BMC Psychology

RESEARCH

Open Access

The impact of noise-induced hearing loss on individual job performance: exploring the role of aggression and work-related quality of life

Milad Abbasi[1], Jalil Derakhshan[2], Faezeh Darabi[3], Media Noori Abdullah[4], Evan Abdulkareem Mahmood[5], Tahereh Eskandari[6] and Saeid Yazdanirad[7*]

Abstract

Background Noise-Induced Hearing Loss (NIHL) may have a significant effect on individual job performance (IJP). These effects may exert through aggression and work-related quality of life (WRQoL). Hence, the present study was conducted to investigate the modeling of the impact of NIHL on IJP by exploring the role of aggression and WRQoL.

Methods In 2022, a comprehensive study was carried out on 335 industrial workers in Kaveh Industrial Town, Saveh, Iran. The study encompassed a range of assessments, including a questionnaire-based survey that included the IJP questionnaire, WRQoL questionnaire, and Aggression questionnaire, as well as a pure tone audiometry test. The data gathered from these assessments were analyzed using structural equation modeling, providing a robust framework for understanding the complex relationships between variables.

Results Based on Spearman correlation test there is a negative correlation between $NIHL_{total}$ and WRQoL and IJP, with coefficients of -0.459 (P-value < 0.01) and −0.575 (P-value < 0.01), respectively. Additionally, there is a positive correlation between $NIHL_{total}$ and aggression, with a coefficient of 0.374 (P-value < 0.05). The direct effect coefficients for the impact of $NIHL_{total}$ on WRQoL, aggression, and IJP were −0.412, 0.453, and −0.128, respectively. Moreover, the indirect effect coefficients of $NIHL_{total}$ on the IJP through aggression, through WRQoL, and through both aggression and WRQoL were −0.057, -0.275, and −0.078, respectively.

Conclusion Overall, the results indicate that NIHL had a negative and positive association with WRQoL and aggression among workers, respectively. Furthermore, IJP was found to be directly and indirectly influenced by NIHL, through reduced WRQoL and aggressive behavior as negative consequences of NIHL.

Keywords Noise-induced hearing loss, Aggression, Individual job performance, Work-related quality of life

*Correspondence:
Saeid Yazdanirad
Saeedyazdanirad@gmail.com
[1]Occupational Health Engineering, Social Determinants of Health Research Center, Saveh University of Medical Sciences, Saveh, Iran
[2]Occupational Health Engineering, School of Public Health, Hamedan University of Medical Sciences, Hamedan, Iran
[3]Occupational Health Engineering, Independent Researcher, Hamedan, Iran
[4]Department of Chemistry, College of Science, Salahaddin University-Erbil, Erbil Kurdistan Region, Iraq
[5]Medical Laboratory Sciences Department, College of Health Sciences, University of Human Development, Sulaymaniyah, Iraq
[6]Department of Occupational Health Engineering, School of Public Health, Iran University of Medical Science, Tehran, Iran
[7]Department of Occupational Health Engineering, School of Health, Shahrekord University of Medical Sciences, Shahrekord, Iran

Introduction

Exposure to occupational noise can have a plethora of detrimental effects on workers [1], with Noise-induced hearing loss (NIHL) being one of the most common risk and prevalent complaints [2, 3]. NIHL is widely recognized as the most significant complication arising from exposure to noises exceeding 85 decibels [4]. The incidence of NIHL is contingent upon the sound level, frequency characteristics, rate of level changes, impulsiveness, temporal characteristics, and individual susceptibility [5, 6].

According to the World Health Organization, approximately 10% of the global population is exposed to noise levels that have the potential to NIHL [7]. Roughly 16% of instances of adult NIHL can be attributed to exposure to occupational noise [8]. Zhou et al.'s 2021 study reported that between 1990 and 2017, the global burden of disease, measured in disability-adjusted life years (DALYs), attributable to occupational NIHL rose from 3.3 to 6.0 million, with the most significant increase observed in low-income countries (110.7%) [9].

NIHL can give rise to a range of symptoms, such as impaired speech intelligibility, depressive symptoms, diminished quality of work life, heightened aggression, social isolation, reduced social interactions, and decreased job performance [10–14]. The impact of occupational hearing loss (HL) on quality of life, as well as work-related quality of life (WRQoL), is substantial [15]. These effects can manifest in various ways. Dalton et al.'s study demonstrated that individuals with HL experience greater reductions in both mental and physical components than those with mild HL, defined as having a PTA of 26–40 dB HL [15, 16]. Given that HL can lead to depression and social communication difficulties, it stands to reason, reductions in these components may negatively impact both the professional and personal lives of individuals with HL.

Beyond the aforementioned effects, HL can significantly impact behavioral aspects in humans. In other words, HL is a significant factor in changes to human behavior. Veron et al.'s study observed that individuals with HL frequently exhibit brain damage, learning disabilities, and frustration, which may result in adverse behavioral outcomes such as violence, aggression, and anger [17]. Similarly, Saki et al.'s study revealed that individuals with significant HL may exhibit higher levels of aggression than those with normal hearing [18]. This aggression has been attributed to the feelings of shame and embarrassment that often accompany HL [19].

Given that HL is a significant health disorder, it can have a substantial impact on individuals' quality of life [20]. While the physical and mental health effects of NIHL can significantly impact individuals' WRQoL, the available research on the quantity and quality of these effects is limited.

Alterations in aggression and WRQoL among employed individuals with NIHL may potentially impact their job performance [21, 22]. Lin et al.'s study demonstrated that workplace aggression has an adverse effect on individuals' job performance [23]. Typically, individual job performance is categorized into two groups: results-based and behavior-based performance [24]. In behavior-based performance, the emphasis is on behaviors that align with the organization's objectives [25]. Based on the aforementioned content, it can be inferred that NIHL has a significant impact on individual behaviors. Some of these effects may arise from the disruption of aggression and WRQoL. Behaviors that are integral to behavior-based job performance, such as communication with others, active learning, destructive behaviors, and arguments with colleagues [24], are evidently impacted by NIHL and its consequences. As such, it is imperative to conduct research aimed at modeling how NIHL impacts individual job performance through aggression and WRQoL. Therefore, in this study, our aim is to present and examine a conceptual framework that illustrates the interaction between these variables. The model assumes that NIHL results in a decline in WRQoL and an increase in aggression, both of which have a negative impact on individual job performance. Additionally, aggression and NIHL are also associated with reduced WRQoL and individual job performance.

