ISSN- 0301-1216
Indian J. Prev. Soc. Med. Vol. 56, No.1, 2025

Formulation and Validation of tool to assess the exposure of occupational health hazards

S. Adithiyalakshmi[1] and PL. Sridevi Sivakami[2]

ABSTRACT

Background: Occupational Health and Safety (OHS) risk assessment is critical for improving worker safety by identifying and controlling high-risk hazards in the workplace. **Objectives:** This study developed and validated a tool specifically designed to assess occupational health hazards among fishermen, **Methodology:** involving three key steps: conceptualization, expert judgment and content validity determination. Structured with four domains: physical, ergonomic, environmental and psychological. **Results:** A pilot study with 50 fishermen yielded a Cronbach's alpha of 0.710, indicating acceptable internal consistency. The tool's content validity was confirmed by fifteen subject experts, with an overall Content Validity Ratio (CVR) above the acceptable threshold of 0.49. Each domain demonstrated high relevance, achieving an itemLevel- Content Validity Index (I-CVI) of 0.95, kappa value of zero, one and an overall Scale - Content Validity Index (S-CVI) of 0.93, underscoring its robustness. Four components were identified through principle component analysis with keiser normalization of 0.653. The cumulation variance of 76 percent provides suitability of retention. **Conclusion:** This tool effectively represents key elements of occupational health hazards for fishermen and can be complemented with additional questionnaires for comprehensive data collection in the fishing sector.

Keywords: Occupational health, Hazards, Risk assessment, Fishers, Validity

Introduction

Occupational health and safety are closely related to the socio-economic status, quality of life and overall being at all levels including individuals and at country levels, an unsafe work environment, job strain and socioeconomic difficulties significantly increase the risk of chronic stress, leading to Burnout Syndrome (BOS), which includes emotional exhaustion, depersonalization and loss of personal accomplishment[1]. It is a branch of healthcare, can be defined as the highest degree of physical, social, mental wellbeing of workers at all occupations. The recent report on occupational safety and health by Institutional Labor Organization, states that the work-related fatalities increased more than five percent resulted as nearly three million workers die every year due to accidents and diseases with Agriculture, fishing, construction and manufacturing being most hazardous occupation[2].

The etiologies of occupational Injuries in India are grouped as ergonomic related; physical, chemical, behavioral, biological, social occupational factors[3]. To prevent these occupational accidents, risk assessment must be regularly reviewed and updated, forming a foundation for occupational safety and health management systems[4]. Occupational hazard assessment is a systemic approach of identifying workplace hazards and evaluation of risks on a day to day basis, which aids in the identification of root causes and implementing control strategies[5]. Reliable instruments and tools are necessary for effective hazard assessment.

1. Research Scholar, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science & Higher Education for Women, Coimbatore, Avinashilingam Deemed University**, Contact**: 9384384840*, **Email**: adithiyaphdresources@gmail.com
2. Associate Professor, Department of Food Service Management and Dietetics, Avinashilingam Institute of Home Science and Higher Education for Women, Coimbatore, Tamil Nadu- 641043.

Corresponding Address: Dr. PL. Sridevi Sivakami, Associate Professor, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Avinashilingam Deemed University, **Email:** sridevi_fsmd@avinuty.ac.in; Mobile: 9384384840

Submission	21.11.2024	Revision	22.12.2024	Accepted	20.02.2025	Printing	31.03.2025

Prior Publication*: Nil*; Source of Funding:* Yes; *Conflicts of Interest*: None, *Article # 557/753

Reliability and validity are the quality indicators which ensure the production of reliable and valid evidence in research[6].Content validity as defined by Yusoff (2019) is an informed opinion from individual recognized as experts in the selected field whereas the expert's judgment involves asking several experts to assess an instrument or tool or to express their opinion on a specified construct[7]. Similarly, it is the correlation between the content of test tool and the construct measured. Thus, a valid instrument or tool is an important aspect in any research to interpret constructs or variables[8].

This paper discusses the formulation of hazard assessment tool and its validation. The main aim of the study is to find the validity and reliability of the formulated tool which will be utilized for community research settings as study tool.

