Comparing Effectiveness of Remote-learning Formats for Resident Physician Didactics

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ABSTRACT

BACKGROUND: It is important to investigate remote-learning options for medical education. We evaluated retention of research-related knowledge after exposure to pre-recorded audio-based didactics (AUDIO) versus video conference-based didactics (ZOOM).

METHODS: Obstetrics and Gynecology residents over the 2020-2021 academic year were randomized to didactics delivered in AUDIO versus ZOOM formats. At baseline, immediately post-exposure, and 3-month post-exposure, objective knowledge was assessed through 15 multiple choice questions. Confidence and satisfaction were assessed on a 5-point Likert scale. Median differences and 95% confidence intervals (CI) were applied to identify a 10% non-inferiority margin.

RESULTS: Thirty of thirty-one (30/31, 96.8%) eligible residents participated. At 3-month post-exposure, AUDIO was non-inferior to ZOOM (6.3% mean difference in knowledge scores, 95% CI –3.5–16.2). There were no differences in satisfaction or confidence, though a greater proportion of AUDIO participants indicated they would use a similar resource independently (p=0.008).

CONCLUSION: AUDIO didactics may be non-inferior to ZOOM.

KEYWORDS: remote learning; postgraduate medical education; ZOOM; comparative effectiveness in medical education

INTRODUCTION

In the United States, postgraduate medical education programs are required to include formal activities that enhance knowledge of research methodology and its applications to clinical practice.[1] Prior studies in the field of Obstetrics and Gynecology have noted varying approaches to teaching postgraduate learners about the performance and interpretation of research.[2-5] The opportunity for further variability in research-related didactic experiences emerged with the transition to remote didactics prompted by the COVID-19 pandemic, as some programs supplemented educational experiences with online modules, videos, Podcasts, and webinars.

While social distancing guidelines related to the COVID-19 pandemic have evolved with time, the integration of remote learning into medical education appears unchanged. Studies have already noted that some learners perceive remote learning to be as effective, or more effective, than traditional in-person didactics.[6,7] Furthermore, the benefits of remote learning are predicted to transcend the pandemic, given their greater accessibility, participant satisfaction, and facilitation of multidisciplinary collaboration.[8]

One option for remote learning that has gained popularity over recent years is Podcast-style learning. Recent literature has supported the use of Podcasts in medical education, with studies showing that they are both effective and widely accepted amongst medical trainees.[9-12] In 2017, Back et al found greater knowledge gains and higher satisfaction amongst medical students randomized to a Podcast about orthopedic diseases when compared to those randomized to a book chapter.[9] Lee et al found that medical students whose airway skill training was supplemented with Podcast videos outperformed those who did not receive the Podcasts.[10] Specifically, in the field of Obstetrics and Gynecology, Dmytryshyn and Selk noted sustained increases in vulvovaginal disease-related knowledge after exposure to Podcast episodes related to herpes and lichen sclerosis.[11] Furthermore, in 2020, Cai et al found that in the first year of production of their weekly Ob/Gyn trainee-targeted Podcasts, they had >173,000 downloads, over 600 Twitter followers, and an average iTunes rating of 4.86 out of 5 stars.[12]

Despite the popularity of Podcasts over recent years, many residency training programs defaulted to delivering their typical didactic content via video conference during the COVID-19 pandemic. While transitioning to a webinar-based format intuitively makes sense in terms of remote replication of the classroom experience, there is a paucity of evidence regarding the comparative effectiveness of remote-learning formats in medical education. The primary objective of this study was to compare the effectiveness of two remote-learning formats in increasing objective measurements of research-related knowledge on 3-month follow-up.

METHODS

We performed an IRB exempt (1584418) randomized non-inferiority trial to assess change in objective knowledge scores after exposure to audio-based (AUDIO) versus video conference-based (ZOOM) didactics. Participants included Obstetrics and Gynecology residents at a single tertiary care institution. The study was administered on two didactic sessions during the 2020-2021 academic year, with the first taking place December 2020 and titled 'Developing a Study Question.' The second study-related didactic session was held January 2021 and titled 'Calculating a Sample Size.' Residents were able to participate in one or both sessions.

