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Hazards and Risks at Rotary Screen Printing (Part 1/6): Survey on Musculoskeletal Disorders

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Abstract
This-research was initiated, following the-recommendation from recent-study, done at the-same-facility. The-main-purpose of the-study was to-survey machine-operators, on occupational-pain and related Musculoskeletal-Disorders (MSDs), at-textile-finishing-department. The-following-instruments were used: document-analysis, the-standardized Nordic-questionnaire (modified), and secondary-data, on sick-leave days, taken by the-workers, for previous-three-years. The-main-findings were: Absolute majority of the-respondents had at-least-one pain-complain, related to-MSDs. Low-back body-region received the-highest-number of complains, of pain, lasted, for at-least 24hours, for the-last-year (37.5%); last-month (25%); and last-week (12.5%). It-was-also-found, that age does *not* affect MSDs, for this-particular demographic-group. For the-three-reported-years, overall, MSDs contributed 36% of the-total-number of sick-leave-days, at the-finishing-department, leading to losses of KES 115,950 (USD 1,159.5), excluding direct-costs, and quality of life-costs. The-highest-number (60%) of sick-leave-days, attributed-to MSDs, among factory-workers, was due-to hand, wrist, and forearm-pain or injury. For, the-finishing-department, the-same-trend accounted for 55%. The-highest-number of sick-leave-days, attributed to-other, than MSDs, causes, was-due-to upper-respiratory tract-infection (URTI). Although, the-last-finding was *not* directly related to the-main-subject of investigation—MSDs; it can*not* be-ignored. Further-comparative studies, are, hence, recommended on the-respiratory-symptoms, among-workers, exposed and unexposed, to-cotton-dust, at the-mill. The-study also made several-recommendation, for further-research. The-research-findings provided some-evidence, and indicative-data, on-MSDs, at the-mill, which can-be-used, by the-mill administration, and policy-makers, to-improve strategies of integrating proper-ergonomic principles, in their-operational-practices. Moreover, the-study contribute (in its-small-way) to-existing-body of knowledge, on the-subject-matter.
Keywords: MSDs, occupational, textile industry, finishing sector, sick leave days.

1. Introduction.

1.1. MSDs: Concepts, types, prevalence-statistics, factors, and cost

1.1. 1. MSDs: Concepts and types.

According to the-Work-Place-Safety and Health-Council (WSHC), *Occupational-disease* is defined as any disease, contracted as-a-result of an-exposure, to-the-risk-factors, arising from work-activity. The-symptoms range from aches and pains, to-numbness and limitation, of movements, in the-musculoskeletal-system (Workplace-Safety & Health-Guidelines).

Musculoskeletal Disorder (MSD) is an-umbrella-term, for various-physical-injuries and disorders, in the-musculoskeletal-system. MSD can-happen-suddenly, or develop over-time. MSDs are also-referred-to as: Repetitive-Strain-Injuries (RSIs); Cumulative-Traumatic-Disorders (CTDs); or Occupational-Overuse Syndrome (OOS). Besides, MSDs have various-definitions; some of the-definitions rely on subjects-reported frequency, duration, or intensity of pain (Trinkoff *et al.*, 2002), while others define subjects as any-report of pain, that-causes-changes, in-functioning (Garg *et al.,* 1991).

MSDs include a-wide-range of inflammatory and degenerative-conditions, affecting muscles, tendons, ligaments, joints, peripheral-nerves, and supporting-blood-vessels. These-include clinical-syndromes, such-as: tendon-inflammations and related-conditions (tendinitis, tenosynovitis, epicondylitis, bursitis); nerve-compression-disorders (carpal-tunnel-syndrome, sciatica); and osteoarthrosis, as-well-as less well-standardized conditions such-as myalgia, low-back-pain, and other-regional-pain-syndromes, *not* attributable to-known-pathology. Body-regions most-commonly-involved are: the-low-back, neck, shoulder, forearm, hands, and the-lower-extremity (Punnett & Wegman, 2004). Moreover, some-MSDs associated with particular-body-region, for-example: De Quervain's disease (affects thumbs); Trigger-finger (fingers); rotator-cuff-tendinitis (shoulders); Tenosynovitis (hands, wrists); Raynaud's syndrome, so-called 'white-finger' (fingers, hands); and Carpal-tunnel-syndrome (fingers, wrists), among-many-others.

1.1. 2. MSDs: prevalence-statistics

MSDs are the-single-largest-category of work-related illness, representing a-third, or more, of all registered occupational-diseases in the-United-States, the-Nordic-countries, and Japan (National Research Council, 2001). It-is projected, that more-than 60% of people suffer MSDs, at-times, in their-lives (Smeldley *et al.,* 2003).WHO (2013) estimates, that over 160 million of new-cases, of work-related-illnesses, occurring every-year. Such-enormous-prevalence of complications, at-international-levels, have made the-WHO to-name the-first-decade of

the-third-millennium as "the decade of campaign against musculoskeletal disorders (as the-silent-epidemic)" (Gupta *et al.,* 2005). For-example, about six-million-workers, in the-U.S.A., alone, experienced work-related-illness and nonfatal-injuries (United States Department of Labor, 2000). In-Britain, MSDs represent the-largest-group of work-related-illness (Palmer & Cooper, 2000). According to Detels *et al.* (2002), MSDs affect one-million-people, each-year, and the-most common-problems are: back-pain, work-related-neck and upper-limb-disorders, repetitive-strain-injuries, and lower-limb-disorders. These-disorders are, largely-preventable, or their-progression can-be delayed.

Study by Riihimäki (2004), stated that in-Finland, in-2002, there were 4,807 cases of occupational-diseases (20 cases per 10,000 workers). 22% of all-cases were-categorized as RSIs (MSDs, which occur due-to non-physiological-stress, in-work, such-as: abnormal, or akward-working-posture, repetitive and monotonous-work) with a-rate of 5.7 cases per 10,000 workers. According to Nasonov, about 12 million-people were suffering from MSDs, in-Russia (Nasonov, 2003). A-report, published by Folomeyeva & Erdes suggested, that the-occurrence of MSDs is the-fastest-growing, as-compared to-all-other-diseases, with the-number-diagnosed increasing by 23.9%, between 1999 and 2003, as-compared to 11.3% growth-rate, of all-the-other ill-health-causes.

On-the-other-hand, MSDs have-been almost-completely-ignored, for-most of the-sub-Saharan-Africa, primarily-due-to financial-constrains, and the-stiff competition, for scarce-resources. According-to a-survey, MSDs contributed 3.4% and 1.7%, of the-total-disease-affliction, in the-developed, and developing-world, respectively (Chopra & Abdel-Nasser, 2008). A-study, from Egypt, by the-WHO/International-League of Associations for Rheumatology-Community Oriented-Programme for Control of Rheumatic-Diseases, showed that 16.2% of adults had work-related-MSDs (OECD, 2005).

By the-time of this-study, the-author came across *only*-one-study, on MSDs, in-Kenya. According-to a study, done by Juliet Akelo (2013), on-MSDs, among-nurses, at-the-Kenyatta-National-Hospital, the-prevalence of reported-incidences of MSDs, was 74.2%. The-study further-established, that physical factors, involving poor-posture, lifting of heavy-objects, and use of excessive-force, were the-most-apparent ergonomic-aspects, at 50% prevalence. The-most vulnerable-parts of the-body were-found to-be: the-back, feet, and shoulders, revealing a-rate of 32.5; 21.5; and 20.4%, respectively. The other-ergonomic-aspects identified were: the-structural-lay-out, of work-place (37%), and work organization (13%).

