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Impact of Anthropometric Indices on the Incidence of Low Back Pain

Shyamal Koley, Harneet Arora

Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University, Amritsar-143005, Punjab, India

Corresponding author: Dr. Shyamal Koley Email: drskoley@gmail.com
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Abstract

The present study deals with the estimation of nutritional status by four anthropometric indices, viz. Quetelet's index (QI), Oliver's typologic index (OTI), Lorenz's constitutional index (LCI) and muscle index (MI). Subjects were selected from 106 confirmed cases of patients with low back pain (69 females, 37 males, aged 21-76 years) who came to the OPD of Aulakh Bone and Joint Centre, Tarn Taran, Punjab, India. An adequate number of controls (n = 50, 36 female and 14 male) with no prior history of back pain were also included from the same clinic for comparison. A total of fifteen anthropometric characteristics were measured for all subjects to estimate the four anthropometric indices. In findings, gender distribution of chi-square values of four anthropometric indices showed MI and LCI were significantly associated with LBP patients in both sexes QI was found to be statistically significant in female patients only. With age-related chi-square values, MI was significantly associated with female patients of all four age groups but, with male patients, only the younger age group, i.e. 21-30 years. LCI, OTI and QI were significantly associated only with male patients aged 41-50 years, 51+ years, and 21-30 years respectively. Occupation-wise distribution of chi-square values revealed that female patients with working women and housewives were significantly associated with MI but only housewives were significantly associated with LCI. In male patients, MI was significantly associated with the group of others (comprisedof politicians, carpenters, retired employees and labourers), OTI with agricultural workers, and QI with agriculture, businessmen and the group of others. It could be concluded from the present study that, MI and LCI could also be successfully used as the risk indicators of LBP.

Key Words: Quetelet's Index, Oliver's Typologic Index, Lorenz's Constitutional Index, Muscle Index, patients with low back pain.

Introduction

Low back pain (LBP) is a major public health problem all around the world. It affects 60-80% population of US adults at some time during their life, and as many as 50% have pain within a given year (1-8). In India, occurrence of LBP is also alarming. Nearly 60% of the population has significant back pain at some time in their life (9,10). A variety of strategies has been proposed to prevent LBP, considering its prevalence, cost, and substantial impact on disability (11). Some of the most commonly used prevention strategies are back flexion, back extension, and general fitness exercises; patient education on back mechanics and ergonomic techniques to prevent injuries; and mechanical back supports (12). Apart from these, researchers suggest risk factor modification based on epidemiological evidence linking modifiable risk factors to the development of LBP (6,7,13).

Epidemiological studies provide important information regarding various risk factors, viz. age and sex (14-16), occupation (17-24), life style and socio-economic status (15,16,25), and smoking habits (13,26-28). One of the most widely studied factors was nutritional status assessed by BMI. The American Heart Association's recommended guidelines following BMI values for the degree of nutrition are:

-BMI < 18.5 kg/m^2 indicates under-nutrition
-BMI 18.5 – 24.9 kg/m^2 indicates normal values
-BMI 25.0 – 30.0 kg/m^2 indicates hyper-nutrition
-BMI 30.0 kg/m^2 indicates obesity
-BMI 40.0 kg/m^2 or more indicates extreme obesity

Other anthropometric characteristics and indices were less often reported as risk indicators for LBP (29). Considering this information, the present study was planned. The objectives of this study were to estimate the value of the four anthropometric indices in LBP patients and to search for any association between these anthropometric indices and LBP.

Materials and Methods

Subjects

The present study was completed using data obtained from 106 confirmed LBP patients (69 female, 37 male) aged 21–76 years (mean age 43.04 years ± 13.16 for females and 37.73 years ± 14.36 for males) who attended in the OPD of Aulakh Bone and Joint Centre, Tarn Taran, Punjab, India. An adequate number of controls (n = 50, 36 female and 14 male, mean age 39.33 years, ± 11.42 for females and 31.43 years ± 11.83 for males) without prior history of back pain were also collected from the same clinic for comparisons. Subjects were further divided into four groups based on age, i.e. 21-30, 31-40, 41-50 and 51+ years, and occupation-related for female patients into, homemakers and a working group comprised of agricultural workers, staff nurses, and teachers. Groups were chosen for male patients comprised of agricultural workers, servicemen, businessmen and others (politicians, carpenters, retired employee and labourers). Written consent was obtained from the subjects. Data was collected under natural environmental conditions between 8 a.m. and 12 noon. The study was approved by the local ethics committee.