Materials and methods

In 2022, this descriptive and analytical study was carried out on 335 industrial workers with varying degrees of occupational NIHL. All participants in this study were exposed to industrial noise levels exceeding 85 dBA and were expected to utilize hearing protection devices during work hours. Based on the assumptions of the current research, considering a type I error of 0.05 ($\alpha=0.05$), a power of 0.8 (power=β-1), and an effect size of 0.05 ($f^2=0.05$), the minimum required sample size was estimated to be 279 industrial workers. The G*Power software was used to determine the sample size. In questionnaire-based studies, due to the possibility of incomplete responses and the application of exclusion criteria, a larger sample size is typically considered. In this study, an additional 20% sample size was included to mitigate potential issues. The inclusion criteria for this study were as follows: individuals with work experience of more than one year, no history of mental illness, and no history of head trauma or surgery. The following factors were considered as exclusion criteria for this study: exposed to the ototoxic chemicals, a history of serving in the air force or artillery, congenital deafness, deafness caused by infectious diseases, ototoxic drugs, tumors or

autoimmune diseases, and suffering from Meniere's syndrome. To gather data, three active companies located in Kaveh Industrial Town in Saveh, Iran were approached, and the study objectives were explained to the managers of the selected industries. Volunteers were then recruited through a public call to participate in the study. Among the volunteers, only those who met the inclusion criteria were selected to participate in the study. Following that, a suitable schedule was designed to conduct pure tone audiometry test (PTA) and delivered the questionnaires to the participants. Based on the study protocol, demographic, aggression, work related quality of life, and individual job performance questionnaires were distributed to participants to complete under the supervision of the researcher. Subsequently, to assess the NIHL of participants, a pure-tone audiometry (PTA) test was conducted in a mobile acoustic room designed to reduce background noise by 20 dBA, providing a silent and appropriate environment for conducting the PTA. The study protocol was reviewed and approved by the medical ethics committee of Saveh University of Medical Sciences, and all study procedures were conducted in accordance with the ethical code IR.SAVEHUMS.REC.1401.34. All participants signed written consent to participate in the study voluntarily.

Individual job performance questionnaires (IJPQ)

This 20-question survey that evaluates the behavioral dimensions of individual job performance, utilizing a 5-point Likert scale that ranges from 1 (Never or Low) to 5 (Always or Very much). The total score ranges from 20 to 100, with higher scores indicating a higher level of individual job performance (IJP). The IJPQ assesses four aspects of job performance, which encompass task performance, counterproductive work behavior, adaptive performance and contextual performance. The overall IJP score is calculated by summing the scores assigned to each question, with the exception of the counterproductive work behavior dimension, which must be reversed. A higher score on the IJPQ indicates better IJP. The validity and reliability of this questionnaire have been confirmed in a study conducted by Abbasi et al. [26].

Work related quality of life (WRQoL)

The WRQoL questionnaire is a professionally designed assessment tool comprising 24 questions that aim to evaluate the perceived quality of life of employees. The questionnaire utilizes a 5-point Likert scale to assess the subjective responses of individuals to each question. The Likert scale ranges from strongly disagree [1] to strongly agree [5]. The tool in question measures six dimensions of WRQoL, which includes General Well-Being (GWB), Home-Work Interface (HWI), Job Career Satisfaction (JCS), Control at Work (CAW), Working Conditions (WCS), and Stress at Work (SAW). These dimensions are important factors that contribute to an individual's overall quality of life in the workplace. The score for each dimension is derived by summing up the responses to the questions related to that particular dimension. The final score for WRQoL is obtained by adding up the scores for all six dimensions. The questionnaire yields a range of scores, with the lowest possible score being 24 and the highest possible score being 120. A higher score indicates a higher quality of work life. The validity and reliability of this questionnaire have been confirmed in a study conducted by Mazlomi et al. [27].

Aggression questionnaire (AQ)

This tool is also known as Bass and Perry questionnaire [28]. This questionnaire comprises 29 questions designed to assess the four primary components of aggression, namely physical aggression, verbal aggression, anger, and hostility. This tool comprises a set of questions, of which nine pertain to the first component, five relate to the second component, seven pertain to the third component, and eight relate to the final component. The final score for each component is derived by adding up the scores of the questions that pertain to that particular component. The total score for all four components represents the overall score for aggression in an individual. The higher the score, the higher the aggression. This questionnaire comprises 29 items, each rated on a 5-point Likert scale ranging from "never" [1] to "always" [5]. Upon tallying the points, the minimum attainable score is 29, while the maximum score reaches 145. Individuals are then classified into three categories based on their scores: low aggression (scores between 29 and 48), medium aggression (scores between 48 and 96), and high aggression (scores above 96).

Pure tone audiometry test (PTA)

The PTA test was conducted based on the ISO 8253-1 standard method [29]. In the first step of the PTA, the audiometer was calibrated to ensure that it met the required quality standards. The test procedure was then explained to the workers by an expert audiologist, and they were prepared for the test in a standard soundproof room measuring 1×1.2 m with a minimum of 20 dB sound reduction across the frequency spectrum and background noise at the time of PTA was less than 30 dBA. This booth is made using acoustic-absorbing materials such as medium-density fiberboard (MDF), foam, and perforated acoustic panels made of Polyvinyl Chloride (PVC). The air conduction test was conducted by an expert audiologist using presenting pure tone signals to the workers through circum-aural closed-back headphones at frequencies of 250 Hz, 500 Hz, 1 kHz, 2 kHz, 3 kHz, 4 kHz, 6 kHz, and 8 kHz. The sequence of