1.1.3. MSDs: influential-factors

According to-Medicine (2007), the-following-factors, are associated-with MSDs, namely: (1) *personal-factors* (sex, marital-status, age, education-level, working-experience, etc.); (2) *behavioral/ psychosocial-factors* (physical-fitness; smoking, drinking, and drug-abuse habits; job-satisfaction, job-stress, etc.); and (3) *working environment factors* (ambient-working-environment, employment-status, payment-methods, working-hours, training, repetitive-tasks, working-department, work-load, flexibility, and the-level of automation, of the-equipment, among-others). For-example: awkward-postures, repetitive-actions, heavy-lifting, vibration, fatigue, working for long-hours, without rest, can-lead to-work-related-MSDs. Typical-health-effects, of working-environment, are: headache, fatigue, impaired-vision, hearing-loss, musculoskeletal-problems, and reduced-work-performance.

In-addition-to work-demands, other-non-occupational-aspects of daily-life, such-as sports and housework, may present physical-stresses, to the-musculoskeletal-tissues. The-musculoskeletal and peripheral-nerve-tissues are affected, by-systemic-diseases, such-as: rheumatoid-arthritis, gout, lupus, and diabetes. Risk-varies by: demographics, socioeconomic-status, and ethnicity. Suspected-risk-factors include: obesity, smoking, muscle-strength, and other-aspects of work-capacity (Alexanderson & Norlund, 2004; Punnett & Wegman, 2004).

The-risk of WMSDs can-increase with an-increase in workloads, low-work-satisfaction, high-work-demands, and work-related-stress. Therefore immediate-attention *must* be provided to-those-individuals. Any-delay in such-cases might-result in very-lengthy-treatment, with a-long-rest-period, and also results in other-sufferings, with financial-losses, to the-individual, their-family, surroundings, and the-community, at large (EFILWC, 2008).

1.1.4. MSDS: costs

Baldwin (2004), reported that work-related MSDs are the leading-cause of work-absences, and lost productivity, accounting for one-third of occupational-injuries and illnesses, reported to the-Bureau of Labor statistics, each-year. Olson (1999) also noted that MSDs account for the-largest-fraction of temporary, and permanent-disability. A-study carried-out by June (2010) shows that over 350,000 working-adults, file for-some-kind of compensation, due to work-related MSDs, each-year.

The-extent of the-losses, associated with WRMSDs, depends on the-severity of the-condition, the-nature and quality of health-care, received, and on the-characteristics of the-patient, such-as: age, and general-health-status. However, the-non-health related-factors, such-as: psychosocial-factors, workplace characteristics, and availability of disability-compensation, are also-important-determinants of the-losses, associated-with MSDs. According to Leigh & Fries, the-costs of MSDs can-be categorized-into three groups, namely: (1) direct-costs; (2) indirect-costs; and (3) quality of life cost. *Direct-cost*, for-example includes payments for hospital, physician,

and allied-health-services, rehabilitation, nursing-home-care, home-health-care, medical-equipment, burial-cost, insurance-administrative-cost, for medical-claims, mental-health-treatment, police, fire-emergency-transport, coroner-services, and property damage-cost, among-others. *Indirect-costs*, such-as productivity-losses, are very-difficult to-calculate, and include productivity-losses, due-to absenteeism (interruption of the-production-process), and the-temporary, or permanent-replacement, of workers. *Quality-of-life cost* includes the-value, attributed to-pain and suffering, by victims and families. Usually the-indirect-cost of occupational-diseases and injuries, is estimated as-part of the direct-cost, and the-quality-of-life cost (social-cost) is excluded, from the-estimates and calculations.

MSD-symptoms are often-intermittent, and episodic, especially in the-early-stages. However, even when they do *not* correspond to defined-clinical-syndromes, they may-be of major-public-health significance. Several-studies have-recently-illuminated the-social and economic-impact of these-disorders, on affected-individuals and their-families (e.g. see Fulton-Kehoe *et al.,* 2000); moreover, MSDs affect the-host-organization, and society, as a- whole.

Beside, the National-Research-Council and Institute of Medicine (Medicine, 2001) has estimated, that by including the-indirect-costs, associated to MSDs, the-total-cost, associated with-reported-MSDs, is as-high as USD 45-54 billion, a-figure that is around 0.8% of the U.S.A.'s Gross-Domestic-Product (GDP). Member-States of the-European-Union indicate, that the-economic-cost of all work-related ill-health ranges from 2.6 to 3.8% of the GDP; 40-50% of the-costs will-be for MSDs. Available-cost-estimates of MSDs, put the-global-cost of MSDs-compensations, between 0.5% and 2% of GDP (Blair *et al.,* 2003). The-European-Forum of Insurance against Accidents at Work and Occupational-Diseases studied occupational-diseases, in 13 European-countries, in 2001-2002 (Brown, 2002). The-results showed that MSDs were the-second most-costly occupational diseases, in European-countries, with 20.5% of the-total-cost, exceeded *only* by diseases caused by-exposure to-asbestos-dust.

Overexertion-injuries to the-musculoskeletal-system (including-those, from lifting, pushing, pulling, holding, carrying, or throwing) cost U. S. A. businesses USD 12.75 billion, in-direct-costs, in-2009 and accounted for more-than a-quarter of the-overall-national-burden (Liberty-Mutual-Research-Institute for Safety, 2011). The situation is similar in-Canada, where a 2005 labor-market-report estimated direct and indirect-cost of MSDs at CDN 20 billion (McGee *et al.,* 2011). In-Canada, 26.4% of all-injuries, at-work, in-2003, were due-to overexertion (Wilkins & Mackenzie, 2007). In-Ontario sprains and strains, accounted for 50.2% of lost-time-claims and 46.6% of these-claims were-due-to events, such-as: overexertion, static-postures, and repetitive-motions. In Manitoba, 60% of all lost-time-injuries are MSDs (WSIB, 2009).

1. 2. Research purpose

Study by Bernard (1997) identified high-risk-sectors, for occupational-MSDs, including: nursing-facilities; air-transportation; mining; food-processing; leather-tanning; and heavy and light-manufacturing (vehicles, furniture, appliances, electrical and electronic-products, *textiles*, apparel, and shoes). Moreover, according to Berberoglu & Tokuc (2013); Leggart & Smith (2003); and Delleman & Dul (2000), there is a-high incidence of MSDs, and work-related physical-problems, in the-textile-manufacturing-industries. For-instance, working in the-textile-finishing-department, is one of the-tedious-professions, requiring long-hours of static-work; it can be a-high-risk-occupation, for developing MSDs, as-static and awkward postures, repetitive-movements, bad-furniture-design, inadequate-rest-pause, and contact-stress, are common. In-addition, several complex-combinations, of the-gradual-deterioration of the-musculoskeletal system, such-as lower-back-pain, or acute-trauma, such-as cuts or fractures, due-to accidents, were also-reported (see David, 2005). Health-effects may-show-up years, after-exposure, or after repeated, or long-exposure (Meenaxi & Sudha, 2012), and if *not* timely-identified, can lead-to incapacitating-results.

