applied sciences

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Prevalence and Exposure to Ergonomic Risk Factors among Crop Farmers in Nigeria

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Abstract: This study examined the prevalence and exposure to ergonomic risks factors among crop farmers in selected states in Nigeria. We used cross-sectional data to provide this evidence. Data were collected with the aid of a standardized questionnaire administered to farmers. A total of 480 smallholder cassava farmers selected across 24 farming communities in Kogi and Kwara states, Nigeria, were engaged in the study. Descriptive statistics and binary regression were used for analysis. About 96% of the respondents reported shoulder pain, 85% reported lower back pain, 82% reported upper back pain, 64% reported neck pain, and 53% reported elbow pain during farming operations. We found that the age of farmers (OR = 2.01) and daily duration of daily chemical spray (OR = 1.17) were risk factors, while previous training on the safe use and application of farm chemicals was found to be a protective factor ($\alpha = 0.05$). The study identified affordability of farm safety measures and poor access to relevant safety information as top constraints to farmers' adoption of safe farm practices. We concluded there is a high prevalence of ergonomic risks during cassava operations among respondents. A crop-specific co-designed ergonomic intervention targeted at Nigerian farmers to reduce exposure to ergonomic risks is recommended.

Keywords: ergonomic; crop farmers; health risks; Nigeria and prevalence

Citation: Olowogbon, T.S.; Babatunde, R.O.; Asiedu, E.; Yoder, A.M. Prevalence and Exposure to Ergonomic Risk Factors among Crop Farmers in Nigeria. *Appl. Sci.* **2021**, *11*, 11989. https://doi.org/10.3390/app112411989

Academic Editors: Giuseppe Manetto, Emanuele Cerruto, Domenico Longo and Rita Papa

Received: 16 November 2021
Accepted: 8 December 2021
Published: 16 December 2021

1. Introduction

Nigeria is estimated to have a population of over a 200 million people with about 75 percent employed in agriculture [1,2]. This makes agriculture an important sector to the nation's economy. Crop production remains the largest driver of the agricultural sector, accounting for 91.6 percent of the sector's contribution to the nation's gross domestic product (GDP) in the third quarter of 2019 [3]. Cassava (*Manihot* spp.) is a food crop in many developing countries, including Nigeria [4]. Cassava production is vital to the economy of Nigeria as the country is the world's largest producer of the commodity. The crop is produced in 24 of the 36 states of the country. Nigeria currently produces approximately 45 million tonnes, which is almost 19% of the world's production. The average yield of Cassava per hectare in Nigeria is 10.6 tonnes [5]. Cassava production in Nigeria is well-developed with more than 40 cassava varieties used for different food products and animal feeds. Cassava contributes substantially to household food security in Nigeria as about 75% consume Cassava products daily. These products include cassava flakes (Garri), fufu, chips, starch, flour, pellets, among others [5–7]. Awoyinka [8] noted that Nigeria earns about USD5 billion per annum from cassava and its by-products, making it a key foreign exchange earner. Cassava is also an instrument for job creation and a catalyst for development. Cassava is grown throughout the year, making it preferable to seasonal crops such as yam, maize, beans, or peas. It displays an exceptional ability to adapt to

climate change, with a tolerance to low soil fertility, resistance to drought conditions, pests, and diseases, and suitability to store its roots for long periods underground even after they mature [9]. Cassava production in Nigeria has the following major stages; land preparation, planting, weed and pest control, and harvesting [10].

Nigerian cassava farmers in particular, are exposed to various health risks factors along cassava production stages, including ergonomic risks factors. These farmers' exposure to ergonomic risks factors along the cassava production chain can be attributed to the fact that most production activities are carried out manually. This involves stages such as land preparation, weeding, chemical application, and harvesting. Most of these farmers in recent times, due to labour scarcity from rural–urban migration, often utilize mainly agrochemicals for weed control with little or no adherence to safety measures in chemical usage. This exposes cassava farmers to sprayer-borne ergonomic risks factors as they are often found mounting heavy sprayers on their backs for long hours and engaged in repetitive static positioning while applying farm chemicals. These farmers also engaged in long-range repetitive static positioning and forward bending while manually tilling/ridging, weeding, or even harvesting. In past studies, work-related musculoskeletal risk factors in agriculture have been related to repetitive static positioning, forward bending, and heavy lifting and carrying, and kneeling while carrying heavy loads, and vibration in agricultural workplaces [11–14].