frequency examination follows a specific pattern, commencing with 1 kHz and progressing in ascending order through 2 kHz, 3 kHz, 4 kHz, 6 kHz, and 8 kHz. Subsequently, the examination reverts back to 1 kHz before concluding with the assessment of 500 Hz and 250 Hz frequencies. The hearing assessment was conducted individually for each ear, and the hearing threshold was recorded at any frequency in either ear. The average HL of each ear was calculated by averaging the hearing threshold values obtained at 500 Hz, 1 kHz, 2 kHz, and 4 KHz [30]. To calculate the total HL for both ears, following formula was used:

$$NIHL_t = \frac{NIHL_R + NIHL_L}{2}$$

In this formula, $NIHL_t$ represents the total NIHL, $NIHL_R$ represents the average NIHL of the right ear, and $NIHL_L$ represents the average NIHL of the left ear. Mean pure tone thresholds are classified as follows: normal (0 to 25 dB HL), mild (26 to 40 dB HL), moderate (41 to 55 dB HL), moderate-severe (56 to 70 dB HL), severe (71 to 90 dB HL), and profound (greater than 90 dB HL) [31].

Data analysis

The collected data were entered into SPSS version 26 [32]. At first, descriptive statistics tests were carried out to determine the frequency, percentage, mean, standard deviation, maximum, and minimum of the studied variables. Given that the results of the Kolmogorov–Smirnov test showed that the variables have not normal distribution ($P<0.05$), Spearman correlation analysis was used to examine the relationships between variables. Also, structural equation modeling (SEM) in AMOS software was applied to perform the path analysis [33]. Structural equation modeling (SEM) was utilized to verify and evaluate hypotheses related to the relationships between understudy variables that interact with one another. The fitness of the designed model was examined using fit indices. The fit indices were Goodness-of-fit index (GFI), Adjusted goodness-of-fit index (AGFI), Normed fit index (NFI), Comparative fit index (CFI), Incremental fit index (IFI), Root mean squared error of approximation (RMSEA), and Normed Chi-square (X2/df). These indices are used to determine the validity and reliability of model.

Table 1 Demographic information of participants

Variables	Category	Relative frequency (%)
Gender	Male	72.5
	Female	27.5
Marital Status	Single	29.4
	Married	70.6
Age (years)	< 25	5.9
	25–35	36.6
	35–45	42.2
	> 45	15.3
Work Experience (years)	< 10	37.2
	10–20	46.9
	> 20	15.5
Education Level	Diploma	58.8
	Bachelor's degree	34.7
	Higher than a bachelor's degree	6.6

Results

This study was conducted among 335 industrial workers with varying degrees of occupational NIHL. Among them, 320 workers were included in the study. Of this, 72.5% and 27.5% of participants were male and female, respectively. The relative frequencies for single and married participants were 29.4% and 70.6%, respectively. The age (year) was categorized < 25, 25–35, 35–45, and > 45 year, with the relative frequencies of 5.9%, 36.6%, 42.2%, and 15.3%, respectively. The work experience (year) was categorized as < 10, 10–20, and > 20 (year). The relative frequencies for these categories were 37.2%, 46.9%, and 15.5%, respectively. In term of education level, participants were categorized as diploma, bachelor's degree, and higher than a bachelor's degree, with relative frequencies of 58.8%, 34.7%, and 6.6%, respectively. These results are presented in Table 1.

The mean hearing loss of both ears at octave band frequency has been illustrated in Fig. 1(a and b). Based on the results, the HL at a frequency of 4000 Hz is the maximum, while at 500 Hz, it is the minimum, respectively.

The mean, standard deviation, Skewness, Kurtosis, Percentiles (25, 50 and 75), minimum, maximum and median values of the age, work experience, $NIHL_t$, WRQoL, aggression and IJP are presented in Table 2. Based on the results, $NIHL_t$ values ranged from 7.1 to 68.4, with a mean (±SD) of 20.1 (±11.1). The mean (±SD) of WRQoL, aggression and IJP were 73.13 (±11.25), 53.77 (±14.23) and 53.76 (±6.85) respectively. More details are presented in the Table 2.

Table 3 shows the results of a Spearman correlation test between NIHLt, WRQoL, Aggression, IJP, age and work experience. The values in the Table 3 represent the correlation coefficients between each pair of variables. The correlation coefficient ranges from −1 to 1, where −1 indicates a perfect negative correlation, 0 indicates no correlation, and 1 indicates a perfect positive correlation. The correlation coefficient between NIHLt and WRQoL and IJP was −0.459 and −0.575, respectively, indicating a negative correlation between these two variables. The correlation coefficient between NIHLt and aggression was 0.374. Moreover, IJP had a significant positive

