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THE IMPACT OF PROLONGED OCCUPATIONAL NOISE ON STAFF WELL-BEING IN HOSPITAL KITCHENS

Nurul Afifah Noor Effendi, Mohd Nasrom Mohd Nawi*, Mohd Noor Mamat, Mohd Nazhari Mohd Nawi, Nurul Ainun Hamzah

Environmental and Occupational Health Program, School of Health Sciences, Health Campus, Universiti Sains Malaysia, 16150 USM, Kubang Kerian, Kelantan, Malaysia

Corresponding author: mdnasrom@usm.my

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ABSTRACT

Occupational noise in hospital kitchens can significantly impact staff well-being due to prolonged exposure. This study evaluated noise levels in cooking, washing, and preparation areas of a hospital kitchen to assess compliance with the 2019 Noise Exposure Regulation and to understand how noise exposure varies by location and time. Measurements were conducted during peak hours during working activities showed that all areas were within the safe exposure limits, with the cooking area (77.620 dB) typically experiencing higher noise levels than the washing (76.338 dB) and preparation areas (75.302 dB). Noise levels significantly varied between peak and non-peak hours in the cooking and washing areas ($p>0.05$) but remained consistent in the preparation area ($p=0.001$). A weak yet significant positive correlation ($p=0.001$, $r=0.145$) was observed between noise levels and proximity to noise-generating distance of equipment, suggesting that reducing distance from noise sources may slightly increase exposure risks. These findings underline the need for ongoing monitoring and targeted noise reduction strategies in hospital kitchens to safeguard staff health, not hospital patients.

Keywords: noise exposure level, kitchen noise, hospital kitchen, peak hours, distance.

1.0 INTRODUCTION

Occupational noise exposure represents a significant health hazard in various industries across Malaysia, with certain occupations like carpentry, construction, textiles, metalworking, food processing, and furniture manufacturing particularly prone to high noise levels above 85 dB(A) [1]. Research indicates that a significant portion of occupational diseases, precisely 60-70% of 700 cases reported since 2018, are attributed to hearing loss due to excessive noise [2], as stated by the director of the Department of Occupational Safety and Health Malaysia (DOSH).

Noise intensity, measured in decibels (dB), plays a crucial role in assessing and managing workplace noise, which, if not controlled, can lead to hearing impairment [3]. Hospital kitchens are notable contributors to noise pollution, with many workers exposed to noise levels exceeding the Recommended Exposure Limit (REL) outlined by the National Institute for Occupational Safety and Health (NIOSH) [4]. These noise levels often coincide with frequencies that induce noise-induced hearing loss (NIHL), a permanent and debilitating condition affecting an individual's ability to hear and interact with their environment [5].

Hospital noise exposure is recognised to have a major impact on both healthy staff and patients' ability to recover quickly. This suggests that activities, ranging from clinical services to support services like laundry, also rise dramatically [7]. One household equipment that allows to wash dishes mechanically rather than by hand is the dishwasher. This feature is convenient, but it also produces acoustic noise. People are frequently exposed to dishwasher noise due to its proximity to living areas, which can be particularly problematic for customers who live in open or small spaces or who may even choose to use the appliance overnight [8]. In other industries, the average continuous equivalent sound pressure level for the cabin noise of turboprop aircraft typically used to transport cargo was found to be below 85 dBA [9]. One of biggest noises coming out of range hood during cooking in the kitchen [10]. It has been discovered that while evaluating the sound quality of dishwashers, the volume of the appliance's collision noise during washing is an important factor. The collinearity of these factors emphasises the need for caution when using them in subsequent modelling [11]. The ability to identify every sound in the surroundings could aid in the creation of systems that can support people or warn of possible threats [12]. The amount of noise generated is directly correlated with the hood's speed settings; the greater the speed setting, the more noise is created [13]. Extended tube acoustic metamaterials can be used in situations when installation space for acoustic absorption materials is limited due to their low-frequency absorption property and structural simplicity [14]. The work focusses on the mechanical assembly of the subsystem and the evaporator's fan, which are the primary sources of noise and the conduit for vibration transfer [15]. The biggest problem with noise and vibration control studies of residential kitchen hoods is that there are so many different designs of residential kitchen hoods in use that it is impossible to generalise the findings [16]. The volume of noise from the kitchen hoods may be due to some factors.

