Clinical Ophthalmology

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ORIGINAL RESEARCH

Effects of Background Music and Multimedia Exposure on Patient-Reported Anxiety in Ophthalmology Waiting Rooms: A Quasi-Experimental Study

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Purpose: To evaluate the impact of waiting room media interventions on patient-reported anxiety, satisfaction, and perceived helpfulness in a high-volume tertiary-care ophthalmology clinic.

Patients and Methods: This is a single-center, prospective quasi-experimental quality improvement study performed at a teaching hospital clinic. Three waiting room environments were implemented using a pseudo-randomized day-of-week allocation: (1) No Media, (2) Music Only (instrumental jazz/piano, 40–70 dB), and (3) Multimedia (slow-moving ocean and aquatic nature footage accompanied by background music). Each group was assigned 125 participants. Anxiety, satisfaction, and perceived helpfulness were measured using 0–10 visual analogue scales. Outcomes were compared using one-way analysis of variance (ANOVA) with post hoc testing and Welch's *t*-tests where appropriate.

Results: In total there were 375 participants, with no dropouts. Anxiety scores differed significantly across waiting room environments ($F(2372)=19.09$, $P<0.001$). Both Music Only (mean 3.59) and Multimedia (mean 3.74) significantly reduced anxiety compared with No Media (mean 5.69; mean difference 2.10, 95% CI 1.34–2.86, $P<0.001$ and mean difference 1.94, 95% CI 1.18–2.70, $P<0.001$, respectively). Multimedia yielded significantly higher satisfaction scores than No Media ($P=0.023$) and Music Only ($P=0.041$). Multimedia was also rated significantly more helpful than Music Only (mean difference 1.03, 95% CI 0.42–1.65, $P=0.001$).

Conclusion: Low-cost sensory interventions significantly reduce patient anxiety in ophthalmology waiting rooms. While background music alone is sufficient for anxiolysis, multimedia environments provide additional benefits in satisfaction and perceived helpfulness. Benefits were particularly pronounced in emergent-care patients, highlighting the utility of these interventions in high-anxiety clinical scenarios. These findings support the implementation of scalable, low-resource strategies to improve patient experience in busy outpatient ophthalmology settings.

Keywords: patient experience, sensory environment, background music, audiovisual stimulation, outpatient care

Introduction

Prolonged wait times in ophthalmology clinics have been associated with patient anxiety and dissatisfaction, with potential implications for psychological well-being and treatment adherence.[1,2] In Canada's high-volume, resource-constrained eye centers, patients frequently experience wait times of one to four hours with minimal environmental engagement, which may further contribute to patient stress.[3] Notably, perceived wait time may predict patient dissatisfaction more strongly than actual wait duration, and environmental interventions that engage patients may reduce perceived wait time independent of clock time.[4,5] Despite increasing recognition in the literature of the psychological burden that healthcare environments impose on patients, few studies have systematically examined how environmental

https://doi.org/10.2147/OPTH.S597269
Received: 19 January 2026
Accepted: 4 May 2026
Published: 12 May 2026

interventions, specifically waiting room media content, can mitigate anxiety and improve satisfaction in ophthalmologic care settings.

A growing body of evidence supports the use of non-clinical environmental interventions such as background music, interactive media, nature imagery, and evidence-based environmental design to improve the patient experience in clinical waiting areas.[5–8] Systematic reviews and meta-analyses have demonstrated that background music can significantly reduce state anxiety and blood pressure in adults awaiting ophthalmic procedures, including surgery, with self-selected music yielding the most consistent effects.[9,10] Randomized controlled trials further support the use of interactive media and nature-based visual stimuli to reduce anxiety and improve satisfaction in both pediatric and adult populations.[6,7,11] Environmental design principles that enhance perceived pleasantness and social support have also been shown to mitigate anxiety in hospital settings.[8]

Conversely, environments lacking positive sensory input, or featuring negative or neutral content, such as news programming, may increase patient anxiety and reduce perceived empathy from care providers.[5,12,13] Video-based media interventions in ophthalmology have been associated with improved patient understanding and satisfaction, suggesting potential utility in enhancing both emotional well-being and engagement during care.[14] Specific to ophthalmology, varying degrees of visual impairment among patients may differentially influence engagement with visual components of waiting room interventions, representing a unique contextual consideration.