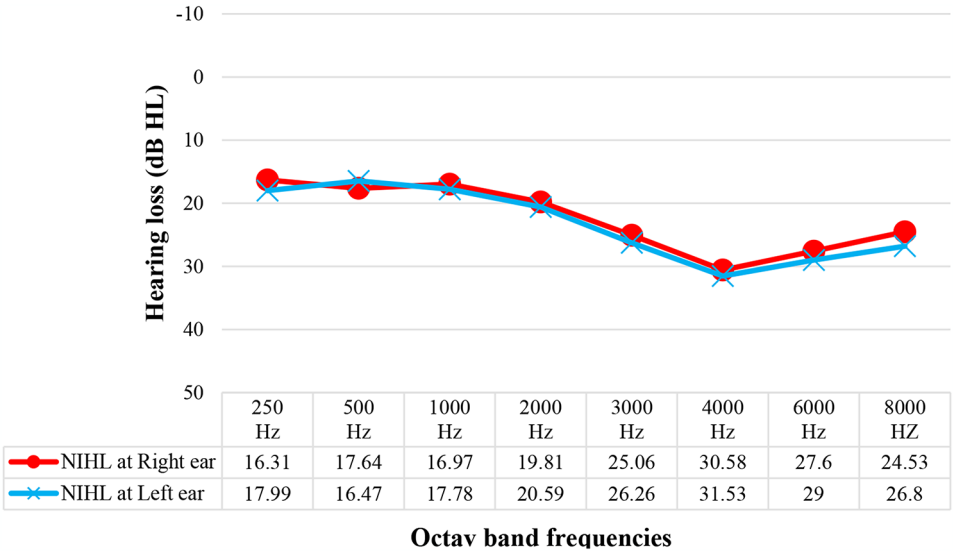

Fig. 1 Mean Hearing Loss in Both Ears at Octave Band Frequencies

Table 2 Statistical distribution of studied variables

		Age (years)	Work experience (years)	NIHL			WRQoL	Aggression	IJP
				Right	Left	NIHLt			
Mean		37.43	13.38	21.35	21.59	20.11	73.13	53.77	53.76
Std. Deviation		7.65	7.01	12.07	13.22	11.14	11.25	14.23	6.85
Skewness		0.06	0.03	1.54	1.61	1.51	0.002	0.53	1.21
Std.E of Skewness		0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Kurtosis		-0.46	-0.93	2.70	2.273	2.22	−0.119	0.04	1.71
Std.E of Kurtosis		0.27	0.27	0.27	0.272	0.27	0.27	0.27	0.27
Minimum		20	1	6.3	10.00	7.13	40	29	43
Maximum		60	30	75	73.75	68.38	103	100	81
Median		38	13	17.50	16.25	16.25	73	53	53
Percentiles	25	31	11.30	12.50	12.50	11.50	66	43	49
	50	38	17	16.25	16.25	16.26	73	53	53
	75	43	27	26.25	26.25	23.76	81	61	57

NIHLt: Noise Induced Hearing Loss (both ears)

WRQoL: Work Related Quality of Life

IJP: Individual Job Performance

Std. Deviation: Standard Deviation

Std.E of Kurtosis: Standard Error of Kurtosis

Std.E of Skewness: Standard Error of Skewness

Table 3 Correlation between studied variables

Variables	$NIHL_t$	WRQoL	Aggression	IJP	Age	Work experience
$NIHL_t$	1	-	-	-	-	-
WRQoL	-0.459^{**}	1	-	-	-	-
Aggression	0.374^{**}	-0.446^{**}	1	-	-	-
IJP	-0.575^{**}	0.792^{**}	-0.535^{**}	1	-	-
Age	0.493^{**}	-0.277^{**}	0.221^{**}	-0.345^{**}	1	-
Work Experience	0.631^{**}	-0.338^{**}	0.288^{**}	-0.423^{**}	0.859^{**}	1

** $P<0.01$

NIHLt: Noise Induced Hearing Loss (both ears)

WRQoL: Work Related Quality of Life

IJP: Individual Job Performance

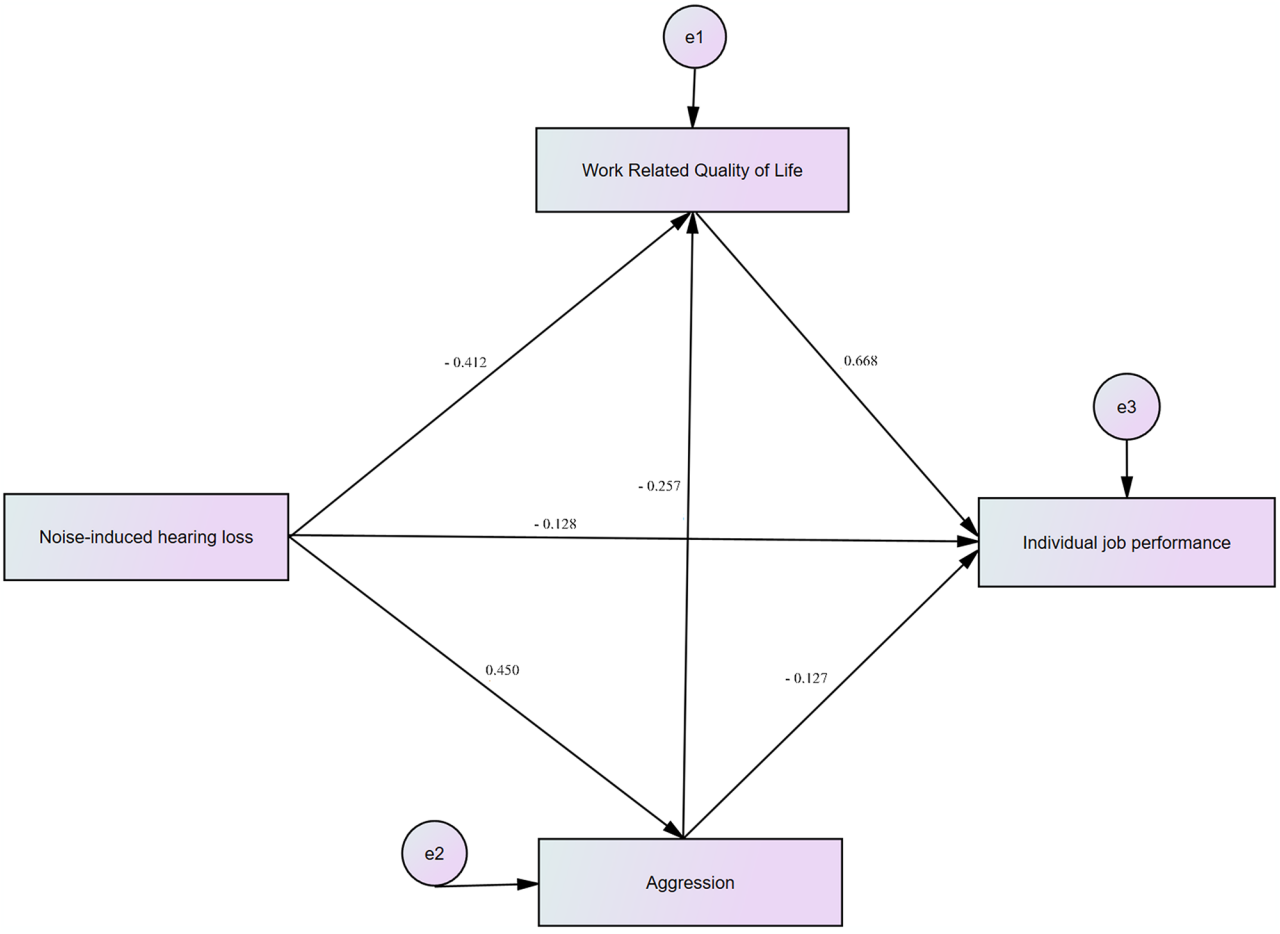

Fig. 2 The theoretical model proposed in the present study

correlation with WRQoL (0.792) and a negative significant correlation with aggression (−0.535).

