Clothing and Thermal Comfort: An Annotated Bibliography

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CLOTHING AND THERMAL COMFORT: AN ANNOTATED BIBLIOGRAPHY

Introduction

This bibliography was developed to explore research and ideas in the area of clothing and thermal comfort. It will be of value to researchers interested in this field. This bibliography demonstrates a need for more research in the aesthetic, cultural, economic, psychological, and social aspects of clothing and thermal comfort. Those seeking to conduct such research will need to know the basics of thermoregulation of the human body and the physical aspects of clothing and thermal comfort. They will find references in this bibliography helpful.

This is a preliminary bibliography. The following journals were searched for articles published in the 1970s: ASHRAE Journal, ASHRAE Transactions, International Journal of Biometeorology, and Textile Research Journal. The selected articles were then searched for further bibliographic references. Card catalogs at Wilson Library and the Biomedical Library at the University of Minnesota, Minneapolis, were searched for relevant publications and further bibliographic references.

Bibliography and Notes

Aaland, Mikkel. Sweat. Santa Barbara: Capra Press, 1978, 10, 13.

> The history and description of sweat bathing including Mediterranean baths, Finnish sauna, Russian bania, Japanese mushi-buno, and native American sweat lodge. Some mention is made of the thermal comfort aspects of sauna and steam baths.

Andreen, J. H.; Gibson, J. W.; and Wetmore, O. C. Fabric Evaluations Based on Physiological Measures of Comfort. Textile Research Journal XXIII (1), January 1933, 11-22.

> Objective of this study was a better understanding of the influence of clothing as related to comfort. Discusses physiological factors. Subjects tested in environmental chamber while active, tested nude and clothed in four different conditions.

Auliciens, A. Effects of Weather on Indoor Comfort. International Journal of Biometeorology 13 (2), 1969, 147-162.

> Auliciens used children to study effects of weather on indoor comfort. Author discusses how there may be a relationship between indoor comfort and outdoor temperatures, vapor pressure, and clothing habits of the subjects.

Azer, Naim Z. The Prediction of Thermal Insulation Values of Garments From the Physical Data of Their Fabrics. ASHRAE Transactions 82 (1), 1976, 87-106.

> Author presents a method of estimating the thermal insulation value of a clothing ensemble that is an alternative to the use of a copper manikin or a climatic chamber.

Azer, Naim and Hsu, Sungman. The Prediction of Thermal Sensation from a Simple Model of Human Physiological Regulatory Response. ASHRAE Transactions 83 (1), 1977, 88-124.

> The objective of the article was to present a new physiological-thermal sensation model different from models developed by Gagge, Fanger, and Sprague. The Azer and Hsu model is described as "capable of predicting thermal sensations in thermally stressful environments at activity levels from sedentary up to 6 mets (1 met=58 W/m^2)."

Azer, N. Z. and Nevins, Ralph G. Physiological Effects of Locally Cooling the Head in a 95 F and 75% RH Environment. ASHRAE Transactions 80 (1), 1974, 93-100.

The paper reports results of experiment designed to explore the possibility of relieving heat stress by ventilating subjects' heads, frontally, with cool air.

Ballantyne, E. R.; Hill, R. K.; and Spencer, J. W. Probit Analysis of Thermal Sensation Assessments. International Journal of Biometeorology 21 (1), 1977, 29-43.

The article describes "probit technique for analysis of subjective assessments of thermal sensation. . .It enables transition temperatures from any selected thermal sensation to the adjacent thermal sensation (e.g., from 'neutral' to 'warm') to be identified." The method was applied in one laboratory study and two field studies.

Bates, Marston. Where Winter Never Comes. New York: Charles Scribner's Sons, 1952. 100-117.

This section of the book contains a description of the clothing of the tropics, its function, and characteristics.

Bazett, H. C. and McGlone, B. Temperature Gradients in the Tissues of Man. American Journal of Physiology 82, September-November 1927, 415-451.

Authors studied their own bodies' physiological reactions. No generalizations can be made from this study but the article is an example of early studies on temperature and human physiology.

Behnke, W. P. and Seaman, R. E. Develop Novel Test Equipment in Fabric Heat Transfer Study. Modern Textiles 50, April 1969, 19-24.

The authors discuss types of protective clothing, the need to know the type of exposure, and then classify thermal hazards. The development of equipment is discussed.

Berglund, Larry G. Thermal Acceptability. ASHRAE Transactions 85 (2), 1979, 825-834.

The paper presents comparisons of recent methods for quantifying the acceptability of an environment. Berglund concludes that "[t]he optimum temperature for office spaces is mainly a function of the occupant's clothing which is influenced by or chosen for the season and outside conditions."

__________. New Horizons for 55-74: Implications for Energy Conservation and Comfort. ASHRAE Transactions 86 (1), 1980, 507-515.

Berglund reports on the work being done to revise ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy. The revision will consider the need for energy efficiency and comfort. Types of dress found in commercial environments are considered.

Berry, Paul C. Effect of Colored Illumination Upon Perceived Temperature. Journal of Applied Psychology 45, 1961, 248-250.

The article contains a discussion of an experiment which tested subjects' perception of temperature when working under five different colors of light. Berry found that "the effect of color is almost exactly equal to that expected by chance alone."

Bogaty, Herman; Hollies, Norman; and Harris, Milton. Some Thermal Properties of Fabrics: Part 1--The Effects of Fiber Arrangement. Textile Research Journal XXVII (6), June 1957, 445-449.

Authors comment on fiber insulation being determined by fiber arrangement and by fabric thickness. It was found that wool's overall resistance remains unaltered at high pressures and smooth fabrics (cotton, synthetics) decrease in thermal resistance. Better thermal resistance is achieved by use of low conductance fibers, mechanically stable arrangements of fibers parallel to surface, and low bulk density.

Breckenridge, J. R. and Goldman, R. F. Human Solar Heat Load. ASHRAE Transactions 78 (1), 1972, 110-119.

The authors discuss work done to further assess the revised model for predicting solar heat load on man. Paper presents prediction model and a Fortran IV computer program for the model.

Brown, J. R. and Croton, L. M. An Experimental Method for the Determination of the 'Clo' Value of Clothing Assemblies. The Journal of the Textile Institute 48 (10), October 1957, 379-388.

The authors describe a reproducible method for determining clo under certain set environmental conditions. The method is a modification and simplification of the method developed by Belding et al.

Brues, Alice M. People and Races. New York: Macmillan Publishing Co., Inc. 1977, 184-197.

This section of the text contains a discussion of the genetic adaptation and temporary physiological adaptability of the body to hot and cold temperatures.

Budd, G. M. Effects of Cold Exposure and Exercise in a Wet, Cold Antarctic Climate. Journal of Applied Physiology 20 (3), May 1965, 417-422.

The author reports the results of tests on six men studied before and after six weeks of outdoor work in the Antarctic.

