Loughborough
University

This item was submitted to Loughborough's Institutional Repository by the author and is made available under the following Creative Commons Licence conditions.

For the full text of this licence, please go to:
http://creativecommons.org/licenses/by-nc-nd/2.5/

Technical Note

Thermal Insulation and Clothing Area Factors of Typical Arabian Gulf Clothing Ensembles for Males and Females: Measurements using Thermal Manikins

F. F. Al-ajmi[a],   **D.L Loveday [b],**   **K.H. Bedwell[c],**   **G. Havenith[c]**

(a) Department of Civil Engineering, College of Technological Studies, Shuwaikh 70654, Kuwait

(b) Department of Civil and Building Engineering, Loughborough University, Loughborough LE11 3TU, UK

(c) Environmental Ergonomics Research Centre, Dept. of Human Sciences, Loughborough, LE 11 3TU, UK

Corresponding author: G.Havenith, Environmental Ergonomics Research Centre, Dept. of Human Sciences, Loughborough, LE 11 3TU, UK

+44 1509 223031; Fax +44 1509 223940; email: g.havenith@lboro.ac.uk

Abstract

The thermal insulation of clothing is one of the most important parameters used in the thermal comfort model adopted by the International Standards Organisation (ISO) (ISO 7730, 2005) and by ASHRAE (ASHRAE-55, 2005). To date, thermal insulation values of mainly Western clothing have been published with only minimal data being available for non-Western clothing. Thus, the objective of the present study is to measure and present the thermal insulation (clo) values of a number of Arabian Gulf garments as worn by males and females. The clothing ensembles and garments of Arabian Gulf males and females presented in this study are representative of those typically worn in the region during both summer and winter seasons. Measurements of total thermal insulation values (clo) were obtained using a male and a female shape thermal manikin in accordance with the definition of insulation as given in ISO 9920. In addition, the clothing area factors (f_{cl}) determined in two different ways were compared. The first method used a photographic technique and the second a regression equation as proposed in ISO 9920, based on the insulation values of Arabian Gulf male and female garments and ensembles as they were determined in this study. In addition, fibre content, descriptions and weights of Arabian Gulf clothing have been recorded and tabulated in this study.

The findings of this study are presented as additions to the existing knowledge base of clothing insulation, and provide for the first time data for Arabian Gulf clothing. The analysis showed that for these non-Western clothing designs, the most widely-used regression calculation of f_{cl} is not valid. However, despite the very large errors in f_{cl} made with the regression method, the errors this causes in the intrinsic clothing insulation value, I_{cl}, are limited.

Keywords: Clothing thermal insulation, Thermal comfort, Arabian Gulf clothing, clothing area factor

1. Introduction

Social custom, cultural needs and regional climate can play an important role in the development of people's clothing and style (i.e. garments and ensembles). Like other clothing worn in different cultures and societies, garments and ensembles worn in the Arabian Gulf region are designed in a shape and style so as to generate for the wearer an acceptable human thermal sensation for a geographical region that is extremely hot and dry. Likewise, McCullough and Wyon (1983) indicate that clothing ensembles and garments worn by people are influenced by the seasonal pattern of outdoor weather conditions. In general, summer conditions in the Arabian Gulf region are typically hot and dry, with an average maximum temperature that may exceed 45°C, while in winter conditions are dry and cool. Thus, in a climate like that of the Arabian Gulf, garments providing less clothing thermal insulation or garments providing more clothing insulation may influence positively the individual sensation of thermal comfort.

The use of the thermal comfort model ISO 7730, which uses the Predicted Mean Vote, PMV (ISO 7730, 2005), as the metric of thermal comfort sensation as well as the ASHRAE (American Society of Heating Refrigerating and Air-conditioning Engineers) Standard 55 (ASHRAE, 2005), have focussed considerable attention towards the development of a database for collecting and documenting information about thermal insulation values, descriptions, weights and clothing area factors, as presented in ISO

9920 (2007). Currently, this database mainly consists of Western clothing data and lacks data on world traditional clothing. To contribute to this database, the clothing thermal insulation values of Arabian Gulf clothing ensembles as worn by males and females were investigated, measurements being taken using thermal manikins. Garment and ensemble descriptions, weights and clothing area factors were tabulated in addition to the insulation data and the clothing surface area factor. The determination of the clothing area factor (required to calculate intrinsic clothing insulation) was carried out using two methods as advised in ISO 9920: a prediction method and an actual determination by a photographic technique.

