






# Mixed Reality Technology as a Delivery Mechanism for Psychological Intervention in Adolescents With Asthma: A Qualitative Protocol

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## Abstract

Australia has one of the highest asthma prevalence rates in the world, with this chronic and debilitating condition affecting one in nine people. The health and mental wellbeing of young people with asthma are worse than not only their peers without asthma but also worse than that of people with asthma at other ages. Psychological interventions could be beneficial in treating symptoms of elevated psychological distress in patients with asthma. However, evidence suggests that engagement with mental health services is low in this population. Technology-based solutions that engage youth may overcome barriers to service uptake for both mental health and asthma management. To fast-track the successful translation of evidence-based treatment into practice, interactive, mixed-reality technologies such as augmented reality (AR), virtual reality (VR) and holographic technology may provide a novel, low-cost solution, yet to date, methodological rigor in the evaluation of mixed reality for this purpose is lacking. To evaluate the perceived usability and acceptability of these technologies, mixed reality tools will be developed by the author team to deliver a component of a psychological intervention for treatment of elevated psychological distress among young people with asthma. Qualitative research will be conducted through one-on-one interviews with young people with asthma, parents/caregivers of young people with asthma, and with health professionals, during which participants will have time to interact with the resources. Moderator guides will be used to direct interviews, and will be supplemented with a questionnaire, including Likert-type measures of usability and acceptability to facilitate triangulation of data. Understanding and data obtained through this study will be used to develop version 2.0 mixed reality tools, which will be tested for feasibility in a RCT. Improving access to and uptake of evidence-based treatments for elevated psychological distress in young people with asthma may reduce the burden of this highly prevalent disease.

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## Keywords

asthma, augmented reality, virtual reality, holographic technology, mixed reality, cognitive and behavioral therapy, psychological distress, adolescents

## Background/Study Justification

### *Asthma in Adolescence*

Australia has one of the highest asthma prevalence rates in the world (Global Initiative for Asthma, 2018). This chronic and debilitating condition affecting one in nine people (Australian Institute of Health and Welfare [AIHW], 2020), and is the leading cause of disease burden among young Australians aged 5–14 years (AIHW, 2020). The health and mental wellbeing of young people with asthma are worse than not only their peers without asthma, but also worse than that of people with asthma at other ages (Akinbami & Schoendorf, 2002; Akinbami et al., 2009). A 2014 survey of Australian adolescents and young adults aged 12–25 years (mean age 21.5 years, 80.3% female, 19.7% male) found that 50% of these young people with asthma experienced symptoms of elevated psychological distress. This is double the rate of the general population (Blanchard et al., 2014); a figure that has significantly increased from 18.7% in 2012, to 22.8% in 2016 (Mission Australia, 2017).

### *Asthma and Psychological Distress in Adolescence*

A range of challenges faced by children and adolescents with asthma may contribute to their increased experience of psychological distress, including social isolation, restricted life choices, limitations on personal potential, embarrassment and shame about their condition and/or treatment, self-consciousness, potential mortality threat, and fear of disease exacerbation (Blanchard et al., 2014). These complex, interconnected issues compound the social, psychological, and developmental challenges experienced by people during this life stage (Cohen et al., 2003; de Benedictis & Bush, 2007). This combined symptom profile contributes to higher levels of functional impairment (Akinbami & Schoendorf, 2002), lower quality of life (Goldney et al., 2003), and higher rates of preventable hospitalization and mortality compared to people without asthma (Calmes et al., 1998).