Despite these findings, there remains a paucity of ophthalmology-specific quality improvement (QI) studies evaluating the effects of waiting room interventions on patient outcomes. Unlike large-scale infrastructural redesign, audiovisual waiting room interventions can be implemented at minimal or no additional cost in clinics already equipped with standard audiovisual infrastructure, representing a scalable and resource-efficient strategy for improving patient experience. To address this gap, we conducted a prospective QI evaluation of three waiting room environments: no media, music only, and calming multimedia (music plus video), implemented using a pseudo-randomized day-of-week allocation within a Canadian tertiary-care ophthalmology clinic. This study examines the impact of these environments on patient-reported anxiety, satisfaction, and perceived helpfulness.

By situating this initiative within the existing evidence base and an applied clinical setting, this work aims to advance patient-centered care and highlight cost-effective environmental strategies that may enhance the waiting room experience in high-volume eye care clinics.

Materials and Methods

Study Design and Setting

This single-center, prospective quasi-experimental, non-randomized, between-group comparative study was conducted within a quality improvement framework in the outpatient ophthalmology clinic of a Canadian tertiary-care hospital. The project evaluated the impact of different waiting room media environments on patient-reported anxiety, satisfaction, and perceived helpfulness. Data collection occurred across 60 designated clinic days between January and November 2025, with each study condition (No Media, Music Only, and Multimedia) implemented on 20 clinic days. Each participant was exposed to their assigned condition on a single clinic visit, with no tasks or activities assigned between visits. Individual exposure duration was not recorded as patient wait times were not measured. Data were collected in both the urgent-care ophthalmology waiting area and the general outpatient ophthalmology waiting room. The study received approval from the University of Alberta Health Research Ethics Board–Health Panel (Pro00147934) and was conducted in accordance with the Declaration of Helsinki.

Intervention Design

Three waiting room environments were implemented using a pseudo-randomized day-of-week allocation. Each study day was pre-assigned to one of three conditions; this schedule was repeated throughout the study period so that clinic flow and staffing patterns were balanced across conditions. All audio and video content were sourced from publicly available royalty-free platforms. Interventions were delivered simultaneously to all patients present in the waiting area, constituting a naturalistic group setting with variable group size depending on clinic volume. The environments were:

(1) No Media (Control): No music or video content.

(2) Music Only: Continuous low-volume instrumental background music consisting of classical piano and jazz selections chosen by the research team from a publicly available YouTube "calming music" playlist. The selections were characterized by a slow-to-moderate tempo range (approximately 60–100 bpm), predominantly major-key tonality, and gentle rhythmic patterning. Music was intentionally non-lyrical and neutral in tone to minimize distraction or irritation. Volume was maintained at an estimated range of approximately 40–70 dB, comparable to normal conversational sound levels, and did not interfere with routine clinic communication. This range was achieved by setting the speaker system to a corresponding level; formal measurement with a dedicated sound level meter was not performed.

(3) Multimedia (Music + Video): The same background music described above, accompanied by visual content displayed on wall-mounted television screens. Video content consisted primarily of slow-moving ocean and aquatic animal footage with ambient natural sound, selected for its neutral, non-stimulating nature and broad accessibility.

Music was streamed via a desktop computer connected to the clinic's existing audiovisual (AV) system and delivered through pre-existing in-ceiling speakers in the waiting area, initiated by a research team member at the start of each clinic day. For the Multimedia condition, the same AV system was used to display visual content on wall-mounted television screens. All equipment used was pre-existing clinic infrastructure, and no additional financial resources were required to implement the intervention.

The music intervention strategy consisted of passive receptive music listening, with no active participant engagement required. No credentialed music interventionist was involved; music playback was initiated and monitored by research team members as part of routine study procedures.

Instrumental jazz and piano music was selected because non-lyrical, slow-to-moderate tempo music (60–100 bpm) with consonant harmony and smooth dynamic transitions has been associated with reduced physiologic arousal, including enhanced parasympathetic activity and lower cortisol levels, in adults awaiting medical procedures.[15–17] These acoustic features, including harmonic predictability, moderate tempo, and gentle auditory stimulation, were expected to promote relaxation while maintaining a calming, low-burden background environment.[15,16,18] Together, these characteristics supported the use of instrumental jazz and piano as an evidence-informed intervention to reduce anticipatory anxiety in the ophthalmology waiting room.

Intervention fidelity was supported by daily verification by clinic staff, who confirmed the correct condition, playlist or video content, and volume level (40–70 dB) were active at the start of each clinic day. Condition allocation was tracked prospectively in the study dataset.

