Auditory and Vestibular Research

Temperament and Its Impact on Noise Sensitivity, Hyperacusis and Noise Annoyance

Milad Abbasi [1], Mahdi Sharifpour [2], Yasin Manoochehri [3], Jalil Derakhshan [4*]

1 Occupational Health Engineering, Social Determinants of Health Research Center, Saveh University of Medical Sciences, Saveh, Iran. https://ORCID.org/0000-0002-0787-1533, Email: Milad8285@Gmail.Com

2 Occupational Health Engineering, student research committee, Saveh University of Medical Sciences, Saveh, Iran. https://orcid.org/0009-0006-7781-8312, Email: Mahdisharifpour05@gmail.com

3 M.A student in business and administration, Islamic Azad university Sanandaj branch, Sanandaj, Iran. https://ORCID.org/0009-0009-6234-0143, Email: Yasinmanouchehri@gmail.com

4* MSc in Occupational Health Engineering, School of Public Health, Hamedan University of Medical Sciences, Hamedan, Iran. https://ORCID.org/0000-0001-5370-3584, Email: Jalil_Derakhshan@Yahoo.Com

Corresponding author: Jalil Derakhshan, MSc in Occupational Health Engineering, School of Public Health, Hamedan University of Medical Sciences, Hamedan, Iran. https://ORCID.org/0000-0001-5370-3584, Email: Jalil_Derakhshan@Yahoo.Com

Highlights:

Dry temperament was strongly associated with hyperacusis, sensitivity, and annoyance

Melancholic and choleric temperaments were strongly associated with Studied variables

Phlegmatic temperament showed the weakest association with Studied variables

Abstract

Background and Aim: Previous research has linked personality traits to noise perception, yet the role of temperament, a fundamental determinant of emotional and sensory processing, remains insufficiently explored. This study aimed to examine the impact of various temperament types on hyperacusis, noise sensitivity, and noise annoyance among industrial workers.

Method: A cross-sectional study was conducted among 320 participants aged 20–60, selected via strict criteria. Variables were assessed using validated questionnaires, including Mojahedi Temperament, Weinstein Noise Sensitivity, Noise Annoyance, and Khalfa Hyperacusis. Data were analyzed using SPSS, with descriptive statistics, correlation, ANOVA, and MANCOVA employed for relationships and group differences.

Results: The results indicated that Melancholic individuals exhibited the highest hyperacusis (Mean = 6.01), sensitivity (Mean = 7.37), and annoyance (Mean = 8.19), whereas phlegmatic individuals showed the lowest sensitivity (Mean = 2.82,) and annoyance (Mean = 3.16). The dryness-wetness temperament dimension correlated positively with hyperacusis ($r = 0.275$, $p < 0.01$) and annoyance ($r = 0.184$, $p < 0.05$), indicating greater noise reactivity in individuals with drier temperaments. The effect of temperament on hyperacusis ($\eta^2 = 0.11$) was stronger than its impact on sensitivity ($\eta^2 = 0.03$) and annoyance ($\eta^2 = 0.07$).

Conclusion: In conclusion, this study highlights the significant role of temperament in shaping individuals' responses to noise, with melancholic and choleric individuals exhibiting the highest levels of noise sensitivity and annoyance, and phlegmatic individuals reporting the lowest levels. These findings underscore the necessity of personalized noise mitigation strategies in occupational settings to protect worker health.

Key words: Temperament, hyperacusis, noise sensitivity, noise annoyance, occupational noise exposure

INTRODUCTION

Noise exposure is a well-documented occupational hazard, particularly in industrial environments, where chronic exposure to high-intensity noise can lead to both auditory and non-auditory health consequences [1, 2]. While the physiological effects of noise exposure, such as hearing loss and its consequences and cardiovascular risks, have been extensively studied, its remain an area of ongoing investigation [3]. Exposure to noise has been associated with heightened stress levels, decreased cognitive performance, and impaired efficiency, underscoring the importance of understanding the psychological mechanisms underlying noise perception [4].

