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Research Article

An Anthropometric Data of Cycle Rickshaw Operators to Approach Ergonomics in Cycle Rickshaw Design

Gorde MS[1]* and Borade AB[2]

[1]Assistant Professor, Jawaharlal Darda College of Engineering and Technology, India

[2]Professor, Jawaharlal Darda College of Engineering and Technology, India

***Corresponding Author:** Gorde MS, Assistant Professor, Jawaharlal Darda College of Engineering and Technology, India.

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Abstract

In spite of the technological advances, a large number of people in developing countries, especially in rural areas, use rickshaws for transport; it is also a livelihood for many people. In India, a population of about 9 lacks people is engaged in riding cycle rickshaw as occupation. It is unorganized sector of India. The aim of present study is collecting an anthropometric data of 12 body measurements, specially selected location in Vidrabha region of Weston India. Vidrabha region is distinct from the rest of India because of its collage of large tribal and other indigenous groups possessing their own cultural, linguistic, religious and historical identity. Data was collected from 550 cycle Rickshaw operator with mean age of 44.4 (±10.9 years). After comparing the mean values of different heights, different lengths of Vidrabha's cycle rickshaw pullers to with the Indian population significantly difference were observed and on the basis of that certain variable are decide as per ergonomic design. The anthropometric data and outcome of the research is beneficial for ergonomic design and/or design modification of bicycle, Cycle Rickshaws and similar types of products.

Keywords: Anthropometric Data; Cycle Rickshaw; Cycle Rickshaw Puller

Introduction

A number of studies have been carried out on various aspects of cycle rickshaw like energy expenditure of cycle rickshaw operators of different part of India [1,2]. A number of anthropometric studies have been reported in India on agricultural workers [3-7], anthropometric data of various part of body have been reported for general population in India [8-11]. In spite of the studies was carried out in order to collect the data anthropometric data for 34 body measurements specially for Eastern India [12]. Studies indicate that Indian population is different in different regions (Majumdar, 1951). Stature of Indian population is smaller than other populations [13].

Cycle rickshaw

The pedal operated Rickshaw is a modified bicycle, which is used extensively as a mode of transport for carrying passengers and luggage. Tricycle originated in Japan around 1868. At that time this man power vehicle was called "Jinriksha". The word rickshaw comes from Asia, where this vehicle was mainly used as a means of transportation for the social elites. The word derives from the Japanese word jinrikisha (jin = human, riki = power or force, sha = vehicle), which literally means "human-powered vehicle" (Sahu., *et al.* 2013) Tricycle is widely used in Asian countries in varying styles and names such as Trishaw, Pedicab, cyclo and Becaks. A cycle rickshaw is often hailed as environment-friendly and less expensive mode of transportation. Since it is considered as Indian traditional ride they are seen in each and every part of India ranging villages, small towns, metros, heritage sites etc. It is unorganized sector of India. In metros these are used inside institutional areas, market places and also in narrow and crowded lanes where there is accessibility problem for vehicles. The Cycle Rickshaw is available in various types as per the operation purpose such as for carrying passengers, luggage and merchandise.

Cycle rickshaw operators

In India, a population of about 9 lacks people is engaged in riding cycle rickshaw as occupation. The cycles Rickshaw operator are predominantly males with little or no formal training in the field of their work. Most of them have learnt the riding through observation and hand on experience. Owing to this, the methodology followed by them is unscientific and instinctive. As it is unorganized sector of India, has no representation of any sort and hence any standards are not followed. The cycle Rickshaw is manufacture fabricates and modified as per the local trends. All this has led to unplanned mushrooming operation in an extremely unscientific way further leading to severe health and occupational hazards to the rider.