Music intervention reporting followed the Reporting Guidelines for Music-based Interventions (Supplementary Table 1).[19]

Participants and Inclusion/Exclusion Criteria

All patients in either waiting area during data collection periods were eligible. Exclusion criteria were inability to provide informed consent, cognitive impairment, marked acute distress requiring immediate clinical attention, or language barriers precluding survey completion. Participation was voluntary and anonymous, with no identifying information collected.

While visual acuity was not formally assessed, study participation was limited to individuals who could independently complete the written survey instruments. This requirement served as a proxy for sufficient functional vision, ensuring participants could adequately perceive and engage with the waiting room visual displays.

Survey Instruments and Measures

All outcomes were measured using horizontal visual analogue scales (VAS), scored from 0 to 10. Satisfaction was anchored from "completely dissatisfied" (0) to "completely satisfied" (10). Anxiety was anchored from "completely relaxed" (0) to "extremely anxious" (10). For the Music Only and Multimedia conditions, perceived helpfulness was rated on a VAS anchored from "completely unhelpful" (0) to "extremely helpful" (10). Space was provided for optional free-text comments; however, qualitative responses were not analyzed for this report. The complete survey instrument is provided in Appendix Figure 1.

Statistical Analysis

Prior to analysis, normality of outcome variables was assessed using the Shapiro–Wilk test and visual inspection of Q-Q plots (Appendix Figure 2). No significant departures from normality were detected, supporting the use of parametric tests including one-way analysis of variance (ANOVA) and Welch's *t*-test. Descriptive statistics summarized demographic variables and outcome scores. Baseline comparability of the three waiting room environments with respect to age distribution and visit urgency (emergent vs. non-emergent) was assessed using Pearson's chi-square tests of independence. In the total sample, one-way ANOVA compared anxiety and satisfaction scores across the three conditions, followed by Tukey HSD post hoc tests. Perceived helpfulness (measured only in the Music Only and Multimedia groups) was compared using Welch's *t*-test. Subgroup analyses repeated these comparisons within emergent/non-emergent strata, and age-stratified analyses repeated them within age categories. Effect sizes were reported as eta-squared (η^2) for ANOVAs and Cohen's d for *t*-tests. Two-sided p-values <0.05 were considered statistically significant. Analyses were performed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and Python (Python Software Foundation, Wilmington, DE, USA) with SciPy and Pandas libraries.

Study reporting followed the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guidelines (Supplementary Table 2).[20]

Results

Participant Characteristics and Baseline Comparisons

The final sample included 375 participants (n = 125 per condition). The pseudo-randomized allocation yielded balanced groups with no significant baseline differences in age distribution ($\chi^2(12) = 20.46$, $p = 0.059$) or visit urgency (emergent vs. non-emergent; $\chi^2(2) = 2.47$, $p = 0.291$). Descriptive statistics, including mean anxiety, satisfaction, and perceived helpfulness scores for each waiting room condition, are summarized in Table 1.

Satisfaction, Anxiety and Perceived Helpfulness Outcomes in the Total Sample

Anxiety scores differed significantly across environments ($F(2, 372) = 19.09$, $p < 0.001$). Both Music Only and Multimedia conditions significantly reduced anxiety compared with No Media, with no significant difference between the two active interventions (Figure 1A and Table 2). However, Multimedia produced significantly higher satisfaction scores than both No Media ($p = 0.023$) and Music Only ($p = 0.041$) (Figure 1B). Although satisfaction differences reached statistical significance, effect sizes were small (Cohen's d = 0.31–0.33), warranting conservative interpretation of their clinical significance. Multimedia was also rated as significantly more helpful than Music Only ($t(248) = 3.30$, $p = 0.001$; Figure 1C and Table 1).

Emergent vs. Non-Emergent Subgroup Findings

Among emergent patients (n = 79), anxiety differed significantly across environments (p <0.001; Table 3). Both Multimedia (p <0.001) and Music Only (p =0.014) significantly reduced anxiety compared with No Media, with a trend towards greater anxiety reduction in the Multimedia condition compared with Music Only ($p = 0.050$).

Table 1 Descriptive Statistics by Condition (Total Sample Size N = 375)

Waiting Room Environment	n	Anxiety Score (Mean ± SD)	Satisfaction Score (Mean ± SD)	Perceived Helpfulness (Score Mean ± SD)
No Media (Control)	125	5.69 ± 3.16	8.03 ± 2.27	—
Multimedia (Music and Video)	125	3.74 ± 2.94	8.72 ± 1.65	7.36 ± 2.49
Music Only	125	3.59 ± 2.89	8.09 ± 2.17	6.33 ± 2.46

Notes: Perceived Helpfulness was only measured for Media conditions.
Abbreviation: SD, Standard Deviation.