Anthropometric measurements

Fifteen anthropometric characteristics, viz. Height (HT), weight (WT), BMI, Quetelet's index (Q.I.), percent body fat (%BF), ideal body weight (IBW), relative body weight (RBW), circumference of upper arm during an isometric contraction of biceps brachii (CCB), circumference of upper arm in relaxed position of muscle biceps brachii (CRB), muscle index (M.I.), circumference of thorax (CT), circumference of abdomen (CA), Lorenz's constitutional index (LCI), shoulder width (SW) and Olivier's typologic index (OTI) were measured on all the subjects using the standard techniques (30) and were measured in triplicate with the median value used as the criterion.

Height was recorded using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, and digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg measured weight. BMI was then calculated using the formula weight (kg)/height^2 (m)^2. The %BF was calculated using the Womersley-Durnin formula (1977).

The following body indices were calculated by standard techniques (29):

Quetelet's Index (Devenport-Kaup's adaptation).
Quetelet's index (QI) represents a measure of nutritional statuscalculated according to the formula: QI = BW/BH^2, where BW means body weight (g) and BH body height (cm). People with normal nutritional status have QI values between 2.15 – 2.56.

Relative body weight

Relative body weight (RBW) is another index used to describe nutritional status, hich uses the following formula:
RBW = (ABW / IBW) X 100,
where ABW means measured body weight (kg) and IBW ideal body weight. The formula is given below:
IBW = (BH – 100) – {(BH -150) / 4} + {(AY – 20) / 4},

where AY= age (yrs) and BH= body height (cm). Values between 90-110 represent normal nutritional status.

Muscle Index

Muscle index (MI) is an index used to determine someone's muscle development. It is calculated according to the formula:

MI = {(CCB – CRB) / CRB} X 100,

where CCB means circumference of the upper arm during an isometric contraction of muscle biceps brachii at 90^0 of elbow flexion (cm) and CRB circumference of the upper arm in relaxed position of muscle biceps brachii at 90^0 elbow flexion (cm). Values between 5 - 12 are normal, values <5 represent obese subjects with weak muscles and values >12 represent children with strong muscles.

Lorenz's Constitutional Index

Lorenz's Constitutional Index (LCI) gives information about body components with the following formula: LCI = CT – CA -14,

where CT = circumference of thorax (cm) and CA = circumference of abdomen (cm). If the calculated value is positive, then an increase in body mass indicates increased size of muscles and bone. On the contrary, if it is negative then the adipose tissue is responsible for the increased body mass.

Olivier's Typologic Index

Olivier's Typologic Index (OTI) represents a quick orientation measure of body constitution and is calculated below:

OTI = (SW / BW) X 100,

Table 1. Descriptive statistics of 14 variables in patients with low back pain and controls

Variables	LBP females (n=69)		LBP males (n=37)		Control females (n-36)		Control males (n=14)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Height (cm)	157.25	6.44	171.62	5.82	155.00	6.29	175.43	7.67
Weight (kg)	62.84	10.30	80.24	12.57	59.47	10.72	67.50	14.52
BMI (kg/m^2)	25.49	4.44	27.26	4.23	24.76	4.36	21.93	4.63
Quetelet's index	2.55	0.44	2.73	0.42	2.48	0.43	2.19	0.46
%BF	31.45	6.08	24.06	5.67	30.45	5.97	16.91	6.21
Ideal body weight(kg)	61.19	4.69	70.65	4.73	58.58	5.12	71.93	5.74
Relative body weight(kg)	70.22	20.49	53.00	18.60	101.48	16.34	93.33	15.85
CCB(cm)	28.92	2.96	31.80	3.07	27.51	3.18	28.71	2.78
CRB(cm)	28.04	2.98	30.03	2.99	26.05	3.10	26.96	2.67
Muscle index	3.17	1.43	5.96	2.90	5.32	2.34	6.05	3.30
CT(cm)	91.41	9.73	94.41	16.30	88.54	9.93	88.89	10.83
CA(cm)	90.00	11.89	95.51	14.09	87.94	11.73	89.82	15.46
LCI	-12.59	8.63	-15.10	21.19	-13.40	5.63	-14.93	7.82
Shoulder width(cm)	52.25	8,05	60.91	11.45	51.69	4.26	56.09	4.35
OTI	133.26	44.97	181.16	61.62	89.11	13.50	85.62	13.31