Research methodology for pilot study

Motivation and Research Objective

The objective of present study is collecting an anthropometric data of Cycle Rickshaw operators specially selected location in Vidrabha region of Weston India as well as compared it with anthropometrics data of Indian population. The anthropometric data and outcome of the research is beneficial for ergonomic design of bicycle, Cycle Rickshaws and similar types of products. The main motive behind this pilot study is the ergonomic design, assessment and optimization of variables affecting the performance of cycle rickshaw puller as per anthropometric data specially for Vidrabha region of Weston India.

Research Instrument

Body weight and different heights, different lengths statures of the subjects were recorded. The parameters like heights of the eye, acromion and elbow both in standing and sitting postures, knee and popliteal heights in a sitting posture were recorded using anthropometer and flexible measuring tape. A random sampling technique was adopted to select the rickshaw stands in a locality. From each rickshaw stand the rickshaw pullers were selected based on a systemic sampling technique.

Survey Administration

All subjects were in voluntary basis and have been given a verbal description of the purpose of the study. They were provided with a questionnaire pertaining to their Name, age, gender, experience, etc. All of them underwent a pre interview for obtaining some information's about their job characterizations.

Respondents' Profiles

Anthropometric data was collected of 550 Cycle Rickshaw riders from selected location of Vidrabha regision i.e. Nagpur, Amaravati, Akola, Buldhana, Washim, Yavatmal, Wardha, Chandrapur, Bhandara, Gondia and Gadchiroli districts of India. Research participants are the cycle Rickshaw operator's male between the age 31.2 to 57.6 years with mean age of 44.4 (±10.9 years). Each cycle Rickshaw puller had a minimum work experience of 1 year .Data of 12 anthropometric parameters were collected from cycle rickshaw pullers (n = 550) of different locations at Nagpur (n= 50) , Amaravati (n= 50), Akola(n= 50), Buldhana (n = 50), Washim (n = 50), Yavatmal (n = 50), Wardha (n = 50), Chandrapur (n = 50), Bhandara (n = 50), Gondia (n = 50) and Gadchiroli (n = 50).

Variables

In this study five variables Stature, Eye, Acromion, Elbow, Crotch in standing condition and seven variables Erect sitting, Eye, Elbow rest, Knee, Popliteal, Lower humber, Upper Lumbar in sitting condition are recorded. The variables were chosen on the basis of previous studies [1,4-7,12] and considering its important in ergonomic design, assessment and optimization of variables affecting the performance of cycle rickshaw puller.

Hypotheses

Detailed anthropometric survey in India is important the body dimension of Indian population varies from region to region (Majumdar, 1972). There is much more difference in body dimensions of western and Indian population and even in Indian population, as they vary by region to region. Anthropometric survey of western, northern, central and southern India has been reported by Sen [14]. Sharma., *et al* [7], Gite and Yadav [6], and Fernandez and Uppugonduri [11]. In spite of the studies was carried out in order to collect the data anthropometric data of cycle rickshaw puller for 34 body measurements specially for Eastern India [12]. However, no such anthropometric survey has been done on cycle rickshaw puller in Vidrabha region of Weston India. Due to geographical as well as climate differences it is expected to have significant difference between anthropometric data. This is needs to be examined in the Weston Indian context. As all variables are dependent variables in which stature is prime importance variable. The following hypotheses were formulated on the basis of Stature.

H_0 = There is no significant difference between anthropometric data of Cycle Rickshaw puller of Vidrabha region of Weston India and Eastern India [12].

$H_0: P_1 = P_2$

H_1 = There is a significant difference between anthropometric data of Cycle Rickshaw puller of Vidrabha region of Weston India and Eastern India [12].

$H_1: P_1 \neq P_2$

Similarly

H_0 = There is no significant difference between anthropometric data of Cycle Rickshaw puller of Vidrabha region of Weston India and Indian population [9].

H_0: $P_1 = P_3$

H_1 = There is a significant difference between anthropometric data of Cycle Rickshaw puller of Vidrabha region of Weston India and Indian population [9].

