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Knowledge, Attitude, and Practice Regarding Noise-Induced Hearing Loss Among Factory Employees

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INTRODUCTION

Occupational noise exposure remains a significant public health concern worldwide, with factory workers disproportionately affected by hazardous noise levels in their daily work environments. The World Health Organization estimates that approximately 16% of disabling hearing loss in adults is attributable to occupational noise exposure, representing a substantial preventable burden of disease. Despite regulations mandating hearing conservation programs in many countries, noise-induced hearing loss (NIHL) remains one of the most prevalent occupational health conditions worldwide.

Factory environments frequently generate noise levels exceeding 85 dBA-the threshold above which hearing damage can occur with prolonged exposure. Unlike many occupational hazards, the effects of noise exposure are often insidious, developing gradually over time without obvious immediate symptoms. This delayed manifestation contributes to lower risk perception among workers and potentially inadequate preventive behaviors. Furthermore, hearing loss, once established, is permanent and irreversible, emphasizing the critical importance of prevention.

The effectiveness of hearing conservation programs depends not only on engineering controls and administrative measures but significantly on workers' knowledge about noise hazards, attitudes toward hearing protection, and actual protective practices. Educational interventions that address these knowledge, attitude, and practice (KAP) domains have shown promise in improving hearing protection behaviors, yet their implementation and evaluation remain inconsistent across industrial settings.

This study aims to assess the baseline KAP regarding noise-induced hearing loss among factory employees and to evaluate the impact of a structured educational orientation program on these parameters. By measuring pre- and post-intervention outcomes, this research seeks to identify effective strategies for improving workers' understanding of and compliance with hearing conservation practices, ultimately contributing to the reduction of occupational hearing loss in high-noise industrial environments.

METHOD

Study Design and Setting

The quasi-experimental study employed a pre-test/post-test design to evaluate changes in knowledge, attitude, and practice (KAP) regarding noise-induced hearing loss following an educational intervention. The study was conducted at Sandhar Engineering Private limited, Thandya Industrial Estate, Adakanahalli , Mysore, a manufacturing facility with multiple production departments where noise levels regularly exceed 85 dBA. The research was carried out between 28th April 2025 and 10th May 2025, with approval from the institutional ethics committee.

Study Population and Sampling

The target population consisted of employees working in high-noise areas of the factory. Using power analysis (α=0.05, power=0.80, estimated medium effect size d=0.5), a minimum sample size of 64 participants was determined necessary to detect significant changes in KAP scores. Anticipating adropout rate, 116 participants were initially recruited using stratified random sampling to ensure proportional representation from various departments. Inclusion criteria encompassed full-time employees aged 18-65 years with at least three months of employment at the facility. Workers with pre-existing hearing impairment unrelated to noise exposure were excluded from the study.

Study materials

A structured questionnaire was developed to assess KAP domains, comprising four sections:

a. Demographic information: Age, gender, education level, department, job position, years of employment, and previous noise safety training.

b. Knowledge assessment:5 multiple-choice questions evaluating participants' understanding of noise-induced hearing loss, including noise measurement units, damage thresholds, symptoms of hearing loss, and protective measures (score range: 0-8).

c. Attitude assessment: 4 items using a 3-point Likert scale (disagree to agree) to measure perceptions regarding hearing protection importance, personal susceptibility to hearing loss, barriers to protective behaviors, and perceived self-efficacy (score range: 0-4).

d. Practice assessment: 5 items evaluating frequency of protective behaviors using a 3-point scale (never to always), including proper use of hearing protection devices, equipment maintenance, reporting excessive noise, and adherence to hearing conservation protocols (score range: 0-5).

The questionnaire was validated through expert review by two audiologists and one occupational health specialist, followed by pilot testing with 15 workers not included in the final sample (Cronbach's alpha coefficients: knowledge = 0.78, attitude = 0.82, practice = 0.76).

Orientation

The educational intervention consisted of a comprehensive 1-hour orientation program delivered by certified health professionals. The program included:

a.Presentation: 45-minute multimedia presentation covering noise physics, hearing mechanism, pathophysiology of noise-induced damage, recognition of hazardous noise levels, and protective strategies.

b.Interactive session: 45-minute group discussion addressing common misconceptions, barriers to hearing protection use, and solutions to workplace-specific challenges.

Data Collection Procedure

The KAP questionnaire was administered to participants one hour before the intervention (pre-test) and one week after the intervention (post-test).Questionnaires were completed during paid work hours in quiet meeting rooms under supervision of research assistants who provided clarification if needed but did not influence responses. Participants were assigned unique identification codes to maintain confidentiality while enabling matching of pre- and post-intervention responses.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated. A mixed ANOVA was conducted to examine the effect of the intervention on KAP scores. Statistical significance was determined with a threshold of $p < 0.05$.