%BF = Percent body fat; CCB = Circumference of the upper arm during an isometric contraction of biceps brachii; CRB = Circumference of the upper arm in relaxed position of muscle biceps brachii; CT = Circumference of thorax; CA = Circumference of abdomen; LCI = Lorenz's constitutional index; OTI = Olivier's typologic index

Table 2. Sex-wise distribution of chi-square values of four anthropometric indices in patients with low back pain and controls

Variables	LBP females Vs. Control females		LBP males Vs. Control males		LBP females Vs. LBP males		Control females Vs. Control males	
	X^2	P	X^2	P	X^2	p	X^2	P
Muscle index	19.20	P< .001	0.67	NS	27.52	P< .000	4.94	NS
LCI	8.09	P<.01	9.28	P<.01	6.02	P<.02	0.00	-
OTI	0	-	5.49	NS	0	-	5.35	NS
QI	21.70	P<.001	0.91	NS	0.66	NS	1.82	NS

Table 3. Age-wise distribution of chi-square of four anthropometric indices in patients with low back pain and controls

Age Group (years)	LBP females Vs. Control females				LBP males Vs. Control males			
	MI	LCI	OTI	QI	MI	LCI	OTI	QI
21-30	3.48	0.67	0	0.06	11.48	0	0	4.57
	NS	NS	-	NS	P<.001	-	-	P<.05
31-40	11.70	0	0	0.15	0.91	0.55	0	0.91
	P<.001	-	-	NS	NS	NS	-	NS
41-50	10.25	0	0	0.91	2.05	8.08	3.97	0
	P<.001	-	-	NS	NS	P<.01	NS	-
51+	17.32	3.10	0	0.64	1.90	0	8.00	2.71
	P<.000	NS	-	NS	NS	-	P<.01	NS

Table 4. Occupation-wise distribution of chi-square of four anthropometric indices in patients with low back pain and controls

Occupation	LBP females Vs. Control females							
	MI		LCI		OTI		QI	
	X^2	P	X^2	P	X^2	p	X^2	P
Working	10.89	P<.01	1.30	NS	0	-	0.14	NS
Housewife	5.89	P<.02	4.66	P<.05	0	-	2.36	NS
	LBP males Vs. Control males							
Agriculture	0.21	NS	1.93	NS	6.60	P<.05	8.56	P<.01
Service	4.48	NS	0	-	0	-	3.20	NS
Business	0.48	NS	0.47	NS	2.59	NS	11.57	P<.01
Others	6.68	P<.05	0	-	0	-	8.50	P<.01

where SW = shoulder width (cm) and BW = body weight (kg). Values > 67 suggest asthenic constitution, values from 58 – 67= muscular constitution and values <58 =picnic constitution.

Statistical analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. Chi-square test was applied to both genders of subjects and control groups to estimate association of anthropometric indices with LBP. Data was analyzed using SPSS (Statistical Package for Social Science) version 17.0. A 5% level of probability was used to indicate statistical significance.

Results

The descriptive statistics of selected anthropometric variables and indices in patients with LBP and controls is shown in Table 1. Table 2 showed gender distribution of chi-square values of four anthropometric indices in LBP subjects and controls. There is no association between MI and LBP in males, but in females a strong association ($p<.001$) was found between these factors. OTI had no significant associationwith these patients. In QI, a statistically significant association was found in female patients only.

