Development of an intelligent ergonomic model for Hazards predictions in Domestic Tasks

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Abstract. Behavioural pattern is linked to many home accidents among occupants which have caused many injuries to life and properties. This study considered the categories and prevalence of risks among women in domestic tasks. A model was developed to predict the safety level of the subjects using Artificial Neural Network (ANN) function. With the use of a structured questionnaire, the study was conducted among 169 unmarried and 171 married women and the data was analysis with SPSS software. The ANN function was developed using the participants’ conducts in performing house chore duties, as the input. The “level of safety” was the output of the system. To test for its functionality, the ANN system was applied to predict safety in the performance of regular domestic duties among some women in the study area. The prediction accuracy of the system met with the objectives of the study.

Among the widely reported, 40% of the participants suffered from “Cuts injury” and while 35.6% complained of “contact with hot objects”. The developed ANN system is useful in homes where women are deeply engaged in domestic work.

1. Introduction
Domestic work (DWk) is all work that is physically, spiritually and mentally inclined, done as home activities on a regular basis [1]. DWk may be considered to be household tasks or work for chores. Washing, house and kitchen cleaning, food preparation, and others, may be included in DWk [2]. Child care is also part of DWk [3]. DWks were described by Eichler and Albanese [1] as having the tendencies to maintain some one’s daily activities.

In many cultures, the division of domestic work by gender is notable as the majority of DWk are assigned to women [4]. Some housewives spend more time at home, cooking in the kitchen and cleaning everything in some areas of the world, particularly in Africa. Any of these home practices are associated with one accident or another. Thus, women are observed to be mostly affected by domestic injuries than men and other members of a family [5].

It was reported that depression and anxiety disorders will be the results when women work longer hours than normal [6, 7]. When this is the norm, some women can be forced to indulge in risky activities, such as the use of alcohol and drugs in unhealthy situations [8] and this practice may result into health challenges.

In anthropometry studies, women have slightly lower grip strength and shorter hands compared to men. Men may have longer upper body strength than women. Women, however, are exposed to musculoskeletal challenges; heavy object lifting can lead to back pains, using common tools can lead to body pain, prolonged standing can be associated with preterm birth, fumes and chemicals can pose safety risks to women respiratory system, lifting and climbing can be dangerous for those that are pregnant among women. [9].
Worldwide, domestic accidents are characterized as public health issues [8]. The effects of domestic injury can prove to be devastating because it can lead to productivity loss and disability [10]. Domestic accidents involve falling from stairs, tables, slipping in the bathroom, hands hitting, cutting and many more. However, burn has been described as one of the most prevalent household threats that can lead to disability and death among housewives. Because of the use of wood, and fuel for cooking, incidence of fire disaster from fuel combustion are common in developing countries. Due to certain stress caused during cooking by unergonomic practices, women may experience neck, back, shoulder pains [11].

Maintaining healthy conduct and ergonomic working practices [12] is a major step to improve safety against injuries in domestic chores. In the exercise of domestic duty, good conduct could entail practicing a safe work attitude. A potent safety culture has been reported to be based on individual making safety practice a habit [13].

However, modifying work habits involves close analysis of an individual's pattern of behavioural, which may lead to hazards at one time or another, while on duty. Using artificial intelligence is one powerful tool commonly used to learn human behavioural patterns (AI).

Artificial Intelligence is saddled with the challenge of developing a human-like capacity for computer thinking and problem solving [14]. Applying AI requires studying attributes from the human perception of the domain and applying them in a computer-friendly manner to build an expert framework. The Artificial Neural Network (ANN) is an aspect of Artificial Intelligence that is considered to be a modern computational technique engaged in the development of human behavioral systems to assess unexpected complex complications. ANN learns to recognise data arrangements that might not have been solved by other related techniques [15]. ANN will study and model non-linear and complex associations as part of the many main advantages that make it most appropriate for evolving behavioral systems [16].

