Health of Coconut Tree Climbers of Rural South India - Medical Emergencies, Body Mass Index and Occupational Marks- a quantitative and survey study

Abstract:

Introduction: Coconut plucking, is profession of a few communities in south India, is an arduous calling now. Permanent cosmetic defects to skin, apart from medical emergencies, have made many to abandon this time honored profession. Objective of the present study was to explore the health status and casualties in traditional coconut tree climbers in south Indian coconut tree climbers.

Method: A total of 240 male volunteers, all below 55 years, engaged in the profession were interviewed between January 2006 and December 2008. Survey on the history of falls, injuries, changes in skin or body parts and the incidence rate of withdrawal from occupation were collected. Anthropometric data of 220 participants and their body mass index (BMI) was calculated. Afflicted parts due to occupational dermatosis were photographed and measured using scion image software.

Results: In group1 (<10years of experience) 15%, group 2, (10-20years of experience) 26.6%, group 3(20-30 years of experience) 44%, and group 4(>30years of experience) 41.3%, fell down from trees resulting in injuries. Histories of accidental cuts / lacerations from the special knife used and skid /slips during monsoons season in group1, 2, 3, and 4 are 7.7, 15.0, 16.9, 12.0 % respectively. Body weight and BMI of climbers in groups 2, 3 and 4 showed significant declines compared to non-climbers. Colles, vertebral and maxillary fractures, tendocalcaneus lesions and severe allergies, were among medical emergencies listed.
**Conclusion:** This study establishes a decline in BMI as the tree-climbing experience progresses, with marked falls noted in groups 3 and 4. It is suggested that data such as this should be taken into consideration in the plantation industry that depends on physical attributes, pesticide and lethal farm implements as routine requirements.

Key Words: Coconut tree climbers, Occupational marks, Rural south India

**Introduction**

Coconut plantation is one of the agricultural activities in southern part of India. Sociocultural compulsions made crops like coconut, economically viable for the planters. Regular plucking of coconuts and spraying pesticides to coconut tree, which is done manually to large extent, requires specialized labors. This activity is traditionally carried out by socio-economically backward communities, where men are trained in the art of climbing trees rapidly and plucking the coconuts or spraying pesticides. These communities are distributed wherever coconut trees are cultivated in large numbers as coconut plantations. The young and adult Kanakkans, Idigas, Thiyyas and Billava communities have been climbers for generations.

The trees are scaled through a series of upward hops along the vertical face of the tree trunk. The movements calling for flexion, abduction, extension and lateral rotation of hip, flexion and extension at knee, plantar and dorsiflexion at ankle, inversion at the subtalar joint, and flexion at metatarsophalangeal and interphalangeal joints of the foot are required for climbing a vertically grown coconut tree. The arms flex, medially rotate and hold the tree trunk, while the body elevates (Fig.1). To assist the leverage a loop made of coir is worn around the waist or between palms which in turn is wound around the tree trunk. A similar loop wound across the ankles prevents the splaying of the feet keeping them approximated to the trunk surface at all times of ascent or descent. The climbing process induces tremendous gravitational strain on the tibiotalar and intertarsal joints, as each professional climber work about 4 hours a day, climbing 25 -30 trees in a day.
The tree ascent or arborisation demands change in the Osteo-myo-fascial components of the human limbs\(^1\). The freeing of the thumb for the performance of opposition, and the modifications in the foot architecture, in the form of ‘arches’ have been landmark changes of significance to the human evolution \(^2-3\). Bipedalism is a unique feature of the human locomotion and thus the human foot is designed in the form of elastic arches to propel the body forwards in walking, running or jumping \(^4\). The human upper limb and lower limb were found to be underutilized, while almost all movement ranges were fully utilized by the apes in climbing activities \(^2\). Limb morphology, specific usage (acquired life style), adaptations in shape, modifications in soft tissue and osteological components of the limbs to large extent are dictated by kinesiological stresses and strains into which limbs are subjected to \(^5\).

While India is in a transition state in economic profile, occupational research approach should balance between the understanding of the modern industrial exposures and health risk of traditional sectors like agriculture and plantations \(^6\). Even though the clinicians have a vague idea of occupational medicine, they are not much aware of the occupational diseases and disorders that can mimic many clinical conditions \(^7\). Occupational hazards in various professional fields have been studied in detail. Occupational exposure to blood and body fluids in physiotherapists, asthma and infectious pneumonia in occupations exposed to respiratory sensitizers, injury risks for healthcare personal working night shifts, microscope use and musculoskeletal disorders in pathologists, low back pain associated with work, use of computer in sickness absence. Occupational risk of healthcare professional in a hospital environment etc. are few of them \(^8-15\).