H_1: $P_1 \neq P_3$

Results and Discussion

Anthropometric data

The table 1 shows the mean value of age, height and weight, the lowest value of age was observed in Akola 31.2 year and the highest age was found in Yavatmal which is 57.6 years the lowest stature was found in Gondia which was 155.77 cm and the highest stature found in Chandrapur which is 171.4 cm the lowest weight was found in Yavatmal which was 39.6 kg and the highest weight was found in Chandrapur 63.09 kg. When the value of height was compared with Indian data [9,12], it was found that there was significant difference. The value of stature as reported by other Indian studies (South India) were 160.7 ± 6.0 cm [11] and 161.5 cm [14].

	Nagpur	Amaravati	Akola	Buldhana	Washim	Yavatmal	Wardha	Chandrapur	Bhandara	Gondia	Gadchiroli	All Places (n = 550)	Pradhan 2010 (n = 880)	Chakrabarti 1997 (n = 710)
Age (Year)	42.7 ± 11.3	42.8 ± 10.1	43.3 ± 12.1	45.8 ± 10.8	45.4 ± 11.7	45.2 ± 12.4	44.3 ± 09.6	46.3 ± 11.0	44.4 ± 11.1	44.5 ± 10.3	43.8 ± 10.3	44.4 ± 10.9	37.7 ± 11.3	-
Stature (cm)	163 ± 5.52	165 ± 5.01	164 ± 6.26	163.2 ± 5.21	162.4 ± 4.79	163.3 ± 4.97	163 ± 5.37	164.5 ± 6.94	163 ± 5.32	163 ± 7.18	162.3 ± 4.72	163.27 ± 5.22	161.4 ± 5.94	165 ± 7
Weight (kg)	51.4 ± 8.63	49.8 ± 7.45	50.2 ± 6.78	47.62 ± 10.61	47.5 ± 7.16	48.96 ± 9.39	47.9 ± 7.86	52.61 ± 10.48	51.8 ± 8.93	47.3 ± 6.55	48.6 ± 6.84	49.43 ± 8.24	48.8 ± 6.28	57 ± 11

Table 1. Physical characteristic of Cycle Rickshaw operator.

Values are mean ± SD.

Anthropology of Indian cycle rickshaw operator

Ref. No.	Variables	Nagpur	Amaravati	Akola	Buldhana	Washim	Yavatmal	Wardha	Chandrapur	Bhandara	Gondia	Gadchiroli	All Places
1	Stature	163 ± 5.52	164.7 ± 5.01	163.7 ± 6.26	163.2 ± 5.21	162.4 ± 4.79	163.3 ± 4.97	162.7 ± 5.37	164.5 ± 6.94	163.2 ± 5.32	163 ± 7.18	162.3 ± 4.72	163.27 ± 5.22
2	Eye	153 ± 5.43	154.3 ± 5.06	153.5 ± 6.30	153.3 ± 5.74	152.1 ± 4.81	152.7 ± 4.97	151.9 ± 6.02	154.4 ± 4.94	153 ± 5.33	153 ± 5.28	152.8 ± 5.06	153.1 ± 5.21
3	Acromion	136 ± 5.6	137.3 ± 5.02	136.7 ± 5.78	135.9 ± 5.23	135.6 ± 5.02	136.6 ± 4.80	135.5 ± 5.39	137.1 ± 5.12	137.3 ± 5.45	135 ± 5.56	134.1 ± 4.71	136.05 ± 5.18
4	Elbow	103.0 ± 5.52	104.2 ± 6.14	102.3 ± 6.26	101.3 ± 6.24	100.7 ± 5.43	101.2 ± 6.71	100.3 ± 5.37	102.3 ± 6.54	101.9 ± 5.85	101.6 ± 5.74	100.5 ± 5.34	101.8 ± 5.67
5	Crotch	77.9 ± 5.52	77.2 ± 5.68	77.4 ± 6.48	77.3 ± 5.56	74.9 ± 4.82	76.2 ± 4.56	75.7 ± 5.63	78.3 ± 4.94	76.7 ± 5.96	75.7 ± 5.28	75.1 ± 5.69	76.582 ± 6.45

Table 2: Anthropometric measurement of different body height of Cycle Rickshaw operators during standing Position.

