HHS Public Access

Author manuscript

Proc Congr Int Ergon Assoc (2021). Author manuscript; available in PMC 2021 July 23.

Published in final edited form as:

Proc Congr Int Ergon Assoc (2021). 2021 ; 222: 677–681. doi:10.1007/978-3-030-74611-7_93.

Work-Related Exposures and Musculoskeletal Disorder Symptoms among Informal E-Waste Recyclers at Agbogbloshie, Ghana

Augustine A. Acquah[1], **Clive D'Souza**[2], **Bernard Martin**[2], **John Arko-Mensah**[1], **Isabella A. Quakyi**[1], **Niladri Basu**[3], **Thomas G. Robins**[4], **Julius N. Fobil**[1]

[1]Department of Biological, Environmental & Occupational Health Sciences, School of Public Health, University of Ghana; P.O. Box LG13, Accra, Ghana

[2]Center for Ergonomics, Department of Industrial & Operations Engineering, University of Michigan, Ann Arbor, MI 48109-2117, USA

[3]Faculty of Agricultural and Environmental Sciences, McGill University, Montréal, QC H9X 3V9, Canada

[4]Department of Environmental Health Sciences, University of Michigan, Ann Arbor, MI 48109-2029, USA

Abstract

Recycling of electrical and electronic waste (e-waste) in developing countries is mostly conducted in the informal sector consisting of low skilled workers. Informal e-waste recycling predominantly involves the physically demanding work of manually collecting, dismantling and burning of e-waste items to extract reusable components and valuable metals including gold or copper. This cross-sectional study investigated the effects of manual e-waste recycling work on the musculoskeletal health of 176 workers at Agbogbloshie in Accra, Ghana – the largest informal e-waste dumpsites in Africa. Findings indicate significant associations between prolonged walking and weighted MSD symptom scores for the lower extremities, and between manual material handlings tasks and weighted MSD symptom scores for the upper extremities and lower back. The study calls attention to the need for ergonomics research in the informal work sector to promote safer practices and address a range of worker health concerns.

Keywords

Electronic Waste; Informal Work; Musculoskeletal Disorders; Exposure

1 Introduction

High demand and overconsumption of electronic and electrical appliances (e.g., computers, cellphones, and refrigerators) has created a global challenge of managing discarded and waste products [1,2]. Each year vast amounts of discarded electronic and electrical waste (e-

crdsouza@umich.edu.

waste) from Europe and North America make their way into developing countries under the guise of donations and end up at dumpsites [3,4].

The processing and recycling of e-waste in developing countries is almost exclusively manual, informal, unregulated and conducted by low-skilled workers, with little or no attention to occupational health and safety practices such as the use of personal protective equipment or properly designed workstations [5].

This study focused on Agbogbloshie in Accra, Ghana. Agbogbloshie is the largest dumping ground for e-waste in sub-Saharan Africa and among the busiest informal e-waste recycling sites in the world [3,6]. Multiple recent studies conducted at Agbogbloshie document the environmental effects of informal, unregulated e-waste recycling [7,8]. Studies also suggest a high level of manual material handling (MMH; e.g., lifting, carrying) in a harsh outdoor environment [9–12]. These conditions are known risk factors for work-related musculoskeletal disorders (MSDs), however, little is known about their effects on the musculoskeletal health of informal e-waste workers (EWWs).

The objective of this study was to investigate the relationship between self-reported ergonomic exposures and work-related MSD symptoms in a diverse cohort of EWWs at the Agbogbloshie e-waste dumpsite and non-EWWs at a comparison site.

2 Methodology

2.1 Study Sample

The study was conducted from August to October 2018 using a cross-sectional design. The study recruited 176 EWWs (including 73 e-waste collectors, 82 dismantlers and 21 burners) at the Agbogbloshie site, and 41 reference workers from a comparison site – Madina Zongo (MZ), that were not engaged in e-waste processing. The ethical review committee of the University of Ghana, College of Health Sciences approved the study. All participants provided written informed consent.

