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Occupational Impact on Body Physique and Health Status: An Anthropometric Analysis of Carpenters

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ABSTRACT:
Constant exposure of human body to any kind of work or profession brings remarkable changes in the body morphology and its physiology either in positive or negative outcomes. Present study has been conducted on a total of 200 adult male carpenters ranging in age from 30-40 years belonging to the different urban and rural areas of Punjab state. They were measured anthropometrically for gross body measurements, skinfolds, circumferences, segmental lengths and body breadths following the standardized techniques of Lohman et al.1988. Systolic and diastolic blood pressure was also recorded for each subject. Findings of the study indicate that carpenters show balanced type of somatotyping i.e. endo-mesoporphic type. Remarkable proportional development has been observed in the hand breadth and forearm length. Upper region of body carries more adipose tissue mass in comparison to the lower region and more development of muscle mass. Majority of the carpenters are found to be under normal grades of body mass index, waist hip ratio, blood pressure values and thus run the lower risk of developing CHDs and CVDs.

Key words*: Carpenters, Occupation, Anthropometry, Health status, Proportional development, Fractional body masses, Somatotyping, Adult males.*

INTRODUCTION

Physical efficiency, body movement and performance in many daily activities can be determined through the study of human body morphology, body proportions, body composition and physique and are increasingly used as primary indicators of healthy growth and development (Bogin, 1999). The concept of human physique and its quantification was critically studied by Sheldon et al., (1940) and its modern methods are devised by Heath and

Carter, (1967) which has found wide applications throughout the world. Somatotypic relationship studies in different occupations by Damon and McFarland (1955) along with role of genetic or constitutional factors in job preference indicated that variability of somatotype decreased as the level of success increased in the occupation. An effect of altitude, ethnicity-religion, geographical distance, and occupation shows remarkable impact on adult anthropometric characters and body dimensions and about 50% of the total variance in shape and size factors could be identified (Majumder et al.1986). Clinically various epidemiological studies provide important information regarding various risk factors, viz. age and sex (Connigham & Kelsey, 1984; Leino et al., 1994; Hurwitz & Morgenstern, 1997) and occupation (Kelsey, 1982; Bongers et al.,1988; Battie et al.,1990;Piazzi et al.,1991; Piccinni et al.,1992;Limburska et al.,1996;Rothenbacker et al.,1997; Nubling et al.,1997; Singh et al. 2012) such that risk of developing heart related disorders, obesity and blood pressure alterations etc.

Many studies highlighted the impact of various different occupations on the body morphology of the individual and build up the relationship with the physical efficiency of the person but anthropometric research on the traditional occupations of Punjab is still lacking. Present study was framed to analyze the impact of professional work on the body dimensions and physical fitness in one of the traditional occupational group of Punjab i.e. carpenters.

SUBJECTS AND METHODS

The present cross-sectional research has been conducted on 200 adult males ranging in age from 30-40 years who are Carpenters by profession.

Research Design: A total of 200 adult males ranging in age from 30-40 years were measured for various anthropometric measurements during April, 2002 to January, 2004 from the various urban and rural areas of Punjab state including Sri Amritsar Sahib, Bathinda, Kapurthala, Ludhiana, Moga, Sri Muktsar Sahib and Patiala districts following the standardized techniques of Lohman et al. (1988). Measurements were taken on right side of

each subject Subjects were contacted personally and appointment had been taken for examination.

Statistical Analysis: z-values for proportionality assessment are calculated using the formula given by Ross & Wilson (1974) : $z = (1/s)(v(170.18/h)^d - p)$ where s – phantom standard deviation for given variable, v-any variable, 170.18 – constant height of Phantom, h-subject height in cm, d-dimensional constant (1 for height, width, lengths, girths and skinfolds,2 for all areas and 3 for all masses and volumes),p-phantom value of any variable .Gross phantom specifications are used as given by Ross and Ward (1982).

All the three primary components of physique have been calculated using equations given by Carter (1980).

Various fractional body masses have been calculated from the body measurements utilizing phantom Stratagem by Drinkwater and Ross (1980) method.