Poor work-posture from poor farm manual lifting and handling leads to musculoskeletal disorders (MSDs). These disorders have symptoms including pain at the lower and upper back, shoulders, ankles, knees, elbows, neck, wrist, and hand. Furthermore, chronic musculoskeletal injuries include tenosynovitis (inflammation of the wrist tendon), bursitis (inflammation of the shoulder joint fluid sac (bursa), and osteoarthritis of the knee (degeneration of the knee joint cartilage), identified to be very common among agricultural workers [11–14]. Ergonomic health risks are so common among experienced farmers that it is often perceived as an inevitable consequence of farm labour [15]. There is still evidence of a gap in crop farmers' exposure to ergonomic risks factors and their prevalence, especially along the cassava production chain. As such, it is yet to receive the needed attention in Nigerian agriculture in terms of research, awareness programmes, training, and other relevant interventions. This gap has also not provided policy impetus for ergonomic risks management along the agricultural production chain. Deliberate efforts are yet to be put in place to reduce ergonomic related injuries in Nigerian agricultural workplaces. Considering the enormous importance of cassava to Nigeria's food security and economic development, and the implications of exposure to ergonomic hazards on farmer's health, this study addressed the identified information gap and provided answers to the following research questions: (i) What are the ergonomic risk factors and their prevalence among crop farmers in Nigeria? (ii) What are the constraints faced by farmers in adopting safe farm practices?

2. Materials and Methods

2.1. Study Area

The study was carried out in Kogi and Kwara States, Nigeria. Both states are found in the North-Central Geo-political zone of Nigeria. See Figure 1.

Figure 1. Map of Nigeria showing the states in Nigeria State. Source: UN Cartographic Section. Available from: https://www.nationsonline.org/oneworld/map/nigeria-administrative-map.htm, accessed on 13 December 2021.

2.2. Study Design and Setting

This study used cross-sectional study data, collected between February 2017 and April 2017. The study areas were 24 cassava cropping communities selected from Kogi and Kwara States, Nigeria. The two states are in the north-central zones of Nigeria, which account for about 30% of the cassava produced in Nigeria. Agriculture is a major livelihood in Nigeria [16,17]. Cassava is a major crop grown in the study area. However, the study engaged cassava farmers that use agricultural chemicals, and the farmer applies the chemicals and is actively engaged in the manual labour of the farm. The sample included 240 farmers from each state, making a total of 480 participants. The sample size was estimated using optimal design (OD) software developed by Steve Raudenbush for power calculation [18]. A total of 20 respondents were each randomly assigned to the study in 24 cassava cropping communities with a power of 80%.

2.3. Standardized Questionnaire

Information was collected from participants individually using a standardized semi-structured questionnaire developed by the authors. The questionnaire contained information on farmers' demographics and social economics characteristics of respondents, ergonomic hazards, frequency of ergonomic injuries experienced by farmers and associated risks factors among cassava farmers in Nigeria. The data were collected once with a questionnaire validating responses at seven days, one month, and three months, accordingly, to arrive at conclusions, especially on chemical prone ergonomic-related symptoms. This is to

ascertain whether the farmer's identification of symptoms were consistent. The questionnaire for this study was subjected to content validity and reliability tests via a pre-test. The research instrument was administered to 15 pilot farmers who were not engaged in the study as a pre-test. The test and re-test method of three weeks interval was used for the reliability of the survey instrument. Pearson product-moment correlation coefficient was found to be 0.74. This index is high, implying the instrument is consistent and reliable in its measurement of the items.

2.4. Statistical Methods

Descriptive statistics such as frequency tables, a measure of central tendency, and a measure of dispersion, including mean, median, mode, and standard deviation, were used for analysis of the demographic characteristics.

The factors predisposing farmers to ergonomic risks among crop farmers were analysed with binary logistic regression.

