A Profile of Noise Sensitivity on the Health-Related Quality of Life Among Young Motorcyclists

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Abstract

Introduction: Motorcycle riders with noise sensitivity (NS) may suffer from degraded health-related quality of life (HRQOL) because they are exposed to acute noise levels on a daily basis. Materials and Methods: This study was aimed to identify the relationship between NS and HRQOL among young motorcycle riders (undergraduate university students) aged between 19 and 25 years (n = 301) through a cross-sectional questionnaire-based study, that is, Weinstein noise sensitivity scale and the World Health Organization Quality of Life. The effects of NS on HRQOL were assessed based on gender, the years of motorcycle driving experience, and noise sensitive among groups using one-way analysis of variances with an alpha value of 0.05. Results: The results showed no significant difference in NS between males and females. On the other hand, motorcycle driving experience for <4 years displayed a higher tendency toward NS. Moreover, a significantly (P = 0.004) decreasing trend among low, moderate, and high NS with their respective HRQOL was observed, while a high NS showed significantly (P = 0.015) lower scores on the social domain of the quality of life. Conclusion: The overall premise of the study has statistical significance and shows that individuals with high NS tend to have degraded HRQOL compared to individuals with low NS. Furthermore, in-depth studies are required from the other demographical background of participants to investigate the motorcyclist’s NS and HRQOL as an integral requirement for the rider’s safety and health.

Keywords: Health-related quality of life, motorcyclists, noise sensitivity, WHOQOL, WNSS

INTRODUCTION

From the public health perspective, noise is regarded as the second highest environmental stressor,¹ which is an inevitable pollutant linked with an increased risk of diseases² such as hearing impairments³ disturbed sleeping patterns,⁴ cardiovascular diseases,⁵ hypertension,⁶ and mental health deficits such as declining task performance and attention,⁷ anxiety and nervousness,⁸ stress hormonal imbalances,⁹ fatigue,¹⁰ and annoyance.¹¹ Unremitting advances in transportation and rapid urbanization have resulted in the high levels of noise, wherein motorcycles are considered to be the vital contributor.¹² In Malaysia, similar to most of the Asian countries, the traffic type is mixed (cars, trucks, and motorcycles), wherein motorcycles not only contribute to noise pollution but also toward the increasing number of road fatalities. According to research, motorcyclists are categorized as the most vulnerable road users, because they constitute 60% of the road accidents and fatalities.¹³ Moreover, young riders aged between 19 and 29 years are mostly at risk.¹⁴ Statistics provided by the Royal Malaysian Police reported motorcycle accidents as the number one cause of road traffic fatalities.¹⁵ Motorcycle noise may directly affect riders with adverse health consequences. Riders encounter turbulent wind flow around their helmet, which creates excessive wind noise.¹⁶,¹⁷ This noise increases with increasing speeds, such as up to 90 dBA at the speed of 50 km/h,¹⁸ which is considerably sufficient for activating physiological stress.

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Noise can cause cognitive impairments that can result in motorcycle accidents. These cognitive impairments may arise because of chronic noise induced stress reactions (elevated cortisol levels), which need in-depth investigation. To explore the mental and physical health status of motorcycle riders, it is important to address the noise sensitivity (NS) factor for understanding individual differences toward noise reactions and noise adaptation. These individual differences and adaptation toward noise can be influenced by the number of driving years, and it can affect the rider’s health-related quality of life (HRQOL).

NS is a stable personality trait; moreover, it is relatively invariant across noise levels and acts like a confounding factor in noise-induced health effects. High noise-sensitive (HNS) individuals tend to be affected more from noise exposure than low noise-sensitive (LNS) individuals, from acquiring higher noise coping abilities. There is general agreement in the literature that NS has the probability of increasing annoyance, aggression, neuroticism, and other psychiatric disorders.

Literature reveals an acute shortage of scientific studies on motorcyclist’s physical and psychological health particularly with reference to noise. The most documented study on motorcyclist’s health is related to hearing damage. The issue related to the NS and HRQOL of motorcycle riders has never been addressed. However, it requires attention to draw grounds before embarking into in-depth investigations related to the mental and physical health of riders. Therefore, the study attempted to determine the relationship between NS effects on HRQOL, which includes physical, psychological, social, and environmental well being. Furthermore, it investigated the rider’s sensory adaptation over the driving years toward motorcycle noise.

**Materials and Methods**

**Study population**

A cross-sectional survey was conducted at the Universiti Teknologi MARA, Puncak Alam campus. The participants were undergraduate students who ride motorcycles as a primary means of transportation. Simple random sampling technique was followed to collect samples across different faculties among the 1500 registered motorcyclists in the Puncak Alam campus with the respondents aged between 19 and 25 years. The sample size (SS) selected for the study was calculated by the formula for infinite SS with 95% confidence interval.