The conceptual model presented in Fig. 2 illustrates the relationships between variables. The model depicts these relationships using one-way arrows. Upon analyzing the results, it can be concluded that total NIHL has a direct and negative impact on workers' WRQoL, resulting in a decrease in WRQoL. Additionally, WRQoL directly influences IJP, indicating that a decline in WRQoL leads to a decrease in IJP. In another pathway, total NIHL directly affects IJP, with an increase in total NIHL correlating to a decrease in IJP. Another pathway in the model demonstrates that total NIHL has a direct and positive effect on aggression, meaning that an increase in total NIHL can result in heightened aggression. This aggression, in turn, negatively and directly impacts IJP, indicating that increased aggression due to NIHL leads to decreased IJP. As per the presented model, it is apparent that aggression has a negative impact on WRQoL. Therefore, NIHL can affect WRQoL directly and indirectly through aggression, ultimately influencing IJP. In summary, NIHL can significantly impact IJP through four direct and indirect pathways. Detailed results of the path analysis are presented in Table 4.

Table 4 The values of effect coefficients of the variables

Path	Effect coefficient
NIHLt → WRQoL	−0.412
NIHLt → aggression	0.450
NIHLt → IJP	−0.128
Aggression → WRQoL	−0.257
Aggression → IJP	−0.127
WRQoL → IJP	0.668
NIHLt → Aggression → IJP	−0.057
NIHLt → WRQoL → IJP	−0.275
NIHLt → Aggression → WRQoL → IJP	−0.078
Aggression → WRQoL → IJP	−0.172

NIHLt: Noise Induced Hearing Loss (both ears)

WRQoL: Work Related Quality of Life

IJP: Individual Job Performance

The results presented in Table 4 displays the effect coefficients for the path NIHLt → Aggression → IJP with an effect coefficient of -0.057 and the path NIHLt → WRQoL → IJP with an effect coefficient of -0.275.

The results presented in Table 5 reports the results of a model fit assessment. The obtained values for GFI and AGFI were both above the recommended threshold of 0.9, with the GFI at 0.990 and the AGFI at 0.975. The obtained values for comparative fitness indices were all above the recommended threshold of 0.9, with the NFI at 0.989, the CFI at 0.994, and the IFI also at 0.994. The RMSEA obtained value was below the recommended threshold of 0.1, which is a good indication of a good model fit. The normed chi-square value was between 1 and 3 which is also an acceptable range. Based on these indices, it can be concluded that the model fits the data well.

Discussion

This study was conducted to investigate the direct effect of NIHL on individual job performance and its indirect effect through the WRQoL and aggression. The findings indicate an association between NIHLt and aggressive conduct. Additionally, the path model demonstrated that NIHLt had a direct impact on aggression, which aligns with prior research [18, 34, 35]. Gomos et al. conducted a study which revealed that people with hearing impairment often experience greater loneliness and communication difficulties with their peers, which may account for their tendency towards aggression [36]. Significant HL can result in reduced speech fluency and perception, which may contribute to aggressive behavior [37]. Furthermore, impaired communication can have a significant impact on emotional connection and social isolation, ultimately leading to aggression [38]. Overall, HL can result in disrespectful behavior, physical or verbal aggression, hostility, and anger. These behaviors may stem from communication difficulties, social isolation, reduced participation in group activities, decreased ability to learn, and fear of being judged or creating gossip among colleagues due to the disability. Additionally, people with HL may feel embarrassed about their condition, which can contribute to these negative behaviors. The study's findings also revealed that aggression had an adverse impact on workers' WRQoL. In other words, workers who displayed aggressive behavior tended to have lower WRQoL. This outcome is consistent with previous research that has explored the impact of aggression on the mental health and psychosocial well-being of employees [39, 40]. According to Merecz et al., workers who encounter workplace aggression tend to exhibit lower job satisfaction, display signs of burnout, and experience poorer overall health [40]. Given that general well-being, home-work interface, job career satisfaction, control at work, working conditions, and stress at work are all components of WRQoL, it stands to reason that aggression can impact WRQoL by influencing these factors. Aggressive and angry workers often lack control over their tasks and are unable to manage their work conditions effectively, resulting in reduced WRQoL [41]. When workers perceive higher levels of aggression in the workplace, it can create an environment that increases the likelihood of encountering workplace violence for their colleagues. Previous research has shown that workplace violence can have detrimental effects on job stress, job satisfaction, the meaningfulness of work, and turnover intentions [42, 43]. These outcomes are either components of WRQoL or closely associated with it.

Table 5 Fit indices of the analyzed model

Indices	Name	Acceptable value	Obtained value
Absolute fitness indices	Goodness-of-fit index (GFI)	> 0.9	0.990
	Adjusted goodness-of-fit index (AGFI)	> 0.9	0.975
Comparative fitness indices	Normed fit index (NFI)	> 0.9	0.989
	Comparative fit index (CFI)	> 0.9	0.994
	Incremental fit index (IFI)	0–1	0.994
Normed fit index	Root mean squared error of approximation (RMSEA)	< 0.1	0.063
	Normed Chi-square (X2/df)	1–3	2.25