Values are mean ± SD in centimeters

Ref. No.	Variables	Nagpur	Amaravati	Akola	Buldhana	Washim	Yavatmal	Wardha	Chandrapur	Bhandara	Gondia	Gadchiroli	All Places
6	Erect Sitting	85.8 ± 5.52	86.1 ± 5.01	85.6 ± 6.26	81.9 ± 5.21	86 ± 4.79	86.6 ± 4.97	85.1 ± 5.37	85.8 ± 4.94	83.9 ± 5.32	84.7 ± 5.28	82 ± 4.72	84.86 ± 5.21
7	Eye	74.4 ± 5.43	77.4 ± 5.06	73.6 ± 6.30	73.6 ± 5.74	75 ± 4.81	75.1 ± 4.97	74.8 ± 6.02	74.6 ± 4.94	75.6 ± 5.33	76.4 ± 5.28	76.4 ± 5.06	75.17 ± 5.21
8	Elbow rest	22.9 ± 5.52	24.1 ± 6.14	22.2 ± 6.26	23.4 ± 6.24	23.5 ± 5.43	25.1 ± 6.71	21.4 ± 5.37	25.5 ± 6.54	20.9 ± 5.85	25.4 ± 5.74	23.9 ± 5.34	23.48 ± 5.67
9	Knee	50.8 ± 5.52	52.8 ± 5.01	50.3 ± 6.26	52.6 ± 5.20	53.7 ± 4.77	55.2 ± 4.98	51.3 ± 5.35	54.6 ± 6.94	52.7 ± 5.32	54.0 ± 7.18	53.7 ± 4.72	52.9 ± 5.22
10	Popliteal	36.3 ± 5.6	41.2 ± 5.02	39.4 ± 5.78	41.8 ± 5.23	40.1 ± 5.02	42.5 ± 4.80	36.7 ± 5.39	41.2 ± 5.12	37.5 ± 5.45	39.1 ± 5.56	41.1 ± 4.71	39.7 ± 5.18
11	Lower Lumbar	13.5 ± 5.52	12.7 ± 5.01	13.1 ± 6.26	13.4 ± 5.21	10.9 ± 4.79	12.8 ± 4.97	11.4 ± 5.37	13.9 ± 6.94	11.2 ± 5.32	10.4 ± 7.18	9.7 ± 4.72	12.1 ± 5.22
12	Upper Lumbar	24.7 ± 5.51	30.3 ± 5.02	28.7 ± 6.30	31.2 ± 5.21	29.0 ± 4.72	35.6 ± 4.89	26.3 ± 5.41	31.2 ± 6.92	26.1 ± 5.32	32.6 ± 7.17	32.2 ± 4.71	29.8 ± 5.23

Table 3: Anthropometric measurement of different body height of Cycle Rickshaw operators during sitting position.

Values are mean ± SD in centimeters.

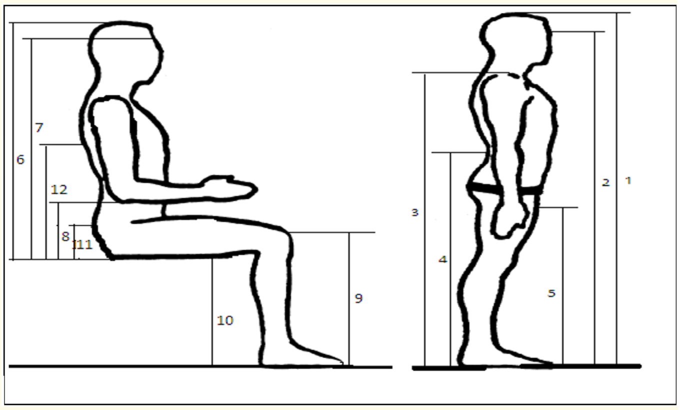

Figure 1: Illustrations of dimensional landmark with reference numbers.