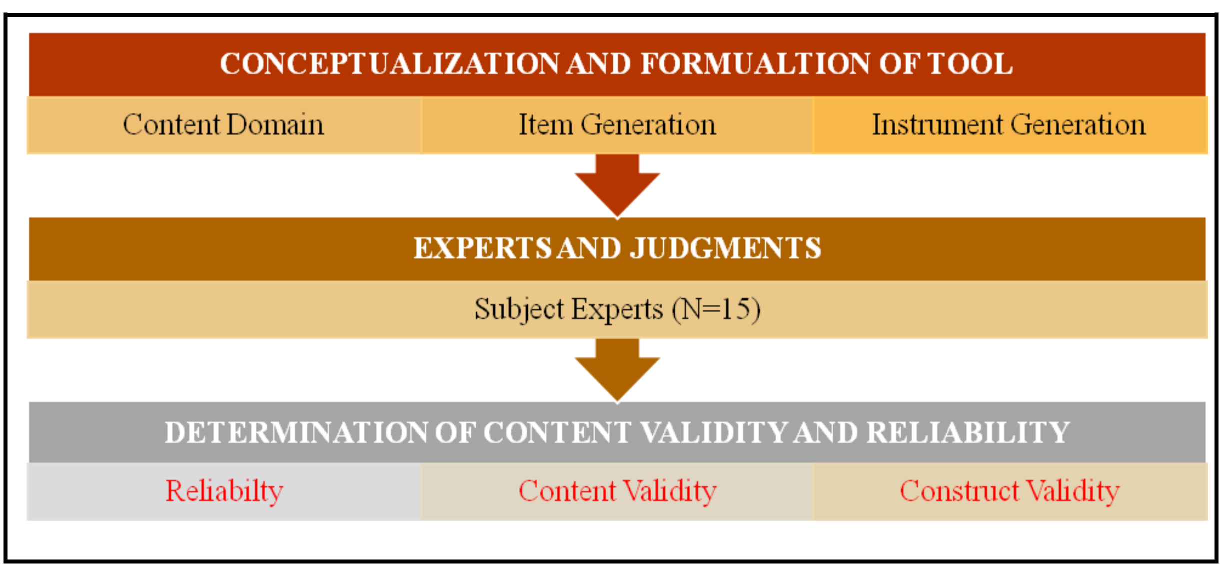
Methodology

The formulation and validation of tool to assess the exposure of occupational health hazards involved three steps as follows

Conceptualization and formulation: This step plays pivotal role in construction of a tool, begins with clear definition of tools purpose and identification of target population, which involves conducting a literature review for the content domain and item generation in a survey tool. The idea of formulation of tool aroused after a detailed literature review as a need for tailored tool to assess the exposure to occupational health hazards. Fishing sector is one of the most hazardous job and exposes to various occupational risks, with 120 million accidents and 200,000 fatalities globally each year[9], therefore, in the present study involved in the formulation of well-structured tool to assess hazard exposure of fishers.

The content domain refers to the area of knowledge directly related to the variables being measured in a study, which outlines the scope and boundaries of what the tool aims to capture[10]. In the present study, the content domain was determined by mixed method approach as given by Ridenour and Newman (2008)[11], the deductive process involves literature review whereas inductive process involves the revision of tool based on the suggestion and comments from subject experts. Item Generation is the crucial step in the development of tools like interview schedules, questionnaires etc.., which involves creation of individual items (Questions) that will measure variables or construct of interest within a study. Using the content domain which provides the structure for item generation, each domain of construct or variables are represented with relevant multiple items of interest ie., likert scale items, closed ended items and binary items.

Instrument Generation: In this step, the items are refined and organized in suitable sequence and format, thus the initial draft of the tool was formulated. This initial draft was reviewed by five subject experts, based on the suggestion and comments, the tool was formulated.



Experts and Judgments: The expert panel to determine the content validity of tool or questionnaire is flexible, although at least five are recommended to minimize the influence of chance agreement, increase in the number of panel members increases the validity of the tool. The expert panel of 15 members were selected for both of the tools, ie., for occupational health hazards of fishers, experts involved in the field of community research, statistician, professors and health care workers.

After the selection of panel experts, their quantitative and qualitative evaluation of relevance of items in relation to the construct are gathered and analyzed to determine the content validity.

The study obtained **ethical clearance** from Institutional Human Ethical Committee of Avinashilingam Institute for Home Science and Higher Education for Women, Approval No: **AUW/XMT-038, FSMD/IHEC/23–24.**

Determination of Reliability and Validity

Internal Consistency Reliability: Once after the formulation of valid tool, Using a pilot study involving 50 fishermen, the internal reliability of the questionnaire was found through Cronbach's alpha value which tells the internal consistency. According to the principles and methods given by Bolarinwa and Akeem (2015). The reliability of the formulated tool can be assessed through pilot study involving 20 to 30 subjects who are not the part of main sample of the survey.