On the study dates, residents attended their regularly scheduled remote didactics sessions delivered via ZOOM© (ZOOM Video Communications, Inc). The study was explained, and informed consent was obtained. Residents who declined participation in the study, or were involved in the study design, were excluded. Study participants completed a pre-didactic assessment where they self-identified their postgraduate year, prior use of technology for learning outside of required didactic settings, preferences in learning style, prior research training, and confidence in approaching various research-related subjects on a Likert scale. Participants then completed 15 multiple choice questions that objectively measured knowledge related to the didactic material scheduled for that day.

Upon completion of the pre-didactic knowledge assessment, participants were block randomized by postgraduate year into one of two remote learning formats: 1) AUDIO, which consisted of pre-recorded audio files accessible from any computer or mobile device and 2) ZOOM, which consisted of lectures delivered through a video conferencing system utilizing a slide-set with a live presenter. Links to the respective didactics were sent to each participant's email upon enrollment in the study.

Both the AUDIO and ZOOM didactics were designed to provide knowledge regarding the basics of designing and implementing clinical research, as described by Hulley et al, with delivery founded in the educational principles as described by Stahl and Davis.[13,14] The didactic content was designed for remote delivery through an iterative process that included pilot testing and feedback from stakeholders within the institution's Division of Research, Division of General Obstetrics and Gynecology, and trainees.

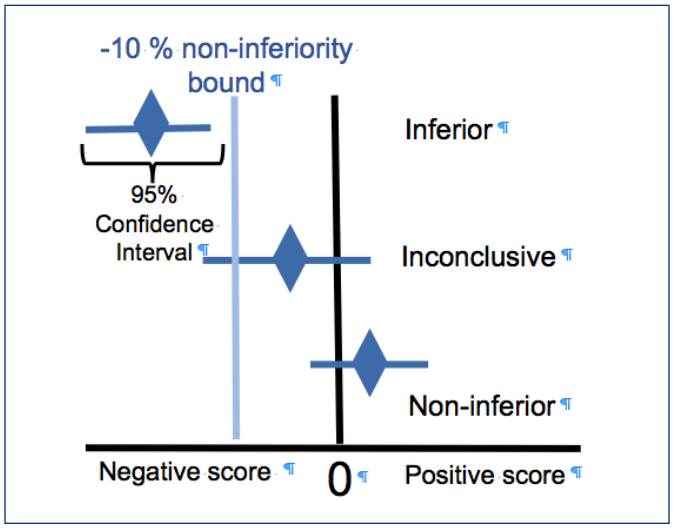
The two formats of the didactics were delivered by the same clinical instructor, with their length and content standardized between formats. Each didactic lasted 10-12 minutes. Only those exposed to the ZOOM didactic had a visual aid (PowerPoint slides) during the didactic. Additionally, only ZOOM participants had the opportunity to ask questions during the presentation, though AUDIO participants were able to email the instructor their questions following the didactic session.

After exposure to the didactic, participants completed a post-test, which included the same 15 multiple choice objective knowledge questions and confidence questions that the participants completed before exposure to the didactic. Additionally, participants were asked to rate their likeliness to use the didactic module on their own time, and likeliness to recommend a similar resource to a peer, on a Likert scale. The same post-didactic assessment was repeated 3-month post-exposure. All assessments were hosted on REDCap.[15,16]

This study sequence (presenting to regularly scheduled didactics, pre-test, randomization, exposure to a ZOOM or AUDIO didactic, immediate post-test, and 3-month post-test) was repeated for a total of two iterations. Participants were re-randomized between the two iterations. Thus, some participants were exposed to two AUDIO didactics, some were exposed to two ZOOM didactics, and some were exposed to one AUDIO and one ZOOM. If a participant completed one didactic session in the study, they could opt out of participation in the next didactic. Likewise, participants who initially declined participation, or otherwise did not attend the first study didactic session, could still participate in the second study didactic if they desired.

The study was designed as a feasibility study with a convenience sample, as there were no available data for power calculation. A block randomization list was used to randomize participants, with the list generated on the SealedEnvelope website (London, United Kingdom).[17] The primary outcome was change in objective knowledge scores from pre-test to immediate post-test. Mean or median changes in scores were compared between groups by T-test or Wilcoxon rank-sum test and within participants by paired T-tests or Wilcoxon signed-rank tests. The study team prespecified a margin of –10% to determine non-inferiority (**Figure 1**). The existence of period and sequence effects was examined by

Figure 1. Non-Inferiority Trial Interpretation



multiple linear regression with a random participant effect to account for within-participant correlation. Questions assessing confidence and likelihood to use the didactic on one's own time were compared by Chi-square or Fisher's exact test. Changes in confidence level within participants were compared by McNemar's test. Data analysis was performed with SAS version 9.4 (SAS Institute, Cary, NC). A p-value<0.05 was considered statistically significant.