However, individuals exhibit considerable variability in their responses to noise, suggesting that noise perception is not solely dependent on objective acoustic characteristics but is also influenced by psychological predispositions [5, 6]. Hyperacusis refers to an exaggerated perception of loudness or discomfort in response to moderate or low-intensity sounds and is often linked to neurological and affective hypersensitivity [7, 8]. Noise sensitivity is a stable psychological trait that predisposes individuals to react negatively to noise, independent of its intensity [9]. Noise annoyance, in contrast, encompasses both emotional and cognitive responses to unwanted noise, which may be influenced by contextual and personality-related factors [10, 11].

While previous studies have established that personality traits, such as neuroticism and introversion, are associated with heightened noise sensitivity [12, 13], individual differences in sensory processing and emotional reactivity may also contribute to variations in auditory perception [14, 15]. Temperament, as a biologically rooted aspect of personality, encompasses these stable predispositions, shaping how individuals regulate emotions, process sensory stimuli, and respond to environmental stressors [14, 16]. Given its role in emotional and physiological reactivity, temperament may influence whether noise is perceived as a minor nuisance or a significant source of distress, further highlighting the need to examine its impact on noise perception.

Traditionally, temperament has been classified into four primary types: melancholic, choleric, sanguine, and phlegmatic, each associated with distinct emotional, cognitive, and behavioral characteristics [17, 18]. Individuals with melancholic and choleric temperaments, who are more emotionally reactive and prone to heightened arousal, may exhibit greater sensitivity to environmental stimuli, including noise [19]. In contrast, sanguine and phlegmatic individuals, characterized by emotional stability and lower physiological reactivity, may demonstrate greater resilience against noise-induced distress [20]. Given these differences, temperament may offer a novel explanation for why some individuals experience severe noise-induced discomfort while others remain largely unaffected.

Despite growing evidence linking personality traits to noise perception and its effects, the specific role of temperament in shaping auditory experiences remains underexplored. Understanding temperament's influence on noise perception and its effects is particularly important in occupational settings, where noise exposure is unavoidable, and individual differences may determine susceptibility to its adverse effects. Although occupational noise exposure is a major environmental risk factor, hyperacusis is not necessarily a direct consequence of noise. It can also occur in individuals without occupational noise exposure, reflecting broader neurological and emotional hypersensitivity [21]. At the same time, occupational noise may amplify the impact of hyperacusis and noise sensitivity in vulnerable individuals. Clarifying this distinction underscores the rationale for investigating temperament as a stable individual characteristic that may interact with occupational noise exposure to influence noise perception. This study aimed to fill this gap by systematically examining the temperament and its impact on noise sensitivity, hyperacusis and noise annoyance. By investigating how different temperamental profiles correlate with hyperacusis, noise sensitivity, and noise annoyance, this research seeks to contribute to the development of personalized noise mitigation strategies and inform workplace interventions that enhance worker well-being.

Methods

This study followed a cross-sectional design. This approach provided a snapshot analysis of noise sensitivity, noise annoyance, hyperacusis, and temperament within the selected population. To test the study hypotheses, the required sample size was estimated using G*Power software (version 3.1.9.4). Given a Type I error rate of 0.05 ($\alpha = 0.05$), a statistical power of 0.80 ($1-\beta$), and an effect size of 0.05 ($f^2 = 0.05$), the minimum required sample size was determined to be 279 participants. To account for potential non-response and incomplete questionnaires (estimated at 15%), the final target sample size was increased to 320 participants.

The study population consisted of individuals aged 20 to 60 years, selected based on strict inclusion and exclusion criteria to minimize confounding variables. An initial eligibility screening interview was conducted with each participant to confirm inclusion criteria. All participants underwent a brief auditory screening to identify any history or symptoms of hearing disorders. Individuals with clinically reported hearing loss, tinnitus, middle or inner ear diseases, or other auditory pathologies—based on the occupational health records maintained by the company's medical unit—were excluded from the study. This ensured that only participants with normal hearing status were included, as auditory problems could significantly influence noise perception. Furthermore, mental health status was a key determinant; it was assessed through a brief structured interview conducted at enrollment and by reviewing each participant's occupational health records maintained by the company's medical unit. Individuals with a documented diagnosis of psychiatric disorders, including depression or anxiety disorders, or those under psychiatric treatment were excluded from the study to prevent potential biases in responses to noise-related stimuli. Additionally, individuals who failed to fully complete the questionnaires or provided inconsistent responses were excluded from the final dataset. Participants were full-time industrial workers employed in manufacturing, assembly, and maintenance units. The average occupational experience was 13.38 years (SD = 6.2), with cumulative exposure to noise levels ranging between 82 and 85 dB(A), based on recent workplace monitoring reports. Both male and female workers were engaged in comparable tasks under similar noise exposure conditions. Given the small number of female participants (n = 26), potential gender differences were considered as a covariate in the statistical analysis.