The implicit model for stage one is stated as:

$$\ln (p/1 - p) = \alpha + \beta x + \varepsilon \quad (1)$$

where ln is natural log Exp and Exp = 2.71.

P is the probability the event occurred p (y = 1) in this case the probability a farmer is exposed to ergonomic risk. $p/(1 - p)$ is the odds ratio and $\ln(p/1 - p)$ is the log odds or logit.

The model implicit form is stated thus:

$$Yd_{it} = ß_0 + ß_1 X_1 + ß_2 X_2 + \ldots\ldots\ldots\ldots\ldots + ß_6 X_6 + \boldsymbol{e}_{it} \quad (2)$$

Yd_{it} indicates exposure to agricultural ergonomic risks (each part of the body that is exposed to ergonomic hazards is rated as experienced by respondents once/week = 1 point, twice/week = 2 points, three times/week = 3 points, 4 times and above/week = 4 points). A farmer is categorized as exposed if the average ergonomic symptoms rating of a respondent is 2 points or more per week in various body parts as self-reported, then $D_{it} = 1$ and $D_{it} = 0$ otherwise (less than 2 points).

X_1 = Age of farmer (years); young (24–40 years) = 0, old (41–60 years) = 1

X_2 = Educational level (estimated years of schooling based on qualification)

X_3 = Previous safety training exposure (1 = yes, 0 = otherwise)

X_4 = Estimated daily duration of spray (Hours)

$X_{5=}$ Farm Size in hectare

X_6 = Years of chemical usage

$\boldsymbol{e}$ = Error term

5% level of significance was used in the interpretation of the result from the specified mode with *p*-value threshold set at 0.05.

Constraints to farmers adoption of safe farm practices among respondents were analysed with descriptive statistics. The ranks were obtained based on the number of respondents that agreed to the pre- identified constraints on the questionnaire.

2.5. Overview of the Health-Related Variables and Measurements

In absence of a reliable medical diagnosis, it is recommended to measure symptoms rather than diseases, since respondents can report symptoms with a lower degree of error [19–22]. Ergonomic symptoms, such as pain in the back, shoulder, wrist, elbow, hip, knees, ankle, or neck, were captured. A respondent is considered exposed to ergonomic risks if an average ergonomic symptom rating of a respondent is more than 2 points per week in various body parts is recurrently self-reported in the last season and the past one month before the interview.

2.6. Ethical Considerations

The study was approved by the Research Ethical Committee of the University of Ilorin, Ilorin, Nigeria, with UERC Approval number: UERC/ASN/2016/349. Participation in the study was purely voluntary and the purpose of the study was communicated to respondents, and we obtained their approval via the informed consent form, which they signed their name or used their thumbprint accordingly.

3. Results

3.1. Demographic Characteristics of Respondents

Table 1 documented the demographic characteristics of respondents. All the farmers sampled were male, with an average age of respondents being 38 years with the oldest being 60 years and the youngest being 24 years old. The age distribution of farmers in the study indicates that most of the respondents were below the age of 40 years. On average household members consists of 5 members; household size varies in the range of 1–10 persons per household.

Table 1. Respondents Demographic Characteristics (N = 480).

Demographic Characteristic	Mean	Standard Deviation
Age	38.0	7.9
Household Size	4.90	2.6
Years of Schooling	13.60	2.5
Farming Experience	13.70	7.6
Farm Size	2.10	2.9
Monthly Health Expenditure	1193	1187

Source: Surveyed Data Analysis, 2018.

This study showed that the average educational years of respondents was about 14 years. The 14 years average of schooling years reported in this study shows that most of the respondents' possessed tertiary education. The farming experience was expected to influence the acquisition of skills and capability to adopt technological innovation in the production of crops. The study shows that the average farming experience was about 14 years ranging from 4 to 30 years. The average farm size was found to be about 2 hectares. This shows most of the farmers are smallholder farmers.