To our knowledge, there are no studies to rate the occupational hazards in traditional coconut climbers of south India. Thus the ambit of this study is focused in the attempt to overview the health status and medical emergencies of these traditional climbers to understand the impact of this particular occupational adaptation better.

Body Mass Index (BMI) has been used as a measure of physical fitness and general health status in general and preventive medicine. Several population based cross-sectional studies have been done to find out the general health status in
comparison with the BMI\textsuperscript{16,17}. But we hardly find any such studies in populations like traditional agricultural sector in rural southern India.

A skin disease that would not have occurred if the patients had not been doing the particular work of that occupation is known as occupational dermatosis. Of all the types of occupational dermatosis, contact dermatitis is the most common, which comprises about 20-90\% of the cases, allergic contact dermatitis due to skin exposure to cardamom, dermatosis and fissure of feet due to exposure to cement and callosity due to hyperkeratinization in manual workers are reported\textsuperscript{18-24}. Few isolated cases of occupational marks in coconut climbers are reported, but they have not reported the data regarding its extent in upper and lower extremity.

Objective of the present study was to explore the body mass index, extent of occupational marks, casualties and injuries associated with the traditional coconut tree climbing occupation in rural south India.

**Methods**

**i. Subjects and study parameters**

The data presented in this paper were obtained from a random sample survey conducted between January 2006 and December 2008 in a few villages of south Indian states (Kozhikode, Ernakulam, Kollam, Idukki districts of Kerala State and Bodi, Bodinaykannur districts of Tamilnadu state). A total of 240 men volunteers aged less than 55 years from communities which were engaged in coconut tree climbing as their full time profession were included in the study survey. In these volunteers i) Anthropometric data was collected calculate their body mass index ii) Skin on body parts were observed carefully for scars/marks that affects cosmetics and areas of occupational dermatosis. Such scars/marks and dermatosis were photographed for documentation and quantification (iii) History of (a) fall from tree during climbing (b) injuries due to climbing (c) withdrawal from tree climbing occupation were taken to find their relation with years of experience, reasons for withdrawals.
a. **Body mass index**

Anthropometric data of 220 participants, those who were regular in tree climbing were collected, to find out their body mass index. Body mass index (BMI) was calculated by using the formula, BMI = Weight in Kilograms / Height in meters$^2$.

For statistical analysis subjects were divided into 4 groups, based on the years of experience they possessed in coconut tree climbing. Group 1: less than 10 years of experience, group 2: 11-20 years of experience, group 3: 20-30 years of experience, and group 4: more than 30 years of tree climbing experience. For comparisons anthropometric data of 80 non climbers were also collected and grouped them as group 0.

b. **Occupational dermatosis**

Areas of occupational dermatosis were photographed and were measured using scion image analysis software (NIH Image for Windows-4.0.3.2, Scion corporation Frederick, Maryland (USA). The images were converted into Bitmap images and were opened in the Scion image analysis software. Appropriate calibration was done using the scale in the image. Area of the dermatosis was measured using area option in the software.

c. **History of fall, injury and withdrawals**

Survey was taken to find out the history of fall, and its relation with years of experience (whether it increases or decreases with years of experience), history of injuries, observational changes in skin or body parts that affects cosmetics, history of withdrawals from their traditional occupation and the reasons for the same.

**Results**

a. **Body mass index (BMI)**

Body weight and calculated BMI of climbers in group 1 (19.41 ± 2.15 kg/m$^2$), group 2 (18.82 ± 2.46 kg/m$^2$), group 3 (18.62 ± 2.83 kg/m$^2$) and group 4 (17.62 ± 2.50 kg/m$^2$) showed significant difference compared to non climbers groups (20.71 ± 2.86...
kg/m$^2$ (P<0.001, One way Anova, Bonferroni’s test) BMI showed successive decline with increase in years of experience. Group 4 alone shows grade 1 thinness (Fig.2)

**b. Occupational dermatosis and other casualties**

Large areas of occupational dermatomes were seen as enlarged thickening on the ankle region, palmar aspect of hand and forearm regions (Fig.3). It is also seen in the sole of the foot and anterior abdominal wall of climbers. The area of occupational dermatosis in the forearm was $426.72 \pm 151.08$ mm$^2$, and on the dorsum of the foot was $421.16\pm 83.13$ mm$^2$ in area(Fig.4). The climbers from Tamilnadu state presented with much large occupational mark on the dorsum of the foot, compared to climbers from other states.