To assess the study variables comprehensively, participants completed a series of standardized Persian-language questionnaires, each designed to measure temperament, noise sensitivity, hyperacusis, noise annoyance. Participants were provided with clear, standardized instructions to minimize response bias, and a trained research assistant was available to clarify any ambiguities. Ethical approval for this study was granted by the Medical Ethics Committee of Saveh University of Medical Sciences (Ethics Code: IR.SAVEHUMS.REC.1403.055). All procedures were conducted in full compliance with the approved ethical guidelines. Prior to participation, all individuals received comprehensive information regarding the study's objectives and methodology. Oral informed consent was obtained from all participants, affirming their voluntary participation. All collected data remained strictly confidential, anonymized, and accessible solely to the research team, ensuring full compliance with ethical and data protection standards.

Demographic questionnaire

This questionnaire gathered essential background information, including age, experience, gender, marital status, and education level.

Mojahedi temperament questionnaire

The Mojahedi Temperament Questionnaire includes ten items assessing the warm–cold (eight items) and wet–dry (two items) dimensions. The instrument has demonstrated acceptable validity and reliability in previous studies. Each item is scored on a scale from 1 to 3, with the total score for each dimension calculated based on the selected cutoff points. The sum of the scores from the first eight items determines the warm-cold temperament classification: a score above 18 indicates a warm temperament, a score between 15 and 18 indicates a moderate temperament, and a score below 15 indicates a cold temperament. Similarly, the sum of the scores from the last two items determines the wet-dry temperament classification: a score above 4 indicates a dry temperament, a score of 4 indicates a moderate temperament, and a score below 3 indicates a wet temperament. By combining the warm-cold and wet-dry classifications, the primary temperaments are derived as follows: Sanguine (warm and wet), Phlegmatic (Cold and wet), Choleric (warm and dry), Melancholic (Cold and dry), Moderate (A combination of one of the above temperaments with a moderate state in either the warm-cold or wet-dry dimension) [22].

Weinstein noise sensitivity questionnaire

The Weinstein Noise Sensitivity Scale is a 21-item self-report scale measuring emotional and attitudinal reactions to everyday noise on a 6-point Likert scale. Higher scores indicate greater noise sensitivity. The Persian version showed good internal consistency (Cronbach's $\alpha = 0.78$) and confirmed validity. The maximum total score of the test is 105, and a higher score indicates greater sensitivity to sound [23].

Noise annoyance scale

To assess noise annoyance, the participants were asked to rate the level of annoyance related to ambient noise on a 100-point graphic rating scale with two verbal extremes: "not annoying at all equal to zero" and "extremely annoying equal to 100". This scale has been used in many other studies as a valid scale [24].

Khalfa hyperacusis questionnaire

A hyperacusis questionnaire designed by Khalfa et al. [7] which has been validated in a number of studies and its psychometric properties have been evaluated was used for this study. This tool measures a person's hyperacusis in three fields of attentional, social, and emotional dimensions. Attentional and emotional dimension fields have four questions and social dimension field has six questions that have a cutoff point of 28. The answers of the items were scored based on a 4-point Likert scale. In Iran, the Persian version of the hyperacusis questionnaire has demonstrated acceptable validity and reliability, with a reported Cronbach's alpha of 0.811. It is easy to use for a variety of studies, given that there are few questions in the tool [8].

Data analysis

All statistical analyses were conducted using SPSS software (version 17.0.0). Descriptive statistics, including means, standard deviations, and frequency were computed to summarize the characteristics of the study variables. The Kolmogorov-Smirnov test was used to assess the normality of data distribution, while Levene's test was performed to evaluate the homogeneity of variances. To examine the relationships between hyperacusis, noise annoyance, noise sensitivity, and temperament scores, Pearson's correlation coefficient was calculated. Differences in hyperacusis, noise annoyance, noise sensitivity across temperament groups were analyzed using one-way analysis of variance (ANOVA), followed by Scheffé's test for post hoc comparisons. Additionally, a multivariate analysis of covariance (MANCOVA) was performed to explore the effects of temperament dimensions while controlling for potential confounders.