Despite the-large-amount of literature, on work-related-MSDs(WRMSDs), in other-parts of the-world, very-little, however, has-been-published on Kenyan-context, and specifically on the-workers in manufacturing-industries, who experience MSDs. The-size and complexity of the-problems, caused by MSDs, calls for-further-investigation, into analysis of the-MSDs, to-find-out the-magnitude of the-problem. According to extensive-search of available-literature, on the-subject-matter, on local-context, at the-time of this-research, *no* study, on MSDs, amongst-workers, in-manufacturing-industry, has-been-carried-out, in-Kenya. Moreover, likewise, *no* study was traced on MSDs, in textile-manufacturing, as-well-as in the-subject-mill, and its-finishing-department. This-research was initiated, among-other-reasons, by the-recommendation, made-by recent-study by Starovoytova (2017), done at the-same-facility. The-main-purpose of the-current-study was to-survey machine-operators, on self-reported occupational pain, and related-MSDs, at-textile-finishing-department, printing-section.

Actual and potential-losses, due to-MSDs, causing enormous-problems, globally; MSDs cause more work-absenteeism or disability, than any-other-group of diseases (Badley, 1994). MSDs have-been also-recognized as a-source of significant-disability, pain, and disadvantage, for the-injured-person and a-substantial-burden on millions of people, in any-country, and affect all-age-groups, and can-also-have a-major-impact on worker-

function, performance and productivity (DMH, 2008). WRMSDs lead to frequent-absenteeism, among-workers, and compensation-claims and loss of production, to the management (Armstrong, 2000). The-loss, due-to such-problems, *not* only affects the-individual, but also the-family, organization, and society, as-well. According to McCunney (2001), the-primary beneficial impact of application of occupational-health & safety principles, on productivity, is reduced-absenteeism. According to OSHA (2007), WRMSDs carry a-high-cost, in-terms-of lost-workdays, in-addition-to medical treatment-costs, making them an-important-issue, for employers. This-study is, therefore, significant, as it-will-identify the-extent of WRMSDs, in the-textile-finishing-department, and, consequently, could offer tailored-solutions, to-reduce, or eliminate the-associated, with MSDs, problems.

2. Materials and Methods.

2.1. Description of the-textile-mill, where the-study was conducted.

The-study was conducted at Rivatex-East-Africa, Limited (REAL), an-integrated textile-mill, which is fully equipped to-handle the-entire textile-processing-cycle. Raw-materials-used, are: cotton, polyester/viscose. For more-details, on the mill's history, structure, and end-products (see Starovoytova, 2017 time-study). The-focus of the-study was on printing-section of the-finishing-department, at the-mill.

2.2. Instruments, used.

Combination of observational-methods and questionnaires in MSDs risk-assessment has-been recommended, in the-literature (see Barriera-Viruet *et al.,* 2006; Stock *et al.,* 2005; Spielholz *et al.,* 2001). The-following-instruments, therefore, were used: document-analysis, the-standardized Nordic questionnaire, observations, and secondary-data, on sick-leave-days, taken by the-workers, for previous-three-years. Nordic-questionnaire was-designed to-answer the-following-question: "Do musculoskeletal troubles occur in a-given-population, and if so, in what parts of the-body are they localized?"

2.3. Terminology applied: Differences between 'hazard' and 'risk' (in the-context of OSH)

Two-terms; 'risk' and 'hazard' were used in-the-title of this-paper. Interestingly, people, often, use them, interchangeably. The-terms, however, are principally-different, necessitating some-explanations, to-benefit the-potential-readers.

Many-stakeholders, do, at-times, confuse the-terms 'risk' and 'hazard'; in a-detailed-study by Peter Wiedemann and his-colleagues, for the-German-Federal Risk-Assessment-Bureau, over 80 % of respondents confused the-terms (Ulbig *et al.,* 2010).

Analogous, the-meaning of the-word 'hazard' can-be perplexing, for-many. Frequently, dictionaries do *not* give specific-definitions, or they combine-it-with the-term 'risk'. For-example, one-dictionary defines a-hazard as 'a-danger or risk', which-helps-explain, why many-people use the-terms, interchangeably. Nevertheless, there is a-fundamental and paramount-difference, between the-two, which is important to-understand. The-author, hence, have tried to-explain it, in-the-following-segments, with the-help of simple-illustrative-examples.

A-hazard is something that can-cause harm (e.g. chemicals, noise, etc.), so it-is something, that is *potentially*-harmful. *A-risk,* on the-other-hand, is the-level of likelihood of that potentiality (high, medium, or low) that a-particular-hazard will *actually* cause harm, to-somebody, or something.

Examples of hazards could-include: working with heavy-machinery; using chemicals, at-work; a-poorly-set-up workstation; or strained-office-relationships. A-risk would be a-danger, that these-situations may-pose; for-example, physical-injury, chemical-burns, Repetitive-Strain-Injury (RSI), or increased stress-levels, respectively.

A-hazard is *any-source* of *potential* damage, harm, or adverse-health-effects, on something, or someone (for-example, to-people, as-adverse-health-effects; to-organizations, as-property or equipment, losses; or to-the-environment). A-general-definition of adverse-health-effect is 'any-change, in body-function, or the-structures of cells, that can-lead to-disease, or health-problems'. Adverse-health-effects include: bodily-injury; disease; change in the-way, the-body-functions, grows, or develops; effects on a-developing fetus (teratogenic-effects, fetotoxic-effects); effects on children, grandchildren, etc. (inheritable genetic-effects); decrease in life-span; change in mental-condition, resulting from: stress, traumatic- experiences, exposure to-particular-chemicals, and effects on the-ability to-accommodate additional-stress (Ulbig *et al.,* 2010).

The-CSA Z1002 Standard 'Occupational health and safety - Hazard identification and elimination and risk assessment and control' uses the-following-terms: *Harm* - physical-injury or damage, to-health; and *Hazard* - a potential-source of harm, to a-worker. Workplace-hazards can come from a-wide-range of sources. General-examples include any: substance, material, process, practice, etc., which has the-ability to-cause-harm, or adverse-health-effect, to a-person, or property.

According to Duffus & Worth, a-common-way, to-classify hazards, is by-category: (1) *biological* - bacteria, viruses, insects, plants, birds, animals, and humans, etc.; (2) *chemical* - depends on the-physical, chemical, and toxic-properties of a-substance; (3) *ergonomic* – repetitive-movements, improper-set-up of workstation, etc.; (4)

physical - radiation, magnetic-fields, pressure-extremes (high-pressure, or vacuum), noise, etc.; (5) *psychosocial* - stress, violence, etc.; and (6) *safety* - slipping/tripping hazards, inappropriate-machine-guarding, equipment-malfunctions, or breakdowns.

Workplace-hazards also-include practices or conditions, that release uncontrolled-energy, like (WorkSMART, 2017): (1) an-object, that could-fall, from a-height (potential or gravitational-energy); (2) a-run-away chemical-reaction (chemical-energy); (3) the-release of compressed-gas or steam (physical-energy, such-as: pressure; and high-temperature); (4) entanglement of hair, or clothing, in rotating-equipment (kinetic-energy), or (5) contact with electrodes, of a-battery or capacitor (electrical energy).