A bidirectional relationship likely exists between asthma and symptoms of psychological distress (Baiardini et al., 2015). Psychological factors and adverse life events exacerbate inflammation and symptoms of asthma (French & Alexander, 1943; Sandberg et al., 2000; Van Lieshout & Macqueen, 2008). Psychological distress may also impact negatively upon self-efficacy and symptom perception and, in turn, upon medication adherence and other health behaviors, including frequency of healthcare utilization (Baiardini et al., 2015). Therefore, psychological interventions may provide young people with techniques and strategies to manage psychological distress and symptoms of asthma as they arise, in order to avoid

exacerbations (Duff, 2001). For example, cognitive and behavioral therapies (CBT) are psychological interventions that treat anxiety disorders (Andrews et al., 2018). These therapies help patients recognize and modify dysfunctional thoughts and behaviors (Andrews et al., 2018). CBT can involve psychoeducation, arousal management, graded exposure, inhibitory control (learning to exert self-control to inhibit habitual behavioral responses), and/or cognitive strategies (Andrews et al., 2018; The Australian Psychological Society, 2018). A 2018 systematic review of five studies found that CBT was beneficial for reducing symptoms of anxiety (as measured by a range of non-diagnostic tools, including the Perceived Stress Scale, Beck Anxiety Inventory, and the State Trait Anxiety Inventory) in adults, particularly when combined with asthma-related education. In children and adolescents with asthma, only two studies were eligible for inclusion, and results were mixed (Pateraki & Morris, 2018). Components of CBT could be beneficial in treating symptoms of anxiety in patients with asthma by providing strategies to promote coping; however, evidence suggests that engagement with treatment is low in this population.

### *Technology for Health Interventions*

Findings from the national youth mental health survey identified that the internet is a leading source of information for youth (Mission Australia, 2017), with a preference for self-help and self-reliance over seeking professional help or help from family and friends (Burns et al., 2016). However, the effectiveness of unguided self-help varies significantly due to the wide range and quality of sources available, as well as retention rates (Andrews et al., 2018). To address these issues, peak bodies are calling for technology-based solutions that can engage youth and address the current barriers to care uptake for both mental health outcomes (Blanchard et al., 2014; Mission Australia, 2017) and asthma management (Blanchard et al., 2014; Levy & Winter, 2015).

Technology-delivered psychological interventions (also known as e-psychology, e-health or e-mental health) refer to psychological interventions delivered via technologies such as smartphone apps, wearable monitoring devices, online resources, and social media (The Royal Australian and New Zealand College of Psychiatrists [RANZCP], 2019). These technologies have potential to be an effective option for mental health support, which may increase access to, and quality of, care (RANZCP, 2019). Technology-delivered interventions have been identified as a key policy/practice initiative as “...evidence-based programs can be delivered en masse at low cost without the need for teacher and clinician training.” (Mission Australia, 2017). Additional benefits of a technological interface include preserved anonymity and an alternative

healthcare delivery option for rural and remote patients (Boydell et al., 2014). Furthermore, the cost of administering interventions such as CBT is high, and research demonstrates that technology-delivered mental health interventions can be cost-effective for both patients and providers (Solomon et al., 2015).

A 2016 meta-analysis found that children and adolescents receiving digital CBT (eCBT) experienced less anxiety than participants in the control condition. Individuals receiving eCBT and minimal therapist care reported lower levels of anxiety than participants in the control (waitlist) condition ( $g = 1.410, p = .008$ ). No significant difference in efficacy between eCBT and face-to-face CBT was identified (Podina et al., 2016). Further research and program development are needed in order to ensure that online programs and interventions are evidence-based and easily accessible to maximize uptake (Mission Australia, 2017). To fast-track successful translation of evidence-based treatment into practice, a new approach is required. Innovative interactive health technology such as augmented reality (AR), virtual reality (VR) and holographic technology, commonly referred to as mixed reality technologies, may provide a novel solution.