Clark, R. P. The Aerodynamics of Warmth and Cleanliness. Clothing Research Journal 2 (2), 1974, 55-67.

The article contains a description of the physical and physiological processes at the skin surface. The author is primarily concerned with clothing design to maintain environmental cleanliness. The concepts discussed in the paper can be applied to clothing design for many situations.

Conn, Richard. Robes of Whte Shell and Sunrise: Personal Decorative Arts of the Native American. Denver: Denver Art Museum, 1974, 81-95.

In his section on fitted garments, Conn describes the clothing needs of peoples living in regions of extreme cold.

Coon, Carleton S. Man Against the Cold. Natural History LXX (1), January 1961, 56-69.

Coon describes a research voyage taken to study the Alakaluf's adaptation to a subpolar climate. Findings of the journey included physiological, racial and physical, and cultural anthropological reports.

Culp, Becky. Adapting to Changed Home Temperatures Through Clothing Choices. Paper presented at Central Region Annual Conference Association of College Professors of Textiles and Clothing, Columbus, Ohio, October 24-26, 1979.

Culp reports on a clothing and energy demonstration with 23 Texas families. Families were asked to lower home temperatures and to adjust clothing and other thermal comfort activities to stay comfortable.

Dhingra, R. C. and Postle, R. Air Permeability of Woven Double-Knitted and Warp Knitted Outerwear Fabrics. Textile Research Journal 47 (9), September 1977, 630-631.

The article contains a discussion of how air permeability influences protection against wind. Knitted outerwear fabrics had a wide range of air permeability compared with woven fabrics. Wool doubleknits were less permeable to air than synthetic doubleknits. Basic fabric structure is major factor influencing air permeability of outerwear fabrics.

Down, James F. and Bleibtreu, Hermann K. Human Variation: An Introduction to Physical Anthropology. Beverly Hills, California: Glencoe Press, 1972, 240-244.

The authors include a short discussion on biological adaptations to cold and hot temperatures.

Dressendorfer, R. H.; Smith R. M.; Baker, D. G.; and Hong, S. K. Cold Tolerance of Long-Distance Runners and Swimmers in Hawaii. International Journal of Biometeorology 21 (1), 1977, 51-63.

The authors report a study which measured "thermal and metabolic responses of six marathon runners and six long-distance ocean swimmers during a standard cold tolerance test." The findings show that there may be a hypothermic insulative adaptation in the runners.

Drinkwater, B. L. and Horvath, S. M. Heat Tolerance and Aging. Medicine and Science in Sports 11 (1), 1979, 49-55.

Researchers studied responses of women of various ages exercising at the same aerobic power in three environments in an attempt to determine "what specific physiological responses were related to heat tolerance and. . . also related to age."

Eveluth, Phyllis B. and Tanner, T. M. Worldwide Variation in Human Growth. Cambridge: Cambridge University Press, 1976, 262-272.

In this section of the book the authors discuss different racial groups' physiological variation in response to cold and hot climates.

Fahnestock, M.; Boys, Floyd E.; Sargent, Frederick, II; Springer, Wayne E.; and Siler, L. D. Comfort and Physiological Responses to Work in an Environment of 75 F and 45 Percent Relative Humidity. ASHRAE Journal 5, March 1963, 25-35.

The researchers felt thermal comfort of physical work was not as well established as for sedentary or slightly active thermal comfort. The article contains a discussion of the physiological responses. Sedentary thermal comfort did not correlate with active thermal comfort.

Fanger, P. O. Thermal Comfort: Analysis and Applications in Environmental Engineering. Copenhagen: Danish Technical Press, 1970.

The book contains discussions of the variables of thermal comfort, comfort equation, clo, and heat transfer affecting the human body. The author also reviews many comfort studies.

Fanger, P. O.; Angelius, O.; and Kjerulf-Jensen, P. Radiation Data for the Human Body. ASHRAE Transactions 76 (2), 1970, 338-369.

The article presents results of a study designed to determine geometrical radiation data used to calculate radiant heat exchange between man and his environment.

Fanger, P. O.; Ostergaard, J.; Olesen, S.; and Madsen, Th. Lund. The Effect on Man's Comfort of a Uniform Air Flow from Different Directions. ASHRAE Transactions 80 (2), 1974, 142-147.

This study was a continued exploration of the possibility of thermal comfort with exposure to uniform velocity from a variety of directions. Past studies have used velocities from in front and above only. Thermal comfort could be achieved for all velocity directions by adjusting the ambient temperature.

Fein, J. T.; Haymes, E. M.; and Buskirk, E. R. Effects of Daily and Intermittent Exposures on Heat Acclimation of Women. International Journal of Biometeorology 19 (1), 1975, 41-52.

Authors found that in heat acclimation of women "[l]evel of physical conditioning affected the acclimation process more than body size."

Fisher, Seymour, Body Consciousness: You Are What You Feel. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1973, 4-5, 26-27, 102.

Fisher makes brief references to body as an energy source, body borders and shelter and clothing used to "muffle the body."

Fitzgerald, Elizabeth and Kay, Nancy. Clothes Encounters. Human Ecology Forum 8 (3), Winter 1978, 12-14.

Authors discuss current and future clothing fiber and energy resource situation. Future scenarios are presented.

Fonseca, George F. Effect of Flexibility of Fabric Systems on Closure Effectiveness in Wind. Textile Research Journal 40 (5), May 1970, 482-483.

Fonseca discusses heat transfer study on three fabric systems having varying stiffness. The flexible system showed lower heat loss at lower wind speeds; the stiff system had the highest heat loss.

__________. Heat-Transfer Properties of Ten Underwear-Outerwear Ensembles. Textile Research Journal 40 (6), June 1970, 553-558.

The article contains comments on findings of little differences in individual clo values of underwear; outerwear could be the deciding factor in heat transfer. In this study underwear appears to have little to do with overall thermal insulation.

__________. Sectional Dry-Heat-Transfer Properties of Clothing in Wind. Textile Research Journal 45 (1), January 1975, 30-34.

Fonsecsa's research showed that one clothing component could sometimes have a shielding effect on non-clothed, adjacent areas of the body. Layers were more effective at high air flows if they compressed inner clothing layers and/or air spaces.

Fourt, Lyman and Hollies, Norman R. S. Clothing: Comfort and Function. New York: Marcel Dekkar, Inc., 1970.

The book covers the topic of human thermal comfort as affected by clothing. Included in the book is a discussion of the interaction of clothing with the body, fibers--synthetics and natural, and fiber research, design of garments, energy balance, tests of physiological factors, fibers and clothing, field experiments, and current trends.

Freeman, H. and Linder, F. E. Some Factors of Determining the Variability of Skin Temperature. Archives of Internal Medicine 54, 1934, 981-987.

An early study in which the authors discuss the use of the thermocouple and the need to have an adequate amount of time for subjects to attain equilibrium to environmental conditions.

Gagge, A. Pharo. ASHRAE Research on Thermal Comfort--A Physiologist's View. ASHRAE Journal 13, February 1971, 60-61.