3.2. Characteristics of Farmers Related to Chemical Prone Ergonomics

We found some characteristics that may contribute to ergonomic risks among farmers. On average, the number of times a farmer participated in the chemical spray was 13/3 months, with a daily spray duration of 6 h. We found that the average re-entry time after the chemical spray was 16 h with the number of self-reported ergonomic discomfort per week attributed to chemical spray being 2. We also observed that most of the farmers engage the 16 L sized sprayer during chemical applications. See Table 2.

Table 2. Characteristics of farmers related to chemical prone ergonomics (N = 480).

Chemical Prone Ergonomic Characteristic	Mean	Standard Deviation
Frequency of chemical spray/3 months	13	3.5
The daily duration of spray (hours)	6	2.4
Years of chemical usage	7	2.6
Re-entry time (hours)	16	7.4
Number of symptoms/farmer	5	6.3
Length of symptoms (hours)	13	2.5
Chemical related ergonomic discomfort/week	2	3.3
Production Lost time (days)/season	6.5	3.5

Source: Surveyed Data Analysis, 2018.

Farmers were also able to self-report an average of three ergonomic discomforts per week in areas such as the lower back, upper back neck, ankle, knees among others. This has a considerable number of implications on the health status of the respondents. The average sickness absence/production lost time due to ill health among farmers was about seven days in the season. This is quite high and could reflect farmers' exposure to work-related health risks.

3.3. Crop Farmers' Self-Reported Ergonomic Injuries

There are numerous types of ergonomic risks factors that are reported in agriculture resulting from static positioning, forward bending, heavy lifting and carrying, kneeling, carrying of heavy loads, and vibration in agriculture. These have consequences such as work-related musculoskeletal injuries including the pain of the back and neck, shoulder, wrist, nerve entrapment syndromes among others. Figure 2 showed the various self-reported ergonomic injuries experienced among crop farmers. Work-related ergonomic injuries have been identified to be prominent among farmers. Our findings showed that 96% had shoulder pain, 85% reported lower back pain, 82% reported upper back pain, 64% reported neck pain and 53% reported elbow pain. Empirical evidence had also posited that work-related ergonomic injuries are manifested in the form of pain at the lower and upper back, shoulders, ankles, knees, elbows, neck, wrist, and hands.