RESULTS

Thirty-one residents were eligible for inclusion. The resident population at the institution during the 2020-2021 academic year was 87.5% (28/32) female, and 62.5% White (20/32). Study participants were relatively evenly distributed across postgraduate years, with 8/30 (26.7%) being in the first postgraduate year, 8/30 (26.7%) in the second postgraduate year, 8/30 (26.7%) in the third postgraduate year, and 6/30 (20.0%) in the fourth postgraduate year. Participants had varying learning preferences, with 12/30 (40%) preferring classroom-based learning, 10/30 (33.3%) preferring experiential learning, 7/30 (23.3%) preferring visual-based learning, and 1/30 (3.3%) preferring ZOOM-based learning. Four participants (4/30) had obtained an MPH or PhD prior to residency.

Prior to inclusion in this study, 29/30 (96.7%) of participants stated they had used an audio-based learning tool in the past. Nearly half (13/30, 43.3%) reported using an audio-based learning tool approximately once a month over the course of the prior 12 months. Many participants (20/30, 66.7%) reported that the typical length of time that they remain engaged in such a resource is 10-20 minutes.

In total, 24 residents attended the first didactic session, with 12 randomized to ZOOM and 12 randomized to AUDIO. Similarly, 24 residents attended the second didactic session, where again 12 were randomized to ZOOM and 12 were randomized to AUDIO. A total of 17 residents attended both sessions and completed post-didactic questionnaires for both, with 5 being exposed to ZOOM both times, 5 being exposed to AUDIO both times, and 7 being exposed to each format once.

Composite change in objective knowledge immediately post-exposure is depicted in **Figure 2**. Immediately post-exposure, the findings were inconclusive regarding the non-inferiority of the AUDIO format compared to the ZOOM format, with a lower bound of the 95% confidence interval crossing the –10% non-inferiority margin (mean difference –2.2%, 95% CI –12.4 to 8.0). However, for the primary outcome of knowledge difference at 3-month post-exposure, the AUDIO format was found to be non-inferior to ZOOM, with a mean difference of 6.3%, favoring greater increases in objective knowledge scores amongst participants exposed to the AUDIO format of the didactic (95% CI –3.5 to 16.2; **Figure 3**). There were no differences in 3-month follow-up scores amongst those with versus without prior research experience and those planning versus not planning a future career in research (all p > 0.05).

Figure 2. Composite Change in Objective Knowledge Scores Immediately Post-Exposure

Participants were exposed to pre-recorded audio-based didactics (AUDIO) or live video-conference-based didactics (ZOOM). The two didactic formats were standardized for length, content, and delivery. Objective knowledge was measured prior to randomization, immediately after exposure to the didactic, and 3 months after exposure to the didactic. When comparting the composite change in objective knowledge between the groups immediately post-exposure, the mean difference was -2.2%, with AUDIO participants having slightly lower score increases (95% CI –12.4 to 8.0, p>0.05).

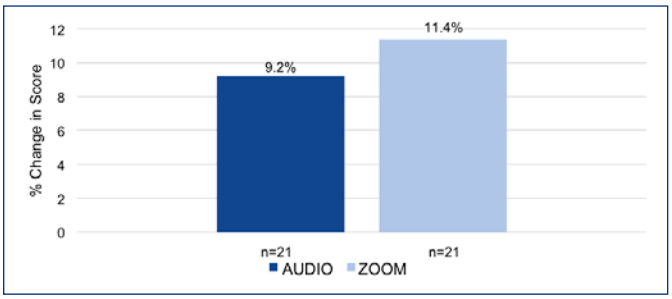
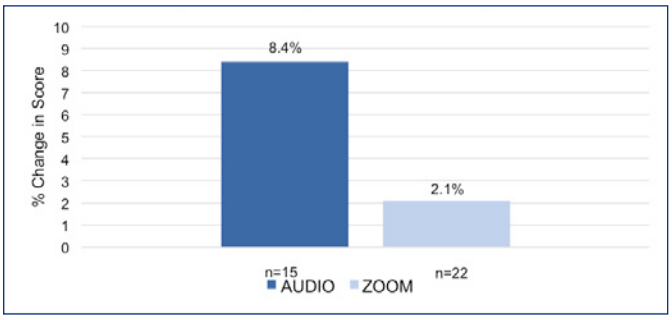


