The 3rd International Conference on Japan–Bangladesh Research and Practice (JBRP2024)
November 29–30, 2024
Online, Coordinated from The University of the Ryukyus, Okinawa, Japan
Organized by the Network of Bangladeshi Researchers in Japan (NBRJ)
Submission Number: 5

Assessment of Joint Forces on the Lower Back During Bricklaying Tasks

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Track: Medicine, Pharmaceuticals, and Public Health

Keywords: Joint Reaction Force, Musculoskeletal Disorders (MSDs), Bricklaying Tasks.

Extended Abstract

Introduction: Bricklaying tasks are characterized by awkward postures and repetitive movements, which have a significant impact on the lower back. Despite the known prevalence of musculoskeletal disorders (MSDs), such as lower back pain, among construction workers[1], research on quantifying the biomechanical load in terms of joint forces on the lower back during bricklaying tasks remains unexplored. This study aimed to quantify the joint force in lower back during bricklaying tasks at foot and knee heights.

Methods: A total of seven male university students (22±1.29 years) participated in this study. The participants performed four simulated bricklaying tasks at foot level height and knee level height. At foot level height, the participants were instructed to carry out the following tasks: scooping mortar from the right side (task-1), applying mortar to the left side (task-2), picking up the brick from the right side (task-3), and laying the brick on the left side (task-4). At knee level (47 cm, the average knee height of the participants) height, the participants were asked to perform same four tasks at a height of 47 cm. Inertial Measurement Unit (IMU) sensors were used to capture the three-dimensional (3D) movements data of the actual tasks. The joint forces of the lumbar region (i.e., L5Sacrum, L4L5, L3L4, L2L3, L1L2, L1T12) were assessed by inverse dynamic simulation using 3D Musculoskeletal(MSK) Modeling.

Results: The joint forces are considered as biomechanical risk factors for developing musculoskeletal disorders(MSDs) in lower back [2]. Therefore, in this study, we evaluated the risk of lower back load by assessing the joint forces for six lumbar joints. Fig. 1 indicates the six lumbar joints force during working at foot height (a) and knee height (b). At foot level (Fig. 1(a)), for tasks 1 to 4, the joint force on the L5Sacrum joint was consistently higher over time, with the highest value being 2.78 KN during task-3. These higher joint forces can strain the lower back muscles, which leads to MSDs, that is supported by Skovlind et al.[3]. In contrast, the joint force on the T12L1 joint was lower over the same period, with the lowest value being 0.33 KN during task-2. However, when performing the same tasks (1 to 4) at knee height, the joint forces (Fig.1(b)) of the selected joints changed significantly. In tasks 1 to 4, the highest and lowest joint forces were 1.92 KN, and 0.38 KN in task-2 for L1L2 and L4L5 joint respectively, which were comparatively lower than at foot level. The probable reason may be the minimal trunk forward bending, resulting in a shorter moment arm for the joints at knee height compared to foot height. Therefore, it can be said that working at knee height can help to avoid the risk of MSDs in lower back. The comparison of mean joint forces

in the lumbar joints for the same tasks at different working heights are shown in Fig. 2. Here, the mean joint force represents the average value of the joint force over the period. The maximum reduction of joint forces is exhibited in the L5sacrum joint (i.e., 54.7%) in task-2, compared to other joints.

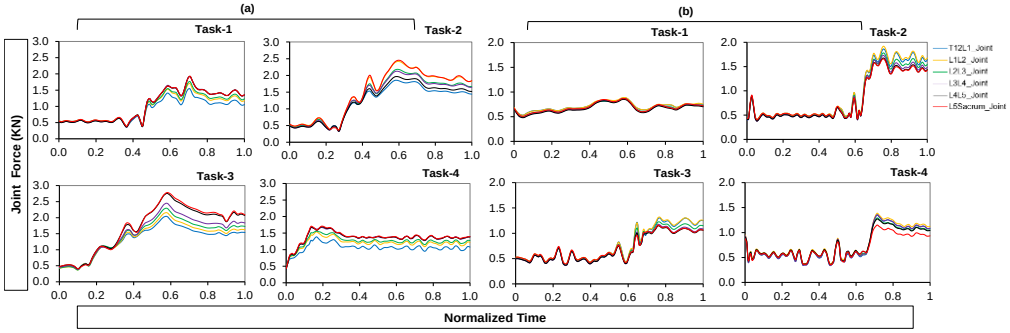

Figure 1: The lumbar joints force during work: (a) at foot level height, (b) at knee level height

Bending the trunk slightly and reaching the object more easily is likely the reason for the reduced joint forces when working at knee level height. Which indicates that working height is an important parameter for reducing the risk of MSDs. Therefore, it can be said that working at knee level height can reduce the risk of MSDs among bricklaying workers.

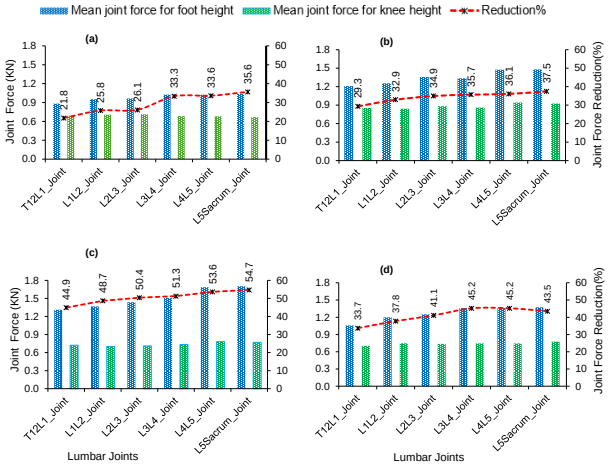

Figure 2: Comparison of mean joint forces: (a) mortar scooping, (b) applying mortar, (c) picking up bricks, (d) laying brick

Conclusion: The joint forces, as a parameter of biomechanical load, were studied for bricklaying task focusing on the lumbar joints at foot and knee heights. The highest joint force was exhibited in the L5Sacrum at foot height which could contribute to the development of MSDs. Additionally, the L5Sacrum joint force was reduced by 54.7% during working at knee level height that was greater than in other joints. Therefore, knee level height is recommended as a comfortable working height to prevent the risk of MSDs in the lower back for bricklayers.

References

[1].Adhikari B, Ghimire A, Jha N, Karkee R, Shrestha A, Dhakal R, Niraula A, Majhi S, Pandit AK, and Bhandari N, Factors associated with low back pain among construction workers in Nepal: A cross-sectional study, PloS one,16(6), e0252564, 2021.

[2].Moya A, Kooij H, and Sartori M, Robust estimation of lumbar joint forces in symmetric and asymmetric lifting tasks via large-scale electromyography-driven musculoskeletal models, Journal of biomechanics, 144, 111307, 2022.

[3].Skovlund SV, Blafoss R, Skals S, Jakobsen MD, and Andersen LL, The importance of lifting height and load mass for muscular workload during supermarket stocking: Cross-sectional field study, International Journal of Environmental Research and Public Health, 19(5): 3030, 2022.