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Friction Coefficient of Headscarf Textiles Sliding Against Hair and Skin

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Abstract

Fixing headscarf by pins is accompanied by pin aspiration, where the people used to hold a number of pins in the mouth and use them to fix the scarf so that the risk of pin aspiration increased. Controlling friction coefficient between headscarf, skin and hair can avoid this problem. In the present work, friction coefficient displayed from the sliding of headscarf of different textiles materials against hair and skin was investigated. Test specimens of headscarf of common textile fibres were tested by sliding under different loads against skin, African, Caucasian and Asian hairs. It was found that, skin showed the higher friction coefficient than hair. Satin displayed the lowest friction among the tested textiles. African hair displayed relatively higher friction when sliding against cotton, flax and inner lining of headscarf. Asian hair showed higher friction for polyester, polyacrylonitrile, crape, jil, chiffon and satin head scarves. Caucasian hair exhibited the lowest friction coefficient. Based on these observations, it can be concluded that proper selection of the textiles to be used as headscarf is essential.

Keywords

Friction Coefficient, Headscarf, Textiles, Hair, Skin

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1. Introduction

The problem of pin aspiration during fixing of headscarf can be avoided by controlling friction coefficient between headscarf, skin and hair, [1]. Wearing of headscarf has been discussed extensively in academic and popular discourse from the social and religious point of view, [2]. Recent study revealed that Asian hair displayed relatively higher friction coefficient than African hair when sliding against polyester headscarf, where friction coefficient decreased with increasing the applied load, [3]. Besides, friction coefficient generated from the sliding of the cotton headscarf against hair displayed higher values than that showed by polyester headscarf. The nylon headscarf when sliding against hair showed relatively lower friction coefficient than that observed for polyester and cotton scarf. Asian hair displayed higher friction values than African hair.

Asian, African, and Caucasian humans are often distinguished by their straight, curly, and wavy hair features, respectively. Understanding the mechanism of the curly pattern of hair is a fundamental issue in anthropology, [4 - 7], and in physiology, for example helping detect various hair diseases and exploring possible therapeutic. The fundamental mechanical properties of human hair including Young's modulus and hardness have been investigated, [8 - 14], owing to the composite-like microstructure. The electrostatic properties and the wetting behaviour of the human hair surface at the nano-metric scale have been investigated by using atomic force microscopy (AFM), [15]. Surface potential imaging was used to determine the electrostatic. Based; on the fact that comfort of textiles is measured by the friction coefficient displayed by sliding of textiles against

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skins or other textiles, it was found that friction coefficient of polyester-cotton blend textiles sliding against wool slightly increased with increasing the cotton content of the tested textile, [16]. As the load increases, friction coefficient decreases [17]. Blending polyester by viscose showed slight friction decrease with increasing viscose content.

In the present work, the friction coefficient displayed by the relative motion between headscarf of different materials and hair as well as skin will be investigated.

2. Experimental

The specimens, of headscarf, were prepared and arranged for the tests and measurements in the surface of a wooden blocks of 50 × 50 × 30 mm. The textiles of the headscarf were cotton, polyester, polyacrylonitrile, flax, crape, jil, chiffon and satin. Tests were carried out at room temperature under varying load ranged up to 6 N normal loads. The test specimens slid against African, Asian and Caucasian hairs. Experiments were carried out by sliding the test specimens against the hair and skin of the back hand. Tests were carried out using a test rig designed and manufactured for that purpose, Fig. 1. The textiles were placed in a base supported by two load cells, the first can measure the horizontal force (friction force) and the second can measure the vertical one (normal load). Friction coefficient was determined by the ratio between the friction force and the normal load.

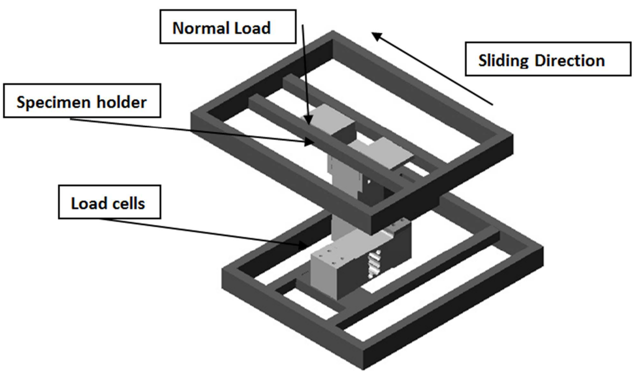

Fig. 1. Arrangement of the test rig.