Figure 3. Change in Knowledge 3 Months Post-Exposure

Participants were exposed to pre-recorded audio-based didactics (AUDIO) or live video-conference-based didactics (ZOOM). The two didactic formats were standardized for length, content, and delivery. Objective knowledge was measured prior to randomization, immediately after exposure to the didactic, and 3 months after exposure to the didactic. When comparting the composite change in objective knowledge between the groups 3 months post-exposure, the mean difference was 6.3%, with AUDIO participants having slightly higher score increases (95% CI –3.5 to 16.2, p>0.05).



The didactic formats were also analyzed by the content of the educational material they covered. For the 'Developing a Study Question' didactic, AUDIO was found to be non-inferior to ZOOM both immediately and at 3-month follow-up (**Table 1**). However, for the 'Calculating a Sample Size' didactic, the findings were inconclusive both immediately and at 3 months (**Table 2**).

Regarding the outcomes of confidence and satisfaction, prior to exposure to the didactics, many participants felt somewhat or very confident developing a study question

Table 1. Immediate and 3-Month Objective Knowledge Scores for the 'Developing a Study Question' Didactic

Participants were exposed to a pre-recorded audio-based didactic (AUDIO) or a live video-conference-based didactic (ZOOM) for two didactic sessions. Objective knowledge was measured through 15 multiple choice questions prior to exposure to each didactic, immediately after each didactic, and again 3 months later. Median scores, ranges, 95% confidence intervals, and p values by Wilcoxon rank-sum test for the "Developing a Study Question" didactic are shown. A confidence interval with a lower bound above -10 meets study criteria for non-inferiority. Results that include this bound are considered indeterminate.

	AUDIO	ZOOM	AUDIO vs ZOOM Difference (95% CI), p value
Pre-test	86.7 (60–100)	90 (66.7–100)	
Immediate Post-test	100 (86.7–100)	96.7 (80–100)	0 (0 to 6.7), p=0.57
3-Month Post-test	96.7 (86.7–100)	90 (13.3–100)	6.7 (–6.7 to 20.0), p=0.24
p for within-group change	p=0.008	p=0.016	

Table 2. Immediate and 3-Month Objective Knowledge Scores after the 'Calculating a Sample Size' didactic

Participants were exposed to a pre-recorded audio-based didactic (AUDIO) or a live video-conference-based didactic (ZOOM) for two didactic sessions. Objective knowledge was measured through 15 multiple choice questions prior to exposure to each didactic, immediately after each didactic, and again 3 months later. Median scores, ranges, 95% confidence intervals, and p values by Wilcoxon rank-sum test for the "Calculating a Sample Size" didactic are shown. A confidence interval with a lower bound above –10 meets study criteria for non-inferiority. Results that include this bound are considered indeterminate.

	AUDIO	ZOOM	AUDIO vs. ZOOM Difference (95% CI), p value
Pre-test	60 (46.7–80)	56.7 (20–80)	
Immediate Post-test	70 (6.7–80)	66.7 (46.7–93.3)	0 (–13.3 to 20.0), p=0.98
3-Month Post-test	66.7 (46.7–86.7)	60.0 (33.3–86.7)	6.7 (–13.3 to 20.0), p=0.48
p for within-group change	p=0.12	p=0.03	

(14/24, 58.3%). However, only one participant felt somewhat or very confident in calculating a sample size (1/24, 4.2%) at baseline. On 3-month follow-up, less than one-third of participants (5/16, 31.3%), noted an increase in their confidence level in developing a study question, whereas greater than three-quarters increased their confidence in calculating a sample size (17/21, 81.0%). There were no significant differences in confidence increases when comparing AUDIO versus ZOOM (p=0.33). There were also no differences in change in confidence when stratified by preferred learning style, plan to pursue fellowship, or plan for a future career in research (all p>0.05).

At 3-month follow-up, a greater proportion of AUDIO participants indicated they would be "Likely or very likely" to use a similar educational resource on their own time (p=0.008). Similarly, at 3 months, a significantly greater proportion of AUDIO participants endorsed being "Likely or very likely" to recommend a similar resource to a peer (p= 0.04).