Noise-induced hearing loss can result from prolonged exposure to loud noises exceeding 85 decibels [17]. The noise exposure, which has long been known to have negative impacts on both auditory and non-auditory health, also poses a serious safety risk [18]. According to study, the system's exhaust capability can only be enhanced when the supercharging fan turns quickly enough to overcome its own flow resistance [19]. The necessity for high-performance fans may arise from the pursuit of unreasonably high exhaust airflow rates, which would raise noise levels, expenses, and energy consumption [20]. High-susceptibility individuals may be more affected by noise and experience more severe hearing loss [21]. Long-term exposure to loud noises can have an impact on social relationships and communications in addition to one's health and well-being [22].

This study seeks to measure the noise exposure levels in a selected hospital's kitchen, assessing variations between different kitchen areas and during various times of the day. Furthermore, it explores how the proximity of noise-generating equipment affects exposure levels. By understanding these dynamics, the study aims to underscore the risks of NIHL among hospital kitchen staff and contribute to more effective noise regulation and control strategies aligned with the Noise Exposure Regulation 2019.

2.0 METHODOLOGY

2.1 Study Design and Study Location

This research employs a cross-sectional design, an observational method ideal for simultaneously assessing noise exposure across different environments in university hospital. Purposive sampling and a nonprobability technique was used to select specific areas within the hospital kitchen based on predefined criteria relevant to our noise exposure study. These criteria included large machinery contributing significantly to overall noise levels and the areas' distinct operational functions—cooking, washing, and preparation.

This purposive approach ensured that the study focused on kitchen sections most likely to vary in noise intensity, thereby providing comprehensive insights into potential risk areas for occupational noise exposure. The study was conducted in a large hospital kitchen chosen for its high-volume meal production involving extensive equipment use. Understanding the noise dynamics in this environment is crucial for assessing occupational hazards and improving worker safety.

2.2 Research Tool

Special equipment is used to collect sound exposure at a distance of 1 to 3 meters from the sound source in each process. In each area, equipment is placed next to the main source of noise to get an accurate reading.

2.2.1 Sound Level Meter

This study measured the noise levels in the hospital kitchen using the Brüel & Kjaer Hand-held Analyzer type 2250-L, a sound level meter known for its high fidelity in replicating human auditory response. This instrument was chosen for its precision and the ability to produce repeatable and impartial sound intensity readings, which are essential for maintaining scientific integrity in environmental noise measurement.

The 2250-L model adheres to the stringent IEC/ANSI SLM standards, falling into the Type/Class 1 category, ensuring the highest accuracy level in sound measurement. Specifically, utilised the A-weighted scale for measurements, a scale designed to reflect the human ear's frequency response, making it particularly effective for assessing potential noise-induced hearing risks in occupational settings. This scale's sensitivity to the frequencies most likely to impact human hearing directly correlates with the study's aim to evaluate occupational noise exposure risks.

A sound level meter (SLM) was used to monitor sound levels within the hospital kitchen accurately. The SLM was securely mounted on a tripod to ensure stability and maintain consistent microphone positioning throughout the measurement process. It was optimally positioned 1.2 to 1.5 meters above the ground level and 1 to 3 meters from the primary noise sources, adhering to industry-standard practices to capture a representative sound profile. The selection of this sound level meter, coupled with strict adherence to recognised measurement standards, ensures that the data collected are accurate and reliable, providing a dependable foundation for analysing noise exposure levels in the hospital kitchen.