Results

The frequency distribution of demographic variables, including age, work experience, gender, marital status, and educational level of the participants, is detailed in Table 1.

Descriptive statistics for the main study variables are provided in Table 2.

As presented in Table 3, the Pearson correlation analysis indicated significant positive associations among hyperacusis, noise annoyance, and noise sensitivity ($p < 0.05$). Hyperacusis also showed a positive correlation with the wet–dry temperament score and a weak negative relationship with the warm–cold dimension.

One-way ANOVA results (Table 4) revealed no statistically significant differences among cold, moderate, and warm temperaments in hyperacusis, noise annoyance, or noise sensitivity ($p > 0.05$). However, significant differences were found among wet, moderate, and dry temperaments ($p < 0.05$). Post-hoc tests confirmed that individuals with a dry temperament reported higher mean levels of all three auditory outcomes compared with wet and moderate groups.

Descriptive and ANOVA results based on combined temperament groups (Table 5) showed significant differences in hyperacusis, noise annoyance, and noise sensitivity ($p < 0.05$). Pairwise Scheffé tests revealed that the Melancholic group differed significantly from the Sanguine, Phlegmatic, and Choleric groups in levels of hyperacusis. Phlegmatic individuals reported significantly lower noise annoyance than those with Choleric or Melancholic temperaments. For noise sensitivity, the no significant difference was found between different groups.

The results from the multivariate analysis of covariance (MANCOVA) indicated that temperament had a significant impact on the dependent variables, including hyperacusis, noise annoyance, and noise sensitivity. In the adjusted model, for the variable hyperacusis, the F-value was 9.98, with a significance level of 0.001, indicating a significant effect of temperament on this variable. The Eta-squared value was 0.11, suggesting a relatively strong effect of temperament on hyperacusis. For noise annoyance, the F-value was 6.66, and the significance level was 0.001. The Eta-squared value was 0.07, indicating a significant effect of temperament on annoyance. For noise sensitivity, the F-value was 2.56, and the significance level was 0.03, indicating that while the effect of temperament on sensitivity was less pronounced, it was still statistically significant.

Discussion

This study aimed to investigate the impact of individuals' temperaments on hyperacusis, noise sensitivity, and noise annoyance among industrial workers.

The results demonstrated that individuals with melancholic temperaments exhibited the highest levels of hyperacusis, noise sensitivity, and noise annoyance, while those with phlegmatic temperaments reported the lowest levels. These findings align with previous research suggesting that individuals with higher levels of neuroticism and introversion, traits commonly associated with melancholic temperaments, are more prone to heightened sensory processing and emotional reactivity [19, 25]. For instance, Shepherd et al. found that individuals with high sensory processing sensitivity, a trait closely linked to melancholic temperaments, tend to exhibit greater reactivity to environmental stimuli, including noise [25]. Similarly, Watson and Clark highlighted that individual with high negative affectivity, a hallmark of melancholic temperaments, are more likely to experience heightened stress responses to environmental stressors, such as noise [19]. Overall, these results indicate a significant impact of temperament on auditory outcomes, with the strongest effects observed for hyperacusis. These findings suggest that the increased sensitivity to noise observed in melancholic individuals may be driven by their predisposition to anxiety and heightened emotional arousal.

Individuals with phlegmatic temperaments, characterized by emotional stability and low reactivity, reported the lowest levels of noise sensitivity and annoyance. This is consistent with studies showing that individuals with low neuroticism and high emotional stability are less affected by environmental stressors, including noise [26, 27]. For example, Costa and McCrae found that individuals with low levels of emotional reactivity exhibit reduced physiological and psychological responses to stress, which may explain the lower levels of noise-related distress observed in phlegmatic individuals [27]. However, not all pairwise comparisons across temperament groups reached statistical significance, indicating that temperament is one of several contributors to individual differences in noise-related outcomes.