Questionnaires along with information sheet explaining the purpose of the study and written consent form for participating in the study were distributed among 356 motorcycle riders. However, only 330 individuals returned the questionnaires. After applying the exclusion criteria, that is, smokers (n = 23), the presence of chronic diseases, for example, asthma and diabetes (n = 0), and incomplete questionnaires (n = 3), the final SS consisted of 301 participants.

**Study instruments**

The general and specific details of the participants were obtained from a self-report questionnaire, which included details regarding age, gender, the years of motorcycle driving experience (as a primary mode of transportation), faculty, semester, motorcycle license, the usage of helmet, smoking habit, and the presence of any chronic diseases. The NS and HRQOL were measured by using the standardized self-assessing tools, that is, Weinstein noise sensitivity scale (WNSS) and the World Health Organization Quality of Life-BREF (WHOQOL-BREF), respectively.

WNSS, which was used to determine the self-reported NS, included 21 items based on a six-point Likert-type scale. Ranging from “disagree strongly” to “agree strongly,” the minimum and maximum scores were 21 and 126, respectively. Previous research from both the field and experimental studies have tested satisfactorily the psychometric properties, predictive validity, and the internal consistency of the questionnaire, which ranges from 0.84 to 0.87 (Kuder–Richardson reliability)

HRQOL was assessed using WHOQOL-BREF that included 26 items rated on a five-point Likert-type scale. WHOQOL-BREF is further divided into four domains, which included physical health (seven items), psychological health (six items), social relationships (three items), and environmental factors (eight items) along with two additional questions to rate the overall quality of life and general health. Respondents were required to answer questions based on their experiences for the last 2 weeks. The mean score of all domains represents the overall HRQOL, while each domain’s scores were also analyzed. A low score on any domain represents the negative evaluations of that domain, while a higher score predicts positive HRQOL. Previous studies have proven valid reliability and validity for adopting this questionnaire as a research instrument tool under diversified cultural and social setups.

**Data analysis and management**

Demographic data such as age, gender, and motorcycle driving years were analyzed using descriptive statistics. The difference in data between males and females for NS and HRQOL were analyzed using an independent t-test. The internal validity of the questionnaires (WNSS and WHOQOL) was tested using Cronbach’s alpha. On the basis of NS scores, the respondents were divided into three groups. The divisions were performed by taking the mean of the total score ± the standard deviation (SD) of all the scores and also testing the homogeneity of variance among the groups. To determine the relationship between different NS groups with HRQOL and motorcycle driving
years, one-way analysis of variance (ANOVA) was applied. The significance level of probability ($\alpha$) was set as 0.05 for all analysis and was computed via Statistical Package for Social Sciences, IBM Statistical Package for the Social Sciences version 22.0 (SPSS Inc., Chicago, IL, USA).

**RESULTS**

The demographic data of the respondents ($N=301$) are represented in Table 1, which constituted 63.1% male respondents ($n=190$) and 36.9% female respondents ($n=111$), with ages ranging from 19 to 25 years. The motorcycle driving years were divided into three categories, <4 years (21.0%), 5–9 years (60.4%), and >10 years (18.6%). All the respondents had motorcycle license (100%) and used a helmet while riding (100%) (data not mentioned in Table 1).

**Noise sensitivity**

The internal consistency for WNSS (21 items) was calculated using Cronbach’s alpha $n = 301$, and the estimated value of the coefficient of reliability for the items was statistically reliable with $\alpha_c = 0.778$. Participants were divided into three NS groups, which were LNS (WNSS$_{\text{mean}}$ = 65.7 ± SD, 4.4; $n = 46$), moderate noise sensitive (MNS) (WNSS$_{\text{mean}}$ = 82.5 ± SD, 6.7; $n = 201$), and HNS (WNSS$_{\text{mean}}$ = 101.8 ± SD, 5.3; $n = 54$). The test of homogeneity of variances was tested (Levene) among the three groups, which was considered nonsignificant ($F (2, 298) = 10.4, P = 0.000$). Due to nonhomogeneity of variance, Welch t-test determined significant [$F (2, 109.1) = 692.2, P = 0.000$] difference among the three noise sensitive groups. Figure 1A presents the means of groups, whereby majority of the respondents belonged to MNS. Figure 1B shows no significant difference in NS levels between the three driving years, whereby majority of the respondents belonged to MNS. Figure 1C shows the means of WNSS with motorcycle driving years, wherein the respondents with <4 years motorcycle driving experience showed highest NS compared to the other groups.

