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Effects of Age, Gender and Body Mass Index on Reaction to Air Condition

EFFETS DE L'ÂGE, DU SEXE ET DE L'INDICE DE MASSE CORPORELLE SUR LA RÉACTION DES GENS ENVERS L'AIR CLIMATISÉ

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Abstract: This study investigated the effect of age, gender, and body mass index (BMI) on reaction to air condition. Forty eight undergraduates (21 males and 27 females) randomly selected from Imo State University, Owerri, Nigeria within the age range of 17-30 years participated in the study. 26 of them were of normal weight (BMI <23) and 22 were over-weight (BMI >24). They were exposed to an air conditioned room for two hours and then their reaction to cold measured using Response to Cold questionnaire. Employing t-test and ANOVA for data analyses, the results showed that body size, age, and gender had no statistically significant effect on reaction to cold condition while exposure to cold condition had a significant influence on both systolic and diastolic blood pressures of all participants.
Key words: Body mass index; Air condition; Reaction; Blood pressure; Systolic blood pressure; Diastolic blood pressure; Cold

Résumé: Cette étude a examiné l'effet de l'âge, du sexe et de l'indice de masse corporelle (IMC) sur la réaction des gens envers l'air climatisé. Quarante-huit étudiants de premier cycle (21 hommes et 27 femmes) sélectionnés au hasard dans l'Université de l'état d'Imo à Owerri au Nigeria dans une tranche d'âge de 17 ans à 30 ans ont participé à cette étude. 26 d'entre eux avaient un poids normal (IMC <23) et 22 sont en surpoids (IMC> 24). Ils ont été exposés dans une salle climatisée pour deux heures, puis leur réaction au froid a été mesuré en utilisant le questionnaire de Réponse au froid. Après le t-test et une analyse de variance des données, les résultats ont montré que la taille corporelle, l'âge et le sexe n'avaient aucun d'effet statistiquement significatif sur la réaction à l'état froid, tandis que l'exposition à l'état froid avait une influence significative sur les pressions artérielles systoliques et diastoliques de tous les participants.
Mots clés: Indice de masse corporelle; Climatisation; Iréaction; Pression artérielle; Pression artérielle systolique; Pression artérielle diastolique; Froid

1. INTRODUCTION

Humans interact with their environment leading to various behaviours. The outcome of such interaction is often dependent upon certain human attributes such as gender, age, social and marital statuses, educational levels, personality types, body sizes/types/weight etc. The degree of these variations sometimes, remains blurred and makes us wonder if human beings react the same way in certain settings.

Since behaviour is biologically and environmentally driven, the interaction of the two is always necessary in measuring behaviour. The study of genetics by Gregor Mendel in 1865 has led to the understanding of inheritance (Liu, 2006), which is like a foundation the environment builds on. "Nature makes the boy toward, nurture sees him forward"

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(Mulcaster, 1582). In this same vein, internal body environment helps regulate behaviour like we feel hungry and are motivated to seek food to create balance.

When it comes to temperature regulation and homeostasis, how does the hotness and coldness of the environment affect individuals; direct their behaviour and show differences in their reaction, across gender and body size? The researchers wonder if the condition of the physical environment of humans influences them physiologically and how it determines their reaction/ behavior in various settings.

Physiological gender differences have always instigated research for they lead to the understanding of certain patterns of gender-related behaviours. According to Marina (2008), in comparison to men, it is true women naturally are prone to carrying more fat. The presence of fat helps insulate the body and keeps it warm, and hence women tend to be warmer in cold environment than their male counterparts. But Raynaud's disease, which causes the blood vessels in the hands and feet to overreact to cold or stress, is more common in women than in men, and studies are being done to see if it is an inherited condition (Cedars-Sinai Health System, 2007).Tanaka et al (2003) conducted an experiment to determine Effects of Decreasing Air Temperature on Peripheral Thermal Reactions in Males and Females, and found that Blood flows and skin temperatures of male and female subjects were similar or showed no significant difference at the beginning and end of the experiment. Skin blood flow of the hand and skin temperatures of the hand and fingers decreased with their values in females lower than in males, when air temperature was decreased linearly in a thermal neutral zone. But, in Fanger's experiments (1970), no difference in comfort conditions was observed between males and females. Chung and Tong's study on the other hand, observed that males sweat more than females at temperature range of 20-30˚C, since the metabolic rate of females is less than that of males. They concluded that females may feel cooler than males because of being more sensitive to temperature changes. At this point, the researchers suggest that what to believe when it comes to thermoregulation is uncertain.

