# Comparative study on different types of Indian wheel chairs activity and its effect on various parameters in normal subjects

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**Abstract**

A wheelchair is a wheeled mobility device in which the user sits. The device is propelled either manually, by turning the wheels by the hand/ via various automated systems. In Indian scenario, patients with different injuries due to musculoskeletal or neurological pathology are using wheel chair with different structures without knowing its importance, purpose and efficiency. Also in current status in Indian scenario no study has been done and in other words, least importance has been given to the need of wheelchair. This study will create an effectiveness of wheelchairs according to high sale and low cost availability in Indian market with respect to its effect on different human system parameters like heart rate, blood pressure, temperature, respiratory rate. Method**:** The study involves three types of wheelchairs commonly used by the patients in India-Non-folding standard wheelchair, Light weight folding wheelchair, Commode wheelchair with inclined seat. 30 subjects were taken. Subjects were made to drive wheel chair for a distance of 40 meters. Pulse, respiratory rate, temperature, blood pressure, VAS, rate of perceived exertion was measured before and after driving and results was estimated.

Conclusion: There are significant changes in different parameters of wheelchairs like heart rate, blood pressure, respiratory rate, temperature, pain rating and rate of perceived exertion while driving a wheelchair. And also there is significant relation between different parameters of wheelchairs. The study indicated that light weight folding wheelchair should be recommended to the patients with neurological or musculo-skeletal injuries.

**Key words: wheelchair, physiological cost index, cardio-respiratory fitness**

## Introduction

A **wheelchair** is a wheeled mobility device in which the user sits. The device is propelled either manually, by turning the wheels by the hand/ via various automated systems. Wheelchairs are used by people for whom walking is difficult or impossible due to illness injury/ disability. Even the patient with paraplegia who has mastered ambulation with crutches and orthosis will choose to use a wheel chair on many occasions because it provides a lower energy expenditure and greater speed and safety. The designing of wheel chair should be done taking in concern the comfort and safety and energy requirements for every individual. Appropriate wheelchair seating is an integral part of the overall management of patients with spinal cord injury. It not only determines patient's mobility but also has implication for skin, posture, and pain and contracture management. A basic standard manual wheelchair incorporates a seat and back, two small front (caster) wheels and two large wheels, one on each side, and a foot rest. They are often highly customised for the individual user's needs. The seat size (width and depth), seat-to-floor height, footrests/leg rests, front caster outriggers, adjustable backrests, controls, and many other features can be customized on, or added to, many basic models, while some users, often those with specialised needs, may have wheelchairs custom-built. Although the effort involved in wheelchair ambulation may be insufficient to cause a cardio-respiratory training effect, it can impose a severe physical stress on physically disabled person **engel p. Hildebrandt**). Nevertheless, because the load is thrown on small muscles the heart rate will be higher in the wheelchair user than in a person with an equivalent oxygen intake who is walking

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(**Glaser Rm, Edwards M**). The reduced cardiac capacity of tetraplegics and paraplegics may also be linked to their lower maximal exercise capacity and oxygen uptake.

**Parts of wheelchair**

Seat, Backrest, Arm-rest, Foot rest, Wheels, Brakes and locks for wheel, Hand rim& Axle. Prior to the purchase and distribution of a wheel chair the following needs to be assessed. Deciding the size – measurement for wheel chair.

**Patient position**

Fully dressed with all assistive devices on. Sitting on a straight chair having rigid seat and backrest .hip should be flexed at 80 degree knee flexed to 90 degree ankle in neutral, shoulder relaxed and elbow flexed to 90 degree.

**Measurements**

Height of seat from floor - distance between floor and upper surface of seat + 5 cm (for foot rest elevation) 19 1/2''.Width of seat = outer aspect of left thigh to outer aspect of right thigh + 5 cm, 18''.Depth of seat = back of pelvis to back of knee – 66 cm 16''. Height of foot rest = sitting surface to the bottom of heel 16-20''.Height of chair back = sitting surface to the apex of scapula 16''.Arm rest height = sitting surface to the outer aspect of 90 degree flexed forearm 9 ½''.

**Methods**

Study was performed on 30 subjects. This was an experimental study based on the comparison between different wheelchair driving namely light weight folding wheelchair, non folding standard wheelchair and commode wheelchair with inclined seat with respect to their effect on human system parameters such as heart rate, blood pressure, temperature, respiratory rate. The study performed co-relation between various parameters and described significant co-relation between them. The study was performed in the Punjabi university Patiala in research lab of Department of Physiotherapy and hand ball ground.

