Background: Work-related musculoskeletal disorders (WMSDs) of the upper limb, particularly the wrist and hand represent a substantial proportion of work-related illnesses and are associated with relatively high medical costs and loss of work. The risk factors for developing such disorders include individual factors, physical requirements at the workplace, organizational and psychosocial factors. Stone quarrying work involves moderate to heavy manual work and most of the work activities involve high risk to the wrist and hand. Laterite and granite stones are commonly quarried as dimensional stone in the west coast of South India. Hence these stonecutters are susceptible for developing chronic wrist pain and associated WMSDs of the wrist and hand. There are no studies available on the prevalence and type of WMSDs of the wrist and the biopsychosocial risk factors in the stonecutters of India. Clinically wrist conditions can be recognized by the presence of pain, tenderness to palpation, restricted range of motion (ROM) of the joints and reduced grip and pinch strength. Norms for ROM of the wrist and grip strength are already available for various populations around the world, but not for Indian population.

Aims of the study: The current study is aimed to investigate the prevalence, characteristics of and risk factors for wrist pain and associated WMSDs in stonecutters through a descriptive cross-sectional survey employing clinical and radiological evaluation. A preliminary aim was to establish normative data for range of motion of the wrist, grip strength and pinch strength for the local population of India.

Methods: Ethical approval was obtained from Manipal University Research Committee. The study was conducted in 3 stages between June 2004 and April 2010.

In Stage I, a normative study was conducted using descriptive cross sectional design and quota sampling. A total of 488 apparently normal subjects were recruited including 260 males and 228 females aged 11 to 83 years. The grip strength and pinch strength were measured using Jamar dynamometer and B&L Pinchmeter according to the American Society of Hand Therapists guidelines. Wrist passive ROM was measured using AccuAngle Universal inclinometer.

In Stage II, a descriptive cross sectional survey was conducted to screen the stonecutters in the quarries located within Udupi district of Karnataka state. A convenience sample of 305 stonecutters was recruited including 7 females, and 155 granite stonecutters and 150 laterite stonecutters. The stonecutters were screened through musculoskeletal and neurovascular examination of the wrist and hand.

In Stage III, a total of 51 stonecutters with 72 symptomatic wrists were segregated from Stage II and enrolled for further clinical and radiological examination of their wrists. Bilateral standardised posteroanterior and lateral radiographs of the wrist were analysed to gain insight into their wrist pain and the underlying pathology.

Results: In stage I, stratified norms for hand and wrist function were established based on age, gender and side. Grip and pinch strength have a curvilinear relationship with age, peaking between 20-40 years (p<0.0001). In local population of India, the grip and pinch strength values were lower than in the multinational consolidated norms. Predictive equations were developed for grip strength using age and anthropometric measures, but with only a predictive value of 30-50%. The wrist passive ROM mean values for palmarflexion, dorsiflexion, radial deviation and ulnar deviation were respectively 88°, 82°, 23° and 39° which were 1-2% higher than those observed in
earlier studies. Palmarflexion and dorsiflexion decreased with age, but radial and ulnar deviation did not demonstrate this trend.

In stage II, the grip strength was generally found to be significantly lower in the stonecutters, especially in age groups of 20-50 years, but the pinch strength or the range of motion of the wrist were not significantly different from the norms. Point prevalence for chronic wrist pain in stonecutters was 17% (51 out of 305) individuals or 12% (72 out of 610) wrists. The granite stonecutters were affected twice as much as laterite stonecutters (35 against 16). This discrepancy was attributed to the lower impact loading involved in laterite stonecutting due to softness of the stone, difference in the work pattern and part mechanisation of the laterite quarry work.

Stage III study analysed the characteristics of the symptomatic stonecutters. In them right and left sides were involved at about the same frequency with 21 workers having bilateral symptoms. Majority of the pain was moderate in intensity. The dorso-radial pain was 5 times more frequent than the ulno-volar pain. On an average the grip strength was reduced by 20% to 55% and pinch strength by 17 to 24% of their predicted level. The range of motion of the wrist was not significantly affected. Only one percent of the symptomatic cases presented with acute symptoms rest being chronic. Despite the pain, weakness and other associated problems 99% of stonecutters continued to do their work.

Work-related musculoskeletal disorders of the wrist observed in stonecutters in the descending order of frequency were tendinopathy (7.8%), instabilities (4%), deformities (2.2%), fractures (1.8%), osseous problems (1.2%) and osteoarthrosis (0.8%). In 2.3% of the cases the wrist pain was diffuse, vague and non-specific. Skin ulcers, subcutaneous foreign bodies and ganglia were also seen in the hand. The stonecutters did not sustain any neuritis, hand-arm vibration syndrome, Dupuytren's contracture or trigger finger.

The biomechanical risk factors included tool handling, work load, work movements, work posture where as the self-chosen pace of the work was less hazardous. Organisational and environmental risks included high volume of work, prolonged work hours and poor work-rest cycle; absence of protective tools like gloves. Overwork, injury and alcoholism formed a vicious circle exacerbating the problems in the stonecutters. Majority of the workers lacked social security and welfare services such as indemnity, insurance and medical care.

**Conclusion:** The study has established normative reference values for range of motion, grip strength and pinch strength for population of India. The point prevalence, characteristics of wrist pain, type of underlying pathologies have been determined. Having identified a range of potential risk factors, the study recommends measures to prevent wrist pain and associated WMSDs in stonecutters. These include, use of protective equipment; work redesigning through mechanisation; work reorganisation through better regulation of work volume, work hours and work-rest cycle; workforce education; creation of medical awareness and provision of medical and social benefits.

Further studies involving stonecutters are desirable to establish cause-effect and dose-response relationships between work task demands and work-related musculoskeletal disorders of the upper limb as well as other regions of the body. Such studies would generate the information to compliment the ergonomic interventions for the prevention and management of work-related musculoskeletal disorders.