Efforts at reducing accident rates in domestic tasks, especially among women, are important and it is the major emphasis of this study. Such effort will increase the protection of lives and property and will enable women to make a significant contribution to the growth of their family and national economy. It is well known that women represent one-half of the world's human capital. The durability, competitiveness, and competitive ability of economies are for women. In any nation, women promote economic development [17].

The study aims to build an ANN system that will be capable of learning from some women behavior pattern in domestic tasks from the selected areas and use the system to predict the level of safety among women in similar task.

2. Materials and Methods
2.1 Study Area and Participants
Data was obtained from a subset of the total population of women. The research was conducted in South West Nigeria (Ifo, Ibadan, and Lagos). Participants in the less developed areas (Ifo) engaged in tenser domestic activities such as handling firewood, fetching water, pounding yam, etc. However some of the urban residents (city of Lagos) use electrical devices such as watching machines, electric blenders, gas and electric cookers, etc.

2.2 Data collection and analysis
Three hundred and fifty (350) questionnaires were administered. The questions, written in English language, consisted of three major parts; the general information about the participants, status and responsibility in the home. The second part was designed to measure the safety level and conduct while performing their domestic duties. Frequency-based response scale of 5 levels: SA = strongly agree, AG = agree, NDA = neither disagree nor agree, DA = disagree, SD = strongly disagree, was used to achieve these targets. The third section was designed to enable measurement of the prevalence, types, and risk factors for domestic injuries.
The questions included indirect ones so as to decrease the degree of bias in data collection. Open-ended questions were included to allow participants to express thoughts on information not presented in the formal questionnaire. Respondents were asked to go through their responses to ensure that before submission, their responses were the true image of their minds. Chi-Square statistical test which evaluated whether or not two or more classes of cases are distinct, was engaged to analyze the reported data using the SPSS kit. The Chi-Square findings, at \( p<0.05 \), determined whether or not the relationship was significant.

2.3 Development of artificial neural network function

Using a portion of the questionnaire, the behavioural habits of women in domestic roles were captured. This was to test the safe practices of participants in the various domestic work engagement.

A collection of Likert-type items was used in a scale of 1-5 ('1' allocated to unsafe habit and '5' assigned to safe practice) to assess the adoption of all standardized attributes capable of contributing to a safe condition in domestic work.

| Interval       | Linguistic interpretation          |
|----------------|-----------------------------------|
| 1              | Poor-safe-practice                |
| 1.10 -2.490    | Weak-safe-practice                |
| 2.50 and 2.90  | Average-safe-practice             |
| 3.0 -3.90      | Good-safe-practice                |
| \( \geq 4.0 \) | Very-good-safe-practice           |

The outcome to the ANN system was a variable ‘safety level’. The participants were asked to assign marks to ‘safety level’ in their various domestic duties’

3.0 Results and Discussion

3.1 Hazards in Domestic Works

In the course of performing their domestic works, as shown in Figure 1, more than 40% of the total respondents reported injury relating with ‘cut and lacerations’ once in the last 12 months. ‘Smoke inhalation’ (30.6%) and ‘back pains’ (35%) of the subjects respectively. Hence, ‘cuts and laceration’ were the prevalent injuries among the participants. Other ones are ‘electric shock, ‘skin contact with hot substances’, ‘pains in some body parts’ and ‘smoke inhalation’.

This outcome agrees with the previously reported injuries, among women in home activities, from other author [21]. However, skin contact with hot substance is an added prevalent injuries among the participants.

![Figure 1. Reported hazards types and prevalent among women in domestic works](image-url)
### 3.2 Pattern of behaviour in domestic works