This article contains a review of thermal comfort research in World War II, 1950, French scientists--Chatonnet and Cabanc, P. O. Fanger, etc.

Gagge, A. P.; Burton, A. C.; and Bazett, H. C. A Practical System of Units for the Description of the Heat Exchange of Man with his Environment. Science 94, November 7, 1941, 428-430.

The authors propose the use of met as a thermal activity unit and clo as a thermal insulation unit for clothing.

Gagge, A. Pharo; Nishi, Yasunobu; and Nevins, Ralph G. The Role of Clothing in Meeting FEA Energy Conservation Guidelines. ASHRAE Transactions 82 (2), 1976, 234-247.

The authors discuss options for promoting thermal comfort under new FEA guidelines. Clothing is cited as optimum choice in view of promoting energy conservation.

Garn, Stanley M. Human Races. Springfield, Illinois: Charles C. Thomas Publisher, 1961, 57-58, 83, 116-129.

In the pages cited, the author describes genetic and physiological adaptations to physical environment.

Goldman, R. Use of Clothing Records to Demonstrate Acclimatization to Cold in Man. Journal of Applied Physiology 15, 1960, 776-780.

Goldman recorded layers of clothing worn and comfort votes of eight men working and living in an arctic climate. He found a trend toward wearing fewer layers in the last period of the study.

Gonzalez, Richard R. and Nishi, Yasunobu. Effect of Cool Environments on Local Thermal Sensation, Discomfort and Clothing Selection. ASHRAE Transactions 82 (1), 1976, 76-86.

The study reported was an investigation of "whether subjects would select, if given a choice, adequate clothing which can alter the acceptability of a cool environment" and also the variations between sexes and age groups in local cold discomfort.

Grandjean, Etienne. Ergonomics of the Home. London: Taylor and Francis Ltd., 1973; New York: Halsted Press, 173-194.

In the pages cited, the author discusses the requirements for a thermally comfortable indoor environment, heat transfer methods affecting human thermal comfort, and thermal comfort trends.

Hall, Edward T. Let's Heat People Instead of Houses. Human Nature 2 (1), January 1979, 45-47.

Hall questions the current use of ambient heating and suggests more research be oriented to developing workable energy-cheap ambient heating and cooling systems.

Hanna, Joel Michael. Biological and Cultural Factors in Peripheral Blood Flow at Low Temperature. M.A. thesis, Pennsylvania State University, 1965.

The author describes adaptations of different peoples to extreme temperatures. He mentions the problems which the human body faces against low temperatures and describes the Quechua Indians of Peru--their cultural and biological factors.

Hanna, Joel M. Cold Stress and Microclimate in the Quechua Indians of Southern Peru. Ph.D. thesis, University of Arizona, 1968.

Hanna discusses influence of cold on Quechua Indians--cultural and biological adaptations and his field study in the town of Nunoa, Peru.

Hardy, James D. Thermal Comfort and Health. ASHRAE JOURNAL 13, February 1971, 43-51.

The article includes information on the sources of thermal discomfort, ill health related to extreme hot and cold temperatures, and the use of climate control.

Harrison, G. A.; Weiner, J. S.; Tanner, T. M.; and Barnicot, N. A. Human Biology. Oxford: Oxford University Press, 1977.

A good secondary source which brings together information and research results on the thermal environment, response to heat and cold, acclimatization, body characteristics and thermal comfort, and climatic and racial variation with cross cultural examples.

Hawkins, Raymond Clifford, II. Human Temperature Regulation and the Perception of Thermal Comfort. Ph.D. thesis, University of Pennsylvania, 1975.

Hawkins studied human thermoregulatory reactions to internal and external sources of thermal stress: physiological thermoregulatory reactions, behavioral thermoregulatory reactions, and alterations in "thermal consciousness."

Holley, Zelda Royce. Opinions of University Women Regarding the Relative Importance of Thermal Comfort, Conformity, and Fashion. M.S. thesis, Kansas State University, 1970.

The author studied sophomore and junior college women in residence halls relative to the importance of thermal comfort and conformity to fashion. Holley found comfort difficult to define. On individual questions relating to thermal comfort, there was never a majority concerned with thermal comfort.

Hollies, Norman R. S. and Goldman, Ralph F., editors. Clothing Comfort: Interaction of Thermal, Ventilation, Construction and Assessment Factors. Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1977.

The book is a collection of papers presented at a Fiber Society Symposium on Comfort. The four main topics are thermal balance and protection, fiber and fabric properties, comfort sensations, and interaction of clothing and the environment.

Huang, Jen-Jim Ju. Consumers' Attitudes Toward and Knowledge of Thermal Comfort for Clothing in Relation to Energy Conservation. M.S. thesis, Ohio State University, 1979.

The author surveyed 75 business and professional women to determine their attitudes toward clothing use and energy conservation and to evaluate their textile knowledge level related to thermal comfort and their satisfaction with their clothing. Comfort was found to be the most important clothing attitude followed by thermal comfort.

Jones, R. E.; Little, M. A.; Thomas, R. B.; Hoff, C. J.; and Dufour, D. L. Local Cold Exposure of Andean Indians During Normal and Simulated Activities. American Journal of Physical Anthropology 44 (2), 1976, 305-314.

The authors report a study which tested natural cold exposure response of Andean Indians during normal day-to-day acitvities as compared to lab test responses. Study validates use of some lab tests where conditions approximate natural exposure conditions.

Jose, Debbie J. Measurements of Physical Comfort: Laboratory and Wear Tests of Men's 100 Percent Cotton, 50/50 Cotton/Polyester, and 75/25 Nylon/Cotton T-Shirts. M.S. thesis, Cornell University, 1975.

The research included wear testing and laboratory testing. Male subjects ranked 75/25 nylon/cotton as most comfortable. Thermal insulation and absorption did not seem to be major factors in determining comfort.

Kang, D. H.; Kim, P. K.; Kang, B. S.; Song, S. N.; and Hong S. K. Energy Metabolism and Body Temperature of the Ama. Journal of Applied Physiology 20, January 1965, 46-50.

The researchers verified earlier conclusion "that tolerance to cold is increased in winter" with the Ama. There may be a relationship between the severe winter cold stress and the increase in basal metabolic rate.

Kelley, James B. Heat, Cold and Clothing. Scientific American 194 (2), February 1956, 109-110, 112,114,116.

The article contains a general discussion of heat, cold, and clothing; the author touches on body mechanisms that preserve or reduce body heat, body position, diet, amount and fit of clothing, and clothing materials

Kelman, Barbara and Mall, Jeanette with Leventhal, Ellen; Sachs, David; and D'Alton, Martina. Keeping Warm: A Guide for Winter Time. New York: Quick Fox, 1978, 51-73.

The pages cited include descriptions of fiber characteristics, principles of layering clothing for winter wear, areas of cold vulnerability for the body, outerwear alternatives, and textiles used in the home for thermal comfort.