The inner lining of the headscarf is made of pure cotton textile. Crape is a synthetic polyester fibres of crimped appearance and gauzy texture. Satin weave of filament polyester fibres was tested. Satin has a high luster due to the high number of floats on the fabric. Chiffon is made from polyester fibres, while jil is made from cotton fibres.

3. Results and Discussion

Although all human hair has the same basic chemical composition in terms of keratin protein content, the friction behaviour differs for African, Asian and Caucasian hair. Hair friction depends on the roughness of the hair fiber. African hair has uneven thickness so that it is curly. Its roughness is relatively higher than Asian and Caucasian so that the hair fibres.

The luxury of textiles depends on the slipperiness and smoothness. The touch by the human skin is considered an important factor that qualifies the use of textiles, [18, 19]. Friction coefficient specifies the slipperiness or smoothness of the textiles. It seems that, as the load increases the pressure applied on the fibre fringes increases, flattens the fringes and makes their surface smoother. In consequence, friction coefficient decreases, [20]. Friction coefficient displayed by the sliding of cotton headscarf against skin and hair is shown in Fig. 2. Friction coefficient decreased with increasing applied load, where skin displayed the highest friction coefficient, where the values were 0.58 and 0.43 at 0.3 N and 5.8 N loads respectively. Caucasian hair showed the lowest friction, where the trend was consistent with increasing normal load. This observation confirms that the possibility of the slip of cotton textiles increases for Caucasian hair.

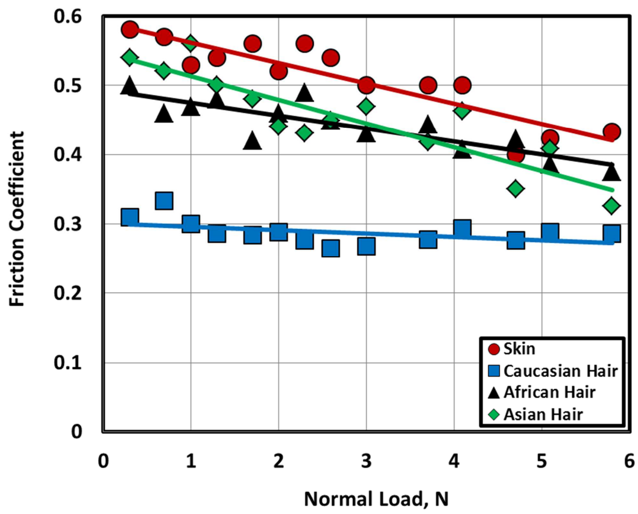

Fig. 2. Friction coefficient displayed by the sliding of cotton headscarf against skin and hair.

Polyester headscarf showed lower friction coefficient than cotton, Fig. 3. The difference in friction for African, Asian and Caucasian hairs was insignificant. Skin displayed the lowest friction. The highest friction values which did not exceed 0.49 were displayed by Asian hair. The load had slight effect on friction compared to that observed for cotton. This behavior may be due to the lack of the fibre fringes in polyester as well as the relatively higher strength of polyester compared to cotton.

Polyacrylonitrile headscarf slid against hair showed relatively higher friction coefficient than that observed for polyester and cotton scarf, Fig. 4. Asian hair and skin displayed higher friction values than African and Caucasian hairs. It seems that Asian hair is the thickest and most coarse hair compared to Caucasian and African hair. It has lower density than any of the other ethnic groups.

