

## ORIGINAL ARTICLE

# ABLUTION WORKSTATIONS DESIGN FOR PERSON WITH PHYSICAL DISABILITIES IN MALAYSIA

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## ABSTRACT

*An investigation on ablution workstations design for person with disabilities has been carried out in this study. The focused were on wheelchair user or person with lower-limb impairment in Malaysia. The objective of this research is to determine the most suitable ablution workstation for person with disabilities. One hundred wheelchair users which include 74 males and 26 females participated in the study. The findings highlighted that the most suitable and preferred ablution workstation for person with disabilities is a separate design for washing hands and legs. The results also indicated that the noteworthy body parts that should be enhanced are arms, neck, trunk, and legs. Therefore, it can be concluded that it is important to design an ablution workstation with correct anthropometric dimensions referring to the population under investigation taking into account their preferences and disabilities limitation. Thus, the innovation will bring equality between people with disabilities and physically normal people in future facilities design. The workstation will become one of the worthy social contributions to the population of Muslim disabilities especially in Malaysia.*

**Keywords:** Ablution, workstation, preference, physical disabilities, anthropometric dimensions

## INTRODUCTION

Physical disability is characterized as the inability of the body either lost or missing a limb or disability in any part of the body which affect them to limit their fundamental activities including ablution. Research about ablution workstation for person with disabilities are still lacking despite the fact that ablution workstation is considered as one of vital public facilities particularly in this country with the highest Muslim population. Nevertheless, there are few studies regarding accessibility built environment in Malaysia for person with disabilities at shopping malls, public transport terminal, public buildings, hotels, tourist attraction and others<sup>1-9</sup>

The sustainability of design to be applied to the development of ablution workstation for PWDs cannot be disregarded. This matter is uncertain because there is no universal design guideline that can be referred to the design of the ablution workstation when the Mosque's construction was initiated. This matter may influence also the human body dimensions with reference to the facilities itself and bring forward the result of mismatched in application of architectural design with the anthropometric dimensions<sup>10</sup>. Anthropometric dimensions for normal population is diverse compared to wheelchair user population<sup>11</sup>. These distinctions of anthropometric dimensions will give impact on the design of the ablution workstation<sup>12</sup>. This is one of the reasons that PWD population unable to

fit with the current ablution workstations intended for normal population. Moreover, as we probably aware, wheelchair user is vulnerable group. Thus, focus should be given to the main design criteria which are anthropometric dimensions when designing for person with disabilities. In view of this matter, this paper investigates the suitability and most preference ablution workstations design for person with disabilities to perform their ablution ritual.

## METHODS

### ABLUTION RITUAL

Ablution originates from the word al-wadha'ah which means cleanliness and brightness<sup>8</sup>. Muslims perform ablution to purge themselves before facing Allah's during prayer, and at times before reading the Qur'an. Every Muslim is required to perform an ablution by washing the areas surrounding compulsory parts of their body<sup>5,13</sup>. Abu Hurairah claimed that the Prophet Muhammad (Peace Be upon Him) (PBUH) mentioned, "He (Allah) only accepts prayer of person that has implemented ablution ritual<sup>5,13</sup>. The washing ritual involves washing four compulsory body parts: face, both hands, forehead to crown of head, and feet. Therefore, to ensure that an ablution procedure is perfect for Muslim person with disabilities, the design of an ablution criteria ought to be parallel with the need of individuals with disabilities.

### SUBJECTS

One hundred wheelchair users which include 74 males and 26 females participated in the study. These participants were selected based on two criteria: (a) they are able to understand and speak Bahasa Melayu or English, and (b) they have signed the informed consent. Ethical approval for the study was obtained from the University of Malaya Medical Center Ethics Committee.

#### ANTHROPOMETRIC DIMENSION FOR WHEEL CHAIR USER

The selection of the anthropometry body dimensions were considered according to their significance and usefulness for the development of designing the sitting workstation and ablution workstation. The description for each anthropometric dimensions is referred from the book entitled *Body space: Anthropometry, Ergonomics and the Design of the Work* by the Malaysia Standard, MS ISO 7250-1:2008<sup>14</sup>, as shown in Table 3.1 below.