**C (i). Frequency of fall from the tree**

The percentage of people who have fallen from coconut tree and resulted in injuries in different experience group are: group 1(>10 year of experience)-15%, group 2(11-20 years of experience) - 26.6%, group 3(21-30 years of experience)-44%, group 4(< 30 years of experience)- 41.3% (Fig.5). A total of 35.5 %( 78 cases out of 220 climbers) fell down from coconut trees while doing their job. A total of four tree climbers had a fatal fall from coconut trees and resulted in death from the area of survey as reported by the local daily news papers.

**C (ii). Cuts / lacerations/fractures**

Histories of cuts/lacerations due to the special knife they use to cut the coconut while on the tree and slippery tree in rainy season was 7.7% (group), 15%(group2), 16.9%(group3) and12%(group4, Fig.6). A total of 13.6 % (30/220) got wounds and was unable to do their job to meet their daily expenses for some days. Colles fracture (fracture of lower end of radius bone in forearm-1/240), injury to Tendocalcaneus-1/240), fracture of spine (4/240) maxillary fracture (1/240) and severe allergy to dust of coconut tree top(2/240) were the other medical emergencies reported by the study participants.
C (iii). Withdrawals from profession

7.9% (19/240) of tree climbers in the area of survey discontinued from their traditional profession and remained unemployed (Fig.7). Among them only 5.2% (1/19) stopped climbing due to health problems other than those associated with tree climbing. 94.73% (18/19) stopped because of casualties that happened during their occupation (Fig.8).

Discussion

Few among the occupational health research topics or area include musculoskeletal complaints of computer professionals in neck and shoulder region with occupational cramps and myalgia, bone marrow edema in talus of professional ballet dancers with pain, musculoskeletal symptoms of upper extremities and neck in professional of visual display terminal workstations, knee arthrosis and thoraco-lumbar disc disorders in fisherman. The real disabilities or fatalities in those professions are not severe as that of the professional coconut tree climbers of the rural south India. Four coconut climbers where fallen from trees resulted in death and two were disabled with paraplegia from the area of survey according to the local daily newspapers. It is interesting to note that accidental falls and fatalities usually involve very experienced climbers. Colles, vertebral and maxillary fractures, tendocalcaneus lesions were the few injuries resulted due to fall from the coconut trees. We feel this is more serious occupational hazard than onboard slip and falls of flight attendants preceding backpain.

The less number of people in group 1 (n=26) compared to other groups (n=60, 59, 75 respectively in group 2, 3, 4) explains the rapid withdrawing of able bodied men, not ready to stick to ancestral occupation, which is also reported by local daily newspapers (The Hindu; Tamilnadu edition, December 15, 2008; The Hindu; Kerala edition, February 16, 2008). Even though availability of less strenuous alternate jobs and better education status of new generation are major reasons they quote for quitting this community based profession; few explain that the cosmetic reasons, that
is the scars resulting from occupational dermatosis, ugly looking foot and other body parts, inability to wear footwear that make them prominent bare foot walkers in the society etc. are the areas of common concern (The Economic Times, 19 August 2009).

It is very possible that after a few decades the complete lack of coconut pluckers may drive the coconut industry to seek alternative means of cultivation (The Economic Times, 19 August 2009). There are few machines available in costal south India which assists climbing coconut trees. One of the main disadvantages the climbers quote is the, inaccurate performance with the machines while climbing the slanting coconut trees. It should be noted that the majority of coconut trees of south coastal India belong to this variety. Well developed countries prefer machines without human climbing. In Malaysia, Indonesia and Thailand trained monkeys (mainly long tailed macaques) are used in coconut and palm plantations. The fatalities, medical emergencies and present health status of these coconut climbers suggest an emergency to introduce any one or both of these systems and rehabilitate and redirect the coconut climbers to another productive and high yielding profession.

The technique of gripping the tree with both hands and feet and thus pushing up the body to climb higher results in intermittent pressure over the fore arm skin, palms and soles. The friction created will increase the epidermal turn over which in turn lays thickened vertically oriented collagen bundles in papillary dermis. The occupational marks seen in coconut climbers show no evidence suggestive of irritant or allergic contact dermatitis. These callosities suggest the severe degree to which the skin can adapt in response to the frictional forces between the skin and the coconut tree. Similar areas of the callosities were reported in 4 isolated cases from India.

In the present study we found such callosities not only on the sole, palm the flexor aspect of the fore arm, but also the dorsum of the foot and in few cases the anterior abdominal wall. The callosities found on the dorsum of the foot found to be more prominent than any other area, suggesting that the friction caused by plantar loop made of coir as the reason. Fissures with callosities could be found in the sole of the foot mostly due to the occupational adaptation of the skin along with occupational requirement of bare foot walking. Experienced climbers of group 3 and 4 complained
that they are unable to wear foot ware, as they are not able to grip it, between their
great toe and second toe.