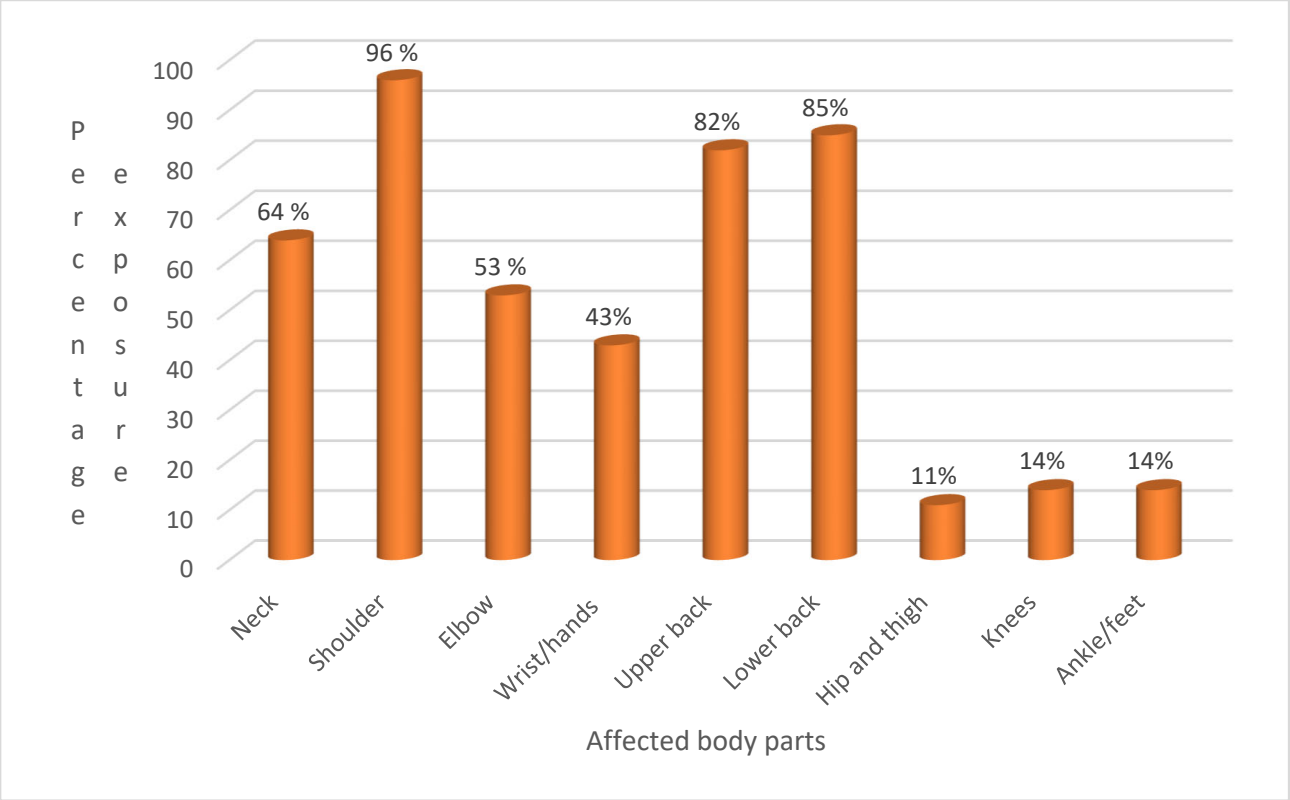

Figure 2. Self-reported ergonomic injuries experienced by farmers (N = 480). Source: Surveyed Data Analysis, 2018.

3.4. Frequency of Ergonomic Hazards Experienced by Farmers

Ergonomics Related Characteristics of Farmers

Table 3 shows that about (29%) of the farmers experienced neck pain twice a week, 52% had shoulder pain twice a week, elbow and wrist/hand pain was reported twice a week by 28% of the respondents. Upper and lower back pain was reported twice a week by 43% and 35%, respectively. These findings revealed the prevalence of ergonomic exposure

by farmers weekly. This also shows the consequences of ergonomic exposure on farmers' health accordingly. This could in both the short and long-run affect farmers' productivity.

Table 3. Frequency of ergonomic hazards experienced by farmers/week (N = 480).

S/N	Part Affected	Frequency of Exposure per Week {Frequency (%)}			
		Once	Twice	Three-Times	Always
1	Neck	68(14)	140(29)	68(14)	17(4)
2	Shoulder	137(28)	256(52)	34(7)	17(4)
3	Elbow	34(7)	137(28)	17(4)	17(4)
4	Wrist/hands	17(4)	135(28)	119(25)	34(7)
5	Upper back	85(18)	204(43)	34(7)	52(11)
6	Lower back	85(18)	168(35)	52(11)	52(11)
7	Hip and thigh	-	52(11)	34(7)	34(7)
8	Knees	34(7)	17(4)	-	34(7)
9	Ankle/feet	-	17(4)	-	17(4)

Source: Surveyed Data Analysis, 2018.

3.5. Factors Predisposing Cassava Farmers to Ergonomic Health Risks

Table 4 shows the factors predisposing farmers to ergonomic health risks. The logistic regression was estimated to ascertain the effects of the independent variables on the likelihood that respondents are exposed to ergonomic health risks along cassava farming operations. The probability of Chi-squared was found to be significant at 5% which implies the overall model was statistically significant with a Chi-squared statistic of 281.29.

Table 4. Factors predisposing cassava farmers to ergonomic health risks.

Binary Logistic Regression Estimates Y Exposure to Ergonomic Health Risks	Odds Ratio	Z
Age (years); old = 1, young = 0	2.010	3.18 *
Educational qualification (years)	0.867	−0.97
Previous safety training exposure;1 = yes	0.626	−2.27 *
Daily duration per spray(hours)	1.167	2.54 *
Farm size (hectare)	1.053	1.05
Years of chemical usage	1.053	−0.97
Constant	0.193	−3.04
LR Chi-Squared Statistic	22.42	
Significance level	0.000	
Log-likelihood	−281.29	
Degree of freedom	5	

Note: * represent significance at 5%. Source: Surveyed Data Analysis, 2018.