2. Clothing Description

2.1. *Gulf Male Traditional Clothing*

Arabian Gulf male clothing ensembles in summer differ from those of the winter months in terms of their thicknesses and colours. Traditional Arabian Gulf male garments and ensembles consist of underwear ensembles, gowns and jackets.

The main Arabian Gulf male ensembles and garments that are most common and that may distinguish Arabian Gulf male clothing from other people's clothing (non-Arabian ensembles and garments) are described in the following sections.

2.1.1. *'Thowb'* (or may be called 'dishdasha') is a long, loosely fitting gown that covers most of the male body (86%) except for the hands, head and feet. The 'Thowb' or 'dishdasha' can be custom-made by a tailor to suit the wearer's size and measurements, or it can be bought as ready-made clothing. The 'Thowb' is shaped to fit loosely and is characterised by having many openings that enhance ventilation of enclosed still air and removal of moisture that is in contact with the human body surface thereby contributing to the wearer's comfort. These

openings are: upward from the neck collar; to the front from chest 'vents' between buttons; to the sides from both hands' sleeve 'cuffs'; a downward opening. These five openings of the Thowb and the corresponding movement of ventilation air are shown in Fig. 1. Summer male Thowbs have a fine clothing layer (or a lightweight Thowb), that may be made of a cotton blend fabric with light colours i.e. white, off-white, beige, light blue, etc, which help in reflecting incident solar radiation and reduce its effect on the body. The winter Thowb differs from that of the summer by consisting of a slightly thicker layer (or a heavyweight Thowb), that may be made of soft wool fabrics blended with dark colours i.e. black, dark blue, brown, grey, etc. However, the Thowb's colour and fabric selection are variable with the seasons and with fashion trends. Jackets or coats are commonly worn on top of winter garments and ensembles.

2.1.2. *The male Headdress* consists of three pieces. These pieces can be described as follows. Firstly, the 'Kuffiya' (or may be called the 'Taqia') is a closefitting cap (or closed skull cap) that is made of crocheted fine cotton to cover the head and to provide a firm foundation upon which to drape the Ghutra (which is explained next). Secondly, the Ghutra is a large square-shaped cloth made from a wide selection of fabrics. As summer wear, a white Ghutra is favoured; this is made of a fine cotton voile. A white and red Ghutra (sometimes called a Shemagh) is a favourite winter wear, and consists of a red and white chequered cloth that is made from a heavier cotton blend or soft wool blend. In general, the Ghutra can be worn only after being folded into a triangular shape. Finally, the Egal is a headband that holds everything (i.e. Kuffiya and Ghutra) on the head and is

made of a double circlet of twisted black wool or nylon cord, which anchors the headdress on the head.

2.1.3. *Male underwear* consists of a T-shirt and underpants, the underpants being worn beneath short trousers (the latter being called a short Serwal) or long trousers (called a long Serwal). Long and short trousers may be custom-made or tailored-cut, and shaped as a slacks-type trouser falling either straight to the ankle (as in long trousers) or falling straight to the knee (as in short trousers), whilst both are worn beneath the Thowb. In addition, long cotton trousers may be worn on top of the underpants in the winter season. Arabian Gulf male ensembles and garments are sketched and shown in Fig. 2.

2.2. *Gulf Female Traditional Clothing*

Arabian Gulf female clothing consists basically of three types of ensembles and garments. These are: Islamic, traditional and Western style of clothing. Although the majority of Arabian Gulf females wear Islamic and traditional clothing, there are some Arabian Gulf females who choose to wear Western clothes. In summer, female clothing ensembles of the Arabian Gulf differ from that in the winter according to the thickness, style of embroidered decorations, clothing design and colours.

The main Arabian Gulf female ensembles and garments that are most common and may distinguish the Arabian Gulf female clothing from other people's clothing (non-Arabian ensembles and garments) are described in the following sections.

2.2.1. *The 'Daraa'* is a traditional gown that falls in a straight line from the shoulder to the ankle, with two long sleeves that are tapered toward the wrist. The Daraa can be designed in a loosely-fitting or closely-fitting shape, and can vary according

to the colour, thickness and decorations, the latter usually being embroidered in gold thread.