Anthropometric characteristics of Cycle rickshaw operators were different for different area of India as well as Indian population. There is some genetic difference of populations along the different places in India which is always reflected in the anthropometric characteristic of Cycle rickshaw operator. The lower values of Cycle rickshaw operator may be due to their poor socio-economic conditions and the lack of proper nutrition.

Hypothesis Testing

To test hypothesis Statistic Z test were used.

Null hypothesis H0: P1 = P2

$$Z = \frac{P1 - P2}{\sqrt{\left\{\frac{P1 * q1}{n1}\right\} + \left\{\frac{P2 * q2}{n2}\right\}}}$$

Ref. No.	Variables	All places	Pradhan	Chakrabarti	Ref. No.	Variables	All place	Pradhan	Chakrabarti
		(n = 550)	2010	1997			(n = 550)	2010	1997
1	Stature	163.27 ± 5.22	161.4 ± 5.94	165 ± 7	7	Eye	75.17 ± 5.21	73.8 ± 3.90	73.2 ± 3.02
2	Eye	153.1 ± 5.21	150.8 ± 5.75	153 ± 6.8	8	Elbow rest	23.48 ± 5.67	21.5 ± 3.40	22.2 ± 3.12
3	Acromion	136.05 ± 5.18	134 ± 5.52	134.9 ± 6.8	9	Knee	52.9 ± 5.22	52 ± 3.00	50.1 ± 2.49
4	Elbow	101.8 ± 5.67	99.6 ± 4.48	103.8 ± 5.6	10	Popliteal	39.7 ± 5.18	42.6 ± 2.80	41.4 ± 2.16
5	Crotch	76.582 ± 6.45	74.2 ± 2.73	76.5 ± 5.2	11	Lower Lumbar	12.1 ± 5.22	10.6 ± 2.60	9.7 ± 0.36
6	Erect Sitting	84.86 ± 5.21	83.7 ± 4.50	83.9 ± 3.37	12	Upper Lumbar	29.8 ± 5.23	30.6 ± 3.00	29.1 ± 1.07

Table 4: Comparison of Anthropometric measurements of different body height of Cycle Rickshaw operators.

Where,

P1 = 163.27/550 = 0.296, q1 = 1-P1 = 1- 0.296 = 0.703, n1= 550

P2 = 161.4/880 = 0.183, q2 = 1-P2 = 1- 0.183 = 0.816, n2 = 880

Statistic Z test

$$Z = \frac{0.296 - 0.183}{\sqrt{\left\{\frac{0.296 * 0.703}{550}\right\} + \left\{\frac{0.183 * 0.816}{880}\right\}}}$$

Z = 4.9

At 5 percent level which comes as under normal curve area table, R: | Z | > 1.645

The observed value of Z is 4.9 which is in the rejection region and so null hypothesis was reject in favour of there is a significant difference between anthropometric data of Cycle Rickshaw puller of Vidrabha region of Weston India and Eastern India [12].

Similarly, Second hypothesis test

i.e. Null hypothesis H0: P1 = P3

$$Z = \frac{P1 - P3}{\sqrt{\left\{\frac{P1 * q1}{n1}\right\} + \left\{\frac{P3 * q3}{n2}\right\}}}$$

Where,

P1 = 163.27/550 = 0.296, q1 = 1-P1 = 1- 0.296 = 0.703, n1= 550

P3 = 165.0/710 = 0.232, q3 = 1-P3 = 1- 0.183 = 0.767, n2 = 710

Statistic Z test

$$Z = \frac{0.296 - 0.232}{\sqrt{\left\{\frac{0.296 * 0.703}{550}\right\} + \left\{\frac{0.232 * 0.767}{710}\right\}}}$$

Z = 2.63

At 5 percent level which comes as under normal curve area table, R: | Z | > 1.96

The observed value of Z is 2.63 which is in the rejection region and so null hypothesis was reject in favour of there is a significant difference between anthropometric data of Cycle Rickshaw puller of Vidrabha region of Weston India and Indian population [9].