**Parameters study were**

Body temperature measured in $F^{0,}$ Respiratory rate measured per minute. Blood pressure measured in mm/ Hg, Heart rate measured per minute, Visual Analogue Scale (VAS), Borg scale of rate of perceived exertion, Physiological cost of index

**Procedure**

**Step 1**

The subjects were selected on the basis of inclusion and exclusion criteria. Height was measured by anthropometric rod followed by weight measurement by weighing machine.

**Step 2**

Proper assessment of the subject was done taking into concern muscle length testing, girth measurement, range of motion, sensory assessment.

**Step 3**

Markings were marked both at starting point and end point. The distance was marked for 40 meters. Now the subject was comfortably sitted on light weight wheelchair which was having proper fittings like arm rest, back rest, brakes, foot rest etc. The subject was asked to remain relaxed before and after the procedure. The procedure was told to patient and he/ she was instructed to drive wheel chair within a range of 3 meters.

**Step 4**

**Readings were taken as**

Procedure for measuring **respiratory rate**: Subjects arm was placed across chest and examiner put her fingers positioned as if continuing to monitor the radial pulse. Counting of respirations for 60 sec was done.Procedure for measuring **radial pulse**: Patient comfort was assured. Radial pulse point to be monitored was selected. Examiner puts her first three fingers squarely and firmly over the pulse site. Counting is done for 30 seconds and it was multiplied by 2.Results were recorded.

Procedure for measuring **temperature**: Patient comfort was assured. The equipment required for recording temperature was hand held thermometer. Turn on the hand held digital thermometer. Examiner insert thermometer into subject's mouth at the posterior base of tongue to the right or left of fraenulum. Subject was instructed to close the lips and not teeth. Thermometer probe was held in place for 1 min, until a beep was heard.

Procedure for recording **blood pressure**: Patient comfort was assured. The equipment required of taking blood pressure includes a blood pressure cuff, a sphygmomanometer and a stethoscope. Blood pressure cuffs were secured on the subject's extremity by Velcro. The cuff covers approximately one-half to two-thirds of the subject's upper arm. The cuff was inflated. Initially when pressure was applied in the cuff, the blood flow was occluded and no sound was heard through the stethoscope. As the pressure was gradually released, a series of five phases/ sounds were identified

Phase 1-the first clear, faint, rhythmic tapping sound that gradually increases in intensity; indicates systolic pressure. Phase 2- a murmur sound was heard. Phase 3- sounds become louder and crisp. Phase 4- sound distinct, soft blowing quality; indicates diastolic pressure. Phase 5- sounds disappear, second diastolic pressure.

**Step 5**

Now the subject was made to drive wheel chair for a distance of 40 meters.

Subject was instructed to remain relaxed during driving. A beep was fired at the starting point when the subject starts driving. The time was recorded while the subject was driving wheelchair with the help of stopwatch. When subject reaches at the end point a beep was fired again to stop it.

**Step 6**

All the readings were taken again in the same manner as earlier. Help was taken by another person for taking recordings so that with time recordings were not altered and changes in the parameters could be appreciated.

**Step 7**

Some new parameters taken after reaching the end point include:

VAS: The subject was asked to point markings at vas scale for both right and left upper limb. Borg scale for rate of perceived exertion: The subject was asked to point out markings at Borg scale. The same procedure was applied for other two wheelchairs i.e. commode and non-folding wheelchair

## Data analysis and results

| | AGE | HEIGHT | WEIGHT | BMI |
|---|---|---|---|---|
| **Mean and SD** | 20.0666±1.0482 | 165.2833±6.4603 | 62.8333±5.9194 | 22.9506±1.2057 |

**Table 1.** Describes the mean and standard deviation of age, height, weight, and BMI of all the 30 subjects who were included in the study.