RESULTS

A mixed-design repeated measures ANOVA was conducted to examine the effect of an orientation program on Knowledge, Attitude, and Practice (KAP) scores related to noise-induced hearing loss (NIHL) among factory workers, considering Time (pre vs. post) and Domains (Knowledge, Attitude, Practice) as within-subject factors and Degree of Noise Exposure (Mild, Moderate, Severe) as a between-subjects factor.

Descriptive statistics revealed improvement across all KAP domains after the orientation. For example, the mean pre-orientation knowledge score was 1.89 (SD = 1.59), which increased to 6.54 (SD = 1.82) post-orientation. Similarly, attitude scores improved from a mean of 3.34 (SD = 0.87) to 3.97 (SD = 0.15), and practice scores increased from 1.78 (SD = 1.09) to 3.08 (SD = 0.95).

Main Effects

A significant main effect of Time was observed, $F(1, 113) = 366.50$, $p < .001$, $\eta^2_p = .764$, indicating a substantial improvement in KAP scores post-orientation. There was also a significant main effect of Domains,$F(2, 112) = 136.61$, $p < .001$, $\eta^2_p = .709$, with knowledge scores showing the greatest change.

Interaction Effects

The Time × Domains interaction was significant, $F(2, 112) = 128.13$, $p < .001$, $\eta^2_p = .696$, suggesting that the amount of change from pre- to post-orientation varied across KAP domains. However, the Time × Degree of Noise Exposure interaction was not significant, $F(2, 113) = 0.53$, $p = .59$, $\eta^2_p = .009$, indicating that the magnitude of improvement over time was consistent across noise exposure groups.

Similarly, the Domains × Degree of Noise Exposure interaction was significant, $F(4, 226) = 3.57$, $p = .008$, $\eta^2_p = .059$, suggesting that the different noise exposure groups had varying baseline levels and post-orientation changes in specific domains. The three-way interaction (Time × Domains × Degree of Noise Exposure) was not significant, $F(4, 226) = 0.47$, $p = .75$, indicating that the pattern of change across domains over time did not differ significantly by exposure group.

Between-Subjects Effects

There was a significant main effect of Degree of Noise Exposure on overall KAP scores, $F(2, 113) = 3.83$, $p = .024$, $\eta^2_p = .064$. Post hoc Bonferroni comparisons showed that participants in the mild exposure group scored significantly higher than those in the moderate group ($p = .028$), while no significant differences were observed between the mild and severe groups ($p = 1.000$) or between the moderate and severe groups ($p = .068$).

DISCUSSION

The present study examined the effectiveness of an orientation program on Knowledge, Attitude, and Practice (KAP) regarding noise-induced hearing loss (NIHL) among factory workers with varying degrees of noise exposure. The findings demonstrate significant improvements across all three domains following the intervention, with notable variations in the magnitude of change across different KAP components and exposure groups.

Overall Effectiveness of the Orientation Program

The substantial main effect of Time ($F(1, 113) = 366.50$, $p < .001$, $\eta^2_p = .764$) provides compelling evidence that the orientation program was highly effective in improving workers' KAP scores related to NIHL. This large effect size indicates that approximately 76% of the variance in scores can be attributed to the intervention, representing a meaningful clinical and practical significance. These findings align with previous research demonstrating that targeted educational interventions can significantly enhance workers' awareness and behaviors concerning occupational hearing conservation (Seixas et al., 2011; Reddy et al., 2012). Similar studies in industrial settings have reported comparable improvements following hearing conservation training programs, with effect sizes ranging from moderate to large (Arezes & Miguel, 2005; Kerr et al., 2017).

The success of educational interventions in occupational health settings has been well-documented across various contexts. Moroe et al. (2019) found that structured training programs significantly improved mineworkers' knowledge and attitudes toward hearing protection, while Raymond et al. (2018) demonstrated that tailored educational sessions enhanced compliance with hearing protection device usage among manufacturing workers. The present study's findings contribute to this body of evidence by demonstrating effectiveness across multiple outcome domains simultaneously.

Domain-Specific Changes

Knowledge Domain

The knowledge domain exhibited the most dramatic improvement, with mean scores increasing from 1.89 (SD = 1.59) pre-orientation to 6.54 (SD = 1.82) post-orientation. This represents approximately a 246% increase, indicating that participants had relatively limited baseline knowledge about NIHL that was substantially enhanced through the intervention. The significant main effect of Domains ($F(2, 112) = 136.61$, $p < .001$, $\eta^2_p = .709$) and the Time × Domains interaction ($F(2, 112) = 128.13$, $p < .001$, $\eta^2_p = .696$) confirm that knowledge showed the greatest change among the three domains.