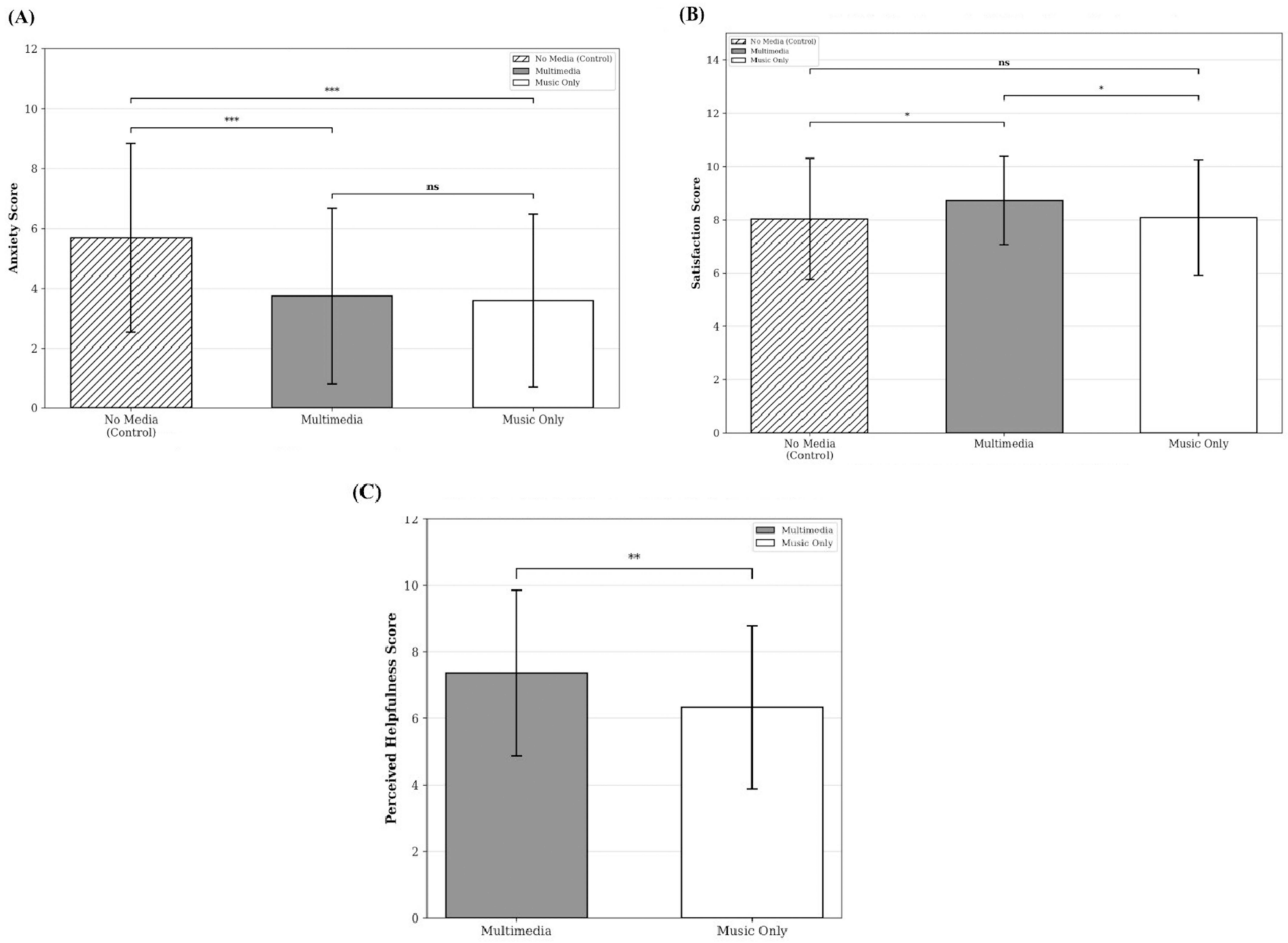

Figure 1 Impact of Waiting Room Environment on Patient Outcomes. (**A**) Mean anxiety scores by waiting room condition (N=375). Both Music Only and Multimedia conditions significantly reduced anxiety compared with No Media control. (**B**) Mean patient satisfaction scores (N=375). The Multimedia condition showed higher ratings than both comparator conditions. (**C**) Mean perceived helpfulness ratings (n=250). Multimedia was rated significantly more helpful than Music Only. Error bars represent ±1 SD. Significance indicated by brackets: *p <0.05, **p <0.01, ***p <0.001, ns = not significant.