The female summer Daraa has a fine clothing layer which may be made of cotton blend fabric, with light colours i.e. white, off-white, beige, light blue, etc, that help in reflecting incident solar radiation, thereby reducing its effect on the body. On the other hand, the female winter daraa has a slightly thicker layer than that of the summer daraa, and the former may be made of a soft wool fabric blend with dark colours i.e. black, dark blue, brown, grey, etc. However, female daraa design, decorations, colour and fabric selection are variable with the season and fashion trends as well as individual personal taste.

2.2.2. *The 'Abaya'* is a tradition silk or wool black cloak that covers the entire body from head to toe, except the face. The Abaya is traditional clothing that may reflect the individual's strong Arabian cultural background or perhaps religious belief. Arabian Gulf females wear the Abaya to cover their more attractive clothes, when they leave the house.

2.2.3. *The 'Hijab'* is a large square-shaped cloth made of a large variety of fabrics and colours, and selections are variable with the season. It is used as an Islamic headscarf that is worn to conceal female hair, leaving the face unconcealed. The 'Hijab' is an item of religious clothing that is used most commonly by all Muslim women. The Hijab can be worn only after being folded in a triangular shape.

2.2.4. *The 'Burqa'* is a short traditional black veil used to cover the entire face. The Burqa is commonly worn by Arabian Gulf 'Bedouin' women. The Burqa is made of a black cotton blend fabric, and is worn over a Shiala. The 'Shiala' is a black

headdress worn similarly to the Hijab, except that the Shiala is commonly worn with the Burqa.

2.2.5. *Arabian Gulf female underwear* is most commonly of Western design.

Underwear may consist of a bra that is commonly worn beneath a sleeveless undershirt or half or full-slip. Underpants are worn beneath long or short long legged trouser. Trousers differ in terms of their shapes and styles; some are tight while others are slack, loose-fitting, according to fashion trends. Underwear is usually made of a large variety of fabrics and colours. Selections are variable with season and fashion trends as well as individual personal taste. In addition, female winter underwear is slightly thicker than that of the summer, (http://www.kuwait-info.org/main.php). A sketch of Arabian Gulf female ensembles and garments is shown in Fig. 3.

3. Experiments and Methods

The male and female garments and ensembles selected in this study are representative of Arabian Gulf clothing worn for winter and summer seasons. A quantitative description of Arabian Gulf male and female clothing, including the weights of individual garments and ensembles, fabric composition and body surface area coverage is provided in Table 1 and Table 2.

A thermal manikin of male form ('Newton', MTNW, Seattle, USA) and one of female form ('Victoria', P.T.Teknik, Denmark) were used for the investigation. As results are intended to be added to ISO 9920, manikin measurements and surface area measurements were conducted in accordance with advice given in that standard. Each manikin was placed in a controlled environmental chamber and dressed in the respective Arabian Gulf male and female garments and ensembles described above.

Measurements of insulation values were performed under the following conditions (ISO 9920, 2007): air velocity less than 0.15 m/s; air and mean radiant temperatures of 21 ºC; relative humidity of 40%; mean skin temperature of the manikin at 34ºC. Heat loss measurements were recorded every second and, when stable, were averaged over a 10 minute period. The nude manikin insulation (I_a) was determined separately to be 0.60 clo for both manikins.

3.1. *Calculation Method*

3.1.1. *Insulation.* For clothing insulation, the method described in ISO 9920 was used, which defines whole body clothing heat resistance (I_T) by adding up sectional clothing resistance over different body parts ($I_{T,i}$) according to a parallel model (Havenith, 2005). Here:

$$I_T = \cfrac{1}{\sum f_i \times \left(\cfrac{H_i}{\overline{t}_{sk} - t_a} \right)} = \cfrac{1}{\sum f_i \times \cfrac{1}{I_{T,i}}} = \cfrac{1}{\cfrac{\sum f_i \times H_i}{(\overline{t}_{sk} - t_a)}} \tag{1}$$

where f_i is the area fraction of segment (i) $A_{sk(i)}$, related to whole body area A_{sk}, and calculated using:

$$f_i = \frac{A_{sk\,(i)}}{A_{sk}} \tag{2}$$

In equation (1), t_a is the ambient temperature, $\overline{t}_{sk}$ is the mean skin temperature (in this case uniform over the body) and H_i is the local heat flux of segment (i) in W/m^2.

In order to determine the intrinsic clothing insulation I_{cl}, the clothing area factor is required as defined in the following equation:

$$I_{cl} = I_T - \frac{I_a}{f_{cl}} \tag{3}$$

where I_{cl} is the intrinsic or basic clothing insulation, which is defined as the insulation from the skin surface to the clothing surface.