Content Validity

Followed by, the content validity of the formulated tool was determined using qualitative and quantitative methods. The qualitative content validity involves suggestions from expert's panel to refine grammar, ensure accurate and appropriate language and sequence of items whereas quantitative method plays crucial role in selecting the correct content in an item. This can be quantified by content validity ratio, content validity index and kappa value.

Content Validity Ratio : This helps in identifying or selecting an item for a operating construct. Here, panel experts are requested to score each item from 1 to 3 ranges from not necessary, useful but not essential and essential respectively. The CVR score was calculated by the given formula and value above 0.49 is considered acceptable[10]; **CVR = (N_e – N/2) / (N/2)**

- **N_e** – Number of panelists scored as 'essential'**, N –** Total Number of panelists

Content Validity Index: The content validity index provides the relevancy of listed items and domain in a tool. The expert panels are also asked to score the relevancy of each domain after reading and reviewing the given tool. The relevancy table uses the Likert scaling given in table 1 for scoring which ranges from 1 to 4 – 'highly relevant' to 'not relevant' to the construct.

Table-1: Content Validity Relevancy Likert Scale

Score	Relevancy
4	Highly relevant
3	Quite relevant
2	Somewhat relevant but need minor revision
1	Not relevant

The content validity was calculated at both the item and scale level, for item level content validity index, the Item-Level CVI (I-CVI) was used, which measure the degree of expert agreement on the relevance of each item. It was calculated by dividing the number of experts who scored each item as 'quite relevant' and 'highly relevant' by total number of experts.

$$\text{I-CVI} = N_{\text{agree}} / N_{\text{total}}$$

$$\text{S-CVI} = N_{\text{items with full agreement}} / N_{\text{total items}}$$

For scale level content validity (S-CVI) which provides overall measure of content validity across all items in a tool, Universal agreement method was used. Here, the number of items that all experts agree relevant is divided by total number of items. S-CVI/UA represents the proportion of items that have complete expert agreement on their relevance[10].

Kappa Statistic: It provides information on degree of agreement beyond chance which is important supplement to content validity index. The kappa statistic is calculated by probability chance of agreement and content validity index, P_c – Probability of chance agreement index was calculated by following formula[12].

$$P_c = [N! / A! (N – A)!]*0.5^N$$

P_c – Probability of chance agreement**, N –** Number of expert**, A –** Experts scored items that are relevant**;** Using this, kappa value was calculated

$$K = (I\text{-}CVI – P_c) / (1- P_c)$$

The evaluation criteria for kappa value as follows, above 0.74, between 0.60 and 0.74 and between 0.40 and 0.59 are considered as excellent, good and fair respectively.

Construct Validity: The construct validity was determined using exploratory factor analysis with principal component analysis method. The Kaiser Mayer Olkin (KMO) was used for assessing the sample adequacy, with KMO value of greater than 0.5 indicating the suitability for factor analysis. Factors are extracted based on eigen value greater than one[13].

Results

As given in table 2, the Cronbach's alpha value tells the reliability of the data obtained form the formulated occupational health hazard assessment tool.

Table-2: Internal reliability of validated tool

Cronbach's alpha value	Cronbach's alpha value based on standardized items	Number of items
0.710	0.664	20

A pilot study involving 50 fishermen was conducted in Ramanathapuram coastal villages of Tamil Nadu, India, which resulted in Cronbach's alpha of 0.710, the internal consistency of twenty item tool was considered as acceptable tool.

The tool for the assessing the exposure to occupational health hazards of fishers was constructed with the following domain of construct given in **Table-3**. As discussed in methodology, domains and items were constructed by mixed method approach: deductive and inductive method, through literature review and with inputs and suggestion from the expert panel members. The formulated tool has four domains as physical (4), ergonomical (7), environmental (4) and psychological (5) domains under which 30 items were listed, the item selection was done by trial and error method, the initial drafts of tool were reviewed by five subject experts and based on their review, the grammar, appropriate selection of items and its sequence had been finalized for further content validation with expert panel with 15 members. Except the physical domain, other domains had four point ordinal scaling, ranking their frequency of exposure to each hazards as "Yes, regularly', 'Occasionally', 'Rarely' and 'Never' whereas in physical domain, it had close ended items.

