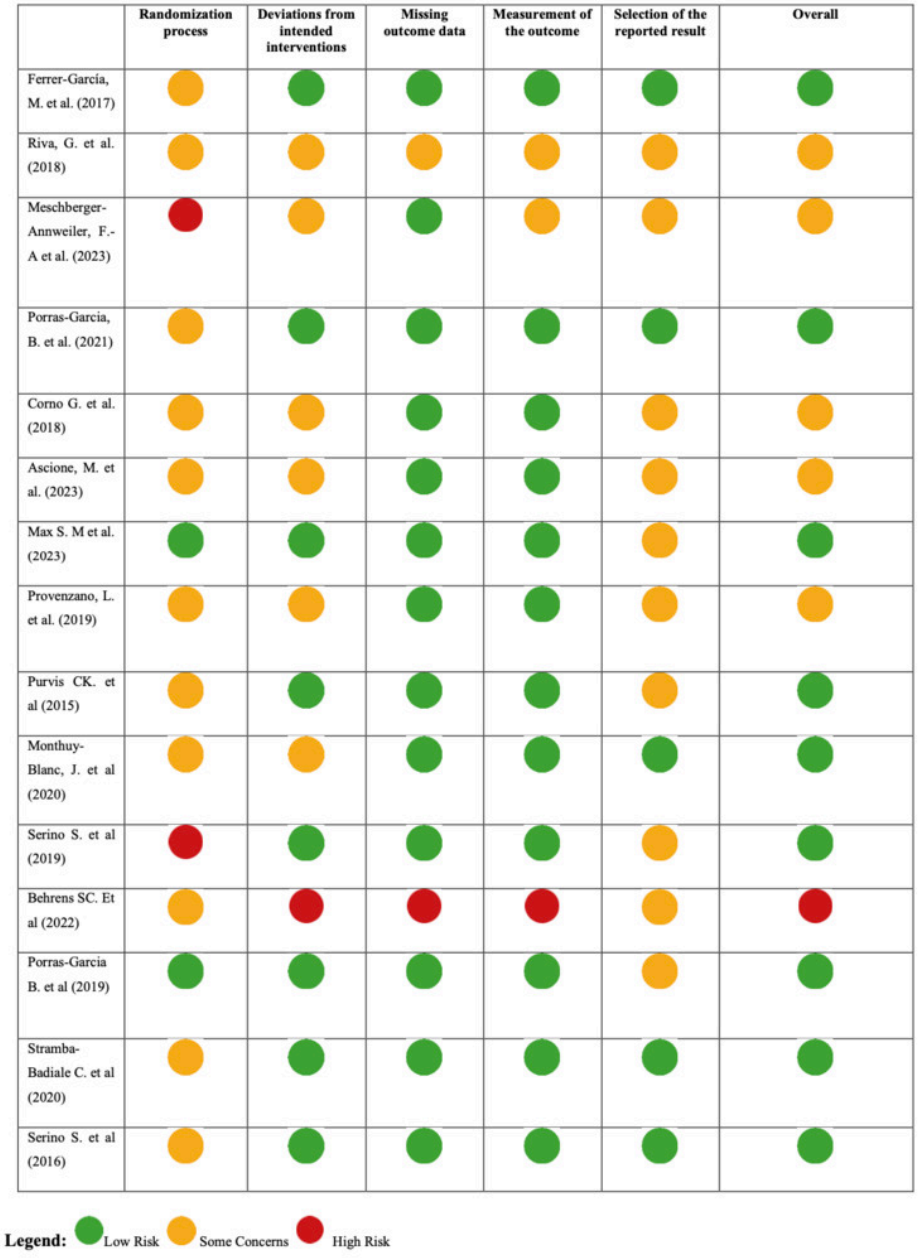

Figure 1. Risk of Bias

3.2. ANOREXIA NERVOSA

Anorexia nervosa (AN) is an Eating Disorder (ED) with a lifetime prevalence of 0.16%,[3] accompanied by a significantly high mortality rate[16] and a resistance to treatment.[17] Many studies have focused on enhancing treatments for this disorder and improving prognosis by analyzing various components of its typical symptomatology.