| Parameters | Mean and Standard Deviation | Difference of mean and SD |
|---|---|---|
| **Pulse-pre** | 84.6 ± 5.49 | |
| **Pulse-post** | 99.3 ± 6.48 | 14.6± 0.88 |
| **Temperature-pre** | 97.9 ± 0.50 | |
| **Temperature-post** | 98.3 ± 0.39 | 0.41± -.1114 |
| **Respiratory rate-pre** | 17.9 ± 2.18 | |
| **Respiratory rate- post** | 23.3 ± 2.53 | 5.46±0.35 |
| **Blood pressure-pre** | 121 ± 7.92 | |
| **Blood pressure-post** | 126.5 ± 4.93 | 5.5±-2.98 |

**Table 2.** Describes the mean and standard deviation and difference of mean and standard deviation of pre and post test values of pulse, temperature, blood pressure and respiratory rate of light weight folding wheelchair (A).

| Parameters | Mean and SD |
|---|---|
| Time | 46.36± 8.45 |
| Velocity | 1.15± 0.21 |
| Borg scale | 1.03± 0.55 |
| Vas | 0.26± 0.52 |
| Physiological cost index | 12.11± 4.84 |

**Table 3.** Describes the mean and standard deviation and difference of mean and standard deviation of pre and post values of time, velocity, VAS, physiological cost index of light weight folding wheelchair (A).

| Parameters | Mean and Standard Deviation | Difference of mean and SD |
|---|---|---|
| Pulse-pre | 87.2± 4.8947 | |
| Pulse-post | 110.2± 9.1704 | 23.2±4.2757 |
| Temperature-pre | 97.8933± 0.5533 | |
| Temperature-post | 98.2733± 0.4385 | -0.3803±-00.1148 |
| Respiratory rate-pre | 17.6666± 1.8631 | |
| Respiratory rate- post | 24.7333± 1.9815 | 7.067±0.1184 |
| Blood pressure-pre | 122.667± 6.396 | |
| Blood pressure-post | 131.333± 6.8144 | 8.666±10.35 |

**Table 4.** Describes the mean and standard deviation and difference of mean and standard deviation of pre and post test values of pulse, temperature, blood pressure, respiratory rate of non-folding standard wheelchair (B).

| Parameters | Mean and SD |
|---|---|
| Time | 115.4± 17.16 |
| Velocity | 2.88± 0.42 |
| Borg scale | 3.15± 0.88 |
| Vas | 3.06± 0.63 |
| Physiological cost index | 8.21± 3.56 |

**Table 5.** Describes the mean and standard deviation and difference of mean and standard deviation of pre and post values of time, velocity, VAS, physiological cost index of non-folding standard wheelchair (B).

| Parameters | Mean and Standard Deviation | Difference of mean and SD |
|---|---|---|
| Pulse-pre | 84.96 ± 5.37 | |
| Pulse-post | 98.6 ± 5.90 | 13.36±0.52 |
| Temperature-pre | 98.06 ± 0.43 | |
| Temperature-post | 98.36 ± 0.41 | 0.3±-0.02 |
| Respiratory rate-pre | 18.1± 1.82 | |
| Respiratory rate-post | 22.43± 2.43 | 4.33±0.60 |
| Blood pressure-pre | 122.5± 6.396 | |

**Table 6.** Describes the mean and standard deviation and difference of mean and standard deviation of pre and post test values of pulse, temperature, blood pressure, respiratory rate of commode wheelchair with inclined seat (C).

| Parameters | Mean and SD |
|---|---|
| Time | 46.36± 8.45 |
| Velocity | 1.15± 0.21 |
| Borg scale | 1.03± 0.55 |
| Vas | 0.26± 0.52 |
| Physiological cost index | 12.11± 4.84 |

**Table 7.** Describes the mean and standard deviation and difference of mean and standard deviation of pre and post values of time, velocity, VAS, physiological cost index of commode wheelchair with inclined seat (C).

| Variables | T-value | P-value |
|---|---|---|
| Pulse | -5.40 | ($p<0.05$) |
| Blood pressure-systolic | -1.97 | ($p<0.05$) |
| Temperature | -0.13 | ($p>0.05$) |
| Respiratory rate | -2.81 | ($p<0.05$) |
| Time | -14.43 | ($p<0.05$) |
| Velocity | -14.43 | ($p<0.05$) |
| Borg scale | -11.13 | ($p<0.05$) |
| Vas | -18.59 | ($p<0.05$) |
| Physiological cost index | 2.83 | ($p<0.05$) |