3.1.2. *Determination of clothing area factor* f_{cl}

The clothing surface area factor f_{cl} is defined as the ratio of the surface area of a clothed manikin or person to the surface area of the nude manikin or person. Several methods are available to determine f_{cl}, some of them based on prediction equations (McCullough and Jones, 1984). In order to check whether these are valid for these styles of non-Western clothing, f_{cl} calculated in this way was compared to f_{cl} values determined with more cumbersome (Havenith, 2005) photographic techniques.

The estimation of f_{cl} based on the intrinsic insulation of ensembles was made using the equations of McCullough and Jones (1984) as in ISO 9920:

$$f_{cl} = 1.0 + 0.30 \times I_{cl} \tag{4}$$

Note that f_{cl} is solved iteratively using equations 3 and 4.

The most reliable approach, however, is to measure clothing area factors using photographic techniques or computer-aided anthropometric scanning (Havenith, 2005). In this study, f_{cl} values of Arabian Gulf clothing were determined using photographs (taken by a high resolution digital camera) of the front view of the clothed person. Photographs were also taken of the same person dressed in a skin tight undergarment, which is used as the nude condition. These were then compared with photographs taken of the person wearing garments and ensembles of Arabian Gulf clothing. Advantages

9

and disadvantages of the latter techniques may be found in Havenith (2005) and McCullough and Jones (1984).

4. Results

Sketches of male and female garments are shown in Fig. 2 and Fig. 3.

The f_{cl} values determined for Arabian Gulf male and female clothing ensembles by the two methods are given in Fig. 4, and the impact of the differences in the calculation of I_{cl} (using equation(4)) is presented in Fig. 5.

The differences between the results for f_{cl} obtained by photographic techniques and by regression (i.e. Equation (3)) for male ensembles and garments are in the range of 5 to 19%, while for female ensembles and garments they are in the range of 3 to 29%. Fig. 4 clearly shows that the equation method makes large errors in the determination of f_{cl}, the average deviation being around 14%. These differences may be attributed to the relatively sophisticated layout or design of Arabian Gulf clothing. The effect of these differences in f_{cl} on the calculation of I_{cl} is smaller than the f_{cl} differences. They range on average at 6%, with a range of -0.5 to 15%. Other existing prediction equations for f_{cl} (e.g. in McCullough and Jones, 1984) will not give a consistently better performance than the one used here, as they all are linearly related to clothing insulation.

Additions of garments to an ensemble will always increase the predicted f_{cl}. However, in reality this may cause compression of fabric and air layers (Zhu et al., 1985), thereby reducing f_{cl}. This may be observed in the male winter clothing of ensemble Number 5 (Table 3), where a jacket was additionally worn. This yields a clothing area factor value (i.e. 1.45) lower than that of the clothing area factor value of ensemble Number 4 (i.e. 1.46), without the jacket.

The findings for clothing thermal insulation of Arabian Gulf garments and ensembles for males and females are presented in Table 3 and Table 4, respectively. The findings for male and female (summer-winter) clothing may be summarised as follows.

The measured thermal insulation values (I_T) for males ranged from 1.05 clo (0.163 m^2°CW^{-1}) to 1.70 clo (0.264 m^2°CW^{-1}), while their clothing area factor values range from 1.30 to 1.46, with clothing coverage of at least 85% to 91%, respectively. On the other hand, the measured thermal clothing insulation values (I_T) for females ranged from 1.19 clo (0.185 m^2°CW^{-1}) to 2.11 clo (0.327 m^2°CW^{-1}), while their clothing area factor values range from 1.39 to 1.94, with clothing coverage of at least 85% to 94% of the body, respectively.

Until now, people applying ISO heat and comfort standards to work places in the Gulf region had to use estimates for the insulation of the clothing types worn, relying on tables of Western clothing as given in ISO9920. Also, they had to rely on the regression prediction of the clothing area factor f_{cl}, which this study has shown to be unreliable. Having these new data available is expected to improve the reliability of thermal assessments with the respective ISO heat and comfort standards and thus contribute to workers' comfort and health.

5. Conclusions

This paper provides a lookup table for clothing insulation of ensembles typical of the Arabian Gulf region. This can be used in the assessment of indoor climate, thermal comfort, in building design, and in the application of ISO heat stress standards for which, until now, no data for Arabic clothing were available.