#### STATISTICAL ANALYSIS

The IBM Statistical Package for Social Science (SPSS) (IBM SPSS Statistics for Windows Version 21.0, Armonk, NY: IBM Corp) was utilised for the anthropometric measurements. Data were calculated separately for both the male and female subjects.

#### APPARATUS

Anthropometer measuring set.

#### EXISTING ABLUTION WORKSTATION DESIGN USED IN THIS RESEARCH

It is crucial to find out that the wheelchair user have different needs compared to normal population specifically in terms of ablution workstations. People with disabilities should be able to use ablution facilities with full of comfort without any assistance. In this research, three existing ablution workstation are used to be investigated. They are:

##### *a) Ablution Workstation - Design A*

This is an ergonomic ablution station for person with disabilities and people with special needs. The ergonomic wash basin design can avoid water over spilling whilst providing comfort to the user while performing ablution. The multi-directional fountain water system was designed to ensure full coverage of the feet whilst performing ablution.

##### *b) Ablution Workstation - Design B*

This is the portable ablution workstation developed for person with disabilities including wheelchair users. The design of the ablution workstation is based on anthropometric dimensions of wheelchair user under investigation. Ergonomic sink was designed to

avoid over spilling of water while performing the ablution. The ablution workstation was separated into two parts which are ergonomics sink and portable feet wash basin. The main workstation is also portable.

##### *c) Existing Ablution Workstation at PWD mosque - Design C*

This is the existing ablution workstation at PWD mosque at the Industrial Training and Rehabilitation centre. These three ablution workstations design are used in this study.

#### DATA ANALYSIS

##### *SPSS*

The result from collected questionnaire will be analyzed using SPSS Software. The reliability test will be analyzed to know the validity of the result from questionnaire. Meanwhile, the frequency, percentage also will be analyzed and tabulated.

##### *Anthropometric Dimensions*

The statistics analysis is using IBM Statistical Package for Social Science (SPSS) for Windows version 23 software. Somatic characteristics were determined using arithmetic means ( $\bar{x}$ ), standard deviation (SD) and the values of the 5th, 50th, and 95th percentile. The 5th, 50th, and 95th percentile of the measurements are calculated for both male and female wheelchair users. Independent t-test is carried out to evaluate significance differences of each anthropometric measurement between wheelchair user and normal people since the significance differences of dimensions are useful in the application of anthropometric data design. The p-value for the dimensions analyzed need to be less than 0.05 in order to have significance differences between dimensions of Wheelchair Users and Normal Adults.

#### RESULTS

The results present anthropometric data for the wheelchair user and the design criteria of the ablution station that covers the hand basin, foot basin and water tap position.

Table 1 presents the sitting anthropometric dimensions of the wheelchair users by gender. Thirteen dimensions related to an ablution workstation were selected. The mean and standard deviation of sitting height were 78.39 cm (SD=8.31cm) for male and 71.9 cm (SD=8.8 cm) for female. It also provides the value of each body dimension at the 5th and 95th percentile. The anthropometric data shows that the males recorded a higher mean value than the females<sup>10</sup>.