2.2 Data Collection Procedure

First, participants were administered a questionnaire to obtain information on age, gender, primary job category, years of working in the current job, typical hours worked per day, and days worked per week.

Next, the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) was administered to obtain information about MSD symptoms [13,14]. The CMDQ assesses musculoskeletal symptoms collectively described as discomfort, aches and pains experienced in the last 7 days for 11 different body parts on three rating scales, *frequency*, *severity*, and *work interference*. An aggregate MSD symptom score, referred to as *pain score* was computed by multiplying the weighted *frequency* (0, 1.5, 3.5, 5.0, 10.0), *severity* (1.0, 2.0, 3.0) and *work interference* (1.0, 2.0, 3.0) ratings. Weighted scores were obtained for four body regions, lower extremities (sum of both knees, lower legs, thighs, and hips/buttocks), upper extremities (sum of both shoulders, upper arms, forearms, and wrists), the upper back and neck, and the lower back.

Lastly, a modified Occupational Physical Activity Questionnaire (Reis et al., 2005) was used to assess self-reported exposure to physical work factors characterized as the frequency of prolonged (> 4 hours) sitting, standing, and walking, and frequency of performing lifting, carrying, and pushing-pulling in a typical work-week on a 5-point ordinal scale [15]. For the present analyses, exposures were re-categorized as either 'high' (once daily or more) vs. 'low' (ranging from never to '3–4 times a week'). OPAQ also asks for the maximum weight handled during MMH on a 5-point scale in 5kg increments. For analysis, we re-categorized the maximum weight handled as either 'high' (> 10 kg) vs. 'low' (≤ 10 kg).

When responding to the CMDQ and OPAQ, participants were instructed to use the previous full workweek as the reference period (i.e., a 7-day period starting Monday morning). Questionnaires were administered in English, and when needed, explanations were given in Dagbani, the local dialect spoken by e-waste workers.

2.3. Statistical Analyses

Descriptive statistics for demographics, weighted pain scores, and physical exposures (binary) were computed for the EWW and MZ groups. Mixed effects analyses were used to examine the relationship between pain scores for each body region as the outcome variable, and demographics and binary exposure variables as predictors. We present only the reduced models. Statistical analyses were conducted in IBM SPSS v24.

3 Results

3.1 Summary Statistics

Participants were all men with an average ± SD age of 25.9 ± 7.3 years, work experience of 6.7 ± 5.8 years, and worked 6 ± 1 days/week and 9.9 ± 2.7 hours/day. Pain scores were significantly higher in the EWW vs. MZ group for the lower extremities (mean ± SD: 20.7 ± 32.6 vs. 7.3 ± 18.5; $p = 0.051$), upper extremities (21.0 ± 39.1 vs. 8.5 ± 21.7; $p = 0.012$), but not for lower back (12.1 ± 16.3 vs. 7.2 ± 13.0; $p = 0.077$) nor the upper back & neck (6.2 ± 12.1 vs. 3.3 ± 8.3; $p = 0.148$). Self-reported exposure to prolonged walking (53 vs. 16%), daily lifting (79 vs. 39%), carrying (77 vs. 29%), pushing-pulling (42 vs. 12%), and heavy load handling (90 vs. 42%) were higher in the EWW vs. MZ group; but similar in terms of prolonged standing (22 vs. 24%) and sitting (32 vs. 33%).