In addition, the paper shows that for non-Western design clothing, prediction equations established in ISO 9920, ISO 7730, ASHRAE standard 55 etc. for the calculation of the

clothing area factor do not provide a reliable result. The percentage differences between the predictions and measured data ranged between 5 to 19% for male clothing, and 3 to 29% for female clothing. Thus, for non-Western design clothing, f_{cl} factors will need to be measured. The impact of the error made on the calculation of I_{cl} is smaller than the error in f_{cl} itself. The differences in I_{cl} between the two methods are less than half those in f_{cl}. Thus, limited knowledge of, or a relatively large error in, f_{cl} will have limited impact on the calculation of I_{cl}.

It is expected that with the availability of the data presented here, reliability of heat stress and comfort predictions for this geographic area using the ISO-models will improve.

Acknowledgments.

References

1. ASHRAE Handbook. 2005. Fundamentals. Chapter 8. American Society of Heating Refrigeration and Air-conditioning Engineers, Inc.1791 Tullie Circle N.E., Atlanta, GA 30329.

2. BS EN ISO 7730. 2005. Ergonomics of the thermal environment. Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria. International Standardisation Organisation, Geneva.

3. ISO FDIS 9920. 2007. Ergonomics of the thermal environment - Estimation of the thermal insulation and evaporative resistance of a clothing ensemble**.** International Standardisation Organisation, Geneva.

4. Fanger, P.O. 1972. Thermal comfort: Analysis and Applications in Environmental Engineering. Danish Technical Press. Copenhagen.

5. Havenith, G. 2005. Clothing heat exchange models for research and application. Proceedings Int. conf. on Environmental Ergonomics, Ystad, Sweden, pp. 66-72.

6. Kuwait Government information profile. Kuwaiti Men's Traditional Dress, the Official Website of The State Of Kuwait. http://www.kuwait-info.org/main.php

7. McCullough, E.A. and Wyon, D.P. 1983. Insulation characteristics of winter and summer indoor clothing. ASHRAE Transaction vol.89, part 2B pp. 614-629.

8. McCullough E A, Jones B W , 1984. A comprehensive data base for estimating clothing insulation, Report Institute Environ. research, Kansas State University, Manhattan, Kansas: 1984 IER technical report 8401

9. Zhu, X.S., McCullough, E.A and Jones, B.W 1985. Thermal insulation of layered Chinese clothing. ASHRAE Transaction vol. 91, part 2B pp. 493-505.

Fig. 1. 'Thowb' or 'dishdasha' with five openings: upward from neck (through collar), chest opening, two sides from sleeves and downward openings.

Fig. 2.   Arabian Gulf male garments.

Fig. 3.   Arabian Gulf female clothing of Islamic dress with hijab and traditional dress with Abaya and Burqa

Fig. 4.   Relation between f_{cl} values determined by the photographic technique and those from the regression equation. Numbers refer to ensemble numbers given in Tables 3 and 4.

Fig. 5.   Relation between I_{cl} values determined by the photographic technique and those from the regression equation.

Table 1. Characteristics of various Arabian Gulf male clothing materials used in the garments shown in Fig. 2.

Ensemble / Type	Code	Type/construction	Body surface area covered (%)	Fiber/content	Ensemble weight (kg)
Summer clothing	1	Underwear-pants	12%	100% cotton	0.108
	2	Underwear-shirt with 1/3 sleeves	40%	100% cotton.	0.121
	3	Short trouser (short serwal)	25%	Polyester, cotton	0.125
	4	Long trouser (long serwal)	44%	Polyester, cotton	0.181
	5	Summer Thowb	81%	Cotton, wool, polyester.	0.419
	6	Kuffiya (or Taqia)	3%	Cotton, polyester , nylon	0.017
	7	While Ghutra	10%	Cotton, silk, polyester ,	0.130
	8	Sandal(s) or slippers	4%	Leather	-
Winter clothing	9	Thowb or dishdasha	81%	Wool	0.594
	10	Long sleeve cotton trouser	44%	Cotton	0.181
	11	Kuffiya (or Taqia)	4%	Cotton	0.017
	12	White/Red Qhutra or Shemagh	10%	Wool, polyester	0.194
	13	Eqal	2%	Wool	0.117
	14	Coat or thermo-coat (or Jacket)	64%	52% Polyester, 29% viscose, 19% cotton	0.904
	15	Socks	14%	Cotton, polyester	-
	16	Shoes	7%	Leather	-

Table 2 Characteristics of various Arabian Gulf female clothing materials used.