Variable factors consider for Ergonomic Design of Cycle rickshaw Puller

Crank Length

Investigators have reported that maximal pedaling power is affected by crank length (Inbar., *et al.* 1983; Landwer., *et al.* 2000;

Yoshihuku., *et al.* 1996). This optimal crank length is related to leg length (Inbar., *et al.* 1983). In the mathematical modeled it was found that crank length directly effects on optimal pedaling rate, maximal power produce as well as pedaling speed. Maximum power varied by 0 ± 10% for crank lengths of 130 ± 210 mm, depending on the dimension of optimal muscle length, and that optimal pedal speed was nearly independent of crank length (Yoshihuku and Herzog (1990,1996). But this model may not affect by step wise muscle activation and relaxation, which normally occurs during activation and relaxation periods (Caiozzo., *et al.*1997). Impulse and power were similar for crank lengths of 145 ± 220 mm (Martin., *et al.* 2000), but they did not report values for maximum power, optimal pedaling rate, or optimal pedal speed. Thus, it seems that the exact effects of crank length on maximum power, optimal pedaling rate, and optimal pedal speed remain to be determined. Therefore, investigation should carry out to determine the effects of crank length on the maximum cycling power, optimal pedaling rate, and optimal pedal. But as per anthropometric data 170 mm crank length is taken for ergonomic design of cycle rickshaw.

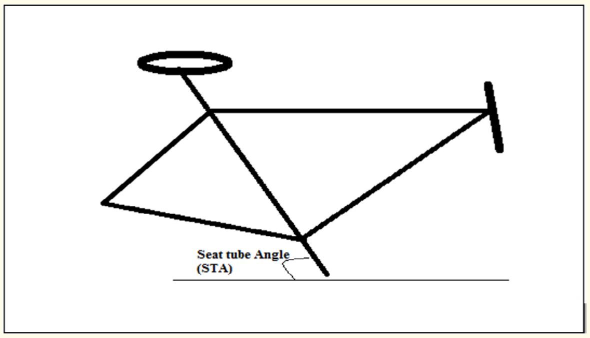

Figure 2: Seat tube angle.

Seat tube angle

The seat tube angle commonly referred as STA, the angle between seat tube and ground is the most important angle (Gonzalez., *et al.* 1989, Derrick., *et al.* 1997). Most of researchers examined the effect of seat tube angle on cardio respiratory measures with steady- state pedaling at angles with various rang 600 to 900 and reported oxygen consumption (Heil., *et al.* 1997). As the research carried out in steady- state condition the effect of other factors of road pedaling on oxygen consumption is unaccounted. Most of researchers carried of their research by taking other kinematic variables constants and concluded that the changes in performance are related to musculoskeletal changes stemming from the variation in Seat tube angle (Heil., *et al.* 1995; Price and Donne, 1997). By using mathematical model STA is calculated taking seat height, crank length and foot position of pedal constant 760(Gonzalez., *et al,* 1989). Whereas at constant external power output 300W the optimal Seat tube angle should be 670 (De Groot., *et al.* 1994). The differences in power output may be due to altered muscle lengths and moment arms associated with the changes. (B.R. Umberger., *et al.* 1998). All the researcher carried out their research by considering other variable constant, but still there is lot of scope on considering other variable or the effect of other variable on the performance on pedaler. Still as per anthromentric data 670 is consider as SAT for ergonomic design of cycle rickshaw.