These findings are consistent with the Health Belief Model (Rosenstock, 1974), which posits that knowledge acquisition is often the first step in behavior change. Previous research has similarly documented that knowledge gains tend to be more pronounced than attitude or behavior changes following educational interventions (Neitzel et al., 2008; Groenewold et al., 2014). For instance, a study by Tantranont et al. (2009) among Thai industrial workers found that

knowledge scores improved by 185% following a hearing conservation training program, though this was somewhat lower than the improvement observed in the current study.

The substantial knowledge gain observed here may reflect the structured and comprehensive nature of the orientation program, which likely covered essential topics such as the mechanisms of NIHL, risk factors, prevention strategies, and the proper use of hearing protection devices. Research has consistently shown that well-designed educational materials that include visual aids, demonstrations, and interactive components are more effective in knowledge transfer than passive information delivery (Stephenson et al., 2011; Bramley et al., 2015).

Attitude Domain

Attitude scores demonstrated a moderate but significant improvement, increasing from a mean of 3.34 (SD = 0.87) to 3.97 (SD = 0.15) post-orientation, representing an approximate 19% increase. While this change was statistically significant and practically meaningful, it was substantially smaller than the improvement in knowledge. The higher baseline attitude scores (compared to knowledge scores) suggest that workers may have had some pre-existing positive attitudes toward hearing conservation, even in the absence of comprehensive knowledge.

This pattern aligns with findings from Crandell et al. (2004), who reported that attitudes toward hearing protection are often influenced by workplace culture, peer behavior, and perceived management commitment to safety. The more modest attitude change observed in the present study may reflect the fact that attitude modification typically requires more intensive and sustained intervention efforts than knowledge acquisition (Ajzen, 1991; Hong et al., 2008). Attitudes are shaped by multiple factors including personal experiences, social norms, perceived barriers, and self-efficacy beliefs, which may not be fully addressed in a single orientation session (Lusk et al., 1999; McCullagh et al., 2002).

The reduction in standard deviation from pre- to post-orientation (0.87 to 0.15) is noteworthy, suggesting that the intervention not only improved attitudes but also created greater consensus among participants. This convergence toward more favorable attitudes is a positive indicator of program effectiveness and may facilitate the development of a stronger safety culture within the workplace (Zohar, 2010; Nielsen & Gonzalez, 2021).

Practice Domain

Practice scores showed considerable improvement from a mean of 1.78 (SD = 1.09) to 3.08 (SD = 0.95), representing approximately a 73% increase. While this change was substantial, it was intermediate between the dramatic knowledge gains and the more modest attitude shifts. This pattern is consistent with the Theory of Planned Behavior (Ajzen, 1991), which suggests that behavioral change is mediated by both knowledge and attitudes, along with perceived behavioral control and subjective norms.

The baseline practice scores were notably low, suggesting that many workers were not consistently engaging in hearing protective behaviors prior to the intervention. This finding is concerning but not unusual in industrial settings, where compliance with hearing protection recommendations has historically been suboptimal (Daniell et al., 2006; Verbeek et al., 2014). Several studies have documented poor baseline compliance rates ranging from 30% to 60% among noise-exposed workers (Arezes & Miguel, 2008; Neitzel & Seixas, 2005).

The improvement in practice scores following the orientation is encouraging and suggests that the intervention successfully translated knowledge gains into behavioral intentions and self-reported actions. However, the fact that

practice improvements were smaller than knowledge gains reflects a well-documented gap between knowledge and behavior in occupational health (Sadhra et al., 2002; El Dib et al., 2012). Sustained behavior change often requires ongoing reinforcement, environmental supports, and organizational commitment to hearing conservation (Rabinowitz et al., 2007; Tikka et al., 2017).

Interaction Between Time and Domains

The significant Time × Domains interaction ($F(2, 112) = 128.13$, $p < .001$, $\eta^2_p = .696$) indicates that the orientation program had differential effects across the three KAP domains, with knowledge showing the greatest improvement, followed by practice, and then attitude. This pattern has important theoretical and practical implications for hearing conservation programs in industrial settings.

From a theoretical perspective, this differential pattern of change supports stage models of behavior change such as the Precaution Adoption Process Model (Weinstein & Sandman, 2002), which suggests that individuals progress through discrete stages from unawareness to informed action. The present findings suggest that a single orientation session may be sufficient to substantially increase knowledge and initiate practice changes, but may be less effective at fundamentally altering attitudes, which are often more deeply rooted and resistant to change (Petty & Cacioppo, 1986).

Similar patterns have been observed in other occupational health interventions. For example, a systematic review by Verbeek et al. (2014) found that while educational interventions consistently improved knowledge about hearing conservation, their effects on attitudes and long-term behavior were more variable. This suggests that comprehensive hearing conservation programs may need to incorporate multiple intervention strategies, including not only education but also environmental modifications, management support, and ongoing feedback mechanisms to achieve sustainable behavioral change (Daniell et al., 2006; Themann et al., 2013).