### *Mixed Reality for Health Interventions*

Using a smartphone as a viewing device, AR superimposes digital information so that content seems to coexist within the real world (Bacca et al., 2014). VR is an entirely immersive technology that uses a headset for viewing of content, while holographic technology diffracts light into an image that is then projected. These mixed reality technologies are a novel mechanism to deliver evidence-based CBT for young people with elevated psychological distress. By delivering information through videos, graphics and animation, mixed reality technologies can: address low health literacy (Bacca et al., 2014; Kim & Xie, 2017); be tailored for population characteristics; increase engagement in content (Akçayir & Akçayir, 2017); improve geographic reach and accessibility of information (Porter & Heppelmann, 2015); and allow for real-time content updates, thus reducing the evidence to practice gap. Mixed reality resources are cheap to produce due to low-cost development tools and the availability of premade 3D assets that can be purchased and are easily customizable. Available studies (Garzón et al., 2019; Martín-Gutiérrez et al., 2017; Riva et al., 2016) report mixed reality technology to be an increasingly popular education tool given the ability for personalization, and increase motivation to learn as viewers are placed at the centre of the knowledge process. A recent pilot study identified qualitatively that mixed reality technology was consistently rated to be helpful for inhaler technique by patients, health professionals and key-community stakeholders (King et al., 2017).

The evidence-base underpinning mixed reality for the delivery of psychological interventions is lacking. A 2018 meta-review including 25 meta-analyses and systematic and narrative reviews, found that mixed reality tools were effective for delivering behavioral treatment to reduce symptoms of

anxiety disorders, eating and weight disorders, and pain management (Riva et al., 2018). Authors suggest that this is due to the ability for VR technology—like the human brain—to create an embodied simulation of the body in the world; that is, for the user to experience sensory events, and determine the best course of action to deal with those events, creating neural pathways which are activated when the simulated event is experienced in the real world (Riva et al., 2018). A more recent pilot study also found CBT delivered via VR to be feasible for the treatment of symptoms of anxiety in adults with diagnosed generalized social anxiety disorder, with mean scores on the Social Interaction Anxiety Scale decreasing significantly from baseline to follow-up (mean [*SD*] at baseline = 59.9 (8.1), follow-up = 43.1(13.9),  $p = .003$ ; Geraets et al., 2019). Limitations of these studies included high drop-out rates and small sample sizes (Valmaggia et al., 2016).

To date, methodological rigor in the evaluation of mixed reality technologies is lacking (Bacca et al., 2014). To overcome previous limitations, this research will examine acceptability of mixed reality technologies as a CBT delivery mechanism to manage symptoms of elevated psychological distress among young people with asthma.

### **Aims**

Explore the feasibility of mixed reality tools to aid the delivery of CBT to manage symptoms of elevated psychological distress among young people with asthma, aged 13 to 17 years. This will be achieved through two stages:

1. Develop mixed reality-enabled CBT resources, and
2. Explore the acceptability and usability of these CBT resources for use by youth (13–17 years), their guardians and health professionals.

### **Explanation and Justification of Method**

This project will utilize a qualitative action research framework, in which researchers and patients work collaboratively to explore and address healthcare topics which may be sensitive (Pope & Mays, 2006a; Malterud, 2001).

Moderator guides will direct evaluation of the tools via qualitative research (interviews), developed based on 18 categories of the theoretical domains framework (TDF; McCullough et al., 2015), the Theoretical Framework of Acceptability (TFA; Sekhon et al., 2017) and the Enlight protocol (Baumel et al., 2017). The TDF will help frame the data through a policy lens to allow for translation of evidence to policy and practice. The TFA comprises seven constructs reflecting the multi-faceted nature of acceptability, incorporating both anticipated and experienced thoughts, beliefs and feelings regarding the intervention (Pavlova et al., 2020; Sekhon et al., 2017). Previous research demonstrates more robust understandings of acceptability when a framework is applied, compared with no framework (Murphy & Gardner, 2019; Pavlova et al., 2020; Sekhon et al., 2017). The Enlight protocol is

an evaluation tool for eHealth interventions (Baumel et al., 2017). Qualitative interviews will be supplemented with a questionnaire, including self-reported measures of acceptability and usability to facilitate triangulation of data.

## Method

### *Aim 1: Development of Mixed Reality Resources*

Mixed reality tools will be developed by the experienced author team. These will be based on needs assessment of the biopsychosocial needs of adolescents with asthma, coupled with information gained through consultation with key stakeholders (health professionals, experts in design and technology). One AR resource, one VR resource, and one holographic resource will be evaluated. Three different technologies have been chosen for hypothesis-generating purposes to establish if one mechanism is superior to others, which can be a focus in future research.