The environment consisted of three critical workstations: cooking, washing, and preparation areas. Noise levels at each station were continuously recorded over an 8-hour working day, from 8 am to 4 pm, with recordings taken at one-minute intervals to capture the variability and peak noise exposures. This rigorous sampling frequency was selected to provide a comprehensive overview of the acoustic environment, ensuring that transient and sustained noise levels were accurately documented.
Additionally, the distance between the SLM and the noise-generating equipment was meticulously measured using a high-accuracy laser rangefinder. This tool ensured that the recorded distances were exact, supporting the reliability of our noise exposure assessment. Detailed monitoring is essential for assessing compliance with the Noise Exposure Regulation 2019 and identifying potential health risks associated with prolonged exposure to noise in occupational settings like hospital kitchens.

2.2.2 G4 LD Utility Software

In this research, the G4 LD Utility software is critical in managing and analysing data collected with Larson Davis Sound Level Meters (SLM), the Human Vibration Meter Model HVM200, and Spartan™ Noise Dosimeters. This free software facilitates seamless connectivity with these devices, supporting comprehensive data management and documentation.

The software's ability to represent data visually through graphs and spreadsheet formats is particularly advantageous for our study, enabling efficient report generation and in-depth analysis. Users benefit from the capability to export data directly to Excel®, which simplifies further statistical analysis and integration with other research data. The software's customisation options allow for tailored data visualisation, including octave band data representations and heat maps, providing nuanced insights into frequency-specific noise levels and patterns.

These features are indispensable for our research, enhancing our ability to analyse complex acoustic data accurately and present findings in an accessible format. The use of G4 LD Utility software thereby directly contributes to the robustness of our methodology and the reliability of our results, ensuring that data handling and analysis are conducted with precision and ease.

2.2.3 HILDA HD100 High Accuracy Laser Rangefinder

The HILDA HD100 High Accuracy Laser Rangefinder is an indispensable tool for professionals and DIY enthusiasts. It offers unparalleled precision in a compact, battery-powered design. Ideal for indoor applications, including interior design, home renovations, and property valuation, this rangefinder guarantees accurate distance measurements with a variability of only ±2mm. Available in models with maximum ranges of 40m, 60m, 80m, or 100m, the HD100 meets the diverse needs of various projects, from small residential spaces to more significant commercial properties. It simplifies the measurement process by displaying readings in three units: meters, inches, and feet, catering to international usability and preferences.

2.4 Statistical Analysis

The data analysis for this study was conducted using SPSS version 27. Descriptive statistics summarised the noise exposure levels in the, ensuring compliance with the Noise Exposure Regulation 2019. A one-way ANOVA was performed to compare the noise levels (LAeq) across three workstations: cooking, washing, and preparation. This test was chosen because the data exhibited a normal distribution and equal variances across these groups. Significant differences in LAeq were found among the areas.
An independent T-test was used for temporal comparisons to assess noise level variations between peak and non-peak hours, given that the data distribution remained normal. This analysis revealed significant differences in the cooking and washing areas, though no significant variation was observed in the preparation area.
Additionally, the Spearman correlation test was employed to examine the relationship between noise levels and the proximity to noise-producing equipment, as this dataset did not follow a normal distribution. The results indicated a weak but statistically significant positive correlation, suggesting that noise levels increased slightly as the distance from the equipment decreased. This finding underscores the importance of strategic equipment placement to minimise noise exposure.

3.0 RESULTS AND DISCUSSION

It was found that the main source of noise from cooking activities comes from the kitchen hoods on top of the cooking equipment. For washing activities, dishwasher was the main contributor making a noise and in preparation area collision of equipment and grinder machines is the cause.
In this study it was found that the noisiest equipment is the kitchen hood, which may be due to the design, the size of the hood surface or the suction speed and further research needs to be carried out. Prolonged noise exposure from this equipment can cause hearing impairment to the workers.

3.1 Compliance with Noise Exposure Regulation 2019

Table 1 displays the monitored average noise levels within three areas of the hospital kitchen: cooking, washing, and preparation. These levels were measured using industry-standard sound level meters calibrated to ensure accuracy. The Equivalent Continuous Sound Levels (LAeq) recorded were 79.2 dB(A) for the cooking area, 88.2 dB(A) for the washing area, and 76.2 dB(A) for the preparation area, all of which comfortably comply with the regulatory limit of 82 dB(A) as stipulated by the noise exposure regulations [6].