The findings indicated that there was a detrimental association between NIHLt and the WRQoL. Additionally, in the structural equation model, NIHLt was observed to have a direct and negative impact on WRQoL. According to previous research, workers who have HL tend to have an uneven balance between their work demands and the level of control they feel they have over their work, in comparison to those without HL [44, 45]. Social isolation and feelings of exclusion, which are common consequences of HL, can also contribute to a decreased quality of work life [46, 47]. Various studies have indicated that psychological factors, including anxiety, annoyance, fatigue, negative emotions, insomnia, and concentration difficulties, are outcomes of HL that can impact the WRQoL of workers who experience HL [45, 46, 48, 49]. Overall, NIHL can reduce WRQoL through several mechanisms. Firstly, it can impact workers' general well-being due to the impairment of one of their primary senses, leading to a decrease in their overall health status. Secondly, it can disrupt effective communication with colleagues and family members, thereby affecting the Home-Work Interface component of WRQoL. Another way to explain the effect of NIHL on WRQoL is through its impact on job stress and job satisfaction, which are the main foundations of WRQoL. In total, hearing loss affects communication, job performance, well-being, and safety, leading to misunderstandings, isolation, stress, cognitive decline, and limited career opportunities. These circumstances significantly impact the quality of working life [50, 51].

The primary aim of this study was to examine the direct impact of NIHL on IJP, as well as its indirect influence through WRQoL and aggression. The findings indicated that NIHL had a significant and adverse effect on IJP, both directly and indirectly through its impact on WRQoL and aggression. In their research, Schat and Frone investigated the influence of occupational psychological aggression on job performance through personal health and job attitudes. They found that psychological aggression in the workplace could negatively predict both contextual performance and task performance. They also discovered that these relationships were attributed to a decrease in job attitudes and health, which were due to psychological aggression at work [39]. In a similar vein, Bowling and Beehr discovered in their study that workplace aggression had a significant negative correlation with both organizational commitment and job satisfaction [52]. Organizational commitment and job satisfaction are two constructing indices of IJP. Individuals with HL often experience difficulties in comprehending everyday speech, which can impede their ability to communicate effectively with colleagues in the workplace. Consequently, they may face challenges in participating and collaborating with others. Performing tasks safely is a key aspect of job performance. The findings of Picard et al.'s study demonstrated that HL significantly elevates the likelihood of workplace accidents, resulting in a decrease in job performance [53]. Another study conducted by Pickard et al. revealed that individuals with varying degrees of HL are more prone to engaging in unlawful behaviors. The prevalence ratio of traffic accidents was found to be 1.06 for offenders with an average bilateral HL of 16 to 30 dB, and this ratio could rise to 1.31 for those with HL up to 50 dB. In essence, HL was found to increase the likelihood of destructive and unsafe behaviors, thereby significantly diminishing IJP [54]. Numerous studies have demonstrated that HL can result in social isolation, reduced cognitive abilities, and alterations in brain structure, all of which can have a significant impact on IJP [13, 55]. According to the findings presented in Table 4, it can be observed that the path NIHLt → WRQoL → IJP has a higher effect coefficient compared to other direct and indirect paths towards influencing IJP. This indicates that the impact of NIHLt is more pronounced through WRQoL as opposed to aggression. It is worth noting that this path has been shown to have a significant impact on IJP, highlighting the importance of considering both NIHLt and WRQoL when aiming to influence IJP. IJP comprises several crucial elements, including cooperation and assisting others, effective verbal and written communication, managing conflicts with colleagues, avoiding unsafe behaviors, demonstrating resilience and adaptability, and acquiring new skills and technologies. Prior research has indicated that NIHLt can impact these elements. Additionally, the WRQoL plays a pivotal role in determining the level of job performance by influencing these elements. For instance, a decrease in job satisfaction, work control, and an increase in work-related stress, which are key components of the WRQoL, can adversely affect the aforementioned factors and lead to a decline in IJP. Conversely, aggression compared to the WRQoL may have a lower impact on these elements.

Due to the novelty of the subject matter and the absence of a comparable model, along with the limitations of the research methodology employed generalizing the outcomes to other worker populations should be done with caution or avoided until evaluated directly in those populations. This cross-sectional study was carried out on industrial workers or blue-collar worker, it is not feasible to ascertain the causal relationship between pairs of variables due to the cross-sectional nature of study. Moreover, when generalizing the outcomes to women workers, white-collar workers, and pink-collar workers, these differences should be considered. Furthermore, it is worth noting that the measurement of IJP, WRQoL, and aggression was subjective, and the utilization of objective methods would yield more valid results. Thus, utilizing objective methods to measure these variables can yield more accurate and reliable results.

Conclusion

Overall, the results indicate that NIHL had a detrimental effect on WRQoL and could also increase behavioral aggression among workers. Furthermore, IJP was found to be directly and indirectly influenced by NIHL, through reduced WRQoL and aggressive behavior as negative consequences of NIHL. The findings of this study, along with other studies highlighting the detrimental effects of NIHL and underscore the importance of utilizing engineering and administrative methods as much as possible to mitigate NIHL and its adverse health effects [5, 56].

Abbreviations

HL	Hearing loss
NIHLt	Noise Induced Hearing Loss
PTA	Pure Tone Audiometry test
WRQoL	Work Related Quality of Life
IJP	Individual Job Performance
Std. Deviation	Standard Deviation
Std.E of Kurtosis	Standard Error of Kurtosis
Std.E of Skewness	Standard Error of Skewness
GFI	Goodness-of-fit index
AGFI	Adjusted goodness-of-fit index
NFI	Normed fit index
CFI	Comparative fit index
IFI	Incremental fit index
RMSEA	Root mean squared error of approximation
X2/df	Normed Chi-square

Acknowledgements

We would like to express our sincere gratitude to all the workers who participated in this study.

Author contributions
M.A and S.Y conceived and designed the study. F.D and T.E collected the data. JD, EAM, and SY entered the data, analyzed the data and edited the manuscript. T.E, JD and EAM wrote the draft of manuscript. MNA and MA contributed to the final version of the manuscript and supervised the project. All authors provided critical feedback and helped shape the research, analysis and manuscript.

Funding
This research received no external funding.

Data availability
Data will be available from Milad Abbasi upon request.