However, a-hazard just *has* the-possibility or causing harm; it-is *not* currently causing harm, and is *not* likely to-cause harm, without an-acting-stimulant (behaviour, reaction, action, or inaction). For-example: Hydrogen-Peroxide is an-industrial-bleach, and it-is a-chemical-hazard. When it-is used, and stored-properly, it-is *not* causing any-harm. However, if it-is misused, or say, drank, then it-will-cause damage. This-possibility, that it-will cause-harm, is called risk. On-the-other-hand, the-possibility, of someone drinking bleach, is low.

Risk, is the-chance, or probability, that a-person will-be-harmed, or experience an-adverse health-effect, if exposed to a-hazard. It may also-apply to-situations with-property or equipment-loss, or harmful-effects on the-environment. The-CSA Z1002 Standard 'Occupational health and safety - Hazard identification and elimination and risk-assessment and control' uses the-following-terms: *Risk* – the-combination of the-likelihood of the-occurrence of a-harm and the-severity, of that-harm. *Likelihood* – the-chance of something happening (whether defined, measured, or determined, objectively or subjectively, qualitatively or quantitatively, and described using general-terms or mathematically (e.g., a-probability, or a-frequency, over a-given-time-period). For-example: there is a-risk, of developing lung-cancer, from smoking cigarettes; of slipping on-the-wet-floor and breaking a-bone; of developing skin-cancer, from long-term-exposure to-the-sun, etc.

Factors, which influence the-degree, or likelihood, of risk are: (1) the-nature of the-exposure: how much a-person is exposed, to a-hazardous-thing, or condition (e.g., several-times, a-day, or once a-year); (2) how the-person is exposed (e.g., breathing in a-vapour, skin-contact, or digestion), and (3) the-severity of the-effect. For-example, one-substance may cause skin-cancer, while another may cause skin-irritation. Obviously, cancer is a-much-more-serious-effect, than irritation.

In-summary, hazard is an-inherent-root of a-*potential*-harm; it-is a-thing, or a-situation, that has the-potential to-cause loss, an-undesirable-outcome, or damage. Hazard can become risk, but needs a-stimulant, or a-particular-behavior, for-the-transformation, to-occur. Risk is the-degree of possibility of that-hazard to *actually* cause-harm, in-conjunction-with the-potential-consequences, of such-harm (the-outcome). A-risk is a-*possible*-threat/danger, which, hence, may, or may *not*, happen. Essentially, risk is the-rating, that demonstrates chances, that somebody or something (a-human, an-organism, or the-environment) will-be hurt, by a-hazard. The-risk-rating is usually, measurable, in-degrees, such-as: high, medium, or low.

3. Results and Analysis.

3.1. Questionnaire

Standardized-Nordic musculoskeletal-questionnaire, for assessing prevalence of work-related MSDs- is repeatable, sensitive and useful, as a-screening and surveillance-tool, for WRMSDs (see Medicine, 2007). It was, hence, used by many-researchers, for-instance: Deyyas & Tafese, (2014); Tafese *et al.,* (2014); Girma (2014); and Medicine (2007), among-others. Likewise, in-this-study, it was used as a-reference-point, for-developing the-final-questionnaire, for the-survey. This-research complies with the ISO 20252:2006 (E) Market, Opinion and Social-Research Standard; hence a-preliminary-study was-conducted on one-machine-operator, from a-different-department. Afterwards, the-questionnaire was, largely, adopted, from the-standardized Nordic-model, with minor-modifications/simplifications.

Verbal-consent was obtained, from-respective-participants, after a-necessary-explanation, about the-purpose, and the-procedure, of the-study. Participation was on-voluntary-basic, and was-done anonymously.

3.1.1. Demographic-Information

12 questionnaires were-administered to-the-entire-staff (machine-operators) of the-finishing-department, printing-section; the-response-rate (RR) was 66.7%. Table 1 shows the-demographic-characteristics of the-respondents.

Table1: Demographic-information of the-respondents.

	Mean	S D	Range
Age (yrs)	25.375	10.23	24 - 43
Duration of Employment (yrs)	2. 75	2.18	1 - 8
Height (cm)	169.07	11.84	146 - 182
Weight (kg)	65.375	9.80	54 - 85

3.1.2. Self-Reported pain/discomfort

Workers were-asked about perceived-pain or discomfort, which lasted, for at-least 24hours, in: (1) the last12months; (2) last-month; and (3) last-7days. Figure 1, showing nine-anatomical-regions of a-human body, was included in the-questionnaire, for guidance in proper-identification and terminology of affected-body-regions. The-presence of WRMSDs was measured by the-recall and self-declaration of pain.

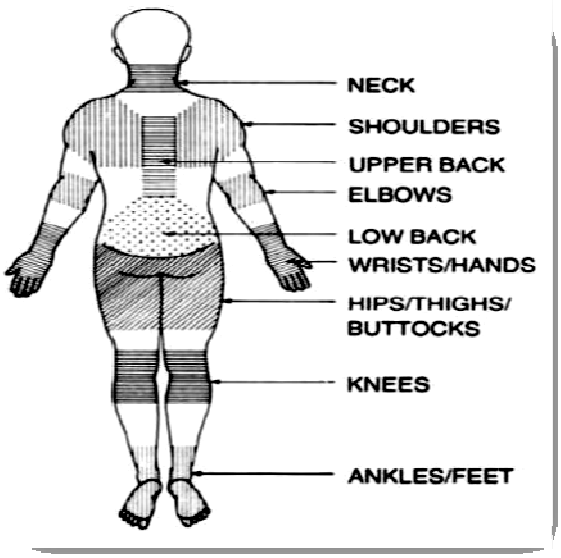

Figure 1: Nine-reference-areas (anatomical-regions) of a-human-body (Medicine, 2007).

Responses are summarized in Figure 2.

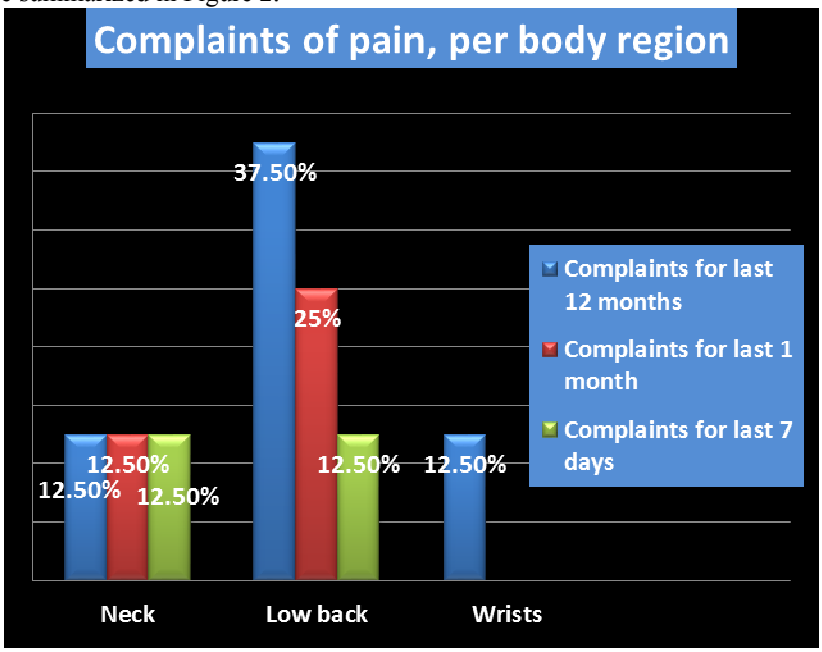

Figure 2: Pain-complains vs. body-area.