One study demonstrates, in a clinical sample, how Virtual Reality Body Exposure Therapy,[11] combined with standard AN treatment, can be effective in addressing Fear of Gaining Weight (FGW), defined as excessive concern about the possibility of gaining weight all over the body or in specific body parts, even at a significantly low weight.[1,18]

Furthermore, incorporating Attentional Bias Modification Training (ABMT) into AN treatment can improve attentional control, especially regarding body-related attention deficits.[19] Indeed, a study shows how a session of ABMT using VR and Eye Tracking (ET) helps balance attention devoted to weight and non-weight-related body areas, thereby reducing fixation on weight-related body areas.[20]

Provenzano, Porciello et al. aim to reduce Body Image Disturbance (BIDs)[5] using virtual bodies and the illusion of embodying them. While this reduction does not occur, they demonstrate how VR improves the sense of embodiment in virtual bodies of different sizes.[21] Furthermore, they pro-

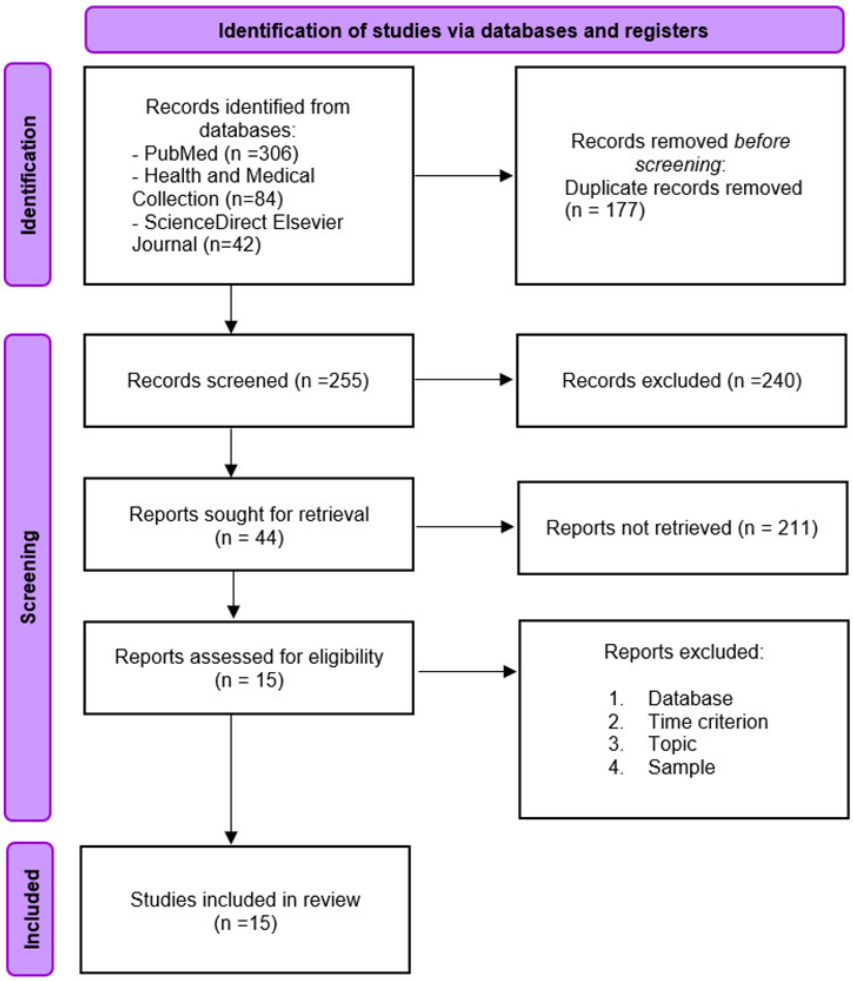

Figure 2. PRISMA 2020 flow-diagram.[13]

pose the possibility, contradicting previous literature, that dissatisfaction with body image may not be caused by overestimation of body weight but by a dysfunctional desire for a thinner body. This is because both the AN patient sample and the healthy control sample accurately estimated the dimensions of their actual bodies.[21]

3.3. BULIMIA NERVOSA E BINGE EATING DISORDER

Bulimia Nervosa (BN) and Binge Eating Disorder (BED) have lifetime prevalences of 0.63% and 1.53%, respectively. Over the years, the prevalence of BN has increased, while BED has slightly decreased.[3] The preferred treatment for these disorders is Cognitive-Behavioral Therapy (CBT); however, it has been noted that treatment often does not lead to stable long-term results, and second-level treatment is frequently required.[22,23]