Table-3: Domains and Items Construct of the Formulated Tool

Hazard Assessment Tool for Fishers		
Domains	**Items**	**CVR**
D1: Physical	1. Personal accidental details (Vehicle accident, type of accident, cause of accident)	**1**
	2. Accident of co-workers	0.47
	3. Part of body affected	**0.6**
	4. Fishing related illness	**0.6**
D2: Ergonomical	5. Lift, carry or push weights more than 20kg's	**0.7**
	6. Repetitive movements	**0.6**
	7. Unfamiliar tasks	0.47
	8. Interaction with hazardous substances	0.47
	9. Work in bent, twisted or awkward work posture	**0.6**
	10. Work at a height more than two meters or above	0.47
	11. Work by stand more than two hours in a row	**0.6**
D3: Environmental	12. Encountering slippery areas	**1**
	13. Exposed to direct sunlight (hours exposed to sunlight)	**0.867**
	14. Exposed to extreme weather condition	**1**
	15. Exposed to high levels of noise	0.47
D4: Psychological	16. Experience stress	**1**
	17. Workplace violence	0.47
	18. Bullied or harassed at work	**0.73**
	19. Discrimination at work	**0.6**
	20. Spend time with family	**1**

The content validity ratio of formulated tool was given in the table 3, which provides the 'essentiality' of each items of interest. Based on the Lawshe (1975) CVR score must be more than 0.49, if there are fifteen to twenty panel members. The CVR value is in the range of +1 to -1, value above zero indicates that half of the panel members believe that most measurement items are considered the essentiality of constructed items. Almost all the items had content validity ratio more than 0.49 in our formulated tool.

From **Table-4**, the formulated tool demonstrates item level content validity index of 0.95 and kappa value between zero and one, signifying the content validity of the formulated tool. For construct validity, the items having ordinal scale was included, thus items under physical hazard domain were excluded. The sample adequacy was determined using Keiser Mayer Olkin Measure of Sample Adequacy and Bartlett's Test of Sphericity which resulted in 0.653 with $p<0.001$ thus it was taken for principal component analysis. The cumulative variance contribution and components identified were given in table 5 and table 6. Four components were identified using principal component analysis.

Table-4 : Content Validity Index and kappa Value of the Formulated Tool

Domains	Physical	Ergonomical	Environmental	Psychological	Proportion relevance
E1	1	1	1	1	1
E2	1	1	0	1	0.75
E3	1	1	1	0	0.75
E4	1	1	1	1	1
E5	1	1	1	1	1
E6	1	1	0	0	0.5
E7	1	1	1	1	1
E8	1	1	1	1	1
E9	1	1	1	1	1
E10	1	1	1	1	1
E11	1	1	1	1	1
E12	1	1	1	1	1
E13	1	1	1	1	1
E14	1	1	1	1	1
E15	1	1	1	1	1
Experts in Agreement	15	15	13	14	**0.93**
I-CVI	1	1	0.87	0.93	**0.95**
UA	1	1	0	0	**0.5**
k value	0	0	1	1	

The **Table-5** presents the total variance explained by the extracted components before and after rotation. The four components had eigen values greater than one and accounted for 76.73 percent of total variance making them suitable for retention.

Table-5: Cumulative Variance Contribution of the Formulated Tool

No. of Components	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
Component 1	3.804	34.586	34.586	3.134	28.493	28.493
Component 2	2.004	18.217	52.803	2.572	23.384	51.878
Component 3	1.445	13.136	65.939	1.387	12.610	64.488
Component 4	1.188	10.797	76.736	1.347	12.248	76.736

Four components representing different occupational hazards among fishing sector. Each component in table 6 groups related hazards based on their highest factor loadings providing further insights. The factor loading above 0.4 were given in **Table-6**, thus indicate ergonomical and environmental hazards are interrelated necessitating interventions based on nature of work.

Table - 6: Rotated Component Matrix of the Formulated Tool

Items	Number of Components			
	1	2	3	4
I.6. Repetitive movements	0.782			
I.8. Handling hazardous substances	-0.775			
I.12. Exposed to slippery areas	0.640			
I.13. Exposed to direct sunlight	0.782			
I.15. Exposed to high noise	-0.837			
I.5. Lifting heavy items		0.904		
I.7. Unfamiliar tasks		0.952		
I.14. Exposed to extreme weather conditions		0.654		
I.9. Improper working postures			0.680	
I.10. Working two meters above ground			0.881	
I.11. Standing more than two hours in a row				-0.888

Discussion

The tool was constructed based on the literature review and adapted similar standardized tools such as Occupational Health and Safety vulnerability measure, Institute for Work and Health (2016) reviewed by five subject experts which was then given for essentiality and relevancy tests. The final tool formulated had Cronbach alpha value of 0.710 indicating internal consistency of the formulated tool signifying its reliability. According to Mo et al., (2020), Reliability refers to the consistency of results or findings when same tools are used repeatedly to assess the concept and the Cronbach alpha value greater than 0.6 is considered acceptable. Whereas validity refers to extent to which a tool correctly measures the intended purpose and requirements. The higher the validity of the tool, it effectively captures the targeted attributes[13].