3.2 Associations Between Work Exposures and MSD Symptoms

Mixed effect analysis for lower extremity pain scores indicated significant effects of age ($B = -0.9 \pm 0.4$ unit decrease per 1-year age increase; $p = 0.017$), of days worked per week ($B = 5.8 \pm 2.6$ increase for every additional day worked per week; $p = 0.026$), for prolonged walking ($B = 15.0 \pm 5.4$; $p = 0.006$) and prolonged standing ($B = -24.9 \pm 6.4$; $p < 0.001$). Negative associations with age might suggest a healthy worker effect (i.e., affected workers leaving the work force over time), and for prolonged standing possibly due to less strenuous activity among workers standing compared to walking, respectively. Significant predictors of upper extremity pain scores were days worked per week ($B = 4.9 \pm 2.2$; $p = 0.025$) and maximum weight handled ($B = 11.9 \pm 5.3$; $p = 0.025$). Frequent lifting ($B = 4.7 \pm 2.3$; $p =$

0.048) was the only significant predictor of pain scores for the lower back. Pain scores for the upper back & neck were generally low and did not yield any significant predictors.

4 Discussion

EWWs at Agbogbloshie experience MSD symptoms substantially worse compared to a reference group of non-EWWs. Exposure to long bouts of walking, as well as frequent and heavy manual material handling by EWWs are directly associated with MSD symptoms in the lower and upper extremities and lower back, respectively. The equipment used for transporting (e.g., hand-drawn carts, wheelbarrows), dismantling (e.g., hammers, chisels, pliers) and burning (i.e., long metal rods for handling burning items) e-waste items is rudimentary and worn out [9]. Only 25% of e-waste workers wear any PPE, e.g., safety shoes and/or gloves [12].

Limitations of this study include its reliance on self-reported data (e.g., recall bias), the cross-sectional study design, and potential selection bias due to a healthy worker effect. Longitudinal studies using direct observations and instrumentation are warranted; however, these methods require extensive resources and ergonomics expertise.

5 Conclusion

This initial study provides evidence about the detrimental physical effects of informal e-waste recycling. By fostering international collaborations, the broader ergonomics community can help address some of the disproportionate occupational health and safety burden experienced by EWWs in developing countries. Example contributions include assisting with ergonomic exposure and MSD assessment research; facilitating dialog aimed at the development, implementation and evaluation of locally adapted injury prevention strategies, providing occupational health and safety training, and promoting awareness about and use of personal protective equipment. Potential ergonomics interventions would need to balance the objectives of reducing occupational and environmental exposures with maintaining job availability/security for the many workers who rely on informal e-waste recycling for their livelihood.

Acknowledgements

The authors are grateful to the e-waste workers at Agbogbloshie for their participation in this study. The authors also thank the field team and colleagues at the University of Ghana School of Public Health for their assistance in data collection.

This research was supported by the 1⁄2 West Africa-Michigan CHARTER in GEOHealth with funding from the US National Institutes of Health / Fogarty International Center (NIH/FIC) (paired grant nos. 1U2RTW010110-01 and 5U01TW010101) and Canada's International Development Research Center (IDRC; grant no. 108121-001). Co-authors C.D. and B.M. were partially supported by the training grant T42-OH008455 from the National Institute for Occupational Safety and Health (NIOSH), US Centers for Disease Control and Prevention (CDC). The views expressed in this publication do not necessarily reflect the official policies of nor endorsement by NIH, NIOSH, CDC, and/or the Canadian and US Governments.