Brachial-Femoral Adipo-Muscular Ratio (BAMR/FAMR) has been calculated using the formulae given by Vague et al. (1971)

Classification of body mass index has been done using the criteria given by WHO (2002)

Grading of WHR given by Willet et al. (1999) has been used to find out the prevalence of risk of developing cardiovascular diseases. Criteria given by WHO/ISH (1999) for the classification of blood pressure levels has been used for the present study to diagnose the prevalence of Normal, Optimal, High-Normal, Isolated Systolic Hypertension and different grades of hypertension.

RESULTS

Table 1 shows the Mean somatotypes of Carpenter are 4.09 - 3.46 - 2.89 and indicate dominancy in endomorphy component. Somatotype distributions provide the information about the magnitude of dispersion or scatter of somatotypes about their mean values. Ross and Wilson (1973, 1974) presented formulae to calculate the distance between any two somatoplots and the dispersion around the mean somatoplot (or somatotype) in two and three dimensions. Somatotype Dispersion Mean (SDM) is the average of the distance in two

dimensions and Somatotype Attitudinal Mean (SAM) in three dimensions, between any two somatoplots.Mean values of somatotype components in two (SDM) and three (SAM) dimensions are 4.76 and 2.11 respectively.

Table 1: Somatotype Analysis (Carter,1980) of Carpenters

Endomorphy		Mesomorphy		Ectomorphy		SDM		SAM	
Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
4.09	1.11	3.46	1.42	2.89	1.49	4.76	2.56	2.11	0.99

SDM – Somatotype Dispersion Mean **SAM** – Somatotype Attitudinal Mean

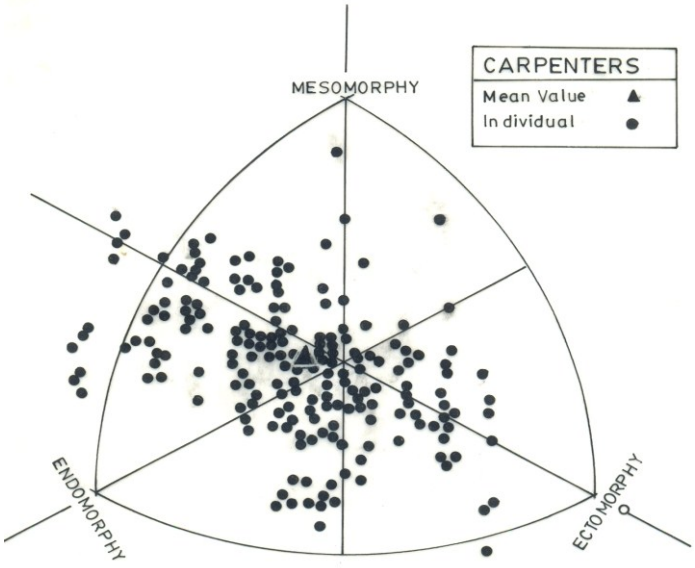

Figure 1: Somatoplots in Carpenters

Descriptive statistics of gross body measurements, skinfold thickness, body circumferences, segmental lengths and body breadths along with its proportional z values have been shown in Table 2.

Individual somatotypes of Carpenters are mostly present in the meso-endomorphic followed by ecto-endomorphic regions of the somatocharts (Figure 1).Their mean somatoplots show balanced endomorph type of body physique in carpenters.

It has been found that proportional weight of carpenters is more with respect to their height. Z- values for all the skinfolds are negative in Carpenters thus indicates lesser proportional development of subcutaneous tissue at all sites in relation to stature than phantom. In case of

Table 2: Mean Values and SD (standard Deviation) of Gross Body Measurements, Skinfold thickness, Body Circumferences and Segmental Lengths & Breadths of Carpenters with reference to its proportional development (Mean Z values)