This compliance indicates that, over an 8-hour work period, the noise exposure levels remain within acceptable bounds, ensuring that workers are not subjected to potentially harmful noise levels. Notably, even during quieter operational periods, the minimum noise levels recorded in each area were below the legal thresholds, underscoring a consistent adherence to safety standards.

Furthermore, each area exhibited varying maximum noise levels; however, all values remained below the critical threshold of 140 dB(C), the limit for Peak Sound Pressure (LCpk). This adherence suggests that, even during high noise activity, the environmental conditions do not pose an immediate risk of noise-induced hearing loss to the workers. The consistent compliance with maximum noise level regulations across all areas reinforces the effectiveness of current noise management strategies within the hospital kitchen environment.

Table 1. The average mean of noise level in hospital kitchen

Location	LAeq (dB)	Lmin (dB)	Lmax (dB)	LCpk (dB)
Cooking area	79.2	50.8	100.9	122.0
Washing area	78.2	58.0	108.0	120.7
Preparation area	76.2	57.2	98.9	119.4

3.2 Comparison of Noise Levels in Different Areas in Hospital Kitchen

Table 2 presents a detailed statistical analysis comparing the average noise levels (LAeq) across three main areas of the hospital kitchen: cooking, washing, and preparation. The mean LAeq for the cooking area is 77.620 dB(A), with a standard deviation of 4.16, indicating it has the highest noise levels. The washing area's mean LAeq is slightly lower at 76.338 dB(A) with a standard deviation of 4.12, while the preparation area has the lowest average noise level at 75.302 dB(A) with a standard deviation of 3.48.

These results signify notable differences in noise levels across the areas, as confirmed by a one-way ANOVA test. The higher noise levels in the cooking area can be attributed to noise-intensive equipment such as combination ovens, multifunction cookers, stoves, and exhaust fans. Other factors likely influencing noise levels, such as pot banging and staff communication, were noted but not quantitatively analysed in this study.

Comparatively, a previous study by the National Institute for Occupational Safety and Health (NIOSH) [4] found that noise levels in different kitchen stations exceeded the NIOSH Recommended Exposure Limit (REL) but stayed within the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL). In contrast, our study indicates that all measured noise levels were within safe exposure limits, suggesting potentially different operational conditions or effective noise control measures in place at the studied hospital kitchen. These findings underscore the importance of continuous monitoring and tailored noise reduction strategies specific to each kitchen area to ensure compliance with safety standards and protect staff from noise-induced hearing loss.

Table 2. LAeq comparison across different areas

Location	Mean (SD)	F(df)	p-value
Cooking area	77.620 (4.16)	43.209 (2,1440)	$p < 0.05$
Preparation area	75.302 (3.48)		
Washing area	76.338 (4.12)		

3.3 Comparison of Average Noise Levels During Peak and Non–Peak Hours

Table 3 compares the noise levels (LAeq) in the hospital kitchen's cooking area during designated peak and non-peak hours. During peak hours, the mean LAeq was recorded at 80.87 dB(A); during non-peak hours, it was notably lower at 74.02 dB(A). A t-test revealed a statistically significant difference in LAeq between these intervals ($p<0.001$), indicating heightened noise exposure during high-activity phases.

Table 3. Comparison of noise level (LAeq) during peak and non-peak hours for different areas in hospital kitchen

Area	Mean (SD)		Mean diff. (95% CI)	t statistic (pdf)	*p-value*
	peak	non – peak			
Cooking Area	80.87 (2.00)	74.02 (2.70)	6.85 (6.43, 7.27)	31.809 (479)	0.001**
Washing	74.94 (3.68)	77.38 (4.22)	-2.44 (-3.15, -1.73)	-6.77 (479)	0.001**
Preparation	75.48 (3.94)	75.12 (2.88)	0.36(-0.27, 0.98)	1.126 (479)	0.261

*independent T-test
**significant value at p<0.05

This pronounced difference in noise levels is attributable to operational factors such as the intensive use of equipment during peak hours. Such variations necessitate targeted noise control measures to improve the working environment for kitchen staff. Incorporating visual aids like line graphs to depict the fluctuation of noise levels throughout the day could enhance understanding and facilitate effective noise management.