In occupational health and safety management, risk assessment plays a critical role which involves identifying, evaluating and controlling high risk hazards to improve overall safety. Recently, occupational health and safety risk assessment has drawn considerable interest from researchers and practitioners resulting numerous methods designed to enhance the workers' health and safety across diverse sectors[14].

Physical Domain (Item 1 to 4) includes items on personal accidents, its type and frequency and experiences of fishing related illness. It demonstrates high content validity ratio (CVR) value indicating the expert consensus on item importance. The items such as 'Personal accidental details' achieved a CVR of one, which reflects the complete agreement among experts while on the other hand, items like 'Accident of coworkers', 'Part of body affected' scored lower (CVR=0.47 – 0.6) reflecting moderate relevance. The item level content validity index (I-CVI) for this domain is one and kappa value of zero indicates the unanimous expert consensus, thus physical domain holds robust content validity.

Ergonomical Domain (Item 5 to 11) addresses factors such as lifting heavy weights, repetitive motions, exposure to hazardous substances and working in awkward postures. The content validity ratio value diverse, with ‘Lifting heavy or push weights more than twenty kilogram scored high CVR of 0.7 whereas other items such as ‘Involved in unfamiliar tasks’ and ‘Interaction with hazardous substances’ had scored lower CVR values. In similar to physical domain, the item level content validity index and kappa value are one and zero respectively, which indicate that the items are relevant to ergonomic domain but lower CVR scores also indicate further alignment, whereas, Environmental Domain (Item 12 to 15) focuses on environmental risks, including frequency of exposure to slippery areas’, extreme weather and noise. The high content validity ratio (CVR) was seen for items such as ‘Encountering slippery areas and exposure to extreme weather. Occupational stress, workplace violence, harassment, discrimination and family time (Item 16 to 20) are encompassed under psychological domain, other than the item of ‘Stress experience’; other items scored a slightly lower CV suggesting some variance in perceived relevance. The psychological domain has item level content validity as 0.93 and kappa value of one reflecting high level of agreement and relevance though it is not uniform. The scale level content validity index demonstrates proportion relevance of 0.93 underscore the strong content validity across the formulated tool.

From construct validity analysis, four distinct components were extracted with total of eleven items contributing to 76 percent in similar to the Indian KAP study[15]. Through principal component analysis and varimax with kaiser normalization. The highest factor loadings above 0.4 were given in table 6. The component 1 represents task related occupational strain and consists of both ergonomical and environmental hazards such as repetitive movements (0.782), exposure to slippery areas (0.64), exposure to direct sunlight (0.782) and negative loadings with handling hazardous substances (-0.775) and exposure to high noise (-0.837) indicating the hazard exposure at perilous work at sea.

The component 2 represents the occupational strain in relation to ergonomical and environmental exposure which consists of lifting heavy item (0.904), unfamiliar tasks (0.952) and exposure to extreme weather conditions (0.654), these strong positive loadings emphasize these as major occupational hazard contributing to physically demanding tasks increasing the occupational health risk. Component 3: Improper working areas and postures consisting improper working postures (0.680) and working above two meters from ground (0.881) and lastly component 4 stability hazards consisting working above two meters from ground (-0.888) and exposure to extreme weather conditions (0.459)**.** Tool for assessing the health hazard exposed by fishermen was formulated and validated. Content validity related to the robustness of an instrument’s score interpretations and the extent to which these scores accurately represent the variables they aim to assess[12]. This tool can be complemented with a questionnaire for collecting background information, perceived stress scale and Nordic musculoskeletal questionnaire for effective collection of data on occupational health hazards in fishing sector.