Parameter	**Mean**	**SD**	**Mean Z-value**	**SD Z-value**
Height (cms)	166.69	5.93	-	-
Weight (kg)	61.38	8.66	0.10	1.10
Body Mass Index (BMI)	22.09	2.99	-	-
Waist Hip Ratio (WHR)	0.91	0.17	-	-
SKIN FOLDS (mm)	**Mean**	**SD**	**Mean Z-value**	**SD Z-value**
Triceps	11.31	3.95	-0.86	0.88
Biceps	7.05	2.81	-0.39	1.44
Forearm	5.67	1.97	-0.39	0.83
Subscapular	14.88	4.08	-0.31	1.09
Suprailiac	13.68	4.73	-0.99	0.65
Thigh	12.69	3.47	-1.68	0.42
Calf	9.57	3.02	-1.33	0.65
Abdominal	17.29	5.01	-	-
CIRCUMFERENCE (cms)	**Mean**	**SD**	**Mean Z-value**	**SD Z-value**
Upper Arm	27.04	2.59	0.31	1.12
Forearm	25.94	1.78	0.97	1.26
Wrist	16.88	0.93	1.19	1.26
Thigh	48.01	4.51	-1.59	1.15
Calf	31.92	3.27	-1.14	1.49
Chest	89.86	6.64	0.76	1.38
Waist	83.12	9.99	2.92	2.31
Hip	92.24	8.65	-0.07	1.61
SEGMENTAL LENGTHS (cms)	**Mean**	**SD**	**Mean Z-value**	**SD Z-value**
Upper Arm	35.45	1.94	2.07	0.95
Forearm	28.82	2.30	3.54	1.54
Hand	17.94	0.92	-0.06	1.10
BODY BREADTHS (cms)	**Mean**	**SD**	**Mean Z-value**	**SD Z-value**
Hand	9.45	0.96	2.76	1.98
Humerus Bicondylar	6.79	0.54	1.31	1.64
Femur Bicondylar	8.50	1.05	-1.71	2.34
Biacromial	41.37	2.93	2.20	1.56
Biiliac	30.56	2.44	1.36	1.51
Transverse Chest depth	28.82	3.25	0.88	2.03
Antero-posterior Chest depth	21.29	2.28	3.08	1.72

body circumferences thigh shows least (z= -1.59) and waist shows maximum (z = 2.92) proportional development in comparison to all the other circumferences. Out of all the segmental lengths upper arm length (z=2.07) and among body breadths antero-posterior chest depth (z=3.08) followed by hand breadth (2.76) are proportionally more developed.

Fractional body masses analysis (Table 3) indicates that muscle mass is more in carpenters in comparison to other three components. Higher values of Brachio adipo muscular ration (BAMR) in comparison to the Femoral adipo muscular ratio (FAMR) indicates more development of adipose tissue mass in the upper region of the body.

Table 3: Body Composition Analysis of Carpenters.

Fractional Body Masses (Drinkwater and Ross (1980))	**Mean**	**SD**
Fat Mass	8.57	2.09
Skeletal Mass	10.21	1.87
Muscle Mass	19.46	2.75
Residual Mass	18.76	2.23
Brachial-Femoral Adipo-Muscular Ratio (Vague et al.1971)	**Mean**	**SD**
Arm Muscle Area	46.90	9.04
Arm Fat Area	11.86	4.32
Brachio Adipo Muscular Ratio	0.25	0.10
Thigh Muscle Area	155.76	29.19
Thigh Fat Area	29.35	8.84
Femoral Adipo Muscular Ratio	0.19	0.05
Mean Adipo Muscular Ratio	0.22	0.06
Percentage Adipose tissue mass	16.50	5.10
Absolute Adipose Tissue Mass	10.31	3.96

Table 4: Body Mass Index (BMI) classification of Carpenters using WHO (2002) criteria.

Body Mass Index (BMI)	**Grade**	**Carpenters (n=200)**
< 16	Grade-3-Thinness	1(0.5%)
16- 16.99	Grade-2-Thinness	2 (1%)
17- 18.49	Grade-1-Thinness	18 (9%)
18.5-22.99	**NORMAL**	**116 (58%)**
23-29.99	Grade-1-Overweight	61 (30.5%)
30-39.99	Grade-2-Overweight	2 (1%)
≥ 40	Grade-3-Overweight	-

Using criteria of BMI classification (WHO, 2002) all the individuals (n=200) from the present study has been categorized into different grades of body mass index (Table 4). It has been observed that maximum number of individuals that lie in the normal range of BMI are 58 % and about 30.5% individuals lie in the grade-1-overweight and there is no individual lying under the grade-3-overweight.Percentage of individuals fall under the grade 2 and 3 is almost negligible i.e. about 0.5% and 1% .Mean values of BMI are given in the Table 2.