**Table 8**. Describes the unpaired t-test value and P value of pulse ,blood pressure, temperature, respiratory rate, time, velocity, Borg readings and physiological cost index of wheelchair A and B. P value was found to be significant ($p<0.05$) except temperature which was not significant ($p>0.05$).

| Variables | t-value | p-value |
|---|---|---|
| Pulse | 6.35 | ($p<0.05$) |
| Blood pressuresystolic | 3.24 | ($p<0.05$) |
| Temperature | 2.04 | ($p<0.05$) |
| Respiratory rate | 5.47 | ($p<0.05$) |
| Time | 19.76 | ($p<0.05$) |
| Velocity | 19.76 | ($p<0.05$) |
| Borg scale | 11.11 | ($p<0.05$) |
| VAS | -18.61 | ($p<0.05$) |
| Physiologicalcost index | -3.54 | ($p<0.05$) |

**Table 9.** Describes the values of unpaired t-test and P value of pulse blood pressure temperature, respiratory rate, time, velocity , Borg readings , and physiological cost index of wheelchair A and B. P value was found to be significant ($p<0.05$) for all the parameters of wheelchair B and C.

| Variables | t-value | p-value |
|---|---|---|
| **Pulse** | 1.045 | p>0.05 |
| **Blood pressuresystolic** | -1.09 | p>0.05 |
| **Temperature** | 2.70 | p<0.05 |
| **Respiratory rate** | 2.01 | p<0.05 |
| **Time** | 2.27 | p<0.05 |
| **Velocity** | 2.27 | p<0.05 |
| **Borg scale** | -0.23 | p>0.05 |
| **VAS** | 1.507 | p<0.05 |
| **Physiological cost index** | 0.29 | p>0.05 |

**Table 10.** Describes the values of unpaired t-test and P values pulse , blood pressure, temperature, respiratory rate, time, velocity, Borg readings and VAS, physiological cost index of wheelchair Band C. P value was found to be significant (p<0.05) for all the parameters of wheelchair A and C except for temperature and readings of Borg scale and physiological cost index which was found to be in significant (p>0.05).

| Variables | Df | Friedman value | Significance level |
|---|---|---|---|
| **Borg scale** | 2 | 63.25 | p<0.001 |
| **Vas** | 2 | 277.56 | p<0.001 |

**Table 11.** Describes the value of Friedman test for three parameters namely Borg readings, VAS of all three wheelchairs namely light weight folding wheelchair, non folding standard wheelchair and commode wheelchair with inclined seat. The results were found to be significant at p<0.001, for a two- tailed study.

| Variables | Sum of squares | D f | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 1399.4 | 2 | 699.7 | 22.25737 | P<0.001 |
| Within Groups | 2735 | 87 | 31.43678 | | |

**Table 12.** Describes ONE-WAY ANOVA for pulse. Variables were analyzed both between groups and within groups.

| Variables | Sum of squares | D f | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 119.4 | 2 | 59.7 | 13.40361 | P<0.001 |
| Within Groups | 387.5 | 87 | 4.454023 | | |

**Table 13.** Describes ONE-WAY ANOVA for respiratory rate. $F_{calculated}$ was found to be significant (13.40361) at p< 001. This indicates that there is relationship between three types of wheelchairs with respect to respiratory rate.

| Variables | Sum of squares | D f | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 417.2222 | 2 | 208.6111 | 5.227796 | P<0.001 |
| Within Groups | 3471.667 | 87 | 39.90421 | | |

**Table 14.** Describes ONE-WAY ANOVA for blood pressure. $F_{calculated}$ was found to be significant (5.227796) at p< 001. This indicates that there is relationship between three types of wheelchairs with respect to blood pressure.

| Variables | Sum of squares | D f | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 0.402889 | 2 | 0.201444 | 3.149644 | P<0.001 |
| Within Groups | 5.564333 | 87 | 0.063958 | | |

**Table 15.** Describes ONE-WAY ANOVA for temperature. $F_{calculated}$ was found to be significant (3.149644) at p< 001. This indicates that there is relationship between three types of wheelchairs with respect to temperature.

| Variables | Sum of squares | D f | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 86118.07 | 2 | 43059.03 | 209.4412 | P<0.001 |
| Within Groups | 17886.33 | 87 | 205.59 | | |

**Table 16.** Describes ONE-WAY ANOVA for time. $F_{calculated}$ was found to be significant (209.4412) at p< 001. This indicates that there is relationship between three types of wheelchairs with respect to time taken to cover a distance of 40 meters.