Both BN and BED are characterized by compulsive episodes of excessive food intake accompanied by a sensation of loss of control. Therefore, it can be argued that they share a dysfunctional pattern: food addiction.[24] The concept of food addiction is widely discussed in the scientific community, and the inclusion of Pathological Gambling in the DSM-5 as a behavioral addiction has led to further reflections on this topic.[25] Despite some disagreement, many diagnostic criteria for Substance Use Disorder can be compared with those of food addiction. For example, tolerance and withdrawal,[26] or more specifically, craving (intense desire to consume the substance), social and interpersonal problems, and use in risky situations (e.g., eating while driving).[25]

Considering this, some authors (Ferrer Garcia et al.) have demonstrated that Cue Exposure Therapy, aimed at extinguishing anxiety and food craving through exposure to food-related stimuli,[11,12] applied through the use of VR, is more effective in treating BN and BED, especially for patients who have failed first-level treatment with CBT.[22]

Furthermore, food addiction is associated with dysfunction in the reward system, similar to Substance Use Disorder.[27] Specifically, heightened anticipatory activity of the left Dorsolateral Prefrontal Cortex (DLPFC), implicated in inhibition control and reward, has been observed.[28]

Thus, one study proposes an approach that promotes the combination of VR and neurostimulation to act on both the cognitive-behavioral mechanisms and the underlying brain mechanisms of EDs.[24] It suggests integrating repeated

Transcranial Magnetic Stimulation (rTMS) on the DLPFC combined with VR-CET to intervene in food addiction, so that the high frequency of stimulation can enhance cortical activity control.[24]

Finally, another study hypothesizes the possibility of modifying food-related behavioral patterns using VR to study manual interaction with food and its implications in BED symptomatology.[29]

3.4. BODY-RELATED ATTENTIONAL BIAS E BODY IMAGE DISTURBANCES

A central aspect of Eating Disorders (EDs) is body-related attentional biases, defined as the tendency to focus on the least attractive parts of the body, according to one's own perception, rather than other body parts.[4] This suggests that processed body images can be influenced by weight and shape-related schemas, leading to increased negative emotions and dysfunctional behaviors typical of EDs. Moreover, attentional biases are a variable implicated in the formation and maintenance of Body Image Disturbances (BIDs), which are also a central part of EDs symptomatology.[5,30]

These elements fit well within the framework of this review, as there is ample evidence supporting that Virtual Reality (VR) represents an added value to EDs treatments, substantially contributing to the reduction of biases and BIDs.[18,20]

Drawing from the Allocentric Lock Theory,[9,31] it can be hypothesized that body-related memories of individuals suffering from EDs are locked into a mental representation of their body that is no longer updated by perceptual inputs from the external environment, due to BIDs, despite any changes in body weight and shape.[6]

Some studies have utilized VR for the assessment of BIDs, demonstrating that using a virtual environment, where both egocentric and allocentric perspectives were available, allowed for an accurate assessment of BIDs, especially from an allocentric perspective.[6,32] Additionally, a variable that enabled a greater sense of Body Dissatisfaction is the use of a social virtual environment with high body salience.[33]

Another study showed how performing body swapping via VR allowed for embodiment in a virtual body and served as a valuable tool to modify body memory, which was positively updated after VR use.[9] Furthermore, embodiment in a virtual body, or rather, Full Body Illusion (FBI), has also proven effective in treating fear of weight gain as well as reducing BIDs,[18,34] although in the case of AN, this has not always been the case.[21]

Finally, a study analyzed gender differences in body-related attentional biases using VR and ET, revealing that women pay more attention to weight-related body areas, unlike men who focus on other body areas, with preliminary results demonstrating that their attention is more concentrated on muscle-related body zones.[35]

4. DISCUSSION

Virtual Reality (VR) has proven to be a useful tool in the study, assessment, and treatment of EDs.[11,24] VR helps reduce the risk of unforeseen variables and improves data quality.[36] It allows for the creation of natural interactions, facilitating the study of spontaneous behaviors (e.g., movement tracking, eye tracking).[36] It also promotes a sense of presence with greater comfort and control, even in a virtual environment.[36] Furthermore, VR contributes to the assessment of Body Image Disturbances (BIDs)[33] and plays a role in restoring body image,[31] thanks to its ability to create a multisensory body illusion.[34]

These characteristics are central to treatments involving the use of VR in the clinical management of EDs.[12] Specifically, as summarized in Figure 3, VR applications in this context include: (1) VR cue exposure, for reducing food cravings and anxiety responses; (2) the reference frame-shifting approach, for modifying negative body-related memories and reorganizing multisensory integration processes; (3) body illusions, for reducing body-related attentional biases.[12]

In our review, we found no references to protocols that encompass both assessment and treatment for Avoidant/Restrictive Food Intake Disorder (ARFID). This could be attributed to its recent introduction, low prevalence, and the young age of those affected,[1] as well as the lack of general guidelines regarding its treatment.[10] However, this certainly represents a future avenue of research.