Speed ratio

The Speed ratio can highly affect the efficiency of peddler (AK. Mahalle., et al. 2014). In conventional case speed ratio generally taken as 2, which is capable to provide speed up to 17 km/hr. This much of speed is the generally higher limit of for Cycle Rickshaw pullers. To achieve higher speed higher pedaling is required which is not suitable for cycle rickshaw puller. So, the speed ratio 2 is higher for cycle rickshaw and it is necessary to investigate that whether optimum efficiency obtain of lower side of speed ratio i.e. smaller than 2.

Wheel diameter

The wheel diameter is the most important factor which highly effect on the efficiency of cycle rickshaw puller. As it is not suitable to used higher speed ratio to overcome this difficulty smaller wheel diameter can be used. This smaller diameter of wheel keeps constrained on the speed. The Higher speed ratio is not of much use as peddler does not have capacity to pedal rickshaw at a higher speed. The stability can also increase due to lower center of gravity of smaller wheel diameter. Generally, 700 mm, 675 mm, and 650 mm diameter wheel are available in the market. So as per anthropometric data 675 mm is consider for design of cycle rickshaw.

Load

Load is the critical factor which highly effect on the performance of the peddler. As the cycle rickshaw is commonly used to transport passenger and baggage or load. This load can vary from 50 kg to 300 kg. so, the investigation should carried out to identify what should be the maximum load that cycle rickshaw puller can carry to optimal performance. Still we ergonomically design cycle rickshaw

Kinematics of Pedaling:

Pedaling mechanism of Cycle rickshaw is a man- machine system, in which crank, and saddle are rigid component of constant lengths whereas thigh and shank length vary from person to person. The Cranking mechanism, Chassis, Chain drive, Front and Rear wheel, Steering mechanism, Puller Seat are the main components of Cycle rickshaw. The front wheel, steering mechanism, crank shaft assembly are hold by chassis having diamond type frame. Whereas rear axle, rear wheel, passengers' seat are supported by rear part of chassis. The pedal crank is mounted on crank shaft with 1800 to each other and rickshaw puller drive the cycle rickshaw by pedaling this two pedaling crank. Thigh muscles power is used with oscillatory movement to get circular pedaling motion of the cranks. The torque exerted by the feet on crankshaft is transferred to the rear axle through a chain drive to achieve rotation of rear wheel.

The thigh form driving link which oscillates, leg act as a coupler, imparting motion to the crank (Pedal) and the crank which rotates, forms the output link. The fixed link is the frame. This form inversion of four bar chain (Input link, Oscillation, Lever, Output link rotating Crank). With the two legs used from driving the cycle rickshaw has two such mechanisms operating at 1800 out of phase.

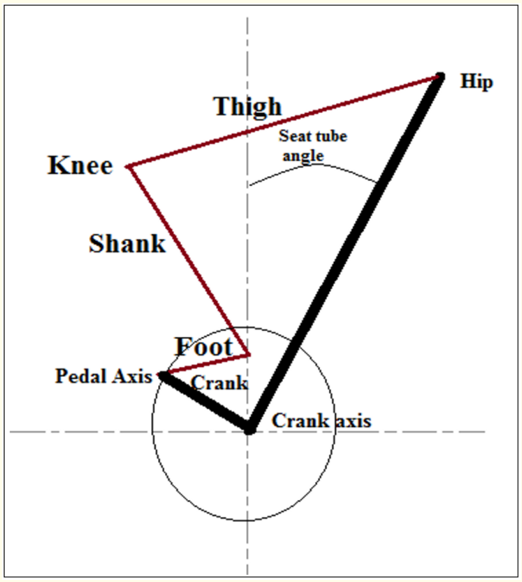

Figure 3: Kinematics of Pedaling.