References

1. Bakhiyi B, Gravel S, Ceballos D, Flynn MA, Zayed J: Has the question of e-waste opened a Pandora's box? An overview of unpredictable issues and challenges. Environ. Int 110(August 2017), 173–192 (2018). 10.1016/j.envint.2017.10.021 [PubMed: 29122313]
2. Perkins DN, Brune Drisse M-N, Nxele T, Sly PD: E-waste: a global hazard. Ann. Global Health 80(4), 286–295 (2014). 10.1016/J.AOGH.2014.10.001
3. Maphosa V, Maphosa M: E-waste management in sub-Saharan Africa: a systematic literature review. Cogent Bus. Manage 7(1) (2020). 10.1080/23311975.2020.1814503
4. Forti V, Baldé CP, Kuehr R, Bel G: The Global E-waste Monitor 2020: Quantities, flows, and the circular economy potential (2020). https://ewastemonitor.info/wp-content/uploads/2020/07/GEM_2020_def_july1_low.pdf. Accessed 25 Oct 2020
5. Oteng-Ababio M: When necessity begets ingenuity: e-waste scavenging as a livelihood strategy in Accra, Ghana. Afr. Stud. Q 13 (Spring 2012), 1–21 (2012)
6. Amoyaw-Osei Y, Agyekum OO, Pwamang JA, Mueller E, Fasko R, Schluep M: Ghana e-Waste Country Assessment: SBC e-Waste Africa Project, Secretariat of the Basel Convention, Châtelaine, Switzerland (2011). https://www.basel.int/Portals/4/BaselConvention/docs/eWaste/E-wasteAssessmentGhana.pdf. Accessed 21 Nov 2020
7. Srigboh RK,Basu N, Stephens J, Asampong E, Perkins M, Neitzel RL, Fobil J: Multiple elemental exposures amongst workers at the Agbogbloshie electronic waste (e-waste) site in Ghana. Chemosphere 164, 68–74 (2016). 10.1016/j.chemosphere.2016.08.089 [PubMed: 27580259]
8. Akormedi M, Asampong E, Fobil JN:Working conditions and environmental exposures among electronic waste workers in Ghana. Int. J. Occup. Environ. Health 19(4), 278–286 (2013). 10.1179/2049396713Y.0000000034 [PubMed: 24588034]
9. Acquah AA, D'Souza C, Martin B, Arko-Mensah J, Nti AA, Kwarteng L, Takyi S, Quakyi IA, Robins TG, Fobil JN: Processes and challenges associated with informal electronic waste recycling at Agbogbloshie, a suburb of Accra, Ghana. In: Proceedings of the 2019 Human Factors and Ergonomics Society Annual Meeting, Seattle, WA, vol. 63(1), pp. 938–942 (2019). 10.1177/1071181319631219
10. Acquah AA, D'Souza C, Martin B, Arko-Mensah J, Botwe PK, Tettey P, Nti AA, Kwarteng L, Takyi S, Quakyi IA, Robins TG, Fobil JN: A preliminary assessment of physical work exposures among electronic waste workers at Agbogbloshie, Accra Ghana. Int. J. Ind. Ergon 82(March 2021), 103096 (2021). 10.1016/j.ergon.2021.103096
11. Acquah AA, Arko-Mensah J, D'Souza C, Martin B, Quakyi IA, Robins TG, Fobil JN: Prevalence ofwork-related musculoskeletal disorders among e-wasteworkers at Agbogbloshie in Accra, Ghana. In: Proceedings of the 2019 International Society of Environmental Epidemiology Conference,Utrecht, Netherlands,10 2019, vol. 3, pp. 2–3 (2019). 10.1097/01.EE9.0000605616.87684.ec
12. Fischer D, Seidu F, Yang J, Felten MK, Garus C, Kraus T, Fobil JN, Kaifie A: Health Consequences for E-Waste workers and bystanders - a comparative cross-sectional study. Int. J. Environ. Res. Public Health 17(5), 1534 (2020). 10.3390/ijerph17051534
13. Hedge A, Morimoto S, McCrobie D: Effects of keyboard tray geometry on upper body posture and comfort. Ergonomics 42(10), 1333–1349 (1999). 10.1080/001401399184983 [PubMed: 10582503]
14. CU Ergo: Cornell Musculoskeletal Discomfort Questionnaires (CMDQ), Cornell University Ergonomics Web (CU Ergo), Cornell, NY. https://ergo.human.cornell.edu/ahmsquest.html (n.d.). Accessed 20 Nov 2020
15. Reis JP, DuBose KD, Ainsworth BE,Macera CA, Yore MM: Reliability and validity of the occupational physical activity questionnaire. Med. Sci. Sports and Exerc 37(12), 2075–2083 (2005). 10.1249/01.mss.0000179103.20821.00 [PubMed: 16331132]