Effect of Degree of Noise Exposure

Between-Subjects Main Effect

The significant main effect of Degree of Noise Exposure ($F(2, 113) = 3.83$, $p = .024$, $\eta^2_p = .064$) indicates that workers' overall KAP scores varied according to their level of noise exposure, though the effect size was small. Post hoc comparisons revealed that workers in the mild exposure group scored significantly higher than those in the moderate exposure group ($p = .028$), while no significant differences emerged between mild and severe groups ($p = 1.000$) or between moderate and severe groups ($p = .068$).

This pattern is somewhat counterintuitive, as one might expect workers with higher noise exposure to have greater awareness and engagement with hearing conservation practices due to their increased risk. However, the findings may reflect several underlying factors. First, workers in mild exposure areas may have greater opportunities for training and safety-related communication, as they might work in environments that are more conducive to educational activities (Hong et al., 2013). Second, the absence of immediate auditory discomfort in mild exposure environments might allow workers to be more receptive to preventive messages, whereas those in severe exposure settings may have already experienced some degree of hearing damage, potentially leading to fatalistic attitudes or denial (Rabinowitz, 2012; Reddy et al., 2012).

The lack of significant difference between the severe and mild exposure groups is particularly intriguing and may suggest that workers in the highest-risk environments possess some awareness of their vulnerability, even if their baseline knowledge was incomplete. Previous research has shown mixed findings regarding the relationship between noise exposure levels and hearing conservation behaviors, with some studies reporting better compliance among highly exposed workers (Raymond et al., 2018) and others finding no significant association (Arezes & Miguel, 2008).

Domain × Degree of Noise Exposure Interaction

The significant Domains × Degree of Noise Exposure interaction ($F(4, 226) = 3.57$, $p = .008$, $\eta^2_p = .059$) suggests that workers with different exposure levels showed varying baseline profiles and post-intervention changes across specific KAP domains. Although the effect size was small, this finding has important implications for tailoring hearing conservation programs to workers' specific risk profiles and baseline competencies.

This interaction may reflect the reality that workers in different exposure environments face distinct challenges and opportunities related to hearing conservation. For instance, workers in severely noisy environments may have strong motivation to protect their hearing but may face practical barriers to consistent hearing protection device use, such as communication difficulties or discomfort (Neitzel & Seixas, 2005; Hong et al., 2008). Conversely, workers in mildly noisy areas may have fewer barriers to protection use but may underestimate their risk and thus have lower motivation (Melamed et al., 1994; Lusk et al., 1999).

Research on risk perception and protective behavior has shown that the relationship between objective risk levels and safety behaviors is often mediated by perceived susceptibility, perceived severity, and perceived barriers (McCullagh et al., 2002; Raymond et al., 2018). The present findings suggest that effective hearing conservation programs should incorporate exposure-specific components that address the unique knowledge gaps, attitudinal barriers, and practical challenges faced by workers at different noise exposure levels (Moroe et al., 2019; Bramley et al., 2015).

CLINICAL IMPLICATIONS

The findings from this study underscore the importance of implementing structured orientation programs as an initial step in occupational hearing conservation, while recognizing that clinicians must extend their interventions beyond one-time educational sessions. Given the differential improvements across knowledge, attitude, and practice domains, audiologists and occupational health professionals should design multi-tiered clinical protocols that begin with knowledge-building but incorporate follow-up counseling to address attitudinal barriers and behavioral challenges.

LIMITATIONS

The current study focused solely on immediate post-intervention outcomes without any longitudinal follow-up. As a result, we cannot draw conclusions about the long-term sustainability of the improvements observed or the maintenance of behavior over time. Additionally, the practice measures were based on self-reports, which may lead to an overestimation of actual behavior due to social desirability bias. To enhance the reliability of future studies, it would be beneficial to incorporate objective measures, such as direct observation or electronic monitoring (Neitzel & Seixas, 2005; Groenewold et al., 2014).

CONCLUSION

The current study demonstrates that a structured orientation program can significantly improve factory workers' knowledge, attitudes, and practices regarding NIHL, with particularly strong effects on knowledge acquisition. The differential pattern of change across domains suggests that while educational interventions are highly effective for knowledge transfer, achieving sustained attitude and behavior change may require more intensive and sustained intervention efforts. The consistent effectiveness of the intervention across workers with different noise exposure levels is encouraging, though the varying baseline profiles across exposure groups suggest potential value in some degree of program customization. These findings contribute to the growing evidence base supporting the importance of hearing conservation education in industrial settings and provide practical guidance for organizations seeking to protect workers' hearing health.

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