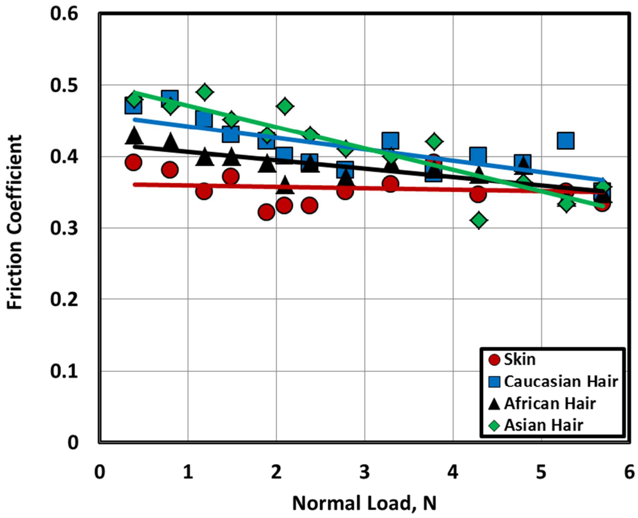

Fig. 3. Friction coefficient displayed by the sliding of polyester headscarf against skin and hair.

Friction coefficient generated from the sliding of flax headscarf against skin and hair is shown in Fig. 5. African hair showed the highest friction coefficient at light loads. African hair has uneven thickness so that it is curly. Its roughness is relatively higher than Asian and Caucasian so that the hair fibres catch on each other and increases the friction between fibres and the counterface. As the load increases, the spiral form of the hair flattens and the relatively lower density causes friction decrease. Asian hair is stronger and thicker than African and Caucasian hair and has a predominantly circular cross-section, where the contact area with the textiles is relatively small. That explanation may be the reason of friction decrease.

Friction coefficient displayed by the sliding of crape headscarf against skin and hair is shown in Fig. 6. Skin caused the highest friction due to the gauzy texture of the crimpy appearance of crape. This behavior may be an obstacle which limits the use of crape as headscarf. Among the hair types, Asian hair showed the highest friction followed by Caucasian and African hair. Jil headscarf displayed relatively reasonable friction values, Fig. 7. This behavior may be from the cotton yarns of jil. Asian hair represented the highest friction. The minimum friction value was 0.27 for skin at 5.8 N load. African and Caucasian hair displayed consistent friction trend with increasing normal load. The maximum friction values were observed at light loads.

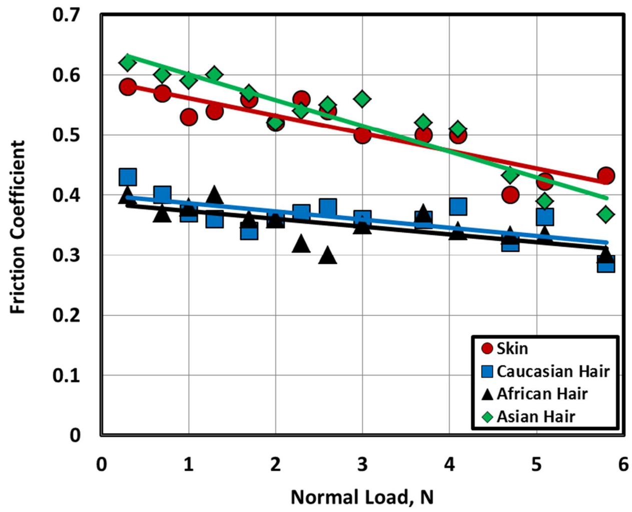

Fig. 4. Friction coefficient displayed by the sliding of polyacrylonitrile headscarf against skin and hair.

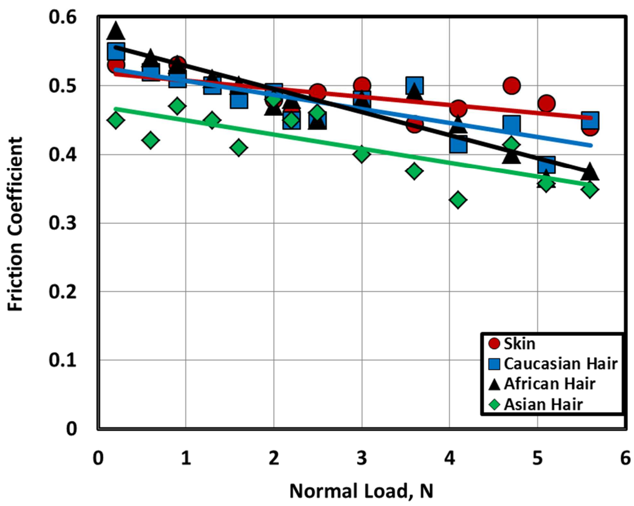

Fig. 5. Friction coefficient displayed by the sliding of flax headscarf against skin and hair.