Kennedy, S. J. Military Textiles and Clothing: Changing Needs. Modern Textiles 47, October 1966, 82-85.

Clothing has been standardized between services as is discussed by the author in this article. Kennedy also comments on the clothing being lighter in weight and that more synthetic fibers are used. He discusses some individual garments.

Kipp, Susan Denise Haines. Field Estimation of Ensemble Clo Value: Comparison of Two Approaches. M.S. thesis, Iowa State University, 1980.

The objective of the research was to develop an instrument to estimate clo value in the field. Kipp concluded a thermal comfort vote can be predicted in the field. She felt more work was needed on the instrument to be able to obtain an accurate clo estimate.

Kira, Alexander. The Bathroom. New York: Penguin Books, 1976, 19.

The book covers historical, social, and psychological aspects of body cleansing and care and elimination and design criteria. Kira mentions in one section the use of the bath to keep warm.

Kjerulf-Jensen, P.; Fanger, P. O.; and Gagge, A. P. Investigation on Man's Thermal Comfort and Physiological Response. ASHRAE Journal 17, January 1975, 65-68.

The authors describe the test chamber and the variables to be measured in investigating thermal comfort.

Klassen, Jacob. Thermal Discomfort in the Name of Energy Conservation. ASHRAE Transactions 85 (2), 1979, 809-812.

Klassen describes Canadian concepts of thermal comfort and building codes and space conditioning practices. Part of the approach is the removal of stringent comfort requirements.

Konz, S. and Aurora, D. An Evaluation of a Dynamic Cooling Shirt. ASHRAE Transactions 79 (1), 1973, 52-60.

A cooling shirt was designed and tested. Authors concluded further work was needed, but that an effective dynamic cooling shirt was possible.

Konz, S. and Gupta, V K. Water Cooled Hood Affects Creative Productivity. ASHRAE Journal 11, July 1969, 40-43.

The authors describe the advantages of liquid cooling vs. air cooling and cooling the entire body vs. the head.

Kranz, Peter. Calculating Human Comfort. ASHRAE Journal 6, September 1964, 68-77.

Comfort is described as maintaining thermal equilibrium using skin temperature as a control. The author states there is a direct relationship between comfort and evaporative capacity. To calculate comfort one can duplicate body's reaction to heat.

Larsen, R. M. The Thermal Micro-environment of a Highland Quechua Population: Biocultural Adjustments to the Cold. M.A. thesis, University of Wisconsin, Madison, 1973.

Larsen's study includes a discussion of technological buffers used to create warm microenvironments and various cultural groups' microenvironments. Larsen described and measured the Quechua exposure climate, shelter insulation, temperature of hut with and without fire, temperature under the bedding, behavioral characteristics, and the microclimate.

Lathan, Barbara J. The Structure of Shirting Fabrics in Relation to Comfort in Wear. Clothing Research Journal 1 (2), 1973, 3-27.

The article includes information on comfort factors in wear of shirting fabrics, objective measures of heat and moisture transmission, and subjective comfort assessments of subjects.

Leach, L. L. Fibres, Fabrics and Body Comfort. Canadian Textile Journal 74, May 3, 1957, 59-65.

The author reports results of tests studying physical comfort and different fiber types. He concludes the article with suggestions for maximum physical comfort in different climates. The focus of the article is on man made fibers.

Lee, Dae Yon; Hong, Suk Ki; and Lee, Pyung Hee. Physical Insulation of Healthy Men and Women over 60 Years. Journal of Applied Physiology 20, January 1965, 51-55.

The authors studied 34 men and women, young and old. Reduction in rectal temperature was greater in aged group and in the males, but may be due to differences in subcutaneous fat thickness. Authors found indication that maximal body insulation due to physical factors does not change due to aging.

Lee, Douglas. Heat and Cold Effects and Their Control. Washington D.C.: U.S. Public Health Service, Monograph No. 72, 1964.

The publication includes the topics of heat regulation, effects of heat, effects of cold, effects of clothing and shelter, and practical applications.

Leo, R. J.; Shitzer, A.; Chato, J. C.; and Hertig, B. A. Steady and Transient Temperature Distributions on the Skin of a Human Thigh Covered by a Water Cooled Pad. ASHRAE Transactions 79 (1), 1973, 62-73.

The authors studied effects of cooling with pads having various tube sizes and spacing between tubes, compared analytical modes and experimental data, and studied local skin surface temperature variations.

Levell, C. A., Breckenridge, J. R.; and Goldman, R. F. Effect of Laundering and Starching on Insulation and Vapor Permeability of Standard Fatigues. Textile Research Journal 40 (3), March 1970, 281-285.

Authors found laundering had no effect on the insulation value or moisture permeability index of the uniform except for small changes caused by shrinkage. Also it was noted that heat stress in a uniform is directly related with the ratio of the permeability index to the insulating value for the index.

McCracken, Deanna Marie. Thermal Insulation Values of Certain Layered Assemblages of Men's Wear. M.S. thesis, Kansas State University, 1967.

The author tested jacket linings and/or shell combinations worn singly or in layers on the copper manikin in still air. McCracken found indications that "the thickness or volume of entrapped air rather than the number of layers of air [make] the difference in air insulation."

McIntyre, Donald. A Guide to Thermal Comfort. Applied Ergonomics 4 (2), June 1973, 66-72.

McIntyre had developed a system where optimum thermal conditions can be obtained by estimating average metabolic rates of occupants and insulative value of occupants' clothing and finding the required subjective temperature using McIntyre's equation. The article was written before the energy crisis.

McIntyre, D. A. and Gonzalez, R. R. Man's Thermal Sensitivity During Temperature Changes at Two Levels of Clothing Insulation and Activitiy. ASHRAE Transactions 82 (2), 1976, 219-233.

Discussion noted that the thermal sensitivity of the subjects was a function of clothing, exercises, and season. Felt choice of comfort scale may be important--seven-point scale may exaggerate apparent sensitivity. Noted that change in skin temperature was not an adequate predictor of thermal sensation.

McIntyre, D. A. and Gonzalez, R. R. Man's Thermal Sensitivity During Temperature Changes at Two Levels of Clothing Insulation and Activity. ASHRAE Transactions 83 (2), 1977, 219-233.

"Thermal sensitivity was measured by exposing subjects to a 6 degree C change in ambient T_a levels from 30C to 11C in June and again in mid-August while at rest and while exercising, either heavily clothed or nude." Change in thermal sensation was by clothing, exercise, and season.

McLean, Jean. Consumers Can Be Rational. Human Ecology Forum 8 (3), Winter 1978, 16.

A straightforward, simple explanation of how clothing can function to aid thermal comfort. The author also discusses the future of fashion in a resource scarce world.

McLuhan, Marshall. Understanding Media: The Extensions of Man. New York: McGraw Hill, 1964, 119-130.

In his chapters on clothing and housing, McLuhan makes some observations relating to thermal comfort. He discusses some connections between clothing and housing.