Age-related distribution of chi-square values of the four anthropometric indices in LBP patients and controls is shown in Table 3. MI was found to be significantly associated with female patients in almost all the age groups (except the youngest, 21-30 years), whereas with male patients, the significant association was found only in the younger group, (21-30 years). LCI, OTI and QI were found to be significantly associated only in male age groups 41-50, 51+ years, and 21-30 years respectively.

Table 4 presented an occupation-related distribution of chi-square values of the four anthropometric indices in LBP patients and controls. In the case of female patients, both the employed and those who stayed at home, were significantly associated with MI and LCI (housewife group only). In male patients, MI was significantly associated with the group of others comprising politicians, carpenters, retired employees and labourers, OTI with agricultural workers, and QI with agriculture, businessmen and the group of others.

Discussion

These days LBP is one of the major health problems in all sections of society. It causes considerable disability and use of health services. Various epidemiological studies have reported some risk factors of LBP (14-28). One of the most widely studied factors was nutritional status assessed by BMI. Other anthropometric variables and indices were less likely to be reported as the risk indicators for LBP (29). Thus the focus of the present study was to search for any association of the four anthropometric indices with LBP.

Muscle Index

As many as 88.41% female and 40.54% male patients with LBP were under the category of weak muscular and only 11.59% female and 56.76% male patients were in the normal muscular category. There is no association between MI and LBP in males (except the younger age group). There was strong association with female patients and this might account for the apparent difference between LBP in males and females.

Lorenz's Constitutional Index

This index gives information about the components of body composition. The findings of the present study showed that 97.1% female and 94.59% male patients had sufficient adipose tissue responsible for their increased body mass. There were significant associations between LCI and LBP both in female and male patients.

Olivier's Typologic Index

The present findings showed asthenic constitution for all patients presenting no significant associations between OTI and LBP.

Quetelet's Index

It represents a measure of nutritional status of individuals. QI was significantly associated with LBP only in females.

It could be stated that of these four anthropometric indices, MI and LCI provided adequate support toward the heaviness of the patients' body constitution, over nutritional status and less muscular development. The findings of the present study did contradict with the findings of Celan and Turk (29) where they found no significant difference between LBP patients (only male) and controls for these four anthropometric indices. Our arguments included that primarily, they considered only male patients, thus no generalized conclusions could be drawn. Secondly, non-significant differences could show no association of anthropometric indices with LBP.

In earlier studies, Lean et al. (31) observed positive correlations between body mass and LBP indicating 1.5 times greater possibility for the occurrence of symptoms

of disk herniation in women with a BMI >30 kg/m^2 as compared to those with a BMI <25. Deyo and Bass (13) reported an increased prevalence of LBP particularly in the very obese (BMI > 29 kg/m^2). In 20% of extremely obese, the risk is 1.7 times higher than in 20% of the most thin. Leboeuf et al. (32) reported that twins with a lower weight had less low back problems. Increased BMI is associated with more frequent occurrence of osteophytes in the thoracic and lumbar spine. In males, the presence of osteophytes was also associated with LBP (33). Women with BMI value 19 – 24 kg/m^2 had the least low back complications and eventually the best indicators of health (34). Obesity is moderately associated with LBP (35). Overweight women have significantly increased probability of LBP (36). On the contrary, negative associations between body mass and LBP indicate that the occurrence of LBP was more frequent in subjects with lower body weight (37). Biering-Sorensen (38) reported that anthropometric parameters, viz. height, weight, length of lower extremities and upper body part, had no prognostic value for the initial onset of LBP. It was also reported that there was no association between body weight and BMI withthe onset of LBP in me. However, in women, nonetheless, an association between greater body weight and onset of LBP was reported (39). The novel part of this study was that at least two anthropometric indices, namely MI and LCI, could be used as risk indicators of LBP, which would be the addition in this fact. The limitation of the study was the small sample size which should be increased in future studies.

Conclusions

It may be concluded from the present study that BMI is widely used as the risk indicator for the development of LBP. Anthropometric indices, especially the muscle index and Lorenz's constitutional index (not the Olivier's typologic index and/or Quetelet's index), may also be successfully used as the risk indicators in the light of nutritional status and muscle development.

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