DISCUSSION

The current study found that AUDIO didactics were non-inferior to ZOOM didactics with respect to mean change in objective knowledge and participant satisfaction at 3 months. Furthermore, participants perceived themselves more likely to engage with an AUDIO didactic outside of scheduled didactic time, and more likely to recommend use of an AUDIO didactic to a friend. These findings support the use of audio-based learning tools, such as Podcasts, in medical education. Furthermore, the current study challenges the assumption that video conferences, such as ZOOM, should be the default in remote-learning settings.

While overall the 3-month follow-up results of this study were reassuring, the data was nuanced when examined by individual didactic topic. At baseline, participants had high levels of confidence in their ability to develop a study question, and this was mirrored by high baseline objective knowledge scores. The authors hypothesize that these high baseline knowledge and confidence levels are why the AUDIO and ZOOM formats of the 'Designing a Study Question' didactic did not have significant differences between their changes in objective knowledge scores when compared to one another. However, only the AUDIO group had a significant increase in knowledge from baseline to 3-month follow-up.

In contrast, participants had lower baseline levels of confidence in their ability to calculate a sample size, with similarly low objective knowledge scores. Interestingly, change in objective knowledge scores after exposure to the 'Calculating a Sample Size' AUDIO didactic were not found to be significant, and the determination of inferiority of the AUDIO didactic to the ZOOM didactic was inconclusive, with the lower bound of the 95% confidence interval crossing the non-inferiority bound.

The authors hypothesize that these different findings based on didactic topic are related to the content of the didactic. The 'Developing a Study Question' didactic involved more creative thinking, which is perhaps more amenable to audio-based learning. The 'Calculating a Sample Size' didactic involved concrete application of mathematical concepts, including how changing alpha or beta influences sample size. It is possible that the provision of a visual aid (PowerPoint slides) conferred a benefit, particularly when it came to model calculations.

While the advantages of visual aids in medical education are known, the benefits of audio-based learning are emerging. The audio-based format used in this study was specifically designed to mirror a traditional Podcast. Many Podcasts are designed to be listened to without the use of visual aids, and easily accessible during free time for asynchronous, self-directed learning. Podcasts have increased in popularity in medical education over the years and are recognized as an effective platform for delivery of medical knowledge with high levels of usability and satisfaction.[12,18]

Although audio-based learning tools, such as Podcasts, have benefits when used in isolation, they are also a promising tool that can be incorporated into hybrid and flipped classroom learning models. Recent studies have found significant knowledge increases associated with using a flipped classroom approach, with participants noting preferences for the flipped classroom format.[19,20] Studies examining such approaches have typically utilized didactic modules – such as videos, websites, or Podcasts – completed asynchronously by learners prior to engagement in synchronous learning, with many noting sustained knowledge increases associated with this approach.[21-25]

This study has many strengths, including the rigorous development and pilot testing of the didactic content and assessments. Furthermore, its emphasis on remote learning of general research concepts enhances applicability and relevance to diverse learning settings and systems. Most importantly, our results may help inform the design of future studies investigating the comparative effectiveness of remote-learning formats.

This study also has many limitations. The Hawthorne effect may have influenced participants' answers and engagement in the didactic modules, and response bias may have impacted the results. Also, the authors did not assess whether learning-format preferences changed after exposure to the two formats. Furthermore, our small sample size limited comparisons, and larger studies are needed to assess potential differences more definitively. Although the p values for between group comparisons were all >0.05, consistent with our non-inferiority hypothesis, the within-group change after exposure to the AUDIO version of the 'Calculating a Sample Size' didactic was also >0.05, which raises question regarding the effectiveness of that didactic module.

Given these many limitations, the current study should be contextualized as a feasibility study to help inform the design of future large-scale studies investigating the two learning modalities. The authors emphasize that the many limitations of this study prohibit it from definitively determining the non-inferiority of either learning modality

CONCLUSION

Even prior to the COVID-19 pandemic, there was a shift toward self-directed and asynchronous learning in medical education.[26] This likely reflects the evolving preferences of learners, which include less in-person didactic time, and more opportunities for interactive and self-directed learning activities. Educators must strive to rigorously evaluate different didactic modalities to meet the needs of the next generation of learners. The findings of the current study challenge the paradigm of ZOOM-based remote learning and support the non-inferiority of Podcast-type didactics in conferring research-related knowledge. However, more robust studies are needed to elucidate potential differences between these two learning modalities.

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Disclaimer

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