| Variables | Sum of squares | D f | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 53.82379 | 2 | 26.9119 | 209.4412 | P<0.001 |
| Within Groups | 11.17896 | 87 | 0.128494 | | |

**Table 17.** Describes ONE-WAY ANOVA for velocity which is a measure of distance over time. $F_{calculated}$ was found to be significant (209.4412) at p< 001. This indicates that there is relationship between three types of wheelchairs with respect to velocity.

| Variables | Sum Of Squares | D f | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 88.21667 | 2 | 44.10833 | 97.37598 | P<0.001 |
| Within Groups | 39.40833 | 87 | 0.452969 | | |

**Table 18.** Describes ONE-WAY ANOVA for Borg scale of rate of perceived exertion. $F_{calculated}$ was found to be significant (97.37598) at p< 001. This indicates that there is relationship between three types of wheelchairs with respect to Borg readings.

| Variables | Sum Of Squares | D f | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 146.4 | 2 | 73.2 | 204.115 | P>0.001 |
| Within Groups | 31.2 | 87 | 0.358621 | | |

**Table 19** describes ONE-WAY ANOVA for VAS. $F_{calculated}$ was found to be not significant (0.0226302) at p< 001. This indicates that there is no relationship between three types of wheelchairs with respect to VAS score.

| VARIABLES | SUM OF SQUARES | D f | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 276.2813 | 2 | 138.1407 | 5.995855 | P<0.001 |
| Within Groups | 2004.424 | 87 | 23.03936 | | |

**Table 20.** Describes ONE-WAY ANOVA for physiological cost index. $F_{calculated}$ was found to be significant (5.995855) at p< 001. This indicates that there is relationship between three types of wheelchairs with respect to physiological cost index.

**Results**

The mean and standard deviation of age, height, weight, and BMI of all the 30 subjects who were included in the study were calculated. The unpaired t-test value and P value of pulse (5.40), blood pressure (1.97), temperature (0.13), respiratory rate (2.81), time (14.43), velocity (14.43), Borg readings (11.13), and physiological cost index (2.83) of wheelchair **A and B**. P value was found to be significant (p<0.05) except temperature which was not significant (p>0.05). The values of unpaired t-test and P value of pulse (6.35), blood pressure (3.24), temperature (2.04), respiratory rate (5-47), time (19.76), velocity (19.76), Borg readings (11.11), and physiological cost index (3.54) of wheelchair A and B.