Multimedia also produced the highest satisfaction, significantly exceeding both No Media (p =0.020) and Music Only (p =0.034). For perceived helpfulness, Multimedia achieved a mean score of (7.20 ± 2.41) compared with (6.03 ± 1.99) in the Music Only group, though this difference did not reach statistical significance (p =0.060).

Table 2 Inferential Statistics for Anxiety, Satisfaction, and Helpfulness Across Waiting Room Environments (Total Sample N=375)

Outcome/Comparison	F/t	df	p-value	Effect size (η^2 or d)	Sig
Anxiety Score (ANOVA)	19.09	2, 372	<0.001	η^2=.09	***
No Media vs Multimedia	—	—	<0.001	d= 0.65	***
No Media vs Music Only	—	—	<0.001	d= 0.70	***
Multimedia vs Music Only	—	—	0.914	d= 0.05	ns
Satisfaction Score (ANOVA)	4.32	2, 372	0.014	η^2=.02	*

(*Continued*)

https://doi.org/10.2147/OPTH.S597269

Table 2 (Continued).

Outcome/Comparison	F/t	df	p-value	Effect size (η^2 or d)	Sig
No Media vs Multimedia	—	—	0.023	d= 0.33	*
No Media vs Music Only	—	—	0.977	d = 0.03	ns
Multimedia vs Music Only	—	—	0.041	d= 0.31	*
Perceived Helpfulness (Welch *t*-test)	3.30	248	0.001	d= 0.42	**

Note: * p <0.05, ** p <0.01, *** p <0.001.
Abbreviations: η^2, eta-squared (for ANOVAs); d, Cohen's d (for pairwise comparisons and *t*-test); ns, not significant.

Table 3 Summary of Outcome Measures by Visit Urgency

Visit Type	n	Anxiety	Satisfaction	Perceived Helpfulness
Emergent	79	Sig (p <0.001, η^2 =0.22)	Sig (p =0.013, η^2 =0.11)	NS (p =0.060, d = 0.54)
Non-Emergent	296	Sig (p <0.001, η^2 =0.09)	NS (p =0.208, η^2 =0.01)	Sig (p =0.009, d = 0.38)

Notes: Perceived Helpfulness compared Multimedia vs. Music Only conditions only.
Abbreviations: Sig, Statistically significant; NS, Not significant; η^2, eta-squared (for ANOVAs); d, Cohen's d (for *t*-tests).

In the non-emergent subgroup (n = 296), anxiety scores differed significantly across environments (p <0.001; Table 3). Both Music Only and Multimedia significantly reduced anxiety compared to No Media (p <0.01), but did not differ significantly from each other (p =0.334). Satisfaction scores showed no significant variation across conditions (p =0.208). However, for perceived helpfulness, mean scores were significantly higher for Multimedia (7.40 ± 2.52) than Music Only (6.43 ± 2.59; p =0.009).

Age-Stratified Analyses

No significant differences were found for any outcome in the 18–24 or 35–44 age groups (Figure 2). The Under 18 age group was excluded due to insufficient sample size (n = 1 for Music Only).

In the 25–34 age group, anxiety scores differed significantly (p =0.007; Figure 2). The No Media condition produced significantly higher anxiety than both Multimedia (p =0.047) and Music Only (p =0.008). Satisfaction (p =0.366) and perceived helpfulness (p =0.658) did not differ significantly across conditions.

In the 45–54 age group, anxiety scores varied significantly (p =0.018). No Media produced higher anxiety than Music Only (p =0.014), while the difference with Multimedia was not significant (p =0.072). Satisfaction (p =0.603) and perceived helpfulness (p =0.571) showed no significant differences.

In the 55–64 age group, anxiety scores once again differed significantly (p =0.010). No Media produced higher anxiety than Music Only (p =0.009), while the comparison with Multimedia was not significant (p =0.080). Moreover, satisfaction (p =0.142) and perceived helpfulness (p =0.053) did not differ significantly across conditions.

In the 65+ age group (the largest-age subgroup n=143), anxiety scores differed significantly across environments (p =0.004). Both Multimedia, (p =0.007), and Music Only, p =0.022, produced significantly lower anxiety than No Media, while the two treatment conditions did not differ significantly (p =0.988). While satisfaction did not differ significantly (p =0.522), perceived helpfulness was rated significantly higher in the Multimedia condition with a mean score of (7.94 ± 2.26) compared to the Music Only group (6.73 ± 2.61; p =0.024).