Conclusion

Work related fatalities increases day by day, to address occupational health and safety issues measures on assessment on exposure to risk and hazards are need of the hour. Though various tools are available, a population and sector specific tool to assess the occupational health hazard will provide robust data. Thus, this study involved in formulation and validation of tool to assess the hazard exposure of fishermen, the Cronbach’s alpha value of 0.710 demonstrates the reliability and robustness of the developed tool. The scale level content validity index of 0.9, with cumulative variance 76 percentage and four components such as task related occupational strain, exposure related occupational strain, work area related occupational strain were identified through principle component analysis. The validated tool developed in this study effectively identifies and assess the occupational health hazards of fishers, with strong content and construct validity with robust internal consistency. Hence it can serve as a valuable instrument for researchers and practitioners aiming to enhance the occupational health and safety in fishing sector which can be further strengthened by addressing standardized occupational perceived stress scale and musculoskeletal questionnaire for holistic approach towards occupational risks and its associated impacts.

References

1. Laraqui O, Manar N, Laraqui S, Ghailan T, Deschamps F, Laraqui CEH. Occupational risk perception, stressors and stress of fishermen. Int Marit Health. 2018, 69 (4):233–42. doi:10.5603/IMH.2018.0038.
2. International Labour Organization. Safety and health at work [Internet]. Available from: https://www.ilo.org/topics-and-sectors/safety-and-health-work
3. Kumar Saha DR. Occupational health in India. Ann Glob Health. 2018,84(3):330. doi:10.29024/aogh.2302.
4. Occupational Safety and Health Administration. Occupational safety and health information [Internet]. Available from: https://www.osha.org
5. Liu R, Liu HC, Shi H, Gu X. Occupational health and safety risk assessment: A systematic literature review of models, methods, and applications. Saf Sci. 2023, 160: 106050. doi:10.1016/j.ssci.2022.106050.
6. Fernández-Gómez E, Martín-Salvador A, Luque-Vara T, Sánchez-Ojeda MA, Navarro-Prado S, Enrique-Mirón C. Content validation through expert judgement of an instrument on the nutritional knowledge, beliefs, and habits of pregnant women. Nutrients. 2020,12 (4):1136. doi:10.3390/nu12041136.
7. Yusoff MSB. ABC of content validation and content validity index calculation. Educ Med J. 2019,11(2):49–54. doi:10.21315/eimj2019.11.2.6.
8. Roebianto A, Savitri I, Sriyanto A, Syaiful I, Mubarokah L. Content validity: Definition and procedure of content validation in psychological research. TPM - Testing. 2023,30(1):5–18. doi:10.4473/TPM30.1.1.
9. Barrow A, Kongira A, Nget M, Sillah SO, Jatta SP, Badjie M, et al. Epidemiology of occupational hazards and injuries among fishermen at Tanji fishing site in The Gambia: An analytical cross-sectional study design. Environ Health Insights. 2022 Mar 23,16 : 11786302221088699. doi:10.1177/11786302221088699.
10. Zamanzadeh V, Ghahramanian A, Rassouli M, Abbaszadeh A, Alavi Majd H, Nikanfar AR. Design and implementation content validity study: Development of an instrument for measuring patient-centered communication. J Caring Sci. 2015,4(2):165–78. doi:10.15171/jcs.2015.017.
11. Ridenour CS, Newman I. Mixed methods research: Exploring the interactive continuum. Carbondale: Southern Illinois University Press. J Mixed Methods Res. 2008, 3 (2):197–8. doi:10.1177/1558689808331033.
12. Panda S, Singh A, Bali S, Bhargava A. Development and content validation of Perceived Barriers to Exercise Questionnaire (PBEQ-I) for Indian office workers. Chettinad Health City Med J. 2023,12(2):33–40.
13. Mo Z, Li X, Zhai Y, et al. Reliability and validity of a questionnaire measuring knowledge, attitude, and practice regarding "oil, salt and sugar" among canteen staff. Sci Rep. 2023, 13: 20442. doi:10.1038/s41598-023-47804-3.
14. Liu R, Liu HC, Shi H, Gu X. Occupational health and safety risk assessment: A systematic literature review of models, methods, and applications. Saf Sci. 2023, 160: 106050. doi:10.1016/j.ssci.2022.106050.
15. Moitra P, Verma P, Madan J. Development and validation of a questionnaire measuring knowledge, attitudes, and practices (KAP) to healthy eating and activity patterns in school children (HEAPS). Nutr Health. 2021, 27: 199–209. doi:10.1177/0260106020982356.

Citation: S. Adithiyalakshmi S. & Sridevi Sivakami PL. Formulation and Validation of tool to assess the exposure of occupational health hazards. Indian J Prev Soc Med, 2025; 56 (1): **64-72**.