McNall, P. E., Jr. and Nevins, R. G. A Critique of ASHRAE Comfort Standard 55-66. ASHRAE Journal 10, June 1968, 99-102.

The article includes a discussion of thermal comfort, methods of heat loss, and thermal variables.

Madsen, Th. Lund. Thermal Comfort Measurements. ASHRAE Transactions 82 (1), 1976, 60-75.

The author discusses a new comfort meter which can be used to measure the predicted mean comfort vote. The meter measures several environmental variables.

Mangum, B. W. and Hill, J. E. Thermal Analysis--Human Comfort--Indoor Environments, Proceedings of a Symposium Held at the National Bureau of Standards. Gaithersburg, Maryland, February 11, 1977.

The proceedings includes papers on indoor thermal comfort, models of human response to indoor thermal comfort, boundaries of comfort, heat stress and work, effect of energy conservation guidelines on comfort, and thermal acceptability.

Meir, Richard L. Science and Economic Development: New Patterns of Living. New York: John Wiley, 97-102.

Meir discusses thermal comfort, including a description of clo, heat generated and lost by the body, cost of energy. He compares achievement of thermal comfort by alternate routes (choice by culture): physical activity, food consumption, clothing.

Milan, Frederick A. An Experimental Study of Thermoregulation in Two Arctic Races. Ph.D. thesis, University of Wisconsin, 1963.

Milan studied Alaskan Eskimos and Athapascan Indians. He discusses physiological changes with behavioral and cultural adjustments.

Monego, Constantin J. Use of the Schlieren Technique to Observe the Still Air Layer Above the Surface of Fabric Covering a Heated Flat Plate. Textile Research Journal XXV (9), September 1955, 763-766.

Schlieren technique makes differences of air density visible. It may be possible to photograph and measure air layer and thus observe it in different environmental conditions. One could examine the insulating values of different fibers and the most effective relative positions for rough or smooth surfaced fabrics.

__________. Insulation Values of Fabrics, Foams and Laminates. American Dyestuff Reporter 52 (1), 1963, 21-32.

"Test results indicate that sheet polyurethane foam offers about 30 percent more resistance to heat flow than the same thickness of fabric." The insulating value of still air of an equal thickness is greater than the fabric foam laminate. Author discusses future research areas.

Moote, Ire. The Thermal Insulation of Caribou Pelts. Textile Research Journal XXV (10), October 1955, 832-837.

Moote compared thermal insulation of several different pelts and mohair pile fabric. Winter caribou pelts were best insulators. Caribou skins' insulative values vary according to the season the pelt was acquired. It was concluded that the availability and not the superiority accounted for the Eskimo's use of caribou.

Morse, R. N. and Kowalczewski, J. J. A Rational Basis for Human Thermal Comfort. ASHRAE Journal 9, September 1967, 72-77.

The purpose of the article was to provide a basis for quantitative comparison of various data taken from different types of clothing and different air velocities or lengths of exposure to the conditions. Authors discussed criterion for comfort.

Nevins, Ralph G. Research Projects in Human Physiology and Thermal Comfort. ASHRAE Journal 10, April 1968, 61-63.

Nevins comments on early research, mentions the comfort equation, variables of comfort, and future research needs.

__________. Energy Conservation Strategies and Human Comfort. ASHRAE Journal 17, April 1975, 33-37.

The author presents some of the alternatives open for energy conservation related to space conditioning. He also suggests areas needing more research.

Nevins, Ralph G.; McNall, Preston E., Jr.; and Stolwijk, J. A. J. How to be Comfortable at 65 to 68 Degrees. ASHRAE Journal 16, April 1974, 41-43.

The authors present some guides for dressing for thermal comfort.

Newburgh, L. H. editor. Physiology of Heat Regulation and the Science of Clothing. New York: Hafner Publishing Co., 1949, 1968 reprint.

The book is a collection of readings on human heat regulation. It includes a chapter on examples of cultures in different climatic zones and their climatic microenvironment adaptation, research on human heat regulation, and physical properties of clothing fabrics.

Nishi, Yasunobu. Field Assessment of Thermal Characteristics of Man and His Environment by Using a Programmable Pocket Calculator. ASHRAE Transactions 83 (1), 1977, 103-124.

Eight basic environmental and physiological measurements are taken and programmed into a pocket calculator. From these initial figures 30 other variables can be calculated. The author includes the program in the appendix of the article.

Nishi, Y. and Gagge, A. P. Moisture Permeation of Clothing--A Factor Governing Thermal Equilibrium and Comfort. ASHRAE Transactions 76 (1), 1970, 137-145.

The authors report an investigation of the "relationship between the resistance of clothing to water vapor and its transfer from the sweating skin surface." The experiments simulated real life situations.

Nishi, Yasunobu; Gonzalez, R. R.; and Gagge, A. P. Direct Measurement of Clothing Heat Transfer Properties During Sensible and Insensible Heat Exchange with Thermal Environment. ASHRAE Transactions 81 (1), 1975, 183-198.

Title of the article describes the content. "An effective value for clo can be determined and vapor permeation efficiency can be predicted." New method simplifies present methods.

Nishi, Yasunobu; Gonzalez, Richard; Nevins, Ralph G.; and Gagge, A. Pharo. Field Measurement of Clothing Thermal Insulation. ASHRAE Transactions 82 (2), 1977, 248-259.

The authors developed and report a method for "directly evaluating the clothing insulation while worn by a live subject" by direct measurement of the thermal efficiency factor.

Nunneley, Sara A. Physiological Responses of Women to Thermal Stress: A Review. Medicine and Science in Sports 10 (4), 1978, 250-255.

Nunneley reviews 68 references on research relating to female thermal stress. Women have been shown to be less heat tolerant than men; this may be due to women's traditional sedentary roles.

O'Hanlon, James F., Jr. and Horvath, Steven M. Changing Physiological Relationships in Men Under Acute Cold Stress. Canadian Journal of Physiology and Pharmacology 48 (1), 1970, 1-10.

Researchers found that the older subjects had warmer finger, toe, thigh, and rectal temperatures and stated that "the older individuals must have increased their oxygen consumption and heat production to a greater degree than those younger." O'Hanlon and Horvath support measuring physiological changes over time instead of at a single point.

Ohara, K.; Okuda, N.; and Takaba, S. Thermoregulatory Responses to Heat and Exercise in Japanese and Caucasians. International Journal of Biometeorology 19 (2), 1975, 99-107.

The authors discuss the fact that the Japanese subjects had a higher rate of local sweating, that both grops were heat acclimatized and therefore, "the difference in heat responses...is related to some extent to differences in inherent factors."

Olesen, Soren; Baesing, J. J.; and Fanger, P. O. Physiological Comfort Conditions at Sixteen Combinations of Activity, Clothing, Air Velocity and Ambient Temperature. ASHRAE Transactions 78 (1), 1972, 199-206.