There are several factors that can change one's susceptibility to cold temperatures. One large determinant is related to an individual's surface-area-to-mass ratio. This is a ratio that looks at the individual's overall surface area as it compares to the overall mass. Does it mean that someone who has a larger surface area relative to their mass will lose heat more quickly and become cold more readily since we lose heat through our skin's surface? According to King (2004), when skin temperature drops vasoconstriction in the skin coupled with the involuntary contraction of the skeletal muscles increase the shell's total insulating capacity. It is estimated that vasoconstricted inactive muscle can provide as much as 85% of the body's total insulation during exposure to extreme cold. This represents a resistance to heat loss that is two to three times higher than that of the overlying fat and skin tissues. A little on the contrary, Bookspan (2003) stated that, body size and shape contribute to susceptibility to cold but like any other individual factor, does not determine it. Although, it is believed that fatter people find an environment hotter than felt by thinner persons, Fanger's experiments (1970) indicated that body build does not have a significant influence on the comfort conditions of subjects. Chung and Tong's experiments (1990) on the same factor also showed that the difference in the neutral temperatures between persons of different body build is not significant.

Considering the role the heart, blood and nerve constriction play in maintaining temperature homeostasis, the researchers wonder if there is a correlation between blood pressure and reaction to cold. The recent proposition of Medical Hypotheses Journal termed: the thermoregulatory-vascular remodeling hypothesis supported this inquisition. The hypothesis' supposition is that temperature homeostasis has precedence over blood pressure homeostasis which vascular remodeling ensues, hypertension is the consequence and that sodium chloride ingestion sets the sequence in motion. Blood pressure goes up when temperatures go down, because blood vessels constrict to conserve body heat. The higher pressure puts stress on the heart (CBC News, Tuesday, August 31, 2004 | 4:27 PM ET). Doctors say the link between weather and heart attacks isn't clear, but highlights the importance of bringing high blood pressure down to normal levels. They also suggest people with blood pressure problems dress warmly. Jansen, Leineweber and Thien (2001) discovered that for SBP as well as DBP a clear dose-response relationship was demonstrated between low temperature and high BP, although for DBP only a few correlations were statistically significant. Mean correlation coefficients for SBP and DBP against temperature were -0.44 ($P < 0.001$) and -0.27 ($P < 0.005$), respectively. Increased outdoor, but not indoor, temperatures had a stronger effect in women than in men. The effect of outdoor temperature remained after controlling for indoor temperature. Short-term trends in temperature did not have a statistically significant effect (Barnett et al, 2007).

Hypotheses

(1) There will be no statistical significant difference between the blood pressures of the experimental and control groups on reaction to air- conditioning.

(2) Males and females will not have a statistical significant reaction differences to air-conditioning.

(3) No statistical significant difference on reaction to air-Conditioning will be found across body sizes.

(4) There will be no statistically significant change in blood pressure after exposure to air-conditioning.

2. METHOD

2.1 Participants

Forty eight volunteer healthy undergraduates from Imo State University, Owerri, Imo State, Nigeria selected through a random sampling took part in the experiment. There were twenty one males and twenty seven females within the age range of 17-30 years old. Twenty six of them were normal weighted people (BMI≤23), while twenty two were over-weight people (BMI≥24).

2.2 Instrument

- The experiment involved certain apparatus, which are materials that helped the researchers see the effect of the independent variables on the dependent variable. The following were used:
- An air-conditioned room: 6.096m in length, width 4.8768m, 2.743m in height and volume of 81.55m^3 and Powered by one Horse Power (1HP) Samsung Air- conditioner with model number AWO9PKHEA.
- Responses to Cold Questionnaire: This was used to measure the physiological feelings of the participants in reaction to air-conditioning. The scale was validated in a pilot study conducted and the ratings were adapted from National Institute for working life, 2003 research. The first item on the questionnaire was rated on an eight-point scale (-3,-2,-1, 0, 1, 2, 3, 4). Yes and no were 0 and 1, respectively and the other items were rated 0, 1, and 2.
- A Stop watch: Stop watch function of a phone (Nokia 1650) was used for accurate time keeping between the measurement and readings' intervals.
- A laptop computer: An hp (Compaq nx9010) laptop was used to play the movie- High School Musical (1&2). This was intended to keep the participants away from idleness.
- Sphygmomanometer: An MMT-3 analogue Sphygmomanometer with model number: Ty 311-00227471.036-93 was used to measure systolic and diastolic blood pressures.
- Weighing Scale: Hana Mechanical Personal Scale was used to measure participants' weight in kilograms for the B.M.I.
- A two-meter length ruler: Used for measuring height in meters.
- White Lab Coats: These were worn by the experimenters because of the clinical setting and the contacts with participants.
- Tables and Chairs: The tables were used for measuring blood pressures, records' taking and placing the laptop. The chairs were leather upholstered for the comfort of the participants.