**Table 1: Description of Anthropometric Dimensions<sup>12</sup>**

|   |                          |   |
|---|--------------------------|---|
| A | Stature                  | Distance from the seat to the crown of the head   |
| B | Sitting Eye height       | Height above the ground of the eye of a person standing erect.  |
| C | Shoulder height          | Distance from the seat to the top of the shoulder   |
| D | Elbow height             | Distance from the seat to the below part of the elbow   |
| E | Knee height              | Taken above floor to the upper knee   |
| F | Popliteal height         | Height of the popliteal fossa (back of the knee) above the ground   |
| G | Trunk depth              | Horizontal distance between the anterior point of the abdomen and the back at the same level.   |
| H | Buttock Popliteal length | Horizontal distance between the most posterior point on the buttock and the back of the knee as measured in the sitting position with knee flexed 90 degrees. |
| I | Thigh thickness          | Distance taken above the floor to the upper thigh of a seated person  |
| J | Shoulder breadth         | Distance between left and right shoulder  |
| K | Hip breadth              | Lateral maximum hip or thigh breadth (whichever is broader) of a seated subject   |
| L | Max Elbows span          | Distance between left and right elbow   |
| M | Arm overhead reach       | Highest Distance when arm doing overhear reach during sitting   |
| N | Arm reach forward        | Distance between shoulder to finger tips horizontally   |
| U | Arm reach down           | Distance between seat and reach down  |
| W | Lateral reach            | Half of arm span  |
| Z | Arms Span                | Widest distance across the arm  |

Table 2 shows the dimensions of the ablution workstation. The 5th percentile measurement was used for the distance between the water tap handle and the front hand basin, the distance between the water tap and the user, and the height between the foot basin and the floor. The 95th percentile measurement was used to measure the height from the hand basin to the floor, and the internal length of the hand basin.

**Table 2: Anthropometric Data for Malaysian Wheelchair Users**

| No. | Dimension (cm)           | Male  |       |                |                 | Female |      |                |                 |
|-----|--------------------------|-------|-------|----------------|-----------------|--------|------|----------------|-----------------|
|     |                          | Mean  | SD    | 5th Percentile | 95th Percentile | Mean   | SD   | 5th Percentile | 95th Percentile |
| 1   | Weight (kg)              | 66.71 | 18.38 | 42.0           | 95.90           | 57.7   | 15.4 | 38.2           | 78.4            |
| 2   | Sitting height           | 78.39 | 8.31  | 64.43          | 88.0            | 71.9   | 8.8  | 57.3           | 84.1            |
| 3   | Eye height, sitting      | 67.5  | 7.2   | 55.9           | 77.9            | 60.2   | 7.1  | 48.8           | 68.3            |
| 4   | Shoulder height, sitting | 52.5  | 6.4   | 43.5           | 61.8            | 47.1   | 6.2  | 36.4           | 54.4            |
| 5   | Waist height, sitting    | 19.9  | 3.9   | 14.6           | 27.0            | 18.5   | 3.3  | 12.5           | 23.0            |
| 6   | Thigh clearance          | 11.6  | 3.1   | 6.5            | 17.0            | 11.2   | 3.1  | 6.6            | 15.6            |
| 7   | Sitting elbow height     | 19.8  | 4.9   | 13.4           | 25.2            | 16.9   | 5.2  | 7.7            | 23.0            |
| 8   | Arm Reach upward         | 118.9 | 16.5  | 95.0           | 138.1           | 102.9  | 9.6  | 92.5           | 115.0           |
| 9   | Knee height sitting      | 50.9  | 5.7   | 41.7           | 60.9            | 49.4   | 7.7  | 39.5           | 64.9            |
| 10  | Popliteal height         | 43.2  | 9.7   | 34.2           | 53.0            | 40.4   | 7.9  | 31.0           | 54.1            |
| 11  | Arm reach forward        | 79.8  | 6.4   | 70.4           | 90.1            | 74.2   | 3.9  | 68.4           | 81.4            |
| 12  | Forearm-hand length      | 29.2  | 7.2   | 22.8           | 45.4            | 27.1   | 6.1  | 21.3           | 41.7            |
| 13  | Elbow fingertip length   | 44.8  | 3.2   | 40.5           | 50.2            | 40.2   | 3.1  | 36.1           | 45.8            |

## SEAT DIMENSIONS

The seat dimensions of a conventional manual wheelchair are as follows:

- a. Total length : 108cm
- b. Total height : 91.5cm
- c. Total breadth : 66 cm
- d. Arm rest height : 76 cm
- e. Seat height : 53 cm
- f. Seat width : 51cm
- g. Seat length : 43cm
- h. Foot rest height : 20cm

## HAND BASIN

The hand basin was designed to be within reach from a seated position so that the wheelchair user can perform ablution without having to shift his or her position. The hand basin height is defined by a wheelchair seat height and 95th percentile female sitting elbow height. If the height of the sitting elbow is lower than the ablution surface, the user must raise his or her arm and shoulder, which can cause stress to the deeper posterior neck musculature as the user stabilises his or her head posture.