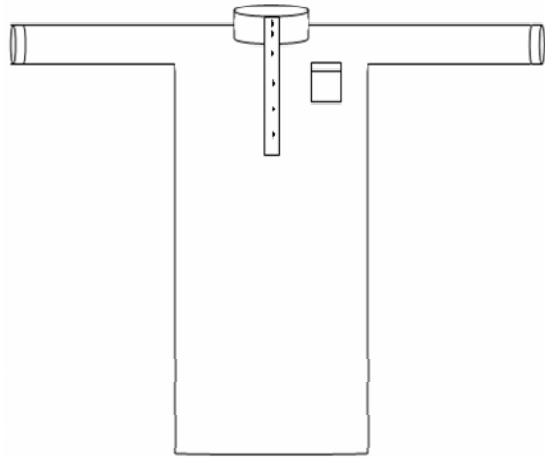| Ensemble type	Code	Clothing ensembles	Body surface area covered (%)	Fiber/content	Weight of (kg)
'Traditional' clothing- 'Winter'	17	Winter Daraa	81%	Velvet, wool	0.578
	18	Abaya	86%	Polyester	0.665
	19	Long trousers	51%	polypropylene	0.215
	20	Shiala	12%	Polyester	0.071
	21	Burqa	7%	Polyester	0.022
	22	Bra	5%	nylon	0.049
	23	Pants	15%	cotton	0.028
	15	Socks	20%	Cotton, polyester	0.054
	16	Shoes	9%	Leather	-
'Traditional' clothing- 'Summer'	24	Summer-Daraa	81%	Polyester-cotton	0.213
	20	Shiala	12%	Polyester	0.071
	21	Burqa	7%	Polyester	0.022
	25	Abaya	86%	polyester	0.665
	22	Bra	5%	nylon	0.049
	23	Pants	15%	cotton	0.028
	8	Sandals	4%	Leather	-
'Islamic' clothing 'Winter'	17	Winter- Daraa	81%	Cotton, polyester	0.713
	19	Long trousers	51%	Polypropylene, cotton	0.215
	23	Pants	15%	cotton	0.028
	22	Bra	5%	nylon	0.049
	26	Hijab	12%	Polyester	0.062
	15	socks	20%	Cotton, polyester	0.054
	16	shoes	9%	Leather	-
'Islamic' clothing 'summer'	24	Summer-Daraa	81%	cotton	0.213
	26	Hijab	12%	polyester	0.062
	23	Pants	15%	cotton	0.028
	22	Bra	5%	nylon	0.049
	8	Sandals	4%	Leather	-

Table 3 Thermal insulation values of Gulf male clothing ensembles in units of (clo) and $m^{2o}CW^{-1}$

Ensemble Type/code	Ensemble no.	Clothing ensembles	f_{cl}	I_a		I_{cl}		I_T	
				clo	$m^2.^oC.W^{-1}$	clo	$m^2.^oC.W^{-1}$	clo	$m^2.^oC.W^{-1}$
Male-summer Clothing	1	Underwear-shirt with 1/3 sleeves, Short sleeve trouser, Thowb and sandals	1.30	0.594	0.092	0.59	0.092	1.05	0.163
	2	Underwear-shirt with 1/3 sleeves, Short trouser, Thowb, Kuffiya, White Ghutra, Eqal, sandals	1.35	0.594	0.092	0.69	0.107	1.13	0.175
	3	Underwear-shirt with 1/3 sleeves, Short trouser, Long trouser, Thowb, Kuffiya, White Ghutra, Eqal, sandals	1.36	0.594	0.092	0.79	0.123	1.23	0.191
Male-winter clothing	4	Underwear-shirt with 1/3 sleeves, Short trouser, Long cotton trouser, Thowb, Kuffiya, Ghutra Shemagh, Egal, shoes.	1.46	0.594	0.092	0.84	0.131	1.25	0.194
	5	Underwear-shirt with 1/3 sleeves, Short trouser, Long cotton trouser, Thowb, Ghutra Shemagh, Egal , Jacket, shoes.	1.45	0.594	0.092	1.29	0.200	1.70	0.264

Table 4 Total thermal insulation of Gulf female clothing in (clo) unit and $m^{2o}CW^{-1}$ unit

.