From the articles examined, a total lack of guidelines for treatments involving the use of VR emerges, not only for EDs but also for other clinically relevant disorders. This could be due to the great hardware and software heterogeneity and the pioneering status VR still holds. Unlike telepsychotherapy, which has already proven its effectiveness as an alternative treatment in adolescents with EDs, especially during the COVID-19 pandemic.[37] It would be beneficial for the scientific community, through multidisciplinary collaborations, to start developing evidence-based guidelines for the implementation of VR in clinical practice.

Figure 3 provides a summary table of the results.

5. CONCLUSIONS

The intent of this review was to provide a comprehensive overview of the scientific evidence, therapeutic approaches, and outcomes that VR can offer in addressing the core symptoms of EDs in clinical settings.

From the analysis of the articles, the positive influence that VR can have on attitudes towards food, body perception, and eating behaviors emerged. Specifically, promising results have been found regarding the use of VR-Cue Exposure Therapy (VR-CET), Attentional Bias Modification Training (ABMT) combined with VR, and repetitive Transcranial Magnetic Stimulation (rTMS) combined with VR for Anorexia Nervosa (AN), Bulimia Nervosa (BN), and Binge Eating Disorder (BED), as well as for body-related attentional biases and Body Image Disturbances (BIDs).

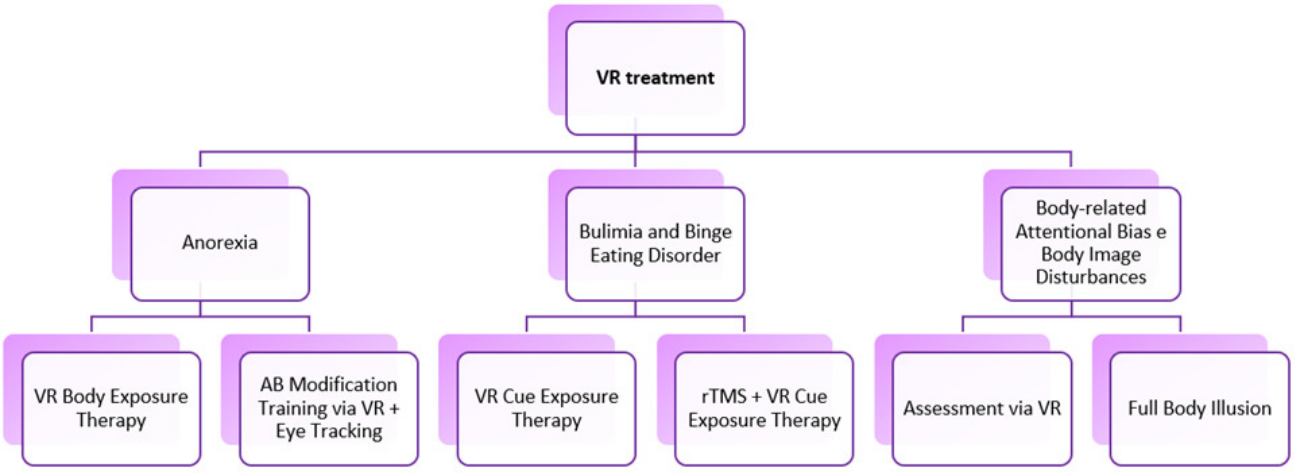

Figure 3. Summary table.

Other lines of research in this area could focus on long-term monitoring of the effects obtained, integration with Artificial Intelligence, and assessing efficacy compared to other forms of treatment.

Further studies are necessary to deepen the understanding of the therapeutic application of VR, including its strengths and limitations. The development of evidence-based guidelines would be beneficial to allow for more standardized comparisons between tools, protocols, and outcomes, promoting an appropriate and ethical use of VR.

AUTHOR CONTRIBUTIONS

Conceptualization, methodology, validation, investigation, data curation, writing—original draft preparation, writing—review and editing, A.F., G.A., G.F., I.V.; conceptualization, methodology, validation, investigation, writing—review and editing, A.F, G.A., G.F., I.V; conceptualization, methodology, data curation, supervision, project administration, P.C.

All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

FURTHER INFORMATION

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SUPPLEMENTARY MATERIALS

Data extraction

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