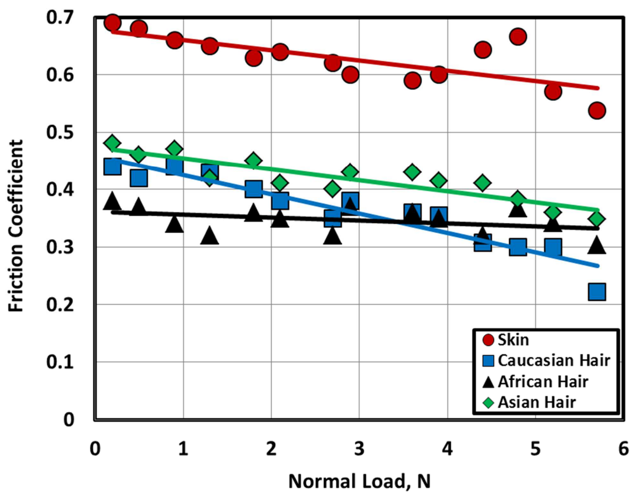

Fig. 6. Friction coefficient displayed by the sliding of crape headscarf against skin and hair.

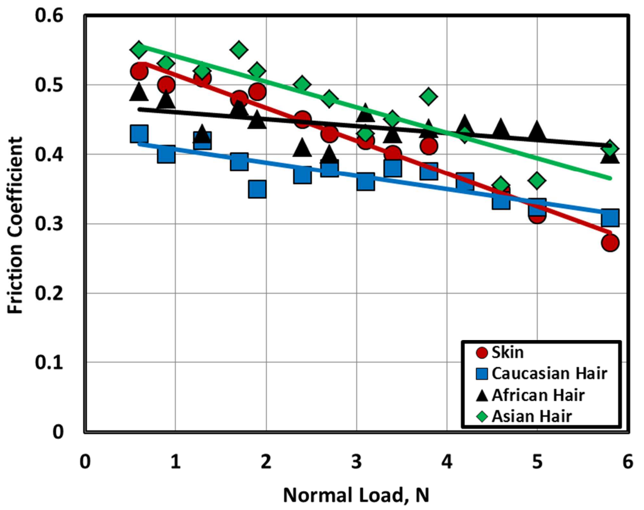

Fig. 7. Friction coefficient displayed by the sliding of jil headscarf against skin and hair.

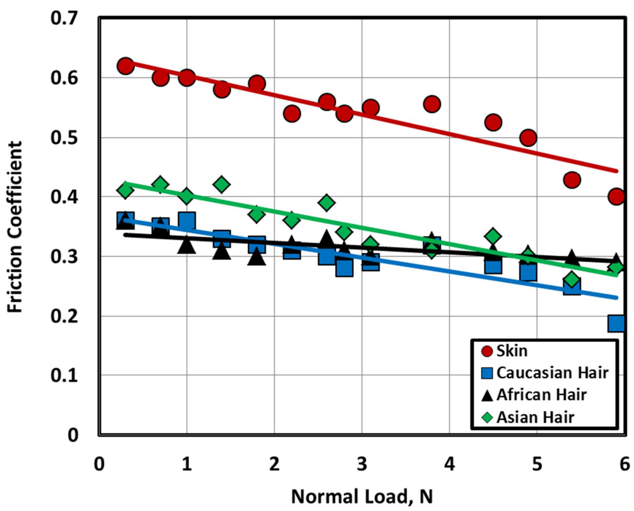

Fig. 8. Friction coefficient displayed by the sliding of chiffon headscarf against skin and hair.