Choleric individuals, who are typically extroverted and emotionally reactive, also exhibited elevated levels of noise annoyance, though to a lesser extent than melancholic individuals. This finding aligns with Mehrabian's observation that individuals with high levels of emotional excitability and extroversion tend to exhibit stronger reactions to environmental stimuli, including noise [15]. Hogan et al. further suggested that individuals with high emotional arousal, a characteristic of choleric temperaments, are more likely to experience heightened stress responses in noisy environments [28]. These findings underscore the role of emotional reactivity in shaping individuals' responses to noise. In line with this, individuals with a warm temperament reported the highest noise annoyance scores, while those with a moderate temperament showed the highest hyperacusis values.

The study also revealed that individuals with dry temperaments (melancholic and choleric) were more sensitive to noise compared to those with wet temperaments (sanguine and phlegmatic). This finding is consistent with the theoretical framework of temperament, which posits that dry temperaments are associated with higher levels of emotional reactivity and sensory sensitivity [16, 29]. For instance, Eysenck and Eysenck suggested that individuals with high levels of neuroticism, a trait common in dry temperaments, exhibit increased activity in the prefrontal cortex and amygdala in response to stressors, which may amplify their sensitivity to noise [30]. Our findings further showed that individuals with dry temperaments consistently exhibited higher mean scores across hyperacusis, noise sensitivity, and noise annoyance. This pattern suggests that dryness as a temperamental trait increases vulnerability to noise-related distress.

Moreover, the association between auditory outcomes and temperament appeared stronger for the wet–dry dimension than for the warm–cold dimension. In particular, individuals with drier and warmer temperaments showed higher hyperacusis, noise annoyance, and noise sensitivity compared to other groups. These significant differences suggest a meaningful link between physiological/psychological traits and temperament, underscoring that dryness exerts a stronger influence on noise outcomes than warmth or coldness alone.

This study has several limitations that should be acknowledged. First, the reliance on self-report questionnaires may introduce bias, as participants' subjective perceptions could influence their responses. Future research should complement subjective data with objective auditory assessments, such as pure-tone audiometry, hearing threshold evaluation, and loudness discomfort level (LDL) testing, to provide more robust evidence. Second, the study focused on industrial workers, which may limit the generalizability of the findings to other populations. Future studies should investigate these associations in both occupational and non-occupational settings. Third, although participants were screened to exclude those with hearing loss, tinnitus, and other auditory disorders, detailed audiometric and LDL data were not collected or analyzed. Moreover, this research provides a descriptive profile of hyperacusis, noise sensitivity, and noise annoyance across temperament types among workers exposed to industrial noise. To gain a clearer understanding of temperament as a determinant of vulnerability to noise-related outcomes, future comparative studies between noisy and non-noisy environments are strongly recommended. Longitudinal studies incorporating both subjective and objective auditory measures are recommended to achieve a more comprehensive understanding of these relationships.

Conclusion

In conclusion, this study highlights the significant role of temperament in shaping individuals' responses to noise, with melancholic and choleric individuals exhibiting the highest levels of noise sensitivity and annoyance, and phlegmatic individuals reporting the lowest levels. These findings underscore the importance of considering individual differences in temperament when designing noise management strategies within occupational noise environments. By tailoring interventions to individuals' temperamental traits, it may be possible to reduce noise-related distress and improve overall well-being in noise-intensive environments.

Ethics Approval and Consent to Participate

Ethical approval for this study was granted by the Medical Ethics Committee of Saveh University of Medical Sciences (Ethics Code: IR.SAVEHUMS.REC.1403.055). All procedures were conducted in full compliance with the approved ethical guidelines.

Competing interests

The authors declare no conflict of Competing interests.

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Authors' contributions

M.A: Conception and design of the study, data collection, interpretation of the results, drafting the manuscript, and supervision of the project; M.Sh: Data entry, statistical analysis, interpretation of the results, and drafting the manuscript; Y.M: Data entry, statistical analysis, interpretation of the results, and drafting the manuscript; J.D: Data collection, interpretation of the results, and drafting the manuscript.