Ensemble Type	Ensembles code	Clothing ensembles	f_{cl}	I_a		I_{cl}		I_T	
				clo	$m^2.^oC.W^{-1}$	clo	$m^2.^oC.W^{-1}$	clo	$m^2.^oC.W^{-1}$
'Islamic' clothing 'summer	6	Summer-Daraa, Shiala, Bra, Pants, Sandals,	1.48	0.60	0.092	0.80	0.123	1.20	0.186
	7	Summer- Daraa, Hijab, Bra, Pants, Sandals,	1.48	0.60	0.092	0.80	0.123	1.20	0.186
'Islamic' clothing'-winter	8	Winter-Daraa, Hijab, Bra, Pants, Socks, Shoes	1.44	0.60	0.092	1.15	0.178	1.56	0.242
	9	Winter-Daraa, Shiala, Bra, Pants, Socks, Shoes	1.43	0.60	0.092	1.17	0.181	1.58	0.245
	10	Winter-Daraa, Shiala, Long trouser, Bra, Pants, Socks, Shoes	1.44	0.60	0.092	1.34	0.208	1.75	0.272
Winter clothing - Without Shiala	11	Winter-Daraa, Long trousers, Bra, Pants, Socks, Shoes	1.39	0.60	0.092	1.17	0.186	1.59	0.247
Summer clothing – Without Hijab	12	Summer-Daraa, Bra, Pants, Sandals,	1.41	0.60	0.092	0.77	0.119	1.19	0.185
'Traditional' clothing summer	13	Summer-Daraa, Abaya, Shiala, Burqa, Bra, Pants,sandals	1.79	0.60	0.092	1.38	0.213	1.71	0.265
'Traditional' clothing-winter	14	Winter-Daraa, Shiala, Burqa, Bra, Pants, Socks, Shoes	1.55	0.60	0.092	1.01	0.156	1.39	0.216
	15	Winter-Daraa, Abaya, Shiala, Burqa, Long trouser, Bra, Pants, Socks, Shoes	1.94	0.60	0.092	1.80	0.279	2.11	0.327
'Traditional' clothing-Summer (without Shiala and Burqa)	16	Winter-Daraa, Abaya, Bra, Pants,sandals	1.51	0.60	0.092	0.85	0.131	1.24	0.192

Top opening
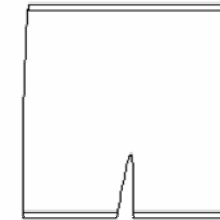
Left sleeves opening

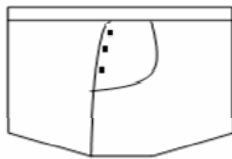Right sleeves opening

Chest with small openings
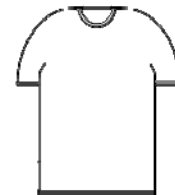
Bottom opening