Declarations

Ethics approval and consent to participate
Ethics approval for this study was obtained from the medical ethics committee of Saveh University of Medical Sciences, and all study procedures were conducted in accordance with the ethical code IR.SAVEHUMS.REC.1401.34. Written informed consent was obtained from all subjects.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 15 April 2024 / Accepted: 23 October 2024
Published online: 05 November 2024

References

1. Monazzam Esmaielpour MR, Zakerian SA, Abbasi M, Ábbasi Balochkhaneh F, Mousavi Kordmiri SH. Investigating the effect of noise exposure on mental disorders and the work ability index among industrial workers. Noise Vib Worldw. 2022;53(1–2):3–11.
2. Abbasi M, Yazdanirad S, Zokaei M, Falahati M, Eyvazzadeh N. A bayesian network model to predict the role of hospital noise, annoyance, and sensitivity in quality of patient care. BMC Nurs. 2022;21(1):243.
3. Abbasi M, Yazdanirad S, Dehdarirad H, Hughes D. Noise exposure and the risk of cancer: a comprehensive systematic review. Rev Environ Health. 2023;38(4):713–26.
4. Huang Z, Qiu W, Zhang V, Wang H, Ye B, Wang Q. Noise-induced hearing loss: from basic to clinical research. Front Integr Nuerosci. 2023;17:13.
5. Chen K-H, Su S-B, Chen K-T. An overview of occupational noise-induced hearing loss among workers: epidemiology, pathogenesis, and preventive measures. Environ Health Prev Med. 2020;25:1–10.
6. Chen X-m, Xue X-m, Yu N, Guo W-w. Yuan S-l, Jiang Q-q, Yang S-m. The role of genetic variants in the susceptibility of noise-induced hearing loss. Front Cell Neurosci. 2022;16:946206.
7. Chadha S, Kamenov K, Cieza A. The world report on hearing, 2021. Bull World Health Organ. 2021;99(4):242.
8. Beyan AC, Demiral Y, Cimrin AH, Ergor A. Call centers and noise-induced hearing loss. Noise Health. 2016;18(81):113.
9. Zhou H, Zhou Y, Zhang H, Yu A, Zhu B, Zhang L. Socio-economic disparity in the global burden of occupational noise-induced hearing loss: an analysis for 2017 and the trend since 1990. Occup Environ Med. 2021;78(2):125–8.
10. Parida S, Heinz MG. Underlying neural mechanisms of degraded speech intelligibility following noise-induced hearing loss: the importance of distorted tonotopy: neural mechanisms of degraded speech intelligibility. Hear Res. 2022:108586.
11. Deng XF, Shi GQ, Guo LL, Zhu CA, Chen YJ. Analysis on risk factors of depressive symptoms in Occupational noise-induced hearing loss patients: a cross-sectional study. Noise Health. 2019;21(98):17–24.
12. Broekhof E, Bos MG, Rieffe C. The roles of shame and guilt in the development of aggression in adolescents with and without hearing loss. Res Child Adolesc Psychopathol. 2021;49(7):891–904.
13. Maharani A, Pendleton N, Leroi I. Hearing impairment, loneliness, social isolation, and cognitive function: longitudinal analysis using English longitudinal study on ageing. Am J Geriatric Psychiatry. 2019;27(12):1348–56.
14. Si S, Lewkowski K, Fritschi L, Heyworth J, Liew D, Li I. Productivity burden of occupational noise-induced hearing loss in Australia: a life table modelling study. Int J Environ Res Public Health. 2020;17(13):4667.
15. Alamgir H, Turner CA, Wong NJ, Cooper SP, Betancourt JA, Henry J, et al. The impact of hearing impairment and noise-induced hearing injury on quality of life in the active-duty military population: challenges to the study of this issue. Mil Med Res. 2016;3:11.
16. Dalton DS, Cruickshanks KJ, Klein BE, Klein R, Wiley TL, Nondahl DM. The impact of hearing loss on quality of life in older adults. Gerontologist. 2003;43(5):661–8.
17. Vernon M, Greenberg SF. Violence in deaf and hard-of-hearing people: a review of the literature. Aggress Violent Beh. 1999;4(3):259–72.
18. Saki N, Bayat A, Moniri S, Moogahi NK. The influence of cochlear implantation on aggression behaviors in children. Int J Pediatr Otorhinolaryngol. 2019;127:109669.
19. Broekhof E, Bos MGN, Rieffe C. The roles of shame and guilt in the development of aggression in adolescents with and without hearing loss. Res Child Adolesc Psychopathol. 2021;49(7):891–904.
20. Dixon PR, Feeny D, Tomlinson G, Cushing S, Chen JM, Krahn MD. Health-Related Quality of Life Changes Associated with hearing loss. JAMA Otolaryngology–Head Neck Surg. 2020;146(7):630–8.
21. Rastegari M, Khani A, Ghalriz P, Eslamian J. Evaluation of quality of working life and its association with job performance of the nurses. Iran J Nurs Midwifery Res. 2010;15(4):224.
22. Schat AC, Frone MR. Exposure to psychological aggression at work and job performance: the mediating role of job attitudes and personal health. Work Stress. 2011;25(1):23–40.
23. Lin WQ, Wu J, Yuan LX, Zhang SC, Jing MJ, Zhang HS, et al. Workplace violence and job performance among Community Healthcare Workers in China: the Mediator Role of Quality of Life. Int J Environ Res Public Health. 2015;12(11):14872–86.
24. Abbasi M, Monazzam MR, Shamsipour M, Arabalibeik H. Individual job performance assessment models: a systematic review study. J Health Saf Work. 2021;11(4).
25. Abbasi M, Monazzam MR, Arabalibeik H, Shamsipour M. Identifying and weighting of dimensions and indicators of individual job performance using fuzzy Delphi and fuzzy analytic hierarchy process techniques. Int J Workplace Health Manage. 2022;15(1):99–112.
26. Abbasi M, Monazzam MR, Karanika-Murray M, Shamsipour M, Arabalibeik H. Development and validation of an individual job performance questionnaire (IJPQ). Work. 2022;Preprint:1–12.
27. Mazloumi A, Kazemi Z, Mehrdad R, Shahri MHK, Hossein MP. Validity and reliability of WRQoL-2 questionnaire for assessment of nurses' quality of work life. J Health Saf Work. 2017;7(2).
28. Buss AH, Perry M. The aggression questionnaire. J Personal Soc Psychol. 1992;63(3):452.
29. IIOf S. ISO 8253-1, acoustics – audiometric test methods – part 1: basic pure Tone Air and bone conduction threshold audiometry. Geneva: ISO; 1989.
30. Organization WH. Report of the informal working group on prevention of deafness and hearing impairment Programme planning, Geneva, 18–21 June 1991. World Health Organization; 1991.
31. Lüders D, Lopes FC, Gonçalves CGO, de Lacerda ABM, José MR, Marques JM. Hearing impairment among workers and satisfaction with the use of hearing aids. Work. 2022;71(3):661–9.
32. George D, Mallery P. IBM SPSS statistics 26 step by step: a simple guide and reference. Routledge; 2019.
33. Thakkar JJ, Thakkar JJ. Applications of structural equation modelling with AMOS 21, IBM SPSS. Structural Equation Modelling: Application for Research and Practice (with AMOS and R). 2020:35–89.
34. Fiorillo CE, Rashidi V, Westgate PM, Jacobs JA, Bush ML, Studts CR. Assessment of behavioral problems in children with hearing loss. Otol Neurotol. 2017;38(10):1456–62.
35. Chao W-C, Lee L-A, Liu T-C, Tsou Y-T, Chan K-C, Wu C-M. Behavior problems in children with cochlear implants. Int J Pediatr Otorhinolaryngol. 2015;79(5):648–53.
36. Adebisi RO, Yakubu DG. Aggressive behaviours on peer social relationship of students with hearing impairment in Federal College of Education (Special), Oyo, Nigeria. Res J Adv Social Sci. 2020;1:40–52.