### *Aim 2: Evaluation of Mixed Reality Resources—Qualitative Research*

To determine facilitators and barriers for the use of each mixed reality tool as well as evaluating perceptions of usability and appropriateness to reach the target audience, qualitative research will be carried out through one-on-one interviews.

During the interviews, participants will be allocated time to interact with the mixed reality resources. Semistructured moderator guides will be used to direct interviews with  $n = 10$  young people,  $n = 10$  parents, and  $n = 10$  health professionals, including general paediatricians, psychologists, psychiatrists, nursing staff and pediatric respiratory specialists. Interviews will run for approximately one hour, and will take place in meeting spaces in the respiratory department at two large, teaching hospitals in metropolitan Adelaide, South Australia, or online via Zoom software. Sessions will be audio-recorded, and verbatim transcripts will be sent back to the participant for validation post interview.

## Sampling/Recruitment

Thirty participants will be recruited for this study from participating hospitals, including 10 young people with asthma, 10 parents of young people with asthma, and 10 health professionals. Participants will be identified through Respiratory Department inpatient and outpatient lists at the Women's and Children's Hospital and the Paediatric Department' Flinders Medical Centre, and via flyers and radio/television news stories advertising the project. Health professionals will be recruited through flyers advertising the project, as well as through presentations by project staff, facilitated by the Department Head. Purposive sampling will be utilized to ensure a good representation of participant characteristics to meet the requirements of the research question.

Hospital staff will provide potential participants with a copy of the participant information sheet and consent form for their

review, and research staff will follow up with interested individuals for screening and consenting procedures.

*Justification of the sample size:* While previous studies often referred to "saturation" to justify sample size in qualitative research, this is a problematic approach, as saturation point may be different for any given research project (Sim et al., 2018). Another common approach is applying "Rules of thumb," based on methodological considerations and past experiences with similar studies. Sim et al collated some of these recommendations, which included "a broad range of between a dozen and 60, with 30 being the mean" (Adler & Adler, 2012), "20-30 informants" (Creswell & Poth, 2016), "20-30 interviews (Marshall et al., 2013), "at least 5 one-hour interviews for theoretical saturation" (Corbin & Strauss, 2014). Though a priori determination of sample size is an imperfect approach, these rules of thumb are similar to sample sizes used in other qualitative feasibility studies (Anderson et al., 2016; Arden-Close et al., 2013; Duncan et al., 2018; Rhee et al., 2014), based on the extensive experience of the research team, the sample size chosen is anticipated to be appropriate for the project timeline.

*Inclusion criteria for young people:* Young people will be eligible for inclusion in this study if they are aged between 13 and 17 years; have been formally diagnosed with asthma by a health professional (inpatients or outpatients); have experienced or are currently experiencing elevated symptoms of psychological distress determined by the K10+ scale (Kessler et al., 2002), have access to a smartphone with the owner's permission to use it during the interview; are English speaking/able to understand written English.

*Inclusion criteria for caregivers/parents:* Participants will be eligible for inclusion in this study if they are the caregiver/parent of a child with asthma (aged 13–17 years) where the child currently has/or has reported in the past elevated symptoms of psychological distress (does not need to be the parent/caregiver of a child actively participating in this study); have access to a smartphone and able to use smartphone technology (basic level); are English speaking/able to understand written English.

*Inclusion criteria for health professionals:* Health professionals will be eligible for inclusion in this study if they have been practicing in their respective fields for at least 12-months; have access to a smartphone and can use smartphone technology (basic level); are English speaking/able to understand written English.

*Exclusion criteria:* Participants with an intellectual disability or cognitive impairment that would inhibit their ability to provide informed consent and participate in the project will be ineligible to participate. Young people with a history of epilepsy or other contraindication for the use of VR will also be ineligible to participate.

## Data Handling/Analysis

Qualitative data will be coded using three pre-specified lenses to enable insight into different aspects of the mixed reality

interventions—the TDF, the TFA, and the Enlight protocol. Transcripts will be coded by two independent researchers, with discrepancies resolved through discussion and consensus. Analysis of the questionnaire data will be descriptive, with counts and percentages for categorical data, and means and standard deviations for continuous data. Missing information from quantitative scales and surveys will be accounted for through random imputation.