Grading or classification of WHR given by Willet et al.,(1999) has been used to find out the prevalence of risk of developing cardiovascular (CVD) and coronary heart (CHD) diseases in Carpenters (Table 5). Results of the study indicates that maximum risk of developing CVD and CHD has been observed in 8.5% of carpenters and 86.5% are under low risk of developing CVD and CHD. Mean and SD values are given in the Table 2.

Table 5: WHR classification (Willet et al., 1999) in Carpenters

Waist Hip Ratio (WHR) Range	Carpenters (n=200)
≤ 0.95	163 (86.5%)
0.96 -0.99	20 (10%)
≥1	17 (8.5%)

Table 6 provides the information about the prevalence of hypertension in the carpenters using the criteria given by WHO/ISH (1999). Maximum number of Carpenters (about 59%) lie in the normal range of blood pressure and about 3.5% of individuals under the category of Isolated Systolic Hypertension.

Table 6: Prevalence of hypertension in Carpenters.

CATEGORY	Carpenters N=200
Optimal	24(12%)
NORMAL	**118(59%)**
High-Normal	44(22%)
Grade -1-Hypertension.	5(2.5%)
Grade -2-Hypertension	1(0.5%)
Grade -3-Hypertension	0(0%)
Isolated Systolic Hypertension	7(3.5%)

DISCUSSION

Carpenters are the wood workers hired on contractactual basis called '*Tarkhan*' in the region of the Punjab. Their expertise are miniature timber wood works such as almirahs, furniture, crockery racks, doors and windows panes and a new concept in modular kitchen woodwork. There work routine involves heavy physical activity with long-standing hours. In the present study carpenters show that endomorphic component dominates along with mesomorphic component (Table 1 and Figure 1). Higher value of endomorphy indicates a predominance of body fatness, which might be due to their habitual sitting job. While the body remains static, it is the upper limbs, which performs all tasks. Very little activity of the whole body is involved which seems to be the cause for the dominance of endomorphic components of the somatotype. This fact is well corroborated by findings of Kumar et al. (1997) who reported that sedentary activities generally have a little higher endomorphic value than that for the person involved in heavy and hard physical labor. Habitual physical activity plays a significant role in restricting the endomorphic component to a certain extent. Alhough genetic factors may be also responsible for the same. In Carpenters, very hard physical labor is required which shows more development of mesomorphic component along with endomorphy. Similarly body compositional analysis indicates more muscle mass development in the upper region of the body of carpenters in comparison to the lower body regions (Table 3). BAMR/FAMR ratios indicate that upper region of the body of carpenters have more adipose tissue mass. Pattern of regional subcutaneous fat distribution is also influenced by age, sex, nutritional status, habitual physical activity patterns and possibly ethnic background (Garn et al., 1998 and Norgan, 1991). According to Cronk et al.(1982) reduction in the subcutaneous fat over the extremities happens, concurrent with the fat deposition over the trunk region of the body in older subjects.

Maximum proportional development of hand breadth of carpenters is due to the fact that while running the wood-clearing instrument, continuously to and fro movements of upper extremity take place. Both the arms are used to handle that instrument. Otherwise in some processes right arm is used for hammer hitting and left one is used to hold the nails. Continuous holding

of wood clearing instrument by Carpenters may result in broadening their hand and proportionally more development of fore arm length.

Generally very low and very high values of BMI indicate an increased mortality risk almost among all the cultures (Waaler, 1984; Bray, 1987; Campbell and Ulijaszek, 1994 and Kennedy and Garcia, 1994). Lower limits of BMI depend not only on the fat mass and fat free mass but also on the level of habitual physical activity of a person especially if the energy balance tends to be negative (James et al., 1988). More strenuous work tends to lower the value of BMI and will probably imply an effect on work capacity thus carpenters under study lie more towards the normal (58%) and thinness grades (10.5%) of BMI classification.

About 96.5% of carpenters are under the low risk of developing cardiovascular (CVDs) and coronary heart diseases (CHDs) and only 8.5% of the individual under study has develop the risk of the same (Table 5). More value of WHR are reflecting greater risk of non-insulin dependent diabetes mellitus and are also associated with impaired glucose tolerance (IGT) in both males and females after controlling for age (Hartz et al.,1983,Krotkiewski et al.,1983 and Sekikawa et al.,1999).