37. Carman KG, Zhang L. Classroom peer effects and academic achievement: evidence from a Chinese middle school. China Econ Rev. 2012;23(2):223–37.
38. Palmer AD, Newsom JT, Rook KS. How does difficulty communicating affect the social relationships of older adults? An exploration using data from a national survey. J Commun Disord. 2016;62:131–46.
39. Schat A, Frone MR. Exposure to psychological aggression at work and job performance: the Mediating Role of Job attitudes and Personal Health. Work Stress. 2011;25(1):23–40.
40. Merecz D, Drabek M, Moscicka A. Aggression at the workplace-psychological consequences of abusive encounter with coworkers and clients. Int J Occup Med Environ Health. 2009;22(3):243.
41. Easton S, Van Laar D. QoWL (quality of working life)-what, how, and why? Psychol Res. 2013;3(10):596.
42. Caillier JG. The impact of workplace aggression on employee satisfaction with job stress, meaningfulness of work, and turnover intentions. Public Personnel Manage. 2021;50(2):159–82.
43. Tyas YPA, Chusniyah T, Wahyu AM, Utami LH, Basith RRA. Workplace aggression and job satisfaction: a study on employees of PT. ABC in Tangerang, Banten. KnE Social Sci. 2022:346–55.
44. Kramer SE, Kapteyn TS, Houtgast T. Occupational performance: comparing normally-hearing and hearing-impaired employees using the Amsterdam Checklist for hearing and work: Desempeño laboral: Comparación De empleados con audición normal o alterada usando El Listado Amsterdam para Audición Y Trabajo. Int J Audiol. 2006;45(9):503–12.
45. Danermark B, Gellerstedt LC. Psychosocial work environment, hearing impairment and health. Int J Audiol. 2004;43(7):383–9.
46. Hua H, Anderzén-Carlsson A, Widén S, Möller C, Lyxell B. Conceptions of working life among employees with mild-moderate aided hearing impairment: a phenomenographic study. Int J Audiol. 2015;54(11):873–80.
47. Canton K, Williams W. The consequences of noise-induced hearing loss on dairy farm communities in New Zealand. J Agromed. 2012;17(4):354–63.
48. Svinndal EV, Solheim J, Rise MB, Jensen C. Hearing loss and work participation: a cross-sectional study in Norway. Int J Audiol. 2018;57(9):646–56.
49. Backenroth-Ohsako GA, Wennberg P, Klinteberg BA. Personality and work life: a comparison between hearing-impaired persons and a normal-hearing population. Social Behav Personality: Int J. 2003;31(2):191–204.
50. Nordvik Ø, Laugen Heggdal PO, Brännström J, Vassbotn F, Aarstad AK, Aarstad HJ. Generic quality of life in persons with hearing loss: a systematic literature review. BMC Ear Nose Throat Disord. 2018;18:1.
51. Alrasheed AM, Junaid M, Ardi KT, Ebraheem FAM, Alaidaroos OZ. Quality of life among adults with hearing loss who were prescribed hearing aids in Aseer Province, Saudi Arabia: a cross-sectional Tertiary Center-based study. Cureus. 2023;15(9):e45922.
52. Bowling NA, Beehr TA. Workplace harassment from the victim's perspective: a theoretical model and meta-analysis. J Appl Psychol. 2006;91(5):998.
53. Picard M, Girard SA, Simard M, Larocque R, Leroux T, Turcotte F. Association of work-related accidents with noise exposure in the workplace and noise-induced hearing loss based on the experience of some 240,000 person-years of observation. Accid Anal Prev. 2008;40(5):1644–52.
54. Picard M, Girard SA, Courteau M, Leroux T, Larocque R, Turcotte F, et al. Could driving safety be compromised by noise exposure at work and noise-induced hearing loss? Traffic Inj Prev. 2008;9(5):489–99.
55. Lin F, Ferrucci L, An Y, Goh J, Doshi J, Metter E, et al. Association of hearing impairment with brain volume changes in older adults. NeuroImage. 2014;90:84–92.
56. Abbasi M, Pourrajab B, Tokhi MO. Protective effects of vitamins/antioxidants on occupational noise-induced hearing loss: a systematic review. J Occup Health. 2021;63(1):e12217.

Publisher's note