**Health-related quality of life**

The mean scores of WHOQOL-BREF for each domain and estimated Cronbach’s alpha coefficient ($\alpha_e$) for reliability scores are presented in Table 2. The internal reliability can be considered statistically valid because all the values are around 0.6–0.7.\(^{137}\)

| Gender      | Low   | Moderate | High  | HRQOL, n (%) |
|-------------|-------|----------|-------|--------------|
| Males       | 31 (67.4) | 129 (64.2) | 30 (55.5) | 190 (63.1) |
| Females     | 15 (32.6)  | 72 (35.8)  | 24 (44.5)  | 111 (36.9) |

HRQOL comparison between males (WHOQOL$_{\text{ Mean}}$ = 66.5, SD = 8.9) and females (WHOQOL$_{\text{ Mean}}$ = 66.8, SD = 9.2) had no significant difference in the scores [$t (−0.251) = 299, P = 0.802$]. Figure 2A shows no differences between the mean HRQOL values among males and females. Therefore, both the genders have an equal probability of being affected by noise and its circumstances on their HRQOL.

Motorcycle driving years showed no significant relation with HRQOL average [$F (2, 298) = 2.1, P = 0.118$] and the four domains, which are physical [$F (2, 298) = 0.725, P = 0.485$], psychological [$F (2, 298) = 2.98, P = 0.052$], social [$F (2, 298) = 1.906, P = 0.151$], and environmental [$F (2, 298) = 1.02, P = 0.363$]. However, motorcycle drivers with <4 years of driving experience had the lowest HRQOL mean scores.

**Relationship between health-related quality of life and noise sensitivity**

One-way ANOVA was used to compare the relationship between HRQOL domains and NS (low, moderate, and high). Overall, the relationship between HRQOL average with NS was found to be significant [$F (2, 298) = 5.669, P = 0.004$]. Further, post-hoc comparisons using Tukey’s HSD indicated that the mean score of the HNS individuals ($M = 63.0, SD = 10.2$) was significantly higher than both LNS individuals ($M = 68.3, SD = 6.5, P = 0.009$) and MNS individuals ($M = 67.2, SD = 9.0, P = 0.007$). However, MNS individuals had no significant relation ($P = 0.726$) with the LNS group. Figure 3 indicates a downward trend in HRQOL from the low to high NS group. Thus, as the NS increases among respondents, the HRQOL decreases.

The physical–QOL relation with NS was not found to be significant among all three NS groups [$F (2, 298) = 2.825,$

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**Table 1: Demographic attributions of the motorcyclist’s noise sensitivity (NS) and health-related quality of life (HRQOL)**

| Gender | Low  | Moderate | High  | HRQOL, n (%) |
|--------|------|----------|-------|--------------|
| Males  | 31 (67.4) | 129 (64.2) | 30 (55.5) | 190 (63.1) |
| Females | 15 (32.6) | 72 (35.8) | 24 (44.5) | 111 (36.9) |

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The results suggest that there is no effect of NS levels on the rider’s physical–QOL domain. Moreover, the psychological–QOL domain also did not show any significant difference with NS among all the three noise-sensitive groups [F (2, 298) = 2.703, P = 0.069]. However, social–QOL domain showed significant relation with NS for all the three groups [F (2, 298) = 4.222, P = 0.016]. Post-hoc comparisons using the Tukey’s HSD indicated that the mean score of HNS individuals (M = 60.3, SD = 19.8, P = 0.013) was significantly higher than MNS individuals (M = 66.9, SD = 14.2, P = 0.013). On the other hand, the scores of the LNS individuals (M = 66.9, SD = 14.2) did not significantly differ between the high (P = 0.084) and moderate (P = 0.998) noise-sensitive groups. The results indicated that HNS individuals have lower social–QOL domain than low or MNS groups. Furthermore, the environmental–QOL domain of the motorcycle riders was again not found to be significant for the noise-sensitive groups [F (2,298) = 2.796, P = 0.063]. The results indicated that there was no effect of NS on the rider’s environmental–QOL domain.

**DISCUSSION**

The primary aim for conducting this study was to explore the subjective health status of noise-sensitive motorcycle riders as a result of high noise exposure (>90 dBA) on a daily basis. In this study, we observed positive association between individuals with high NS and the self-reported poor HRQOL among young motorcycle riders, which is in agreement with earlier studies on noise reactions in different population-based studies including community, traffic, transportation, industrial, and aircraft noise.