From Figure 2, low-back body-region received the-highest-number of complains, of pain, lasted, for at-least 24hours, for the-last-year (37.5%); last-month (25%); and last-week (12.5%). This-finding is in-accord with the-WHO-report stating, that: 'Of all the occupational risk factors, low back pain constituted 37% and ranks first among the complications caused at work' (Artaria & Settimi, 2002). Moreover, Smith *et al* (2004) subdivided the-back into the-upper-section, constituting of the-thoracic-spine, and lower-sections, comprising of the-lumbar,

sacrum and coccyx. He reported, that most-common body-site, that is affected, is the-lower-back, with prevalence of 56.7%, followed by the-neck, with 42.8%. Back-pain causes 0.8 million disability-adjusted-life-years (DALYs), each-year, and is a-major-cause of absence, from-work and of correspondingly-high-economic-losses. Nearly 40 % of back-pain is due to-occupational risk-factors (Connelly *et al.,* 2005). Moreover, Pope (1991) identified back and lower-limb-disorders, as occurring disproportionately, among workers of selected-manufacturing-sectors.

The-second-area of concern, raised by the-respondents, was neck, receiving 12.5% of complains, for each of the-time-periods. Study by Hagberg *et al* (1995) also-reported that muscular-pain, in the-neck and shoulder, is more-frequent, in the-worker-population. 12.5% of the-respondents also-complained on the-pain in wrists, experienced during last-year. Other-areas were *not* identified, as painful, at any-reference-stage.

3.1.1. WRMSDs vs. age

Figure 3 shows the-proportion of workers, complaining on WRMSDs vs. their-age.

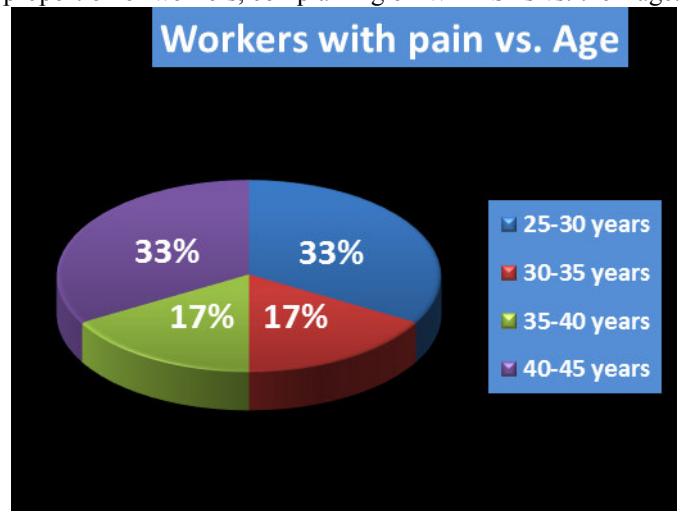

Figure 3: MSDs complains vs. Age.

From the-pie chart, it-is apparent, that most-complains (66%), came from both; the-youngest (25-30 years old) and from the-oldest-workers of 40 to 45 years-old. There is *no* trend, observed; the-study, hence, suggests that there is *no* obvious and direct-correlation, between age and WRMSDs pain-complains.

This-finding is in-accord with the-study by Taghinejad *et al.* (2016), stating, that: 'Some individual factors such as age, weight, height, body mass index (BMI), and gender, had *no* significant association with MSDs'. In-addition, Benjamin & Wilson (2005) discuss the-concept of 'determinants of health' and concluded, that lifestyle, education, socio-economic-status, genetics, stress, exercise, nutrition, and healthcare-needs, have an-equal, if *not* greater-importance, than age, as-determinants of individual-health.

In-contrast, Guo *et al.* (2004) found, that age had a-significant-association with MSDs. Other-studies also-reported higher-incidents of WRMSDs, for older-workers, than younger-ones (Whiting, 2005; Hartman *et al.*, 2003; Holmstrom & Engholm, 2003; Peek-Asa *et al.*, 2004; Hotopp, 2007; Taimela *et al.*, 2007; Silverstein, 2008). Between the-ages of 51 and 62 years, the-prevalence of MSDs may-increase, as-much-as 15%, among workers, in physically-demanding-occupations (Ilmarinen, 2002), especially where such-occupations do *not* maintain, or improve-strength (Savinainen *et al.,* 2004). Holrcomb *et al.,* (2009) also-concluded, that 'MSDs were more-common, in female-workers, and increased with-age, and years of service'. Likewise, studies by Ahmed & Raihan (2014); and Akhtar *et al.* (2007) concluded, that age is affecting WRMSDs. Besides, according to ILO (2004), at the-age of 55-64 years, the-number of self-reported-MSDs-symptoms is 1.7 times higher, than at the-age of 25-34 years. Moreover, according to Belin *et al.* (2011), WRMSDs, in-particular, can-occur, more-frequently, in-ageing workers, because the-ageing-process reduces the worker's muscular-strength, which leads to a-decrease in the-load-bearing-capacity of their-musculoskeletal-system. For-example, Jones *et al.* (2006) in their-study on Great-Britain, reported, that MSDs is the-most-frequently-reported occupational-illnesses among *older*-workers (Silverstein, 2008). Peele *et al.* (2005) also-reported, that MSD might-have a-more pronounced-effect on older-workers, than young workers.

Generally, ageing is associated with decrements in-cognitive-functions, health, and recuperative ability. These include: decreased-aerobic-capacity, lower-heat-tolerance, reduced-muscular strength, slower reactions, and a-decline, in-visual-acuity, and hearing-ability (Pransky & Benjamin, 2005). Any occupational-risks, to which ageing-workers are exposed, will-be-superimposed, on their-existing health-problems, or will-amplify the-natural-deterioration of their-sensory and physical-capacities (EFILWC, 2008). Study by Crawford *et al.* (2009) also-pointed-out, that older-workers need improved-coping-strategies, to-deal with work-related-stress.

The-studies on functional-capability indicate age-related-changes in functional-capabilities of adults, and it-

is generally agreed, that average-humans are *not* able to-perform, to-the-same-level, as when they were young (Kenny *et al.*, 2008; Welch *et al.,* 2008; Attwood, 2005; Kowalsi-Trakofler *et al.*, 2005; Savinainen *et al.*, 2004). In-terms of WRMSDs, there are 3 main-musculoskeletal-changes reported in the-literature: (1) a-reduction in-joint mobility; (2) decrease in-muscular-strength; and (3) the-slowing of reaction and movement-times. Leaviss *et al*. (2008) presents data, that indicates the-physical-work-capacity of a-65-year old is around-half, that of an-average 25-year-old-worker.