Falls from trees and other tree related injuries are the most common cause of
trauma in some rural areas of Melanesia. Review of coconut injuries in Pacific
Islands revealed, patients falling from coconut tree who presented with upper limb
and spinal fractures. However, such type of data is lacking from India to the best of
our knowledge. Occupational hazard due to fall from coconut tree while plucking
coconut is not recorded in literature. Withdrawal of 7.5% of traditional tree climbers
from their only learned skilled job because of causalities that happened from their
occupation needs attention. The higher percentage of fall in well experienced climbers
is a point of consideration, as this can be associated with the failure of further
adaptations of the foot, after a certain limit.

Occupational related injuries and fatalities in industries such as copper mining
and finish agriculture are reported. But there is no such evidence reported about
the accidental cuts and lacerations due to the sharp objects they use in agricultural
industry such as coconut palm harvest. In our study 13.6% of the coconut climbers
presented with history of wounds in their routine occupation indicating the need to
find the remedies to help those who are engaged in this profession.

The normal cut off value of BMI in Asian Indian population has been recorded
as 18.5 to 24.9 kg/m² and 23 kg/m² for average men. A cross sectional survey of
BMI in an urban population of western India describes 21.8 ± 3.8 kg/m² (Mean±SD)
for men. Significant decline in BMI with increase in experience of tree climbing in
the present study, and grade-1 thinness found in the most experienced group (group-4)
draws attention for further studies. Energetic cost of locomotion in orangutans studied
in detail and suggest that the tree climbing is costlier followed by walking and lastly
descending the tree. Whether the high energy cost in humans while tree climbing
decreases their BMI is to be studied.

**Conclusion**
Coconut plucking is arduous and laborious job. Cosmetic defects of the skin, medical emergencies, and complications make the youngsters to do less arduous occupation. As coconut is one among the important grocery for a south Indian kitchen and cosmetics, lack of tree climbers results in agriculturists not selling their crops in time. This study clearly shows a decline in BMI and increase in the rate of fall as the experience progresses. All these should be taken into serious consideration to adopt any modern technology to pluck coconut, and spraying pesticides for coconut mites. It should also be noted that the traditional tree climbers need to be rehabilitated at least after two decades of their engagement in their profession.

References


30. Bertrand M, Training without Reward: Traditional Training of Pig-Tailed Macaques as Coconut Harvesters, Science 1967;155; 3761, 484 – 486


40. Shukla H C, Gupta P C, Mehta H C and Hebert J R. Descriptive epidemiology of body mass index of an urban adult population in western India. Journal of Epidemiology and Community Health. 2002;56;876-880


Figure legends:

Figure 1: A. Coconut tree climber climbing the coconut tree. B. Plucking the coconuts
Figure 2: Body mass index (BMI) in groups of climbers having different extent of climbing experience. Group 1-with < 10 years, Group 2- with 11-20 years, Group 3-with 21-30 years, Group 4- with > 30 years of experience. Note there is a significant decrease in BMI in all groups of climbers compared to nonclimbers (Group0,***,P<0.001, One way Anova, Bonferroni’s test)
Figure 3. A-Feet of a coconut tree climber (> 20 years of experience), showing callosities (arrows) in the ankle region. B-Right foot of a coconut tree climber with amputated medial toes (arrow), C-Occupational mark (arrows) in palmar aspect of hands in a coconut tree climber, C-Occupational mark (arrows) the forearm skin in a coconut tree climber.
Figure 4: Area of occupational marks (dermatosis) in forearm and dorsum of the foot in coconut tree climbers.
Figure 5: Frequency (percentage) of fall from coconut tree during work in groups of climbers having different extent of experience. Group 1-with < 10 years, Group 2- with 11-20 years, Group 3 -with 21-30 years, Group 4- with > 30 years of experience. Note that frequency of fall is highest in coconut tree climbers having more than 30 years of climbing experience.
Figure 6: Frequency (percentage) of cuts/lacerations during work in groups of climbers having different extent of experience. Group 1-with < 10 years, Group 2- with 11-20 years, Group 3 -with 21-30 years, Group 4- with > 30 years of experience. Note that frequency cuts/ lacerations are relatively high in the last three groups of coconut tree climbers.
Figure 7: Percentage of withdrawal (black dotted fraction) from the traditional occupation (coconut tree climbing) in the selected area.
Figure 8: Percentage of withdrawal due to fall from the tree (dotted fraction) and other health reasons (striped fraction). Note that majority of withdrawals are due fall from the tree.