Systematic measurements taken during peak hours, defined as 9:30 a.m. to 11:30 a.m. and 2:00 p.m. to 4:00 p.m., and non-peak hours from 11:30 a.m. to 2:00 p.m., corroborate that activities during these times are directly linked to the observed noise variations. The findings extend the research by the National Institute for Occupational Safety and Health (NIOSH), which noted occasional exceedances of the Recommended Exposure Limit (REL) in critical areas, though within the Permissible Exposure Limit (PEL) set by the Occupational Safety and Health Administration (OSHA) [5]. Further emphasize the need for robust noise management practices in hospital settings to prevent potential health risks associated with occupational noise exposure [5].

To mitigate high noise exposure risks, it is recommended to schedule noise-intensive tasks outside of peak hours, enhance acoustic damping in high-noise areas, and conduct regular monitoring to ensure compliance with noise exposure regulations. This study provides detailed insights into the noise dynamics within hospital kitchen operations, underscoring the critical need for effective noise management strategies to safeguard worker health.

3.4 Correlation Between Noise Level and the Distance of the Equipment

Table 4 illustrates the relationship between the average Equivalent Continuous Sound Levels (LAeq) and the distance from noise-generating equipment in the kitchen. The analysis reveals a statistically significant, albeit weak, positive correlation ($r = 0.145$, $p = 0.001$).

Table 4. Correlation between noise level with distance of equipment

	Mean (SD)	r	*p-value*
LAeq - Distance	76.338 (4.05)	0.145	0.001

*Pearson's Correlation, significant levels at p-value <0.05

This correlation indicates that as the distance from the noise source increases, noise levels decrease slightly specifically, noise levels drop by approximately 0.145 dB(A) for every meter increase in distance from the source.

This finding has substantial implications for designing safer kitchen environments. Effective strategies to reduce noise exposure include strategically relocating noisier equipment to areas less frequented by staff or implementing physical barriers such as noise curtains or panels. Additionally, optimising the layout to increase the distance between workers and the primary noise sources can significantly enhance worker health and productivity.

Considering the potential impact of these strategies, further research should delve into how various layout configurations and noise control technologies affect noise levels in different kitchen settings. Future studies might also explore the interaction between noise levels and other factors such as worker behaviour, equipment usage patterns, and the type of equipment used. These investigations could provide a more comprehensive understanding of noise dynamics in commercial kitchens and lead to more effective noise reduction techniques.

4.0 CONCLUSION

In summary, this study assessed noise levels in the cooking, washing, and preparation areas of a selected hospital kitchen during peak and non-peak hours. The findings indicated that all areas maintained mean noise levels (LAeq) below the Malaysian Noise Exposure Regulation 2019 limit of 82 dB(A), with the cooking area exhibiting the highest levels due to heavy equipment usage such as ovens, cookers, and exhaust fans. Significantly higher noise levels were recorded during peak hours across all areas. The statistical analysis revealed a correlation between noise levels and the proximity to noise sources, emphasizing that noise exposure decreases as the distance from these sources increases. This correlation underscores the spatial dynamics of noise within the kitchen and highlights areas where noise mitigation could be most effective. While current noise levels are within regulatory compliance, the study recommends ongoing monitoring and proactive noise management. Implementing regular noise assessments and maintaining equipment is critical. Additionally, during peak hours, the strategic use of personal protective equipment and possibly scheduling changes could further protect kitchen staff from excessive noise exposure. This research contributes significantly to our understanding of occupational noise exposure in hospital kitchens and the effectiveness of current regulations. It highlights the need for continuous improvement in noise control measures to enhance worker safety. Future research should delve into identifying specific noise-generating activities and evaluating the effectiveness of various noise reduction strategies, such as acoustic damping materials and layout modifications, to optimize the auditory environment in these critical settings.

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