Result Analysis

The average Age of Cycle rickshaw operator is found 44.4 years. The average value of Stature is 163.27 cm. When the value of Stature was compared with Indian data [9,12], it was found that there was significant difference [6,12]. The value of stature as reported by other Indian studies (South India) were 161.5 cm [14], 160.7 cm [11], 165.0 cm [9] and 161.4 cm [12]. The Acromion size is significantly higher and Popliteal size is significantly lower than Indian data [9,12], The anthropometric characteristics of cycle rickshaw operators were different from those of the Indian population. The lower value of Stature may be due to their poor social condition and there are also some genetic differences of populations among the different places in India which may reflect the anthropometric characteristic [15,16].

As per the finding of anthropometric data Vidrabha's cycle rickshaw pullers.

Conclusion

As the anthropometric characteristics of cycle rickshaw operators were different from those of the Indian population. The cycle rickshaw should be design as per local anthropometric data. Otherwise height of driver's seat from pedal (Crotch height) and the distance between the driver's seat and handle should a have structure with variable adjustments corresponding to the stature of each cycle rickshaw operator. As per the presents research work Seat tube angle should be 670, maximum speed ratio should be smaller than 2, wheel diameter should be 675mm as per Vidrabha region stature size. While designing load should be consider as 300 kg including passenger and baggage. The main motive behind this pilot study is the ergonomic design, assessment and optimization of variables affecting the performance of cycle rickshaw puller as per anthropometric data specially for Vidrabha region of Weston India.

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Bibliography

1. Pradhan CK., *et al*. "Physiological assessment of cycle rickshaw pullers". *Indian Journal of Physiology and Allied Sciences* 58 (2004): 113-118.

2. Pradhan CK., *et al*. "Energy expenditure of cycle rickshaw pullers in different places in India". *Ergonomics* 51 (2008): 1407-1417.

3. Dhara PC., *et al*. "Body dimension and body composition of agricultural workers of Eastern India". *Indian Journal of Physiology and Allied Sciences* 59 (2005): 111-123.

4. Kar SK., *et al*. "An investigation of hand anthropometry of agricultural workers". *Journal of Human Ecology* 14 (2003): 57-62.

5. Yadav R., *et al*. "Anthropometric data of Indian farm worker - a module analysis". *Applied Ergonomics* 21 (1997): 69-71.

6. Gite LP and Yadav BG. "Anthropometric survey for agricultural machinery design". *Applied Ergonomics* 20 (1989): 191-196.

7. Sharma PK and Gupta ML. "Anthropometric survey of Indian farm workers". *Agricultural Mechanisation in Asia* 14 (1983): 27-30.

8. Manna I., *et al*. "A comparative study foot dimension between adult male and female and evaluation of foot hazards due to using footwear". *Journal of Physiological Anthropology and Applied Human Science* 20 (2001): 241-246.

9. Chakrabarti D. "Indian Anthropometric Dimensions for Ergonomic Design Practice". National Institute of Design, Ahmedabad (1997).

10. Chakrabarti D and Nag PK. "Human concept in workspace design. In: Ergonomics and work Design, ed. By Nag PK, New Age International Publishers, New Delhi : Ch 8 (1996): 129-157.

11. Fernandez JE and Uppugonduri KG. "Anthropometry of South Indian industrial workmen". *Ergonomics* 35 (1992): 1393-1398.

12. Pradhan CK., *et al*. "Anthropometric characteristics of Indian cycle rickshaw pullers". *Journal of Human Ergology* 39 (2010).

13. Dewangan KN., *et al*. "Anthropometric dimensions of farm youth of the north eastern region of India". *International Journal of Industrial Ergonomics* 35.11 (2005): 979-989.

14. Sen RN., *et al*. "Some anthropometry of people of Eastern India". *Journal of the Indian Anthropological Society* 12 (1977): 199-206.

15. Sahani RK. "Seasonal variation in the nutritional status of the jarawas". *Journal of the Anthropological Survey of India* 53 (2004): 99-116.

16. Bharati S., *et al*. "Spatial patterns of anthropometric variation in India with reference to geographic, climatic, ethnic and linguistic backgrounds". *Annals of Human Biology* 32 (2005): 407-444.

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