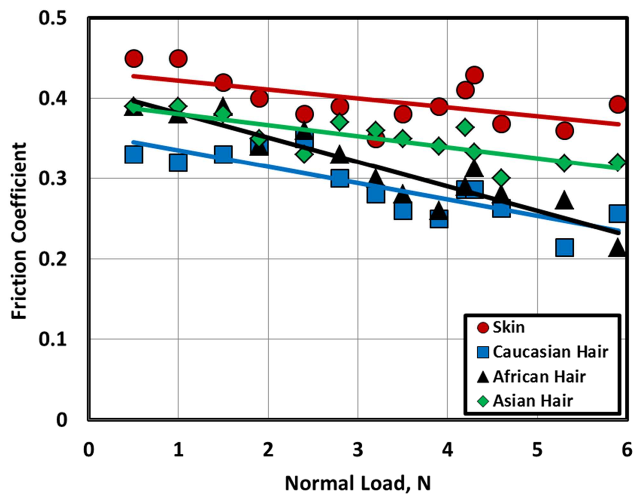

Fig. 9. Friction coefficient displayed by the sliding of satin headscarf against skin and hair.

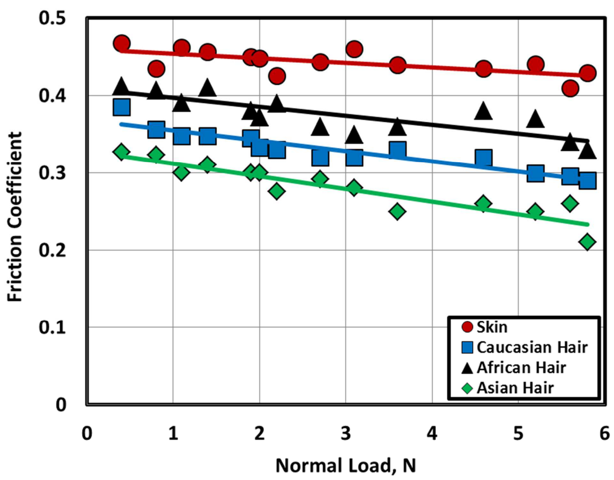

Fig. 10. Friction coefficient displayed by the sliding of inner lining of headscarf against skin and hair.

Friction coefficient generated from the sliding of chiffon headscarf against human hair recorded lower values compared to skin. This performance may limit the use of chiffon like crape as headscarf, Fig. 8. Asian hair showed higher friction than African and Caucasian hair. The lowest friction value was 0.19 at 5.9 N load. The big difference in the values of friction coefficient between skin and hairs indicates that the possibilities of the slip of the textile against hair is much easier than skin.

Satin textile has high number of floats of high luster shape which is known as satin weaves. Figure 9 shows the friction coefficient displayed by the sliding of satin headscarf against skin and hair. Satin displayed the lowest friction values among all tested textiles. Asian hair displayed relatively higher friction coefficient than African and Caucasian hair while skin caused the highest friction coefficient. Finally, friction coefficient displayed by the sliding of inner lining of headscarf against skin and hair illustrated in Fig. 10. The inner lining is made of cotton. Skin showed the highest friction followed by African, Caucasian and Asian hair. The values of friction were relatively low compared to the tested textiles except satin.

4. Conclusions

1. Friction coefficient displayed by the sliding of cotton headscarf against skin and hair decreased with increasing applied load where skin displayed the highest friction coefficient. Caucasian hair showed the lowest friction, where the trend was consistent with increasing normal load.

2. Polyester headscarf showed lower friction coefficient than cotton. The difference in friction for African, Asian and Caucasian hairs was insignificant. Skin displayed the lowest friction. The highest friction values were displayed by Asian hair. The load had slight effect on friction.

3. Polyacrylonitrile headscarf slid against hair showed relatively higher friction coefficient than that observed for polyester and cotton scarf. Asian hair and skin displayed higher friction values than African and Caucasian hairs.

4. African hair showed the highest friction coefficient at light loads for flax headscarf.

5. Skin caused the highest friction by the sliding of crape headscarf against skin and hair. Asian hair showed the highest friction followed by Caucasian and African hair.

6. Jill headscarf displayed relatively reasonable friction values, where Asian hair represented the highest friction.

7. Friction coefficient generated from the sliding of chiffon headscarf against human hair recorded lower values compared to skin. Asian hair showed higher friction than African and Caucasian hair.

8. Satin displayed the lowest friction values among all the tested textiles. Asian hair displayed relatively higher friction than African and Caucasian hair while skin caused the highest friction coefficient.

References

[1] Hamed M. A., Elmistekawy E. M. Ragab S. M., Headscarf pin, a sharp foreign body aspiration with particular clinical characteristics", Eur Arch Otorhinolaryngol, 267, pp. 1957 - 1962, (2010).