The authors wished to explore assumptions that verbalized thermal comfort in relation to preferred skin temperature and sweat secretion independent of clothing and environment.

Olsen, Neva Foster. Pupillometric and Subjective Assessment of the Comfort Provided by Chemically Finished Cotton Fabrics. Ph.D. thesis, Texas Women's University, 1976.

Pupillary and subjective responses to sensory stimulation were evaluated; pupil dilation was greatest for the most comfortable subjective rating and pupil was evidenced for the least comfortable.

Olivieri, Joseph B. Energy Conservation and Comfort--Are They Compatible? ASHRAE Transactions 85 (2), 1979, 799-808.

The author analyzes the results of lower thermostats in buildings with a large glass wall surface area and/or poor insulation. Olivieri suggests some alternatives to be used in new building design.

Parry, Malcolm. Effects of Indoor Climate on Human Comfort, Performance and Health in Residential, Commercial and Light Industry Buildings. Journal of Consumer Studies and Home Economics 3, 1979, 55-58.

The paper is a report of a symposium on indoor climate and human comfort. Discussions included topics such as health hazards due to reduced ventilation, need for increased research on thermal comfort when modifying relative humidity, air temperature, air velocity, and mean radiant temperature, habits of building residents, and education of energy consumers.

Parry, M. J. and Irving, R. J. Thermal Comfort in the Home. Journal of Consumer Studies and Home Economics 4, 1980, 179-191.

"The article is an attempt to indicate the physiological background to the behavior of individuals with respect to a comfortable living temperature." The authors discuss human temperature regulation and thermal comfort research.

Perkins, R. M. Insulative Values of Single-Layer Fabrics for Thermal Protective Clothing. Textile Research Journal 49, 1979, 202-212.

The author tested the insulative properties of fabrics. "The total heat transferred through the fabric after exposure, and the time to reach a second-degree burn injury...were used to evaluate insulation characteristics."

Piggott, M. R. The Feeling of Dampness at Low Temperatures. International Journal of Biometeorology 13 (1), 1969, 81-86.

Researchers reported on earlier studies which reported that sensations of cold were less with high humidity. In this study subjects were tested in cold and damp and results showed no significant correlation between relative humidity and temperature.

Raven, P. R. and Horvath, S. M. Variability of Physiological Parameters of Unacclimatized Males During a Two-Hour Cold Stress of 5° C. International Journal of Biometeorology 14 (3), 1970, 309-320.

Researchers were interested in determining size, duration, and variability of changes in temperature and metabolism during two-hour cold stress tests and also to establish when a physiological steady state is attained.

Rees, W. H. The Protective Value of Clothing. Journal of Textile Institute 37, 1946, 132-153.

This is a classic in thermal comfort literature. Rees begins the article by discussing the functions and origins of clothing. He then discusses physiological aspects of the body, clothing, and fabric for tropical conditions, insulation against the cold, moisture properties of fabrics, and heat of absorption.

Renbourn, E. T. Physiology and Hygiene of Materials and Clothing. Watford, England: Merrow Publishing Co., Ltd., 1971.

The title describes the focus of the book. The author discusses the historic preoccupation with keeping body "unduly warm", temperature of the body, chilling of the body, clothing and physiological research, thermal properties of clothing, sorption heat of clothing materials, the forms of clothing, and clothing hygiene.

__________. Materials and Clothing in Health and Disease with The Biophysics of Clothing Materials by W. H. Rees. London: Lewis and Co. Ltd, 1972.

The authors discuss past and present concepts related to the functions of materials and clothing. Physical and physiological aspects of thermal comfort are included as are medical and psychological aspects.

Rim, Y. Psychological Test Performance During Climatic Heat Stress from Desert Winds. International Journal of Biometeorology 19 (1), 1975, 37-40.

Subjects were tested during periods of desert winds. "[U]nstable extroverts tend to perform worse on Sharav days, whereas stable introverts perform either at their regular level, or slightly better."

Rohles, Frederick, H., Jr. Preference for the Thermal Environment by the Elderly. Human Factors 11 (1), 1969, 37-41.

Rohles surveyed 64 elderly respondents on their feelings toward 41 temperatures ranging from 32° F to 110° F. The results agreed to some extent with previous research in which individuals were exposed to different temperatures.

__________. The Modal Comfort Envelope: A New Approach Toward Defining the Thermal Environment in Which Sedentary Man is Comfortable. ASHRAE Transactions 76 (2), 1970, 308-315.

The envelope of modal thermal comfort was defined as a "zone within [the disbribution of upper and lower temperature limits voted as comfortable by subjects] where the largest number of subjects vote 'comfortable'."

__________. Psychological Aspects of Thermal Comfort. ASHRAE Journal 13, January 1971, 86-90.

Rohles comments on the difference between the ASHRAE comfort definition and psychological aspects of thermal comfort. There seems to be a range of temperature preferences.

__________. The Revised Modal Comfort Envelope. ASHRAE Transactions 79 (2), 1973, 52-59.

This article contains further work on the modal comfort envelope.

__________. The Measurement and Prediction of Thermal Comfort. ASHRAE Transactions 80 (2), 1974, 98-107.

Rohles discusses areas previously ignored in most thermal comfort studies: individual differences between and within subjects, psychology of affectivity, and statistical theory.

__________. Humidity, Human Factors and the Energy Shortage. ASHRAE Journal 17, April 1975, 38-40.

The author summarizes research that has been completed related to the effect of relative humidity on comfort or affectivity.

__________. Temperature or Temperament: A Psychologist Looks at Thermal Comfort. ASHRAE Transactions 86 (1), 1980, 541-551.

Rohles reviews five studies on the psychology of thermal comfort. In the studies discussed respondents often feel psychologically comfortable when misinformed about temperature or heat source or when tested in a "furnished" room as opposed to a "sterile" room.

Rohles, F. H.; Hayter R. B.; and Milliken, G. Effective Temperature (ET*) as a Predictor of Thermal Comfort. ASHRAE Transactions 81 (2), 1975, 148-151.

Sixteen hundred subjects in groups of 10 were exposed to 20 different temperature and humidity combinations. The new thermal index vote was used and correlated with the subjects' thermal sensation vote. A probit analysis aided the construction "of a curve for predicting the percentage of subjects who would be thermally dissatisfied for a given effective temperature, ET*."

Rohles, Frederick H., Jr.; Hayter, Richard B.; and Berglund, Larry G. Comfort and Cold and Warm Discomfort During Summer and Winter in Northern and Southern United States. ASHRAE Transactions 83(1), 1977, 78-87.

The authors found a significant relationship between locale and season and warm discomfort. They feel thermal feelings of warmth or coolness are relative, not absolute. The way an individual responds to his thermal environment depends on length of time he has been exposed to the temperature of the previous environment.

Rohles, F. H., Jr. and Johnson, M. A. Thermal Comfort in the Elderly. ASHRAE Transactions 78 (1), 1972, 131-137.