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Table 1. Frequency of gender, marital status, and education level of participants

Variable	Groups	Frequency	Percent
Gender	Male	294	91.9
	Female	26	8.1
Marital status	Single	70	21.9
	Married	250	78.1
Education	Diploma	200	62.5
	Basic	112	35.0
	Masters & PhD	8	2.5

Table 2. Descriptive statistics of the variables under study

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age	320	21.00	60.00	37.43	7.64
Work Experience	320	1.00	30.00	13.38	7.01
Hyperacusis	320	14.00	61.00	28.99	7.06
Annoyance	320	18.00	98.00	61.46	19.63
Sensitivity	320	13.00	75.00	44.33	16.64
Warm-Cold Score	320	9.00	23.00	17.14	4.93
Wet-Dry Score	320	2.00	6.00	3.74	1.72

Table 3. Correlation matrix of the variables under study

Variable	Hyperacusis	Annoyance	Sensitivity	Warm-Cold Score	Wet-Dry Score
Hyperacusis	1	-	-	-	-
Annoyance	0.294*	1	-	-	-
Sensitivity	0.533*	0.602*	1	-	-
Warm-Cold Score	-0.122*	0.033	-0.005	1	-
Wet-Dry Score	0.275*	0.184*	0.135*	-0.121*	1

*= P-value < 0.05

Table 4. Comparison of continuous variables based on warmth-coldness and dryness-wetness groups

Temperament		N	Mean	Std. Deviation	Std. Error	95%Confidence Interval for Mean		F	Between df	Within df	P-Value
						Lower Bound	Upper Bound				
Hyperacusis	Cold	142	29.75	6.92	0.58	28.60	30.90	2.539	2	317	0.081
	Moderate	11	31.36	11.06	3.33	23.92	38.79				
	Warm	167	28.19	6.81	0.52	27.15	29.23				
Annoyance	Cold	142	60.33	20.02	1.68	57.00	63.65	0.647	2	317	0.524
	Moderate	11	58.54	24.85	7.49	41.84	75.24				
	Warm	167	62.62	18.97	1.46	59.72	65.52				
Sensitivity	Cold	142	44.42	17.46	1.46	41.52	47.32	0.673	2	317	0.511
	Moderate	11	38.63	17.14	5.17	27.11	50.15				
	Warm	167	44.64	15.91	1.23	42.20	47.07				
Hyperacusis	Wet	150	26.99	6.94	0.56	25.87	28.11	13.92	2	317	0.001
	Moderate	61	29.47	7.73	0.99	27.49	31.45				
	Dry	109	31.47	5.99	0.57	30.33	32.61				
Annoyance	Wet	150	58.70	20.42	1.66	55.40	61.99	10.68	2	317	0.001
	Moderate	61	56.22	18.47	2.36	51.49	60.96				
	Dry	109	68.20	17.36	1.66	64.90	71.49				
Sensitivity	Wet	150	42.58	17.32	1.41	39.79	45.38	4.61	2	317	0.011
	Moderate	61	41.73	15.92	2.03	37.65	45.81				
	Dry	109	48.20	15.49	1.48	45.26	51.14				

Table 5. Comparison of continuous variables based on combined temperament groups

Variable	Temperament	N	Mean	Std. Deviation	Std. Error	95%Confidence Interval for Mean		F	Between df	Within df	P-Value
						Lower Bound	Upper Bound				
Hyperacusis	Sanguine	92	27.63	7.75	0.80	26.02	29.23	9.98	4	315	0.001
	Phlegmatic	59	26.27	5.70	0.74	24.78	27.75				
	Choleric	54	29.09	5.14	0.70	27.68	30.49				
	Melancholic	54	33.64	5.79	0.78	32.06	35.23				
	Moderate	61	29.47	7.73	0.99	27.49	31.45				
Annoyance	Sanguine	92	60.73	20.64	2.15	56.46	65.01	6.66	4	315	0.001
	Phlegmatic	59	55.06	19.87	2.58	49.88	60.24				
	Choleric	54	67.81	16.28	2.21	63.37	72.25				
	Melancholic	54	69.25	17.98	2.44	64.34	74.16				
	Moderate	61	56.22	18.47	2.36	51.49	60.96				
Sensitivity	Sanguine	92	43.28	17.03	1.77	39.75	46.81	2.56	4	315	0.038
	Phlegmatic	59	41.45	17.72	2.30	36.83	46.07				
	Choleric	54	47.27	14.13	1.92	43.41	51.13				
	Melancholic	54	49.27	16.91	2.30	44.66	53.89				
	Moderate	61	41.73	15.92	2.03	37.65	45.81				