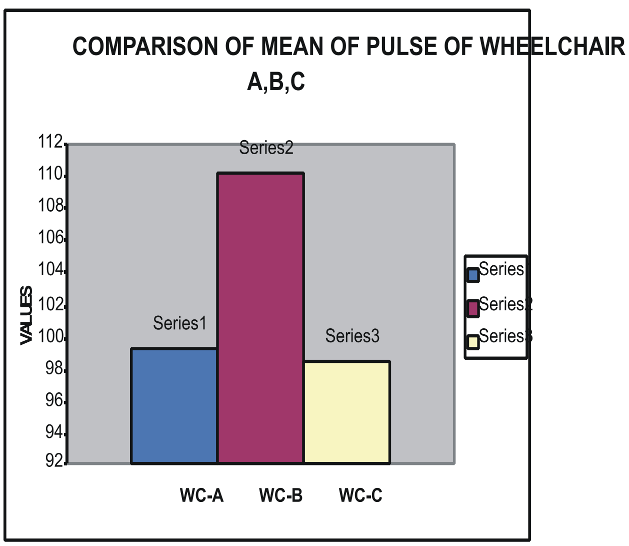


**Figure1**

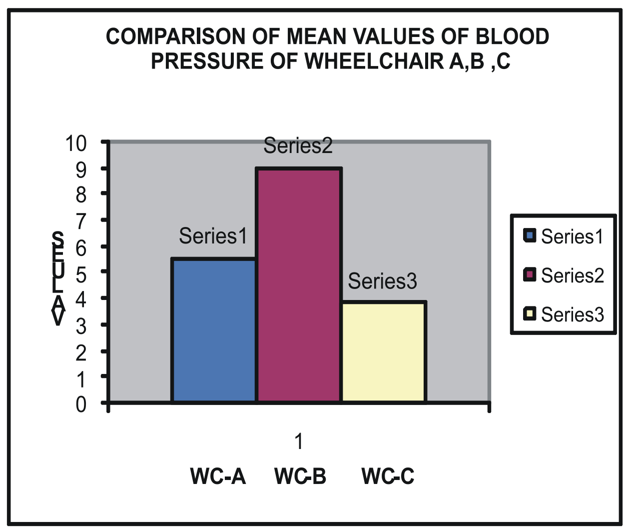


**Figure 2**

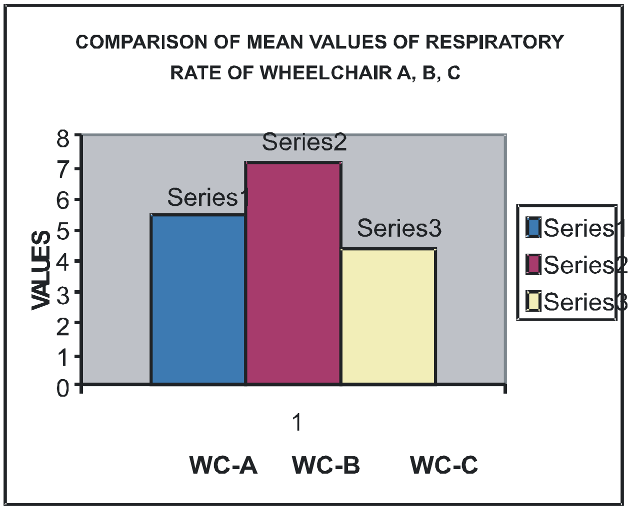


Figure 3

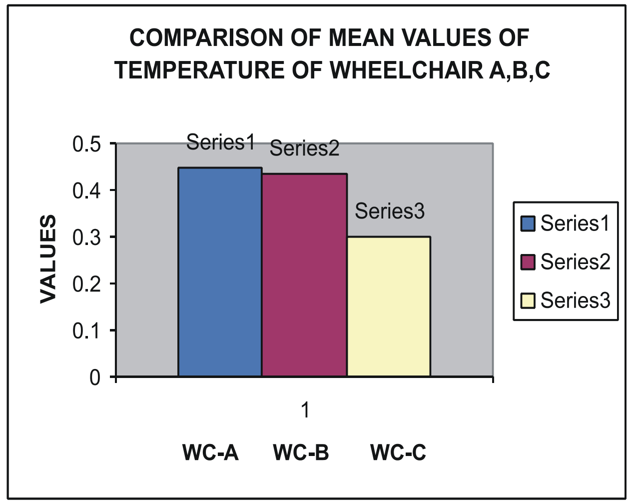


Figure 4

P value was found to be significant (p<0.05) for all the parameters of wheelchair **B and C**. the values of unpaired t- test and P values pulse (1.045), blood pressure (1.09), temperature (2.70), respiratory rate (2.01), time (2.27), velocity (2.27), Borg readings (0.23) and VAS (1.507), physiological cost index (0.29) of wheelchair Band C. P value was found to be significant (p<0.05) for all the parameters of wheelchair **A and C** except for temperature and readings of Borg scale and physiological cost index which was found to be in significant (p>0.05). The Friedman test was applied for Borg readings and VAS and results were significant at p<0.001. The ANOVA was applied for pulse, blood pressure, respiratory rate, temperature, Borg scale; physiological cost index, VAS and results were significant at p< 001. Physiological cost index for all the wheelchairs.

## Discussion

Based on data analysis it may be observed that wheelchair driving has a significant effect on once cardio-. **Roy j. Shephard** concluded from his study that lack of cardio-respiratory and muscular fitness may lead to physiological problems in disabled persons. Such problems can be detrimental to manual wheelchair use and can hinder rehabilitation efforts. So cardio-respiratory fitness should be determined so that he can save his energy in doing jobs of everyday life. Thus the study shows that there is significant co-relation between all the parameters of wheelchairs and there are significant changes in different parameters such as heart rate, blood pressure, temperature, respiratory rate, pain rating and rate of perceived exertion after wheelchair driving. Thus our alternate hypothesis is accepted which states that there are significant changes in different parameters such as heart rate, blood pressure, temperature, respiratory rate, pain rating and rate of perceived exertion after wheelchair driving. And null hypothesis is rejected.