[2] Ragab A., Ebied O. M., Zalat S. Scarf pins sharp metallic tracheobronchial foreign bodies: presentation and management. Int J Pediatr Otorhinolaryngol 71, pp. 769 - 773, (2007).

[3] Al-Osaimy A. S., Mohamed M. K., Ali W. Y., "Friction Coefficient and Electric Static Charge of Headscarf Textiles", Journal of the Egyptian Society of Tribology Vol. 9, No. 3, July 2012, pp. 24 – 39, (2012).

[4] Baoxing X., Xi C., "The Role of Mechanical Stress on the Formation of a Curly Pattern of Human Hair", Journal of the Mechanical Behavior of Biomedical Materials 4, 212 – 221, (2011).

[5] Danforth, C. H., "Physiology of Human Hair", Physiological Reviews 19, pp. 94 – 111, (1939).

[6] McMichael, A. J., "Ethnic Hair Update: Past and Presentstar, Open", Journal of the American Academy of Dermatology 48, pp. 127 - 133, (2003).

[7] Peytavi, U. B., Tosti, A., Whiting, D., Trueb, R., "Hair Growth and Disorders", Springer, Berlin, (2008).

[8] Akkermans, R. L. C., Warren, P. B., "Multiscale Modelling of Human Hair. Philosophical Transactions of the Royal Society, A 362, 1783 - 1793, (2004).

[9] Barnes, H. A., Roberts, G. P., The Non-Linear Viscoelastic Behaviour of Human Hair at Moderate Extensions", International Journal of Cosmetic Science, 22, pp. 259 - 264, (2000).

[10] Sadaie M., Nishikawa N., Ohnishi S., Tamada K., Yase K., Hara M., "Studies of Human Hair by Friction Force Microscopy with the Hair-Model-Probe", Colloids and Surfaces B: Biointerfaces 51, pp. 120 - 129, (2006).

[11] Wei G., Bhushan B., "Nanotribological and Nanomechanical Characterization of Human Hair using a Nanoscratch Technique", Ultramicroscopy 106, pp. 742 – 754, (2006).

[12] LaTorre C., Bhushan B., "Nanotribological Characterization of Human Hair and Skin using Atomic Force Microscopy", Ultramicroscopy 105, pp. 155 – 175, (2005).

[13] Wei G., Bhushan B., Torgerson P. M., "Nanomechanical Characterization of Human Hair using Nanoindentation and SEM", Ultramicroscopy, 105, pp. 248 – 266, (2005).

[14] Bhushan B., Wei Guohua, Haddad P., "Friction and Wear Studies of Human Hair and Skin", Wear 259, pp. 1012 – 1021, (2005).

[15] Dupres V, Langevin D, Guenoun P, Checco A, Luengo G, Leroy F.," Wetting and electrical properties of the human hair surface: delipidation observed at the nanoscale. J. Colloid Interface Sci. vol 306 (1), pp. 34 - 40, (2007).

[16] Mahmoud M. M., Ibrahim A. A., "Friction Coefficient and Triboelectrification of Textiles", Journal of Multidisciplinary Engineering Science and Technology (JMEST), Vol. 3 Issue 2, pp. 3970 – 3976, (2016).

[17] Ibrahem R. A., Friction and Wear Behaviour of Fibre / Particles Reinforced Polyester Composites, International Journal of Advanced Materials Research Vol. 2, No. 2, pp. 22 - 26, (2016).

[18] Gupta B. S. and El Mogahzy Y. E., "Friction in Fibrous Materials", Textile Research Journal, pp. 547 - 555, (1991).

[19] Gowda R.V. and Mohanraj S., "A Novel Approach to Measure Friction in Textile Fibre Assemblies", RJTA Vol. 12 No. 2, pp. 30 – 38, (2008).

[20] Nair A. U., Sheela R., Vivekanadan M. V., Patwardhan B. A., Nachane R. P., "Studies on Friction of Cotton Textiles: Part I-A Study on the Relationship between Physical Properties and Frictional Characteristics of Cotton Fibres and Yarns", Indian Journal of Fibre and Textile Research, Vol. 38, pp. 244 – 250, (2013).