It-has also-been-suggested, that biological-changes, related to the-ageing-process, such-as: degenerative changes to muscles, tendons, ligaments, and joints, contribute to-the-pathogenesis of MSDs (Cassou, *et al.,* 2002). Furthermore, studies indicate, that aged-workers suffer-more-serious, but less frequent workplace-injuries, than younger-workers, and that MSDs are, often, the-result of a-failure, to-match the-work-based-requirements, of a-task to the-functional-capacity of workers (Silverstein, 2008). A-chronic-overload, for the-elderly-worker, caused by a disruption, of the-balance, between physical workload and physical-work-capacity, can aggravate the-development of WRMSDs. Thus, older-workers, in physically-demanding-occupations, are more-likely to-report musculoskeletal-injury and complaints (back, neck, upper/lower extremities), than their-younger-counterparts.

On-the-other-hand, several-studies also-identified, that human-functional-capacity declines progressively with age, and that several-factors, other than chronological-age, such-as level of physical activity, and the-demands of the-work, tend to-contribute-more, to-susceptibility for MSDs, during-work (see Pransky & Benjamin, 2005; Werner *et al.,* 2005; Ghasemkhani *et al.* 2006; Antonopoulou *et al.,* 2007; Lin *et al.,* 2008). These-studies all reported lower-levels of risk, for increasing-age, compared with other-risk-factors, or they reported higher-risk-levels, for younger-workers, compared to-older-workers. Also, studies such-as Hartman *et al.* (2003); Roquelaure *et al.*(2004); and Hotopp (2007), suggested that irrespective of their-age, workers employed in physically-demanding-occupations, where they are exposed to-challenging-tasks, are more-likely to-report underlying-health-problems, than those in sedentary- occupations.

Moreover, McNair & Flynn (2008), suggested that work-performance, in most-jobs does *not* decline, with-age, before the-late 60s, particularly when the-individuals are healthy, motivated and kept-up-to-date. Welch *et al.* (2008) found, that increasing-age was associated-with reduced-physical-functioning, independent of the-presence of medical-conditions, or MSDs. Changes in-physical-abilities, encountered with-ageing, are however, influenced by individual-genetics, and lifestyle, as-well-as the-working and living-environment (Kenny *et al.*, 2008; Buchman *et al.,* 2007). Therefore, highly-trained older-individuals may, in-reality, be-able to-outperform those, much-younger, than them.

Dissimilar-findings and views were presented, in the-given-narrative; one-thing is apparent, however, that degenerative-age-related-processes, and their-effects on MSDs, are more-pronounced, with workers, in their-late 60^{th}. In-this-study, however, the-oldest-respondent was *only* 43 years-old, and hence, although older, than the-rest of the-respondents, he can*not* be-qualified-as old-person, but, rather, 'middle aged'. Consequently, the-earlier-suggestion, that age does *not* affect WRMSDs, stands, for this-particular demographic-group.

3.2. Medical records on sick-leave-days.

The-clinical-officer, of REAL, provided retrospective-data (for the-last 3 years) on the-sick-leave days, taken by the-mill-workers, and the-finishing-department-workers. 4 types of MSDs, which affect most of the-workers, were: low-back-pain; hand, wrist, and forearm-pain; neck-pain; and arthritis.

There were a-total of 70 sick-leave-days in the-year 2014, from the-whole-factory. Out of this 70, 19 were from the-finishing-department, which corresponds to 27.14% of the-total-number of sick-leave-days, sought that year. In the-year 2015, there were a-total of 61 sick-leave-days, due to-MSDs; 19.7% were from the-finishing-department. In the-year 2016, there were a-total of 85 sick-leave-days; 27.1% were from the finishing-department. Figure 4 shows the-number of sick-leave-days, due-to MSDs, for the-whole-factory.

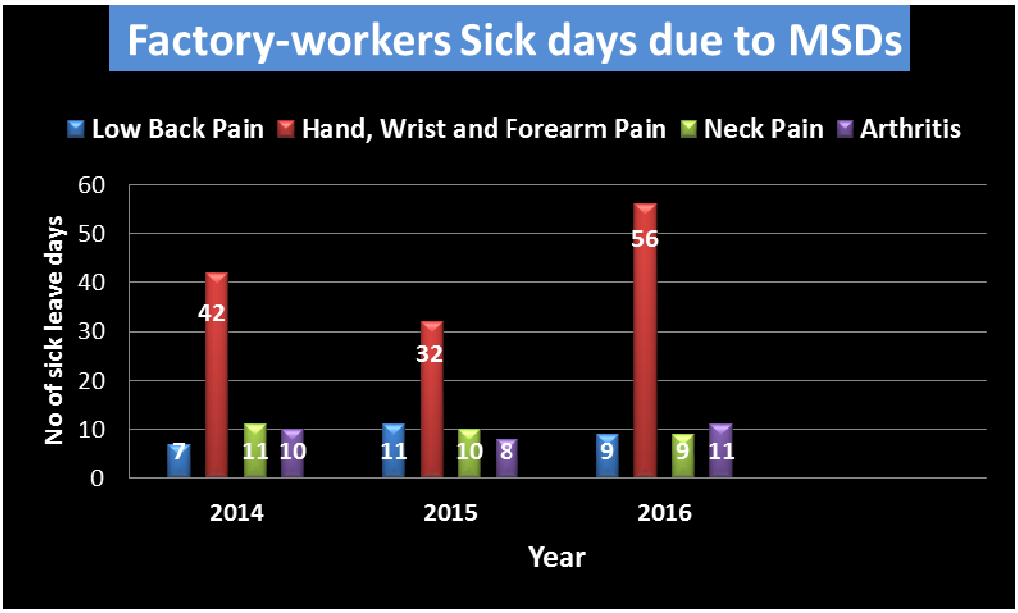

Figure 4: Sick-Leave-days, due-to MSDs, for the-entire-factory

For the-three-reported-years, the-highest-number (60%) of sick-leave-days, among factory-workers, attributed-to MSDs, was due-to hand, wrist, and forearm-pain, or injury. For, finishing-department, the-same-trend accounted for 55%, which is shown in Figure 5, while Figure 6 shows the-number of sick-leave days, due to-other work-related-hazards, in the-finishing-department.