Enquiry between shopkeeper and patients was done on the basis of highest selling and lowest price wheelchair. The highest selling wheelchair was **light weight folding wheelchair** due to Light weight, Easy foldable, Convenience of easy transport, Easy to be handled by the patient, Can be accommodated in narrow passage., Locking system available on both sides. **Non- folding standard wheelchair** was selected on the basis of lowest price with following factors-Most preferred by patients for stability and comfort as width is more and comfort is there, Helper can easily transport the patient on wheelchair by actively pushing through corridors and ramps, It is used in various household activities

**Commode wheelchair with inclined seat** was selected on the following basis-More stable, less feeling of fall, Foldable for easy transport, All indoor activities can be easily performed, Plastic commode seat, Toilet activities can also be performed. Other considerations- ease of maintenance, effect of seating, mobility and posture. Weight of the wheelchair locking system, Comfort ability while seating Cost considerations, Commode attachment. Patient position- fully dressed with all assistive devices on. Sitting on a straight chair having rigid seat and backrest .hip should be flexed at 80 degree knee flexed to 90 degree ankle in neutral, shoulder relaxed and elbow flexed to 90 degree. Measurements: Height of seat from floor - distance between floor and upper surface of seat + 5 cm (for foot rest elevation) 19 1/2''.Width of seat = outer aspect of left thigh to outer aspect of right thigh + 5 cm, 18''.Depth of seat = back of pelvis to back of knee – 66 cm 16''. Height of foot rest = sitting surface to the bottom of heel 16-20''.Height of chair back = sitting surface to the apex of scapula 16''.Arm rest height = sitting surface to the outer aspect of 90 degree flexed forearm 9 ½''.

## Conclusion

The study results indicated agreement with the alternate hypothesis which stated that there are significant changes in different parameters of wheelchairs like heart rate, blood pressure, respiratory rate, temperature, pain rating and rate of perceived exertion while driving a wheelchair. And also there is significant relation between different parameters of wheelchairs. Thus the study indicated that light weight folding wheelchair should be recommended to the patients with neurological or musculo-skeletal injuries. Also the study throw light on the structural parameters of a wheelchair such as seat, arm rest, foot rest, brakes, wheels, and commode attachment. The design and mechanics of a wheelchair puts a constraint to the manufacturer and buyer.

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## How to publish your journal paper

The Catch 22 in research publishing is that few authors work effectively in the process until after they've published a few manuscripts. The good news is that experienced journal editors and authors are willing to pass on their secrets of success. Here is their best advice.

**Have a focus and a vision**

Angela M. Neal-Barnett, PhD, of Kent State University and author of the forthcoming book, "Bad Nerves" (Simon & Schuster, 2003), as well as numerous papers in multiple journals believes that the key to successfully publishing an article is to "get a vision"--a reason and purpose for writing. That concept isn't always familiar to academicians who often write because they have to for tenure or promotion, she says. But, she advises, while "academic wisdom [says] 'publish or perish,' ancient wisdom says 'without vision, the people will perish.'"

Once you have a vision, says Neal-Barnett, write it down and keep it in constant view to remind you of your mission.

**Write clearly**

"There is no substitute for a good idea, for excellent research or for good, clean, clear writing," says Nora S. Newcombe, PhD, of Temple University, former editor of APA's Journal of Experimental Psychology: General.

Newcombe endorses the advice of Cornell University's Daryl J. Bem, PhD, who in Psychological Bulletin (Vol. 118, No. 2) wrote that a review article should tell "a straightforward tale of a circumscribed question in want of an answer. It is not a novel with subplots and flashbacks, but a short story with a single, linear narrative line. Let this line stand out in bold relief."

Newcombe also admits that neatness counts. Though she tries not get in a "bad mood" about grammar mistakes or gross violations of APA style, she says, such mistakes do "give the impression that you're not so careful."

**Get a pre-review**

Don't send the manuscript to an editor until you have it reviewed with a fresh eye, warns Newcombe. Recruit two objective colleagues: one who is familiar with the research area, another who knows little or nothing about it. The former can provide technical advice, while the latter can determine whether your ideas are being communicated clearly.

Many academic departments form reading groups to review each others' papers, says Elizabeth M. Altmaier, PhD, editor of Clinician's Research Digest: Briefings in Behavioral Science. "New faculty should and can form reading groups

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