Based on qualitative feedback mixed reality resources will be improved (version 2.0) for use in future feasibility studies.

Upon completion of the project, data will be synthesized for use in publications and conferences. Reports will be provided to participants and relevant consumer stakeholders, as well as funding bodies as per requirements. All ethical reporting procedures will be followed.

## Ethical and Legal Aspects

- *Confidentiality and security of data:* All data will be de-identified. De-identified data will not be stored in the same place as identified data (e.g. names, contact numbers). Hard copies will be stored in a locked filing cabinet at the South Australian Health and Medical Research Institute (SAHMRI). Electronic files will be stored in a password-protected folder on the secure University of South Australia network. It will be stored for seven years in accordance with responsible research guidelines.
- *Anonymity:* As sessions will be audio-recorded, participants will be able to choose a name to be used throughout the interview if they do not wish to use their real name.
- *Informed consent:* Screening will be conducted by clinical staff who will provide potential participants with a copy of the participant information sheet and consent form for their review, not research personnel. Participants will only be approached by research staff once written consent has been provided to say that they are willing to discuss the project more with research staff, in order to undertake informed consenting procedures. Participants under the age of 18 will need to obtain consent from a parent or guardian. Participants who are unable to communicate effectively in English will be excluded from the study.
- *Protection of participants' safety, emotional and psychological security and wellbeing:* All staff interacting with young people will obtain a Working with Children Check through the SA government. Participants will have access to a trained clinical psychologist and/or pediatrician if they require additional support. The study will be undertaken using a semistructured moderator guide with questions formulated to reduce the risk of safety, emotional and psychological security concerns. A Clinical Psychologist will be available to participants on request and this will be made clear to participants at the beginning of the interviews. Moreover, participants

will be made aware that they can stop participating at any time and will be able to talk with a health professional if needed during the interview.

- *Risks of technology:* Dizziness and nausea are possible side-effects which can occur when using the VR headsets. Participants will be informed of this possibility before interacting with the devices and will be encouraged to take breaks as needed throughout the session.

## Rigor

*Dependability:* Interviews will be audio-recorded, and verbatim transcripts will be sent back to the participant for validation post-interview.

*Credibility:* To facilitate data triangulation, interviews will be supplemented with Likert scales—both validated scales and those specific to the research project—within a questionnaire. Data from participants will be compared with the Likert scale responses, adding depth and support to the interpretation of qualitative responses during interviews (Pope & Mays, 2006b).

Furthermore, the moderator guides have been developed using headings aligned with the TDF, TFA, and Enlight protocols, and data will be coded using these frameworks. This includes once under the TDF to aid knowledge translation potential (McCullough et al., 2015), again under the TFA to evaluate acceptability of the mixed reality intervention as a method to deliver CBT to young people with asthma, and once using Enlight domains to evaluate quality and therapeutic potential for the intervention.

Finally, the project proposal has undergone independent peer review through the Channel 7 Children's Research Foundation grant submission process. The proposal passed the initial EOI (expression of interest) stage where peer review comments were obtained that allowed for tailoring of the full application. The full application was submitted and approved for funding by the Channel 7 Children's Research Foundation.

*Transferability:* By using three groups of participants (young people with asthma, parents/caregivers of young people with asthma, and health professionals), the relevance and credibility of results are more likely to reflect the broader asthma community.

## Authors' Note

The study is registered with the Australia and New Zealand Clinical Trials Registry (ANZCTR): ACTRN12620001109998.

## Ethics Approval

This project is conducted in accordance with the principles of the Declaration of Helsinki (World Medical Association, 2013) and has received ethical approval by the Human Research Ethics Committee for the Women's and Children's Health Network (HREC/18/WCHN/172), and the University of South Australia Ethics Committee (Application ID: 201967).


## Declaration of Conflicting Interests


The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article: The authors report no declarations of interest.


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