Table 2. An overview of the safe behavioral pattern of the subjects in domestic works (N340)

| Ref. | Recorded Conduct in domestic tasks (Rcdt)                                                                 | Average ratings (STD) |
|------|-----------------------------------------------------------------------------------------------------------|-----------------------|
| Rcdt-1 | All recommended safety procedures followed                                                                  | 3.40(0.9)             |
| Rcdt-2 | Attention paid to proper cutting procedures                                                                  | 3.10(1.1)             |
| Rcdt-3 | Wet towels not used to handle hot pots                                                                      | 4.10(1.1)             |
| Rcdt-4 | Wet floors, spilled food or grease cleaned up immediately                                                  | 3.20(1.0)             |
| Rcdt-5 | Too heavy load not attempted to carry                                                                        | 2.40(1.4)             |
| Rcdt-6 | Plugging of appliances into an electric outlet not done until I switched off                                  | 3.90(1.0)             |
| Rcdt-7 | Equipment not started until all parts are in good places                                                    | 3.00(1.3)             |
| Rcdt-8 | I use electrical power equipment with its manual                                                            | 2.20(0.8)             |
| Rcdt-9 | Every cutting are done with the right knife                                                                  | 4.10(0.9)             |
| Rcdt-10 | I concentrate without talking while holding a knife                                                         | 2.00(1.0)             |
| Rcdt-11 | While using any knife, I cut away from my body                                                               | 2.60(1.1)             |
| Rcdt-12 | At all times, I use a cutting board                                                                        | 2.60(1.2)             |
| Rcdt-13 | I secure knives in knife drawers                                                                           | 4.20(0.8)             |
| Rcdt-14 | I handle knives only by the handle                                                                          | 4.20(0.9)             |
| Rcdt-15 | Before I attend to other matters, I switched off all cooking activities                                     | 3.00(1.0)             |
| Rcdt-16 | Lids of pots are removed slowly                                                                           | 4.20(0.8)             |
| Rcdt-17 | I know where to operate fire extinguishers                                                                   | 3.60(1.0)             |
| Rcdt-18 | I concentrate without talking while holding a knife                                                         | 2.20(1.3)             |
| Rcdt-19 | Utensils are never left on the floor                                                                        | 3.50(1.2)             |
| Rcdt-20 | All traffic areas are kept clear of objects                                                                  | 2.20(1.3)             |
| Rcdt-21 | I properly discard all cracked glasses with gloves in hand                                                  | 3.30(1.4)             |
| Rcdt-22 | Broken glasses are not placed in wastebaskets                                                                 | 1.50(1.2)             |
| Rcdt-23 | I don’t use boxes or chairs but ladders to get things from high shelves                                    | 2.80(1.1)             |
| Rcdt-24 | While disposing of refuse, I usually wear gloves                                                           | 2.20(0.9)             |
| Rcdt-25 | I properly wash and sanitize hands                                                                          | 4.00(1.0)             |
| Rcdt-26 | My back are kept straight whenever objects are lifted                                                       | 1.50(0.8)             |
| Rcdt-27 | I keep object close to the body before it is lifted                                                         | 2.20(1.3)             |
| Rcdt-28 | Before I lift any object, my knees are bent                                                                  | 2.30(1.2)             |
| Rcdt-29 | I don’t lift with back but legs                                                                            | 2.70(1.4)             |
| Rcdt-30 | I call for help when I need to lift or move heavy containers                                               | 2.60(1.4)             |
| Rcdt-31 | Awkward postures are avoided while lifting                                                                  | 2.40(1.3)             |
| Rcdt-32 | Personal safety equipment are put on whenever they are required                                            | 3.80(1.1)             |
| Rcdt-33 | I don’t walk barefooted in the house                                                                       | 4.00(1.0)             |
| Rcdt-34 | I wear eye protection when frying                                                                         | 3.90(0.9)             |
| Rcdt-35 | I use respirators while frying                                                                            | 2.80(1.1)             |
| Rcdt-36 | I don’t operate any equipment until I am fully trained                                                     | 2.50(1.2)             |
| Rcdt-37 | I report any broken or malfunction equipment properly                                                       | 3.00(1.1)             |
| Rcdt-38 | I know the locations of water close valves                                                                  | 2.10(1.0)             |
| Rcdt-39 | I know where to shutoff gas                                                                               | 4.10(0.6)             |
| Rcdt-40 | I properly wear gloves while doing laundry work                                                             | 1.50(2.0)             |
| Rcdt-41 | I don’t spread clothes above my head over the string                                                       | 1.60(1.2)             |
| Rcdt-42 | I use waterproof boot and aprons that I use at laundry work                                                | 2.00(0.8)             |
| Rcdt-43 | I don’t pound yam manually but with machine                                                                | 2.40(1.4)             |
| Rcdt-44 | I make sure iron is facing up                                                                              | 3.00(1.1)             |
| Rcdt-45 | In kitchen or while ironing I don’t use a mobile phone                                                    | 2.60(1.2)             |