As subgroup analyses were conducted without correction for multiple comparisons, these findings should be considered exploratory rather than confirmatory, and interpreted alongside the primary results.

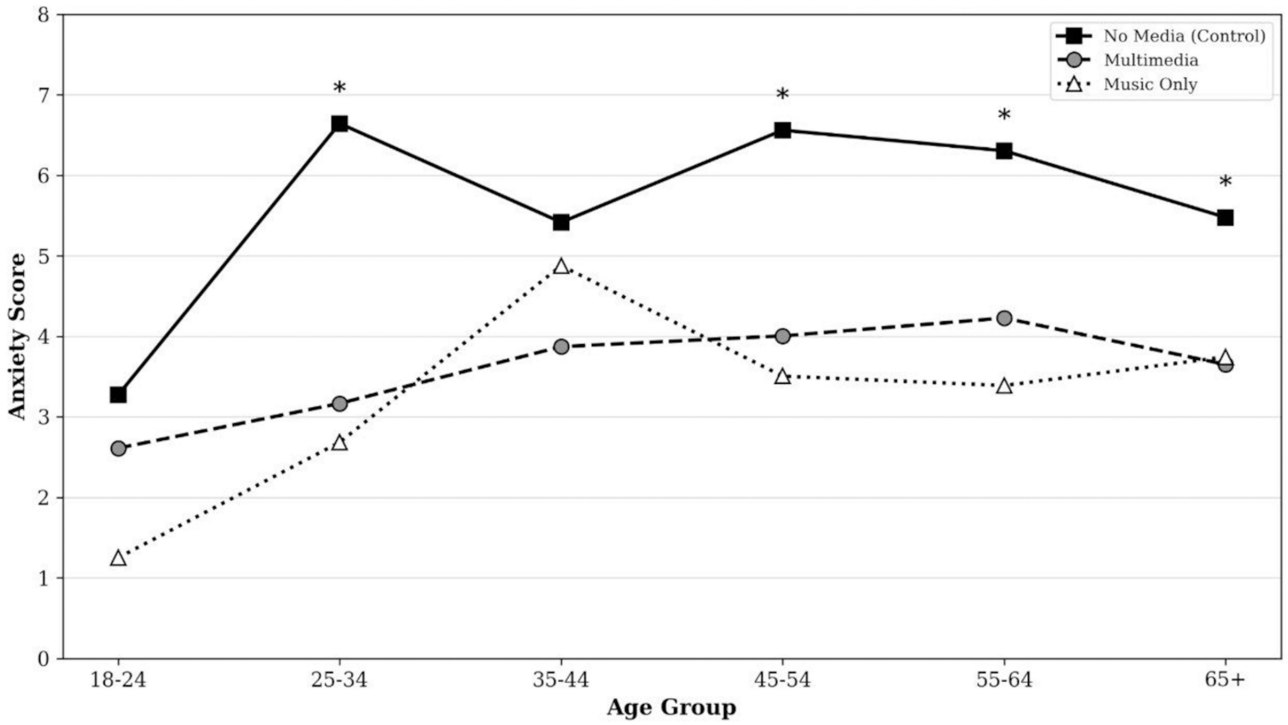

Figure 2 Anxiety Scores by Condition Across Age Groups. Mean anxiety scores plotted across age strata. The No Media condition (solid line) consistently demonstrates higher anxiety than both intervention groups across most age categories, with statistically significant differences observed at ages 25–34, 45–64, and ≥65 years (*indicates $p < 0.05$).

Discussion

This quality improvement study evaluated the impact of three waiting room environments, No Media, Music Only, and Multimedia, on patient-reported anxiety, satisfaction, and perceived helpfulness in a tertiary-care ophthalmology clinic. Across the total sample, both Music Only and Multimedia environments were associated with significantly lower anxiety compared with the no-media condition, suggesting that low-cost sensory interventions may improve the patient experience in high-volume ophthalmology clinics. These findings are consistent with evidence from systematic reviews and randomized trials suggesting that music- and multimedia-based environmental modifications may reduce pre-procedural anxiety and improve satisfaction across medical contexts, including ophthalmology.[9,10,21]