In case of prevalence of hypertension about 71% of carpenters lie under normal blood pressure grades and only 3.5% of them are diagnosed with isolated systolic hypertension (Table 6) which may be due to some occupational stress, genetical factors or environmental conditions etc. According to Kivimaki et al., 2002 work stress has adverse effect on health particularly the risk of cardiovascular disease. These health risks were derived from the mismatch between high efforts at work and low reward received in turn. According to Opit et al. (1984) risk of higher blood pressure is more in low status occupations than those in professional or technical workers, which is further related to work through neuron-endocrine stress mechanism associated with certain occupational characteristic whether the monetary or financial situation of low status occupation is responsible for it is not very clear.

REFERENCES

Battie MC, Biggo SJ, Fisher LD, Spengler DM, Hansson TH et al. 1990.Anthropometric and clinical measures as predictors of back pain complaints in industry: A prospective study. *J Spinla Olsord* ;3:195-204.

Bogin B. 1999. Patterns of Human Growth (2nd edition) Cambridge University press, Cambridge.

Bongers PM, Boshuizen HC, Hulshof CT, Koemeester AP.1988. Back disorders in crane operators exposed to whole body vibration. *Int Arch Occup Environ Health* ;60: 129-37.

Bray GA.1987. Definitions, measurements and classification of syndromes of obesity. *Int.J.Obes*. 2:99-112

Campbell P and Ulijaszek SJ .1994. Relationship between anthropometry and respective morbidity in poor men in Calcutta,India.*Eur.J.Clin.Nutr*.,48:507-512.

Connigham LS, Kelsey JL.1984. Epidemiology of musculoskeletal impairments and associated disability. *Am. J. Public Health*.74:574-9.

Cronk CE ,Roche AF , Kent R ,Berky C ,Reed RB and Valadian I. 1982 Longitudinal trends and continuity in weight/stature from 3months to 18years.*Hum.Biol*.,54:729-749.

Damon A and McFarland R A. 1955. The physique of Bus and truck drivers, with a review of occupational anthropolrgy.*Am J Phys Anthrop*. 13: 711-742.

Drinkwater DT and Ross WD. 1980. The anthropometric Fractionation of body mass. In: M.Ostyn, G.Beunen and J.Simmons (eds.). Kinanthropometry II.pp.179-189.University Park Press, Baltimore.

Garn SM, Sullivan TV and Hawthrone VM. 1988. Persistence of relative fatness at different body sites.*Hum.Biol*.,60:43-53.

Hartz AJ ,Rupley DC ,Kolhoff RK. and Rimm AA.1983. Relationship of obesity to diabetes: influence of obesity level and body fat distribution.*Prep.Med*.,12:351-357.

Heath BH and Carter JEL.1967. A modified somatotype method. *Am J Phys Anthropol* ,27: 57-74.

Hurwitz EL, Morgenstern H.1997. Correlates of back related disability in the U.S. *J Clin Epidemoil*.50:669-81.

James WPT, Ferro-Luzzi A and Waterlow JC. 1988. Definition of chronic energy deficiency in adults. Report of working party of IDECG.*Eur.J.Clin.Nutr*.42: 969-981.

Kelsey JL.1982. Idiopathic Low Back Pain, Magnitude of the problem. In: While AA, Gardon SL, Editors. Symposium On Idiopathic Low Back Pain. St. Louis: Ibnosina Journal of Medicine and Biomedical Sciences (2012) Ibnosina J Med BS **121** Mosby Yearbook; . p 23-38.

Kennedy E and Garcia M. 1994. BMI and economic productivity.*Eur.J.Clin.Nutr*.,48(Suppl.3):S45-S53.

Kivimaki M , Leino-Arjas P , Luukkonen R , Riihimaki H , Vahtera J and Kirjonen J. 2002. Work stress and risk of cardiovascular mortality: prospective cohort study of industrial employees.*Br.Med.J*.325: 857.

Krotkiewski M , Bjrontrop P, Sjostrom L.and Smith U.1983. Impact of obesity on metabolism in men and women.Importance of regional adipose tissue distribution.*J.Clin.Invest*.,72,1150-1162.