In this study, male and female respondents presented an equal chance of being noise sensitive, which is consistent with some studies while inconsistent with some others. In this study, the average scores of WNSS for high NS (HNSavg = 101.8), low NS (LNSavg = 65.7), and total 21 items (83.4) were higher in comparison to the previous

| Domain   | Mean | Standard deviation | αc  |
|----------|------|--------------------|-----|
| Physical | 64.0 | 11.9               | 0.669 |
| Psychological | 69.1 | 11.0               | 0.596 |
| Social   | 65.7 | 15.2               | 0.698 |
| Environmental | 67.6 | 11.2               | 0.585 |

**Figure 1:** The noise sensitivity profile of young motorcyclists: (A) Average WNSS based on grouping (low, moderate, and high), (B) noise sensitivity based on gender, and (C) noise sensitivity based on motorcycle driving age group. Notes: *P*-value generated from Cronbach’s alpha, **P*-value generated from Welch t-test, ***P*-value generated from independent t-test, and ****P*-value generated from one-way ANOVA

**Figure 2:** Comparison of Health-Related Quality of Life Based on (A) Gender and (B) Motorcycle driving years

Table 2: Cronbach’s alpha (αc) for WHOQOL-BREF domains (n = 301)
studies on community, traffic, and environmental noise.\(^{[31,39,41]}\) Similarly, the mean scores of the HRQOL domain of motorcycle riders as compared to the mean scores obtained from the study on community noise\(^{[37]}\) were found to be subsequently declined. The community noise population study estimated the mean scores as 73.5, 70.6, 71.5, and 75.1 for the physical, psychological, social, and environmental domains, respectively. This revealed a significant difference in HRQOL between the two noise-exposed populations.\(^{[37]}\) Compared to another similar study on traffic noise related HRQOL \((\leq 24\text{ years})\),\(^{[42]}\) young motorcyclists scored significantly lower in all the HRQOL domains. This decrease in HRQOL consisted of HNS motorcycle riders who were exposed to high noise exposure \((90\text{ dBA at } 60\text{ km/h})\) on a daily basis.

A significant relation was determined between NS and motorcycle driving years of \(<4\text{ years}\), while there was no relation with the other groups of driving years. This can be attributed to the phenomenon of noise habituation\(^{[24]}\) over the increasing years of exposure to noise. However, the effects of NS on some other factors such as the quality of sleep, mood, and performance, which may not result in adaptation/habituation\(^{[43]}\) were not investigated in this study and, therefore, need further investigations.\(^{[144]}\) In this study, a decreasing trend in cross-sectional association between HNS and self-reported HRQOL was observed, which is in accordance with similar previous studies on different populations.\(^{[144]}\) These results indicated negative impacts because of high noise exposure on the rider’s daily experience.

Several community, environmental, and traffic noise-based studies have significantly associated poor health status with higher annoyance\(^{[38,42,45]}\) among noise-sensitive individuals. Noise moderates the association between NS and annoyance, but it is hard to determine whether annoyance comes first or NS.\(^{[34]}\) However, some other studies reported that NS aggravated annoyance, anxiety, insomnia, somatic symptoms, and sleep disturbance\(^{[46,47]}\) and are linked to poor perceived health and psychological distress and morbidity.\(^{[1,39,40]}\) The significant lower scores in QOL-social domain among HNS individuals are consistent with a study that compared the HRQOL profile of noise-sensitive respondents between quiet and noisy areas, with significantly lower scores in quieter areas.\(^{[44]}\)

Another important aspect to consider is that motorcycling demands concentration, which is cognitively very important for the rider’s riding experience and safety.\(^{[29]}\) According to the World Health Organization, the vulnerable age group for motorcycle accidents ranges from 19 to 29 years. However, the reasons given for such accidents are summed up in a term called “human errors”\(^{[48]}\) without addressing any particular parameter for its cause. Prior understanding to noise studies suggests that a high exposure to noise by motorcycle riders can cause detrimental effects on their cognitive abilities especially for noise-sensitive riders.

This study reflects the affected quality of life in young motorcycle riders due to NS, which verifies the importance for further investigations related to their physical and psychological health. An in-depth analysis of the characteristics of HNS riders can indicate the factors associated with “human errors” for motorcycle road accidents.

**Study limitations and strengths**

Some confounding factors associated with degraded HRQOL such as personality traits, type, and the objective analysis of physiological measures were not investigated because the noise-induced effects are not easily distinguishable. However, the strengths of this study are that the students were from different academic backgrounds, the SS was huge, and standardized questionnaires (recognized as a powerful research assessing tool) were used.

**Conclusion**

This study showed that young motorcyclists with driving years of \(<4\text{ years}\) might suffer from degraded psychological health due to high NS. There were no distinguishing differences observed between males and females as far as NS was concerned. Furthermore, a decreasing trend between low, moderate, and high NS with their respective HRQOL was observed, wherein HNS individuals showed significantly \((P = 0.016)\) lower scores on the social well-being domain. The overall premise of the study was proved with the statistical significance \((P = 0.004)\) that HNS individuals tend to have decreased HRQOL compared to LNS individuals. Furthermore, in-depth studies are required from other demographical backgrounds to investigate the relationship between the motorcyclist’s NS and HRQOL as an integral requirement for the rider’s safety and health.

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Conflicts of interest
There are no conflicts of interest.

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