The significant reduction in anxiety observed in both Music Only and Multimedia groups aligns with prior research suggesting that background music may decrease physiological arousal, reduce sympathetic activity, and improve subjective anxiety in perioperative ophthalmic care.[9,10,21–23] Meta-analyses have also reported improvements in heart rate, blood pressure, and subjective stress levels in response to music during cataract surgery and other outpatient procedures.[9,10,24–26] The absence of a significant difference in anxiety reduction between the two active interventions suggests that auditory input alone may have contributed substantially to the observed anxiolytic effect. The anxiolytic effects observed in both active conditions are consistent with neurobiological evidence that relaxing music modulates the hypothalamic-pituitary-adrenal axis, reduces cortisol secretion, enhances parasympathetic tone, and engages dopaminergic and endogenous opioid pathways associated with reward and emotional regulation.[27] Importantly, these neurobiological effects are not universal to all music, as anxiolysis is more reliably associated with music perceived as relaxing, which varies considerably across individuals.[26,28] By contrast, visual content appears to enhance experiential aspects of care such as comfort and engagement, reflected in higher satisfaction and perceived helpfulness rather than further anxiolysis. Although participants required sufficient vision to independently complete written surveys, the anxiolytic effect of music alone suggests auditory interventions may benefit patients with limited visual engagement, including those with reduced visual acuity.

Despite similar anxiety outcomes, the Multimedia condition was associated with higher ratings of satisfaction and perceived helpfulness.[7,8,29] Satisfaction reflects broader experiential dimensions of care, including environmental

https://doi.org/10.2147/OPTH.S597269

comfort, perceived intentionality of the waiting room design, and overall clinic atmosphere, which may be more sensitive to visual engagement than anxiety alone.[6,7,21] Prior research on healthcare waiting areas suggests that visual stimuli, particularly nature imagery, animals, and neutral or positive video content, may enhance satisfaction even when anxiety levels remain unchanged.[7,8,12,13,30,31] The present findings are consistent with this distinction, suggesting that multimedia content may support a more engaging and supportive waiting room environment.[7,8,32,33] Given the cultural diversity of Canadian urban populations, the standardized selection of instrumental jazz and piano music and nature-based visual content, although informed by prior literature, may not have been equally effective for all patients.[15–17] Because responses to music are shaped by cultural background and personal experience, more preference-sensitive and culturally inclusive content selection may improve engagement and enhance the effectiveness of these interventions.[34,35]

The interventions were associated with improvements in anxiety, satisfaction, and perceived helpfulness, suggesting that music and multimedia may enhance engagement during waiting. Although perceived wait duration was not measured, greater engagement may plausibly reduce perceived wait time, as qualitative research identifies diversion as a key strategy for improving the wait experience.[36] This added benefit may be particularly relevant in high-volume clinics where long waits are common.

Among emergent-care patients (n = 79), Multimedia was associated with the greatest reductions in anxiety and the highest satisfaction scores. Patients presenting for urgent ophthalmic evaluation often experience heightened anxiety due to acute symptoms, diagnostic uncertainty, or fear of vision loss.[29,37–41] Literature suggests that individuals with higher baseline anxiety derive greater benefit from non-pharmacological sensory interventions.[21,40,42] Thus, the observed pattern in this subgroup suggests that multimedia environments may be useful for mitigating situational distress when patients are most vulnerable.[40,43,44]

Non-emergent patients demonstrated similar anxiety reductions across both active interventions but continued to rate Multimedia as more helpful. This suggests that while music may address core emotional distress, visual content may enhance perceived value and patient-centeredness even when baseline anxiety is lower. In a QI context, this distinction is meaningful: satisfaction and perceived helpfulness are strongly tied to patient experience metrics that influence clinic reputation, return visits, and overall engagement.[1,45,46]

Age-based analyses showed that older adults, particularly those 65 and older, experienced consistent benefit across anxiety, satisfaction, and perceived helpfulness outcomes. This trend is notable given that the majority of outpatient ophthalmology patients fall within older age groups and often face longer, more frequent clinic visits due to chronic eye conditions.[9,10,47,48] Studies have shown that older adults respond well to background music and non-pharmacological anxiety interventions.[9,10] The stronger perceived helpfulness ratings for Multimedia in this age group potentially reflect increased appreciation for structured, engaging environments that reduce monotony and improve comfort during prolonged waits.[9,48,49]

Moreover, younger age groups showed more variable results, likely due to smaller sample sizes and generally lower baseline anxiety. However, the consistent directional trends across age groups suggest that sensory interventions may be broadly acceptable and supportive across the ophthalmic patient population.