Kumar V , Kapoor AK and Tiwari SC. 1997. Physical activity and somatotypic evaluation of Bengali Kaystha boys of Delhi.*Ind.J.Sport.Sc.Phy*.Ed.9 (182):41-51.

Leino PI, Berg MA, Puska P.1994. Is back pain increasing? Results from national surveys in Finland during19789- 1992. *Scand J Rheumatol*; 23:296-306.

Limburska I, Gazdzi TS, Zejda ZE. 1996. Back pain in coal miners of Anthracite coal-pilot study results. Med PE;47:339-46.

Lohman TG, Roche AF, and Marforell ER. 1988. Anthropometric Standardization Reference Manual. Human Kinetics: Campaign, IL.

Majumder PP, Gupta R, Mukhopadhyay B, Bharati P, Roy SK, Masali M, Sloan AW, Basu A. 1986.Effects of altitude, ethnicity-religion, geographical distance, and occupation on adult anthropometric characters of eastern Himalayan populations. *Am J Phys Anthropol.*; 70(3):377-93.

Norgan NG.1991. Anthropometric assessment of body fat and fatness.In: Anthropomrtic assessment of nutritional status,ed.J.Himes,pp.197-212.Alan R.Liss,New York.

Nubling M, Michaerlis M, Hofmann F, Stossel S. 1997. Spinal diseases in the nursing profession –A cross sectional study, Gesundhrits wesen.;59:271-4.

Opit LJ, Oliver RG and Salzberg M. 1984. Occupation and blood pressure.*Med.J.Aust.*, 140(13):760-764.

Piazzi A, Bollino G, Mattioli S.1991. Spinal pathology in self employed truck drivers. Med Lavi ;82:122- 30.

Piccinni S, Marchi T, Lorusso A, Margorotto G.1992.The prevalence of spondylopathies among crane operators in the part of Venice. *Med Lavi* ;83:146-9.

Ross WD and Ward R.1982. Human proportionality and sexual dimorphisim. In: R.Hall (ed.) Sexual dimorphism in Homo sapiens.pp.317-361.Praeger, New York.

Ross WD and Wilson BD.1973. A somatotype dispersion index. Research quarterly for exercise and sport, 44:372-376.

Ross WD.and Wilson NC. 1974. A stratagem for proportional growth assessment. In: Children in exercise. (Eds.) Borms, J and Hebbelinck, M. *Acta. Paediatr. Belg*.28: 169-182.

Rothenbacker D, Brenner H, Arndt V, Fraisse E, Zschenderlein B et al. 1997 Disorders of the back and spine in construction workers: Prevalence and prognostic value of disability. Spine;22:1481-6.

Sekikawa W , Eguchi H , Igarashi K, Tominaga M , Abe T, Fukuyama H and Kato T. 1999. Waist to hip ratio, body mass index and glucose intolerance from Funagata Population based diabetes survey in Japan.Tohoku *J.Exp.Med*., 189(1): 11-20.

Sheldon WH, Stevens SS and Tucker WB. 1940. The varieties of Human Physique .New York: Harper and Brothers.

Singh AP.(2010) : *Morphometric Analysis and Traditional Occupations*. Lambert Academic Publishing.GmbH & Co.KG printed in the USA. pp 5-151.

Singh AP, Singh SP and Sekhon J. 2012. Impact of work performance on body proportions in Blacksmiths: A somatometric analysis. *Hum Bio Rev*., 1: 138-150.

Vague J, Vague P, Boyer J and Cloix MC. 1971. Anthropometry of obesity, diabetes, adrenal and beta cell functions: in Radriguez Diabetes,517(Excerpta Medica,Amsterdam).

Waaler HT.1984. Height,weight and Mortality.The Norwegian experience.Acta Med Scand.,215 (suppl.679):1-56.

WHO.2002.Reassess appropriate body mass index for Asian populations by Choo V.,*The Lancet*,20:235;360(9328).

WHO/ISH .1999. Guidelines for the management of hypertension.J.Hypertension, 17:151-183.

Willet MD, Williams PH. and Dietz H, Colditz GA. 1999. Guidelines for healthy weight. *N Eng J Med* ,341:427-434.

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