Three experiments were conducted to study thermal comfort in the elderly. In general the elderly were found to be warmer than college subjects at the same temperature, but Rohles and Johnson also found that the elderly preferred higher temperatures than college age subjects.

Rohles, F. H., Jr. and Nevins, R. G. The Nature of Comfort for Sedentary Man. ASHRAE Transactions 77 (1), 1971, 239-246.

Rohles and Nevins found that the male subjects in their study reacted to temperature and huymidity levels differently than the female subjects. They also noted that women adapt to the thermal environment more rapidly than men.

Rohles, Frederick H., Jr.; Woods, James E.; and Nevins, Ralph G. The Influence of Clothing and Temperature on Sedentary Comfort. ASHRAE Transactions 79 (2), 1973, 71-80.

The authors present an equation "by which a comfortable effective temperature can be predicted as a function of the insulation value of clothing." They found that men and women had different thermal sensations in the same clothing.

Saltford, Nancy. Topical Storms. Human Ecology Forum 8 (3), Winter 1978, 15.

The author discusses fashion in context with energy consciousness or lack of energy consciousness.

Scruggs, B. J. Laboratory Measurement and Evaluation of Thermal and Selected Comfort and Durability Properties of Twelve Textile Fabrics Intended for Indoor Winter Wear with Lowered Temperatures. Paper presented at Central Region Annual Conference Association of College Professors of Textiles and Clothing, Columbus, Ohio, October 24-26, 1979.

Twelve fabrics were tested for insulating abilities. Knit fabrics had lower conductivity than woven fabrics. Fiber content did not affect the thermal conductivity of the fabric. Fiber content and fabric structure did affect comfort (moisture regain and air permeability) and durability.

Seppanen, O.; McNall, P. E.; Munson, D. M.; and Sprague, C. H. Thermal Insulating Values for Typical Indoor Clothing Ensembles. <u>ASHRAE Transactions</u> <u>78</u> (1), 1972, 120-130.

Previous tests have used standard clothing to remove the effect of clothing while studying other thermal variables. The authors of this research were concerned with the thermal evaluation of typical clothing ensembles.

Shvartz, E. and Benor, D. Total Body Cooling in Warm Environments. <u>Journal of Applied Physiology</u> <u>31</u> (1), July 1971, 24-27.

The authors discuss the use of a garment with tubing containing circulating cool water. This garment resulted in complete elimination of evidence of heat stress and strain in all tested temperatures.

Slater, K. Comfort Properties of Textiles. <u>Textile Progress</u> <u>9</u> (4), 1977, 1-70.

Slater reviews many aspects of thermal comfort. The article is a good review of literature and covers the following areas: general aspect of comfort, thermal properties and comfort, moisture vapor transmission, liquid-moisture transmission, air permeability, size and fit, aesthetic comfort, static electricity, and noise.

Spencer-Smith, J. L. The Physical Basis of Clothing Comfort: Part 1, General Review. <u>Clothing Research Journal</u> <u>4</u> (3), 1976, 126-138.

Spencer-Smith reviews the way a thermal balance is maintained when clothing is worn. He discusses direct heat transfer through clothing, water vapor transfer through clothing, and special properties of hygroscopic fabrics.

__________. The Physical Basis of Clothing Comfort: Part 2, Heat Transfer Through Dry Clothing Assemblies. <u>Clothing Research Journal</u> <u>5</u> (1), 1977, 3-17.

As the title suggests the author reports on studies of heat transfer through dry clothing.

__________. The Physical Basis of Clothing Comfort: Part 4, The Passage of Heat and Water Through Damp Clothing Assemblies. <u>Clothing Research Journal</u> <u>5</u> (3), 1977, 116-128.

The author discusses the circumstances in which liquid water transfers occur between layers of fabric, when heat and moisture are transferred.

__________. The Physical Basis of Clothing Comfort: Part 5, The Behavior of Clothing in Transient Conditions. <u>Clothing Research Journal</u> <u>6</u> (1), 1978, 21-30.

Spencer-Smith reviews research related to the passage of heat and water vapor through clothing in non-steady state conditions. He discusses the behavior of hygroscopic clothing.

__________. The Physical Basis of Clothing Comfort: Part 6, Application of the Principles of the Design of Clothing for Special Conditions. Clothing Research Journal 6 (2), 1978, 61-67.

The paper looks at very cold and very hot conditions and the special properties of clothing which are required.

__________. The Physical Basis of Clothing Comfort: Part 7, Assessment of the Comfort Properties of Clothing. Clothing Research Journal 7 (1), 1979, 39-48.

The author looks at assumptions related to direct heat loss in relationship to dry body and clothing and when the body perspires. Maximum heat loss can be underestimated if dry conditions are assumed or used as a base.

Sprague, Clyde H. and Munson, Deanna M. A Composite Ensemble Method for Estimating Thermal Insulating Values of Clothing. ASHRAE Transactions 80 (1), 1974, 120-129.

The researchers measure clo values for separate garments and devise a formula to estimate garment ensembles.

Steadman, Robert G. Keeping Warm and Saving Energy. Paper presented at Western Region Annual Conference Association of College Professors of Textiles and Clothing, Denver, Colorado, October 10-13, 1979.

Steadman discusses the problem of trying to minimize costs of thermal comfort. At present, maximal heating of a well-insulated building and minimal apparel is found to be the most economical; but as energy resource costs rise, proper use of apparel and lower thermostats will become the economical choice.

Stowe, Barbara S. and Krauss, Otto F., coordinators. Clothing and Energy Resources Workshop Proceedings. Michigan State University, East Lansing, Michigan. November 29-December 1, 1978.

The workshop and proceedings covered the following areas: physiological thermal regulation, apparel design and thermal regulation, clothing as communication, thermal comfort and clothing, thermal environment and production, care and maintenance of clothing.

Tobias, Phillip V. Physique of a Desert Folk. Natural History 70 (2), February 1961, 17-25.

Tobias discusses the physiological characteristics of the Bushman. The Pygmoid stature, infantile anatomical pattern, and steatopygia do not seem to be related to desert life. The Bushman's height-weight ratio and broad, low nose is related to the hot climate. The Bushmen have acclimatized to the desert, but they have not undergone genetic adaptation.

Vokac, Z.; Kopke, V.; and Keul, P. Assessment and Analysis of the Bellows Ventilation in Clothing. Textile Research Journal 43 (8), August 1973, 474-482.

The research objective was to separate the loss of heat and moisture inside clothing due to forced exchange of air due to walking movements from loss caused by gradients between body and environment.

__________. Evaluation of the Properties and Clothing Comfort of the Scandinavian Ski Dress in Wear Trials. Textile Research Journal 42 (2), February 1972, 125-134.

The authors found that without wind the fitted knit outfit had higher thermal resistance than the loosely fitted woven garment but had a lower subjective rating.

__________. Physiological Responses and Thermal, Humidity and Comfort Sensations in Wear Trials with Cotton and Polypropylene Vests. Textile Research Journal 46 (1), January 1976, 30-38.