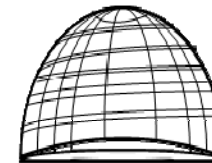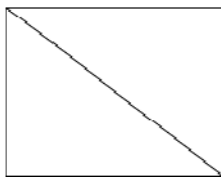1
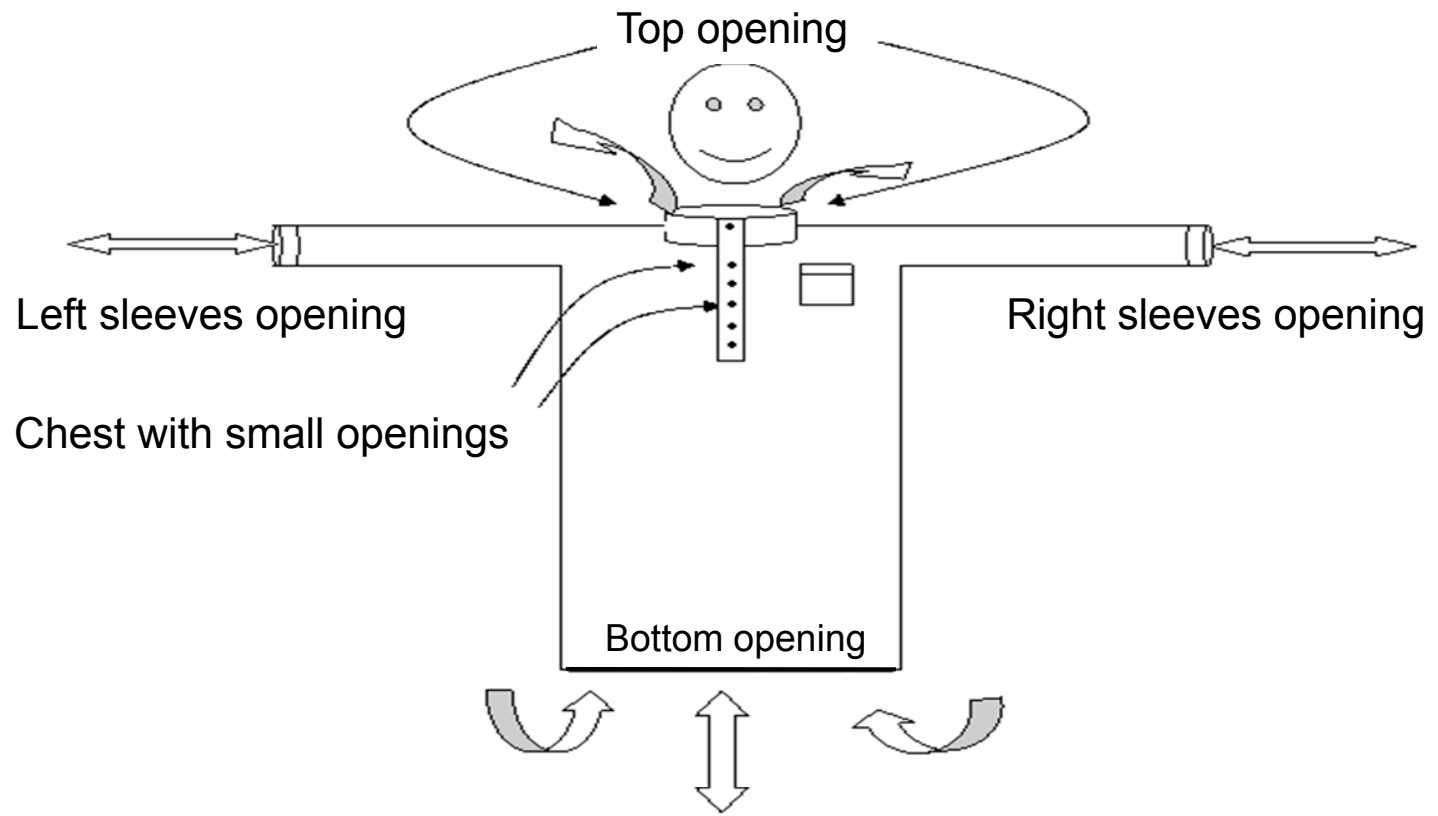
Thowb or Dishdasha

Long Serwal
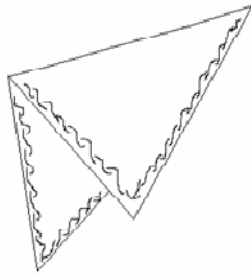
Short Serwal

Pants

T-shirt

Kuffiya or Tagia

Ghutra
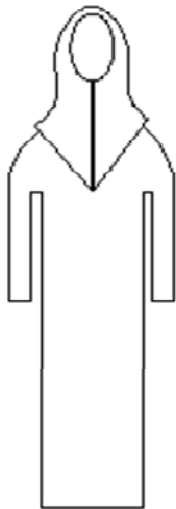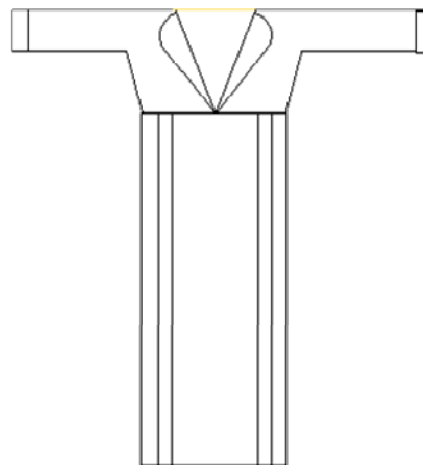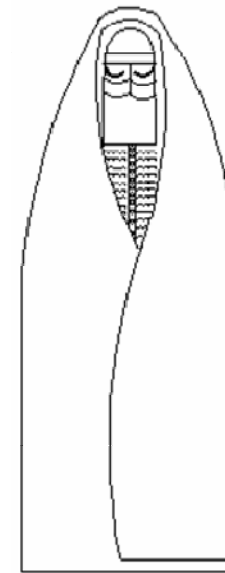
Eqal

Ghutra and Eqal on head

Hijab

Shiala

Burqa

Islamic dress with
Hijab on

Daraa

Abaya with Burqa on