2.3 Procedures

A pilot study was conducted earlier, in order to ascertain behaviours and physiological reactions associated with cold conditions, and this helped in the development and validation of the experimental questionnaire that was used. In addition to expert advice sort, it was found that shivering, yawning, stretching, dizziness, dryness of palms, feet and lips were reactions to cold. Volunteer participants were sort through the handbills circulated throughout the University campus. Prior to the day of the experiment, the volunteers gathered for random selection and also briefing aimed at controlling the variable of food in-take on the experimental day. Two-piece clothing was worn by all participants and they filled Participants' Form which sourced for demographic and medical status information. Body Mass Index was calculated before participants were assigned to any category of body size using weight divided by length squared (kg/m2). The volunteers were randomly selected through random sampling and randomly assigned to groups. On the experimental day, participants' diastolic and systolic blood pressures were measured, recorded and assigned numbers. Participants were divided into two. The first group, made up of six participants, was admitted into the experimental room, where they watched a film (high School Musical) on bare foot. Their blood pressures having been checked under normal room temperature was re-checked after 1 hour and 2 hours, respectively in the experimental condition. At these points they responded to questionnaires measuring their physiological reaction to the air- conditioning. The control group was given the same treatment except for exposure to air conditioning. The experiment lasted for three days and was done in the mornings and same procedure repeated for the other remaining participants. Members of the control group were at the end of the entire exercise exposed to the experimental condition. After the third day, the researcher thanked and debriefed the participants and enlightened them on the essence of the experiment.

2.4 Design/Statistics

Between group design was used, as the group of males was compared with the female group, and the normal weight participants compared with the over-weight participants. A t- test for independent sample was used because the groups were nonequivalent. Blood pressure was measured across different conditions and durations and thus Analysis of Variance (ANOVA) was used to access the coactions effect. T-test was also used to compare the experimental group with the control group.

3. RESULTS

Table 1: T –Test Summary Table Showing a Comparism Oof Means of Experimental and Control Groups

Variables	N	Mean ()	Degree of Freedom	Calculated t-value	Critical t-value
Experimental	24	3.081	46	1.644	2.021
Control	24	2.749			

Since the calculated t-value of 1.644 is lesser than the table value of 2.021 at $p<0.05$ with DF=46, the null hypothesis was not rejected. This means that no difference was detected between the two treatment conditions.

Table 2: A T-Test Summary Table Showing a Comparism of Means of Different Body Masses and Control Groups

Variables	N	Mean ()	Degree of Freedom	Calculated t-value	Critical t-value
B.M.I≥24	10	16.4	22	1.86	2.074
B.M.I.≤23	14	14.6			

Since the calculated t-value of 1.86 is lesser than the t-table value of 2.074 at $p<0.05$ with DF=22, the null hypothesis was rejected. This implies that body size has no significant influence on susceptibility to cold.

Table 3: A T-Test Summary Table Showing the Means of Males and Females.

Variables	N	Mean ()	Degree of Freedom	Calculated t-value	Critical t-value
Males	10	15.7	22	1.125	2.074
Females	14	14.8			

Since the calculated t-value of 1.125 is lesser than the table value of 2.074 at $p<0.05$ with DF=22, the null hypothesis is not rejected. This means that no difference was found between males and females in their reactions to cold.

Table 4: Analysis of Variance Showing an Interaction Effect of the Pre-Test Reading and Two Experimental Readings

	Sum of Squares	Degree of Freedom (df)	Mean Square	F	Sig.
Between Groups	.532	2	.266	4.673	.012
Within Groups	3.930	69	.057		
Total	4.462	71			

Since the t-value of 4.673 is greater than the table value of .012 at $p<0.05$ with DF=71, the null hypothesis was rejected. This implies that there is a significant effect on blood pressures across the temperature conditions.

4. DISCUSSION

This study tested four hypotheses relating to physiological effects of air-conditioning and the over-lying psychological and behavioural outcomes. The first hypothesis stated that there will be no statistically significant difference between blood pressures of the experimental and control groups on reaction to air- conditioning. This hypothesis was not rejected as the statistical analysis indicated no differences on blood pressure between participants exposed to air-conditioning (experimental) and those under normal room temperature (control) for a period of two hours. This finding is supported by the finding of Barnett et al. (2007) that a Short-term trend in temperature does not have a statistically significant effect on people. Of course, in our present study the experiment lasted for two hours only; a short duration. Also Jehn et al. (2002) in support of the present finding stated that after adjustment for body mass index (BMI), age, sex, baseline clinic systolic BP, and clinical center, systolic BP variability was inversely associated with 24-h temperature and daytime temperature. There was no observed association between BP variability and barometric pressure. There was a significant trend of

increasing nighttime systolic BP and diastolic BP with increasing temperature, but these results did not persist after adjustment for confounding variables.