## WATER TAP POSITION

Water tap is the most essential part of an ablution unit and thus the designer of a praying facility must consider the distance between the water tap and the user. A distance water tap requires the user to bend forward and overstretch his or her muscles, resulting in sprains and strains to the shoulder and back muscles, and the user as a consequence may have a risk of falling. However, if the distance is too close to the user the water could be splash to the user body and thus consideration must be paid to place the water tap at a distance which is reachable and at comfortable range to a wheelchair user.

## FOOT BASIN

The height of the top of surface foot basin is defined by foot rest height. This dimension is used to ensure that wheelchair user can place and wash their feet in the basin comfortably without having to bend their back. The height of the water tap is defined by 5<sup>th</sup> percentile female popliteal height. With the flexibility feature, a wheelchair user is able to wash his or her feet at desired height of the water tap thus preventing awkward position and wet clothes.

## CATIA ANALYSIS ON DIFFERENCE ABLUTION WORKSTATIONS

### DESIGN A



Figure 7: CATIA Analysis for Design A

### DESIGN B



Figure 8: CATIA Analysis for Design B

### DESIGN C



Figure 9: CATIA Analysis for Design C

Fig. 7, 8 and 9 present the cleaning ritual during an ablution. The arms up to the elbow, including the hands, are among the four areas that need to be washed. Water will flow from the right forearm to the elbow till finger-tips; and the left hand is used to spread water all over the right arm to ensure that all the necessary parts are washed. The same activity will be repeated for the left forearm, but using the right hand. The washing must be done from the elbow to the finger-tips and vice versa. The right arm is washed three times repeatedly, followed by the left arm. The

trunk is slightly flexed to the front for the user to reach the faucet. As for face cleaning ritual during ablution, includes the top of the forehead to the chin until up to both ears. Water will flow over the face from the top. Then, using both hands, water is spread all over the face from top to bottom so that the water will reach all over the face area vertically from the hair-line to the chin. The face is one of the essential parts in ablution and must be washed at least once, otherwise the ablution is considered incomplete. However, the face is usually washed three times repeatedly.

Foot cleaning is the last step of an ablution ritual. The right foot is washed up to the ankles three times, and so is the left foot. In the RULA analysis, the foot received a score of 2 and thus can be considered as a good posture. Green colour reveals that the posture can be maintained and no further investigation is needed.

The examined posture score is 3 and indicates a yellow colour, which implies that further analysis is required on the design and posture or figure 1 and 3. Discomforts may be experienced by users if they sit longer at the workstation. However, the overall analysis indicates that the posture attained is acceptable and improvements are highly recommended for better results. The quick action of face cleaning will not contribute to any muscle fatigue or discomfort during the cleaning ritual. Advanced improvements and changes may be required if necessary. As for Fig 2, the examined posture score is 2 and indicates a green colour, which implies that the posture is acceptable.

## DISCUSSION

The discussion will cover the significant design criteria of the ablution station that includes water tap, hand basin and foot basin. The anthropometry data of wheelchair users concern not only the appropriate height of a water tap, but also how the user can access the unit comfortably, conveniently, and safely without special assistance. The ablution workstation was designed with appropriate dimensions of water tap, hand basin, and foot basin. Some features were added to ease the wheelchair user to perform ablution.

The hand basin should be designed to allow comfort to the user without having to raise their shoulder (from too high ablution surface) or bending their body (from too low ablution surface), the height of the hand basin was determined to be 76 cm. The concave shape on the front edge of the basin will help to reduce water splashing towards the user.