Quality Improvement Implications

This study provides applied clinical evidence that relatively simple waiting room enhancements may improve the patient experience in ophthalmology clinics, where prolonged wait times are common due to high patient volume and complex workflows. Unlike infrastructural redesign, audiovisual interventions are relatively low cost, scalable, and feasible to implement without major disruption to clinical operations. The pseudo-randomized day-of-week allocation used in this study also supports the feasibility of quality improvement testing in busy outpatient environments.

From a practical quality improvement standpoint, these findings support a context-dependent implementation approach, in which interventions may be applied in a tiered manner based on patient acuity and population needs:

- Music as an effective baseline intervention for anxiety reduction.
- Multimedia adds an incremental benefit for satisfaction and perceived helpfulness.
- Prioritization of multimedia in emergent-care or high-anxiety settings.
- Tailoring content for older adults, who report the strongest overall experience improvement.

From a cost-effectiveness standpoint, background music alone represents the most resource-efficient option for anxiety reduction, requiring only existing audio infrastructure at no additional cost. In settings where wall-mounted screens are already available, the Multimedia condition provides broader benefits extending beyond anxiolysis to patient satisfaction and perceived helpfulness, making it the preferred option where a more comprehensive improvement in patient experience is the goal. Together, these low-cost sensory strategies offer a practical means of improving the patient experience during prolonged clinical wait times.

Strengths and Limitations

Key strengths of this study include its prospective design and pseudo-randomized allocation, which minimized selection bias while preserving ecological validity. The balanced inclusion of emergent and non-emergent patients across a broad age range ensures the findings are generalizable to diverse ophthalmic populations. Furthermore, the use of validated visual analogue scales provided sensitive, patient-centered outcome data.[50] As these interventions are low-cost and readily integrated into existing workflows, they offer practical, scalable solutions for resource-constrained outpatient settings.

While this study provides practical insights, its single-center design and pseudo-randomized allocation may allow for unmeasured confounding related to daily clinic variations. Additionally, the use of single-point, self-reported visual analogue scales captures subjective experience but precludes assessment of objective physiological markers or longitudinal effects on patient outcomes. Lack of participant blinding may have introduced response bias in satisfaction and perceived helpfulness ratings. Individual waiting times were not recorded, limiting our ability to determine whether perceived improvements were independent of actual wait duration. Because participants were grouped by study day rather than individually randomized, observations within the same clinic day may not have been fully independent, and no statistical adjustment for clustering was applied. This may have increased the risk of Type I error, particularly in the subgroup analyses, which were conducted without correction for multiple comparisons and should therefore be considered exploratory. In addition, intervention content was selected by the research team without formal assessment of patient preferences or cultural background, which may have limited its acceptability or effectiveness across a diverse clinic population.[34,35] Additional limitations include the absence of baseline trait anxiety assessment, no screening for psychiatric comorbidities, and lack of hearing impairment measurement in an older ophthalmic population, all of which may have independently influenced outcomes. Participant awareness of study conditions may also have introduced Hawthorne effects, potentially inflating self-reported satisfaction and helpfulness ratings.

Future Directions

Future research should explore patient preferences for specific music or visual content, including culturally tailored, accessible, and language-appropriate options, as patient-directed content selection may also improve engagement and compliance with the intervention.[34,35] Moreover, larger multi-center randomized or stepped-wedge designs should be utilized to strengthen causal inference. Additionally, future evaluations should examine longer-term impacts on patient experience metrics, perceived wait times, and return visits to further elucidate the sustained value of these environmental interventions. Future studies should also incorporate objective physiological measures such as blood pressure and heart rate to further elucidate the mechanisms and magnitude of benefit. Lastly, future studies should include patients with varying degrees of visual acuity to determine whether multimedia interventions remain effective when visual engagement is limited.

Conclusion

In conclusion, this study suggests that low-cost sensory interventions in ophthalmology waiting rooms may reduce patient-reported anxiety. While auditory input alone appears sufficient to achieve meaningful anxiolysis, multimedia environments may provide additional value by enhancing patient satisfaction and perceived helpfulness. These benefits may be particularly relevant for vulnerable subgroups, including emergent-care patients and older adults, who reported the highest utility. Given their minimal resource requirements and ease of implementation, these environmental

modifications may represent feasible and scalable strategies for improving patient experience in high-volume, resource-constrained outpatient settings.

Author Contributions

AS and EI conceptualized the study. AAM and JR collected the data. AAM and JR wrote the initial draft of the manuscript. AAM prepared the figures and tables. AAM conducted the statistical analysis under the supervision of EI, who holds sufficient biostatistics training. AS and EI edited the manuscript. AS and EI supervised this project. EI served as the senior supervising author. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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