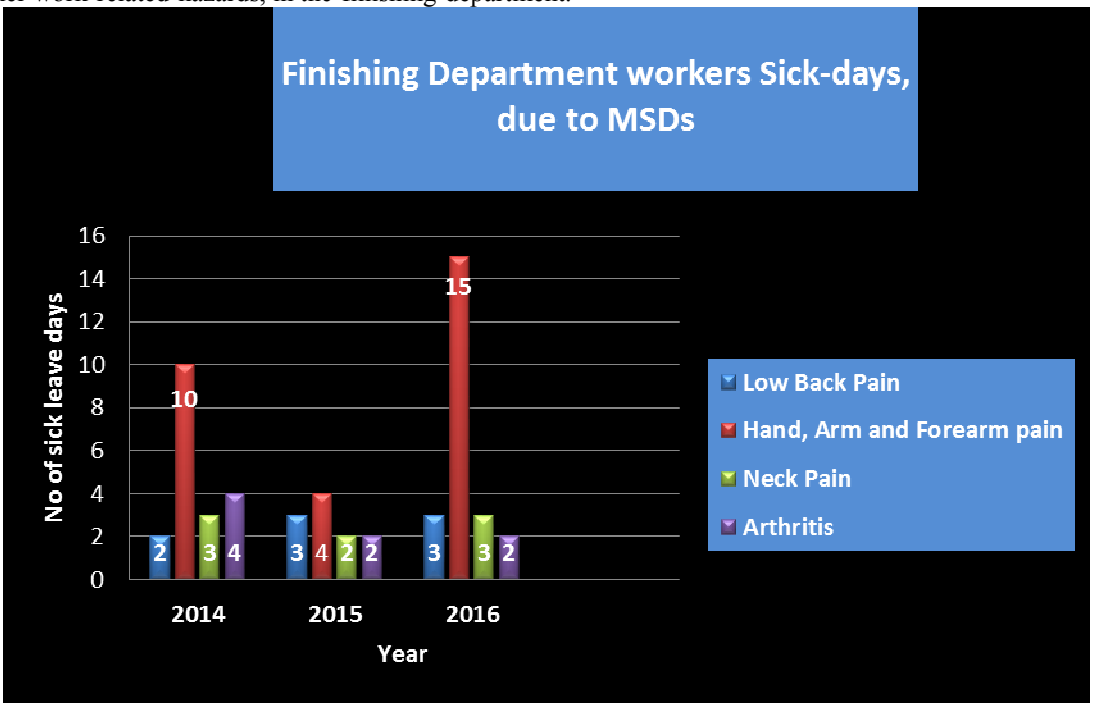

Figure 5: Sick-Leave-days, due-to MSDs, for the-finishing-department

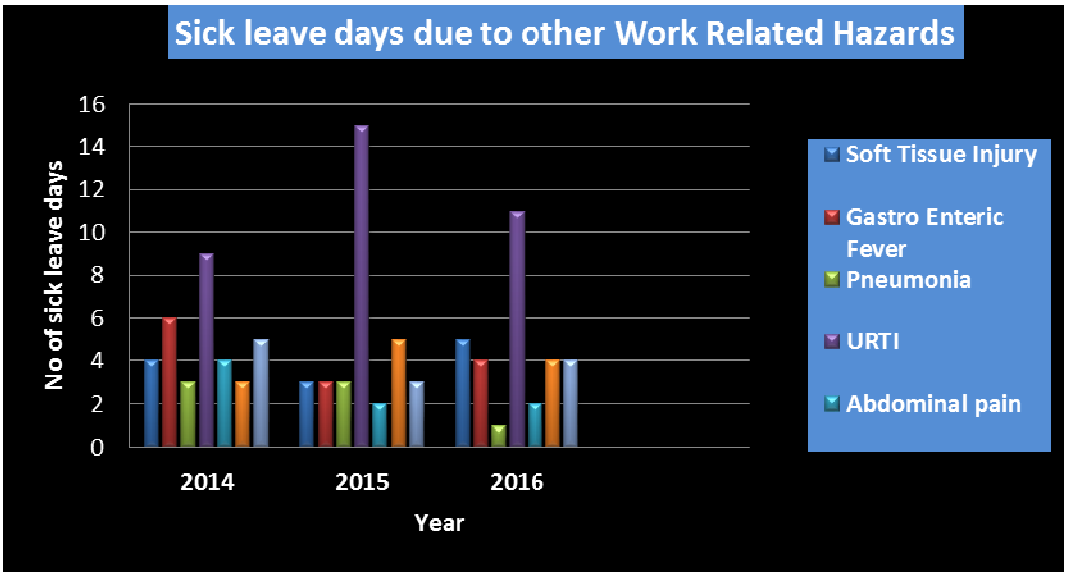

Figure 6: Sick-Leave-days, due to-other Work-Related-Hazards, in the-finishing-department

From the-Figure 6, the-highest-number of sick-leave-days, for the-three-years, was attributed to upper respiratory tract-infection (URTI). This was, rather, expected, as REAL is cotton-processing-mill, where cotton-dust, is common, especially in-the-fibre-preparatory-sections.

Cotton-dust is considered-as biological-occupational-hazard, leading to '*Byssinosis*', also-known-as: strippers-asthma, grinders-asthma, or card-room-asthma. It-is-classically characterized-as shortness of breath; cough, and tightness of chest, on-Monday, or the-first-day, of return to-work, after a-time-off. It-is, hence, also-called 'Monday morning dyspnea', characterized by respiratory-symptoms both; histologically and physiologically, with decline of the-respiratory-function (Memon *et al.,* 2008). The-symptoms can progressively-become-worse, leading, to-increased-occurrence of both; disruptive and restraining lung-function, resulting, in-some-cases, to a-partial, or complete- lung-failure (Hinson *et al.,* 2016).

Byssinosisis a-chronic respiratory-disease, that is seen among-workers, exposed to-dust, *not* only-from cotton, but-also from flax, or soft-hemp (Khan & Nanchal, 2007). Hinson *et al.* (2016), in-their-study, identified the-prevalence of Byssinosisis, among textile-workers, as-high-as 44%.

Although in the-industrialized world, there has-been a-significant-decline, in the-prevalence of cotton-dust lung-diseases, studies show an-increasing-incidence, in the-developing-world. The-prevalence of byssinosis in Africa was-as-follows: in Sudan 42%; in Ethiopia, 43% (1991) and 44% (1994); in Benin 21.1% (2014) (Hinson *et al.,* 2014; Christiani *et al.,* 1994; el Karim *et al.,* 1986; Woldeyohannes, *et al.,* 1991). Prevalence of Byssinosisis, elsewhere, are-as-follows: in 2002, in Turkey- 14.2%, and in Indonesia- 30%; in Pakistan: 35.6% (2008) and 10.5% (2013) (Nafees *et al.,* 2013; Memon *et al.,* 2008; Altin *et al.,* 2002; Baratawidjaja, 1990). The-prevalence of the-disease varies, greatly, from 1.5 to 59%, according to-studies by Da Costa *et al.*(1998); Li *et al.,* (1995); Glindmeyer *et al.*(1994); Aziz *et al.*(1994); and Doker *et al.*(1991). Hinson *et al.* (2016) also-concluded, that even the-unexposed-workers also-had byssinosis-symptoms; 'it is not just the-workers, directly-working, with cotton, who are-affected, it is those working in administration and even neighbors who are affected'. Besides, Laraqui *et al.,* (2002) showed, that the-prevalence of byssinosis varies according to-the-type of cotton, used (raw, coarse, middle, or thin), tobacco-consumption, the-level of dust, at the-workshops, and professional-seniority.

Although, this-finding was *not* directly-related to the-main-subject of investigation—MSDs; it can*not* be ignored. In-addition, there is a-scarcity of data, showing correlation of cotton-dust and prevalence of URTI, particularly byssinosis. Hence, further-comparative-studies are recommended on the-respiratory symptoms, among workers, exposed and unexposed, to cotton-dust, at the-mill. To-come-up with tailored-solutions, to this-problem, the-standard-questionnaire of the-International-Commission on Occupational Health (ICOH) can-be used.

From the-data above, the-total-number of sick-leave-days, in the-finishing-department, for the-last three-years was 150; 54 being, due-to MSDs, constituting 36%. Figure 7 shows the-comparison of sick-leave-days, due to MSDs, and other-work-related-hazards. 36% MSDs contribution, compares-well with findings by Riihimäki (2004), however, it-is much-less, than in the-study of Akelo (2013), probably, due-to the-different-nature of occupations, involved.