Based on the findings, the ablution workstation is designed with a flexible water tap and the distance between the water tap handle and the front hand basin was set at 5<sup>th</sup> percentile female arm reaches forward which is 68.4 cm. This dimension was used to ensure that all users falling into the 5<sup>th</sup> percentile female and above could

reach the water tap handle. The flexible water tap was used to fit the range of wheelchair users with varying levels of disability and wheelchair sitting height.

As for foot cleaning, RULA analysis indicated that the foot received a score of 2 and thus can be considered as a good posture. Green colour reveals that the posture can be maintained and no further investigation is needed.

To summarize, the results and analysis implies that the design of the workstation fits the demand of the users.

## CONCLUSIONS

The results indicated that the most suitable ablution workstation is the A ablution workstation design. The results highlighted that the body parts that should be considered in designing an ablution workstation are arms, neck, and trunk. However, the overall analysis indicates that the posture attained is acceptable and improvements are highly recommended for better results. Thus, it can be concluded that it is important to design an ablution workstation with correct anthropometric dimension as this will bring equality between people with disabilities and physically normal people in future facilities design. Thus, the workstation will become one of the worthy social contributions to the population of Muslim disabilities especially in Malaysia.

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## TABLES AND FIGURES

**Figure 1:** Anthropometry Dimensions measured on the subjects<sup>12</sup>



**Figure 2:** Anthropometric Measuring set

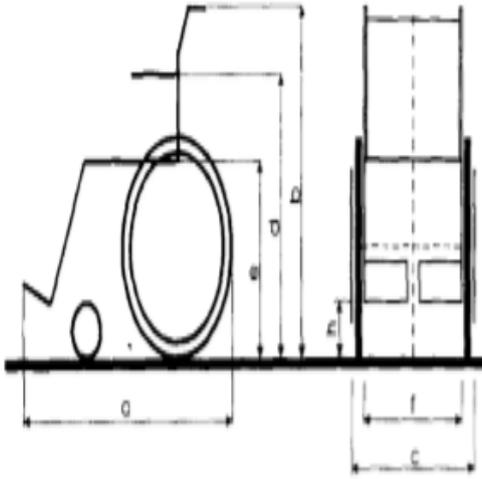


Figure 4: Ablution Workstation - Design B

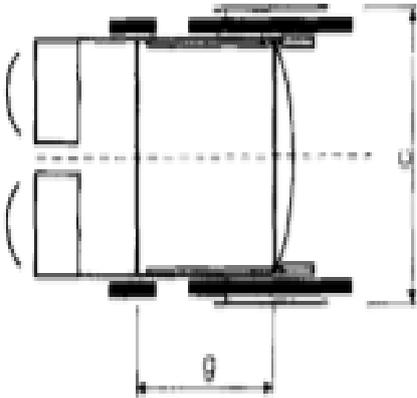


Figure 5: Ablution Workstation - Design C



Figure 3: Ablution Workstation - Design A

**Table 3: Dimensions of the Ablution Workstation Based on Anthropometry Data of Wheelchair Users**

| No | Feature  | Design Criteria   | Design Dimension (cm) |
|----|--|---|-----------------------|
| 1  | Seat height  | Manual wheelchair dimension   | 53                    |
| 2  | Seat length  | Manual wheelchair dimension   | 43                    |
| 3  | Seat width   | Manual wheelchair dimension   | 51                    |
| 4  | Hand basin height from the floor                       | Seat height+95 <sup>th</sup> percentile female sitting elbow height             | 76                    |
| 5  | Inside abluion hand basin length                       | 95 <sup>th</sup> percentile male fingertip to elbow length                      | 50.2                  |
| 7  | Distance from water tap handle to the front hand basin | 5 <sup>th</sup> percentile female arm reaches forward                           | 68.4                  |
| 8  | Distance water tap to user                             | <5 <sup>th</sup> percentile female arm reaches forward (use flexible water tap) | <68.4                 |
| 9  | Foot basin height from the floor                       | foot rest height  | 20                    |
| 10 | Water tap foot basin height                            | 5 <sup>th</sup> percentile female popliteal height                              | 31                    |

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