The researchers of this study found out that other factors indeed like clothing, prior exposure, food taking, room capacity etc, might be responsible for variability in blood pressures. Also, in this present study, it was discovered that blood pressure fluctuations occurred on both diastolic and systolic readings and the pattern was not stable across individuals. Other possible explanations for the present finding include the fact that the body easily adjusts to mild low temperatures, although systolic and diastolic pressures fluctuated more under air conditioning than in normal room temperature. It was also noticed that the decrease after two hours was significant. For majority of the participants, blood pressures decreased below the initial readings prior to experimental conditioning. Few female participants in the control group showed slight changes in blood pressure indicating higher emotionality.

The second hypothesis tested if there will be a statistically significant difference between males and females exposed to air-conditioning. The null hypothesis posited was not rejected, for gender had no statistically significant effect on participants' reaction to cold. In this line of finding are Tanaka et al (2003), who conducted an experiment to determine Effects of Decreasing Air Temperature on Peripheral Thermal Reactions in Males and Females, and found out that Blood flows and skin temperatures of male and female subjects became similar or showed no significant difference at the beginning and end of the experiment. In Fanger's experiments (1970) also, no difference in comfort conditions was observed between males and females. The present study acknowledges that as males and females carry varying amounts of fat cells which structure their body's physiology, this does not determine reaction to cold. Physiological systems always tend to a set-point and maintenance of equilibrium and this follows gender lines to achieve same result. Males psychologically adapt easier to adverse environmental situations than females. This can be seen in their responses in such situations. In the short period of time used for the experiment, the present study discovered that females complained more of drowsiness and idleness. This portrays the evolutionary attention and comfort-seeking tactics of females.

The third hypothesis put forward focused on the idea that there will be no statistically significant difference in reaction to air-Conditioning across body sizes. This hypothesis was not rejected and it was found that B.M.I. does not have effect on susceptibility to low temperature. King (2004) supports this finding as he found that there is little observable difference in heat dissipation based on body size. Bookspan (2003) though, stated that, body size and shape contribute to susceptibility to cold, concluded that like any other individual factor, it does not determine it. Fanger (1970) and Chung and Tong (1990) independently, indicate that body build does not have a significant influence on the comfort conditions of subjects and that the difference in the neutral temperatures between persons of different body build is not significant. The present study also found out that though, a pattern is not maintained in reaction to cold by participants with higher or normal B.M.I., blood pressures of systolic and diastolic readings increased and decreased differentially for the two B.M.I. groups. Over-weight people are at risk of high blood pressure if exposed to temperatures lower than 18 degrees centigrade for a longer period of time. Males and females who gym, and have B.M.I. greater than or equal to 24, feel more comfortable under air-conditioning because of combined effect of muscular and fats generation of heat.

The fourth hypothesis, that there will be no statistically significant change in blood pressure after exposure to air-conditioning tested was rejected. Air-conditioning had effect on systolic and diastolic blood pressures of participants. After one hour of exposure, systolic pressures increased and for many of the participants decreased after two hours. The researchers discovered that the human body undergoes adaptation processes in blood pressure in air-conditioned environment and this maximizes after two hours. The relationship between varying temperatures and blood pressure found in the present study is supported by CBC News of Tuesday, August 31, 2004, that blood pressure goes up when temperatures go down, because blood vessels constrict to conserve body heat. The higher pressure puts stress on the heart.

5. LIMITATIONS OF THE STUDY

In the course of the research and experimentation, the researchers encountered some hitches. The researchers were unable to conduct the experiment in one day as it ran into days and hence involved more finances. Since there was no grant for this study the researchers had to fall back on their savings.

The participants were unable to be clothed uniformly rather; they wore two-piece clothing and were made to be on bare foot in the experimental situation. The participants were hard to get and sustained through out the two hours of the experiment as most of them complained being idle for too long. However we played soft music for them just to keep them out of boredom.

6. CONCLUSION

Human behaviour is bio-genetically and environmentally determined. This unique interaction is often dependent upon certain human attributes such as age, gender, body size, personality types, marital status etc. The extent these variables

individually or interactively determine human behaviour is again influenced by temperature. The finding of this study unveils the unique influence cold condition has on human beings across gender and age.

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