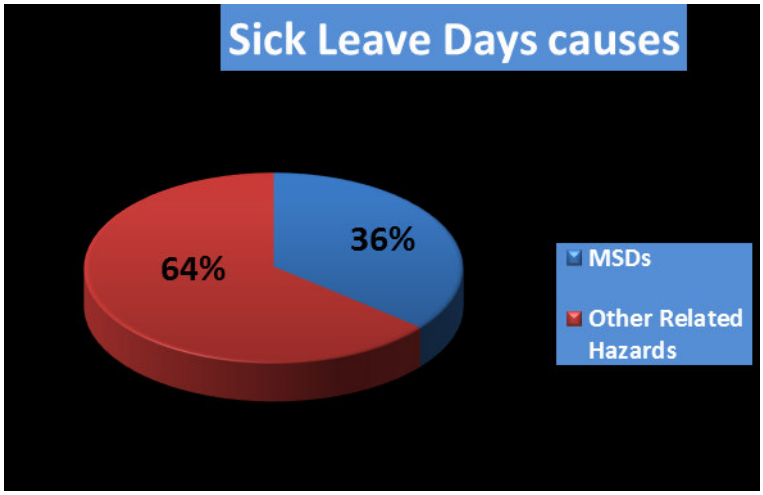

Figure 7: Comparison of sick-leave-days, due to MSDs and other work-related-hazards

According-to the-company-policy, workers, who are on-sick-leave, are paid their-full-salary, for the-first three-months, after-which, they are-paid-half their-salary. The-average-monthly-salary, of a-machine-operator, in the-finishing-department is KES 17,000 (around USD 170). Considering, that for the-last 3years, there were *no* cases, where sick-leave lasted for more, than 3months, and that, they usually operate 5.5 working-days, per-week (including half of Saturdays) at 8 working-hours, per-day; meaning, that each-day, a-worker is on a-sick-leave, due-to MSDs, the-company pays KES 773, for a-day, they have *not* contributed to the-production. This brings the-partial-cost to the-company, due MSDs sick-leave-days, in the-finishing department, to KES 115,950 (USD 1,159.5). This-cost, however, does *not* include direct-costs and quality of life costs. To-reduce or eliminate such-avoidable-expenses, the-administration of the-mill should-focus on elimination or reduction of MSDs.

4. Discussion.

This-section covered numerous-issues, relevant to the-fingings.

4.1. Government-law, to-control and promote, occupational-health and safety.

In-developing-countries, especially those, with high-rates of unemployment, it-is tempting, for employers, who build up-small and middle-sized-industries, to-disregard safety and health (Cakmak *et al,* 2004; Punnett, 2002). In-Kenya, to-protect from such-temptations, and bad-occupational-practices, in-terms of law, there is Occupational-Safety and Health-Act, of 2007 (Kenya Gazette Supplement, 2007), which is an-act of parliament, to-provide for the-safety, health, and welfare of all-persons, lawfully-present, at-workplaces. The-Act states, that every-occupier shall-carry-out appropriate-risk-assessments, in-relation to-the-safety and health, of persons, employed, and on-the-basis of these-results, adopt preventive and protective-measures, to-ensure, that under-all-conditions of their-intended-use, all-chemicals, machinery, equipment, tools, and processes, under the-control of the-occupier, are safe, and without-risk, to-health. The-act defines an-occupier as an-employer, or owner, of a-work-place. Failure to-comply with this-duty, is an-offence, and the-occupier, shall, on-conviction, be-liable to-a-fine *not* exceeding KES 500,000 (USD 5,000), or to-imprisonment for a-term *not* exceeding six (6) months, or to-both. This-duty, imposed, is believed to-play a-big-role, in the-prevention of MSDs, and other-occupational-injuries, in-Kenya. Under the-prevailing-practices, however, Kenya might-have the-best-laws and legislation, but it worth little, without proper-implementation. This-study, therefore, recommends for further-country-wide-investigation on this-Act, and its implementation-history, and challenges, faced, up to-date.

On the-other-hand, according to Dessler (2008), a-safe-working-environment does *not* just-happen; it has to-be-created. The-most cost-effective-way, to-prevent MSDs, is to-integrate prevention, into-industrial-practices.

4.2. Prevention of MSDs

Employers can-prevent WRMSD-hazards, by-incorporating engineering, administrative, and work-practice control-methods. Fist, however, comprehensive-job-analysis should-be conducted. In-this-light, the-study proposing to-conduct a-further-research, to-identify postures and working-practices, leading to WRMSDs, at the-finishing-department.

Based on information from the-job-analysis, an-employer can-establish procedures, to-correct or control risk-factors by using: workstation, tool, and equipment-designs or redesigns; using proper-lifting- techniques and keeping work-areas clean; worker-rotation, more task-variety, and increased-rest-breaks; provision and use of personal-protective-equipment, such as knee-pads, vibration-gloves, and similar- devices.

Moreover, administration should-familiarize them-selves with the-European-standards, which focus on

allowable-parameters, relating to-posture, exerted-force, and the-frequency of movements. These-parameters determine musculoskeletal-loads, that might-cause WMSDs. The-relevant-standards are, as-follows: EN-614-1: Safety of machinery, ergonomic-design-principles and terminology, and general-principles; presents overall-rules, related to-design-process, with consideration of anthropometry and biomechanics; EN 614-2: Safety of machinery, ergonomic-design-principles and interaction, between machinery-design and work-tasks; EN-1005-4: Safety of machinery, human-physical-performance and evaluation of working-postures, in relation to-machinery; and EN ISO 9241-2: Ergonomic-requirements for office-work, with visual-display-terminals (VDTs); guidance, on task-requirements.

5. Conclusion and Recommendations.

This-study revealed, that the-majority of the-workers had-been-suffering from some-kind of MSDs, depending upon the-nature of work. From nine-body-regions, lower-back-pain and neck-pain were dominant. The-study also identified the-retrospective-prevalence of MSDs, at the-factory, and at-the-finishing department, as-well-as expenses, and loss of manpower, as a-result of sick-leave-days, due to-MSDs.

Besides, it-is-worth to-point-out, that this-miniature *unfunded*-study had several-limitations. The-one-year MSDs pain-complains maybe under or over-estimated, due to-recall-bias. Also, there was *no* measurement-scale, for measuring the-intensity of the-pain or discomfort, which was-reported, by the-respondents. Finally, the-sample-size, due to-some-financial and time-constrains, was rather-small, limiting generalability of results.

Nevertheless, the-study provides some-evidence and indicative-data, on MSDs, at the-mill, which can-be used by the-mill-administration and policy-makers, to-improve strategies of integrating proper-ergonomic-principles, in their-working-practice. Finally, the-study contributes (in its-small-way) to-existing-body of knowledge, on the-subject-matter.

The-main-recommendations were on future-studies: (1) to-identify postures and working-practices, leading to WRMSDs, at the-finishing-department; (2) to-compare respiratory-symptoms, among workers, exposed and unexposed, to cotton-dust, at the-mill; and (3) to-investigate (country-wide) implementation history, and challenges, faced, up to-date, on the-Occupational-Safety and Health-Act, of 2007.

6. Acknowledgment.

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