The findings were that the skin temperature was the lowest when the double-layer cotton vest was worn and highest with the double-layer polypropylene vest. The subjects did not express any clear preference.

Wages, Teresa Beth. The Design and Development of a Measure for Comfort in Clothing. M. S. thesis, Texas Tech University, 1974.

The researcher defined three areas of comfort: physical, sociophychological, and psychological. She felt that comfort in clothing is highly individualistic and has a situational factor in clothing selection.

Weiner, Louis S. and Shah, Jashwant. Insulating Characteristics of Battings. Textile Chemist and Colorist 1 (14), 1969, 20-25.

The researchers investigated the influence of thickness, applied pressure, bulk density, and fiber type on insulation parameters of clo and warmth factor. Clo values were determined for different battings and batting thickness. The insulation showed a linear relationship with thickness.

Weinman, K. P.; Slabochova, Z.; Bernauer, E. M.; Morimoto, T., and Sargent, F., II. Reactions of Men and Women to Repeated Exposure to Humid Heat. Journal of Applied Physiology 22 (3), March 1967, 533-538.

The authors found differences between the men and women in rectal temperatures, total body sweat rate, and pulse increment. "The results suggest sex differences in acclimation mechanisms."

Werden, Jane E.; Fahnestock, M.; and Galbraith, Ruth L. Thermal Comfort of Clothing of Varying Fiber Content. Textile Research Journal XXIX (8), August 1959, 640-651.

There was no significant difference found among fiber types in relation to thermal comfort. Authors feel there are many individual and combined factors involving fiber, yarn, and fabric characteristics and manner of applying fabric to the body which affect human thermal, physical, and psychological comfort.

Winsmann, R. R.; Soule, R. G.; and Goldman, R. F. Underclothing and Its Physiological Effects in a Hot-Dry Environment. Clothing Research Journal 5 (1), 1977, 28-34.

Underclothing on a copper manikin adds insulation and decreases evaporative transfer. Four underclothing systems were evaluated. No underwear was the best for cooling. Ladder net and fish net did not appear to be better for cooling than regular underwear.

Wyndham, C. H.; McPherson, R. K.; and Munro, R. Reactions to Heat of Aborigines and Caucasians. Journal of Applied Physiology 19, 1964, 1055-1058.

Physiological reactions to heat and humidity were studied for Australian aborigines, Australian Caucasians, and unacclimatized and acclimatized South African Caucasians. Caucasians showed much higher sweat rates.

Wyndham, C. H.; Metz, B.; and Munro, A. Reactions to Heat of Arabs and Caucasians. Journal of Applied Physiology 19, 1964, 1051-1054.

The physiological reactions to heat were studied for French servicemen, Sahara Arabs, and South African Caucasians. The Arabs showed "no greater adaptation to hot conditions than recent Caucasian inhabitants."

Wyndham, C. H.; Morrison, J. F.; Ward, J. S.; Bredell, G. A. G.; Von Rahden, M. J. E.; Holdsworth, L. D.; Wenzel, N. G.; and Munro, A. Physiological Reactions to Cold of Bushmen, Bantu, and Causcasian Males. Journal of Applied Physiology 19, 1964, 868-875.

Bantu and Bushmen showed similar metabolic rates per square meter and rectal temperatures while Caucasian rates and temperatures were different. Toe and finger temperatures of the Bushmen were higher than those of the Bantu and Caucasians. Subcutaneous tissue insulation against heat flow is greatest for Caucasians.

Wyndham, C. H.; Strydom, N. B.; Morrison, J. F.; Williams, C. G.; Bredell, G. A. G.; Von Rahden, M. J. E.; Holdswarth, L. D.; Van Graan, C. H.;, Van Rensburg, A. J.; and Munro, A. Heat Reactions of Caucasians and Bantu in South Africa. Journal of Applied Physiology 19, 1964, 598-606.

"Heat reactions of 20 Caucasian and 22 Bantu males were compared, first in the unacclimatized state and then in the acclimatized state." There were significant differences between unacclimatized Bantus and unacclimatized Caucasians and between both unacclimatized groups with the acclimatized groups sweat rates increased substantially.

Wyndham, C. H.; Ward, J. S.; Strydom, N. B.; Morrison, J. F.; Williams, C. G.; Bredell, G. A. G.; Peter, J.; Von Rahden, M. J. E.; Holdswarth, L. D.; Van Graan, C. N.; Van Rensburg, A. J.; and Munro, A. Physiological Reactions of Caucasian and Bantu Males in Acute Exposure to Cold. Journal of Applied Physiology 19, 1964, 583-592.

Significant differences were found in the cold reactions of Caucasians and Bantu for the range of temperatures tested. Toe and finger temperatures and rectal temperatures varied between the two groups.

Wyndham, C. H.; Williams, C. G.; and Loots, H. Reactions to Cold. Journal of Applied Physiology 24, 1968, 282-287.

In a study comparing the physiological reactions of one fat and one thin man, the researchers found metabolic rate differences. The findings suggest that thin men have less insulation against heat flow.

Yaglou, C. P. and Messer, Anne. The Importance of Clothing in Air Conditioning. Journal of the American Medical Association 117 (15), 1941, 1261-1267.

The authors tested the differences in comfort perception between men and women. When men and women were dressed in their own clothing, each sex group preferred different temperatures; with a minimum of clothing, the same temperature was preferred by both sexes. When men wore women's clothes and when women wore men's clothes, each group preferred the opposite sex group's temperature choice.

Yoshimura, M. and Yoshimura, H. Cold Tolerance and Critical Temperature of the Japanese. International Journal of Biometeorology 13 (2), 1969, 163-172.

Critical temperature has been found to be a good index in estimating thermal adaptability. The research reported in this article observed critical temperature and cold tolerance of five subjects. The critical temperature was determined to be 25° C lower than values found for Norwegians and Lapps in other studies.

Breathable Finish Imparts Durable Water Barrier. Modern Textiles Magazine 44 (4), April 1963, 28, 85.

The article contains a discussion of "Reevair" fabrics introduced by Reeves Brothers. The fabric has held up under tear strength, breaking strength, and abrasion tests. Fabric was adopted by the Air Force for arctic clothing. Fabric can transmit vapors while holding out water.

Cold Weather Clothing and Sleeping Equipment. Department of the Army Technical Manual, TM 10-275, Headquarters, Department of the Army, October 1964.

The publication contains a discussion of cold weather clothing, the principles of design, cold weather conditions: cold-wet and cold-dry, and components of men's and women's cold weather clothing.

The Effect of Wetness on Clothing Warmth. Modern Textiles Magazine 44 (4), April 1963, 57.

Fabric characteristics related to thermal insulation and surface wetness are discussed in the article.

Thermal Comfort Conditions. ASHRAE Journal 16, January 1974, 90-91.

Components of human comfort are discussed including comments on the primary variables in testing.