From Table 2, the assessed attribute of forty-five (45) healthy conduct and the estimated average rating as stated by the subjects are shown. Mark 0-1 was interpreted as ‘poor safety-conduct’, 1.1
-2.49 mark was ‘weak safety-conduct’, 2.5–2.9 score was ‘average safety-conduct’, 3.0–3.9 marks was ‘good safety-conduct’ as while score 4.0 and beyond was adjudged ‘a very good-conduct’. The pattern of conduct, as indicated in Table 1, revealed that 21 (45.7%) of the total 45 conduct were rated as either ‘very good’ and/or ‘good’. Seven (7) (15.2%) were assigned as ‘average’ and the rest (39.1%) were considered to be below ‘average’.

3.3 Model applications
To compute a value standing for an output that is translated to predict the degree of security, the result was created by running the input variables in the neural network function. Each of the 45 variable values is a proportional rating for the 46 attributes of conduct of women listed in Table 2. Twelve (12) among the values (conducts with references Rcdt-1, Rcdt-12, Rcdt-16, Rcdt-21, Rcdt-22, Rcdt-24, Rcdt-26, Rcdt-27, Rcdt-37, Rcdt-38, and Rcdt-43 and Rcdt-45) were rated ‘1′ (poor safety-conduct), 14 of the samples (behaviour attributes with references Rcdt-2, Rcdt-3, Rcdt-8, Rcdt-9, Rcdt-14, Rcdt-19, Rcdt-20, Rcdt-28, Rcdt-29, Rcdt-31, Rcdt-35, Rcdt-39, Rcdt-40 and Rcdt-44) were scored ‘2′ (weak safety-conduct), 12 attributes (attributes with references Rcdt-4, Rcdt-6, Rcdt-7, Rcdt-15, Rcdt-18, Rcdt-23, Rcdt-25, Rcdt-32, Rcdt-33, Rcdt-36, Rcdt-41 and Rcdt-42) were apportioned ‘3′ marks (acceptable safety-conduct) and the rest (references Rcdt- 5, Rcdt-10, Rcdt- 11, Rcdt- 13, Rcdt- 17, Rcdt- 30 and Rcdt- 34) were allocated ‘4′ (very good safety-conduct).

From the system interface, safety value is displayed as -0.544 and the hazard was 1.023. This mean that a woman engaging in domestic activities with the conducts as described by the attributes references Rcdt-4, Rcdt-6, Rcdt-7, Rcdt-15, Rcdt-18, Rcdt-23, Rcdt-25, Rcdt-32, Rcdt-33, Rcdt-36, Rcdt-41, Rcdt-42, Rcdt- 5, Rcdt- 10, Rcdt- 11, Rcdt- 13, Rcdt- 17, Rcdt- 30 and Rcdt- 34 rated as ‘3.0’, may have injury experience associated with the works since the hazards rating was higher than the safety rating.

If safety must be enhanced, all behavioural patterns that were scored below the average must be improved upon. The adjustment of such conducts will boost the values of safety level and reduce the hazards ratings.

4. Conclusion
In this study, a model was proposed to predict the safety level in domestic tasks, among women in Western Nigeria, using Artificial Neural Network (ANN) function. The ANN function was developed from 45 participants’ safety conduct variables data collected while performing their domestic activities. When applied among some women, the ANN function predicted rightly the safety levels in the domestic duties. The results were reported in the range of 0.0 (low risk) and 1.0 (high risk). The proposed system is useful in homes where women are deeply engaged in domestic works.

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