This study showed that farmers' age and daily duration of chemical spray had a positive significant relationship with exposure to ergonomic health risks at 5% significance level. However, previous safety training in the safe use and application of farm chemicals had a negative significant relationship with ergonomic risks at a 5% level of significance. This study further showed that older farmers are more likely to experience ergonomic health risks by 2.10 times compared to younger farmers. This implied that older farmers are more prone to musculoskeletal injuries. This could be linked to the fact that older farmers are more likely to have more farming years of engaging in unsafe farm acts. Experienced farmers had more ergonomic injuries because they have for years been engaged in poor lifting and carrying and repetitive awkward bending, enhancing the probability of exposure to ergonomic risks factors.

3.6. Constraints to Farmers' Adoption of Safe Farm Practices

This section provides information on the constraints to farmers' adoption of farm safety measures. The study identified affordability of farm safety measures and lack of

access to relevant safety information as top constraints to farmer's adoption of safe farm practices. See Table 5.

Table 5. Constraints to farmers' adoption of safe farm practices N = 480.

S/N	Constraints	Frequency	%	Rank
1	Affordability related constraints	480	100	1st
2	Poor access to safety information	463	95	2nd
3	Absence of legal/policy framework for farm safety	446	93	3rd
4	No trained extension agent on farm safety	446	93	3rd
5	Low awareness level	446	93	3rd
6	Limited knowledge of farm safety measures	412	86	6th
7	I do not see safe farm practices as important	89	19	7th

Source: Surveyed Data Analysis, 2018.

4. Discussion

Result from the study showed that the mean age of the farmers was 38 years. This implied agility, strength, vigour, and the likelihood to take risks and adopt innovation among the respondents. The mean age in the study could be peculiar to the study because of the study entry criteria, which includes cropping cassava, engaging in agrochemicals spraying, and engaging in manual labour by the respondents. The 14 years of average schooling years reported in this study showed that most of the respondents' possessed tertiary education. With this educational status among respondents, it showed they can read and write. This level of education should aid respondents' engagement of information technology in accessing information on safe farm practices. The study also showed that the average farming experience was about 14 years, ranging from 4 to 30 years. This implied that farmers are experienced. This level of experience should give respondents the advantage of providing relevant and accurate information in this study based on their years of agricultural engagement. Their farming experience is expected to influence the acquisition of skills and capability to adopt technological innovation in the production of crops. The average farm size was found to be about two hectares. This showed that most of the farmers are smallholder farmers. This group of farmers accounts for about 80% of the Nigerian crop farmers [2]. The average monthly out-of-pocket health expenditure was found to be N1187 ($3.40). This health expenditure may be low compared to related studies as farmers use more of herbal remedies which were difficult to quantify as the estimated health expenditure is limited to orthodox medicine taken by farmers.

As shown in Table 2, findings from the study showed that on average, the number of times a farmer participated in the chemical spray was 13/3 months, with a daily spray duration of 6 h. We found that the average re-entry time after the chemical spray was 16 h with the number of self-reported ergonomic discomfort per week attributed to chemical spray being 2. We also observed that most of the farmers engage the 16 L sized sprayer during chemical applications. We also found that chemical related ergonomic discomfort/week was 2 with seasonal production lost-time of about 7days. Farmers spray on the average of 13times in 3months with a 16L sprayer on the back for about 6hours a day, this could aid farmers exposure to ergonomic risks. These findings have a considerable number of implications for farmer's health and overall productivity.

Manual operations in agriculture usually include a plethora of physically demanding tasks that, most of the time, entail a combination of material handling, high muscular force, and postural load [9,23]. We found self-reported prominent ergonomic injuries to include pain in the shoulder, lower back, upper back, neck, and elbow among cassava farmers.

The pain in these body parts may be linked to manual operations of production. These self-reported ergonomic injuries may affect farmers' health and ability to perform optimally during farm operations. Previous evidence has highlighted agricultural musculoskeletal injuries to include pain in the back, neck, tenosynovitis (inflammation of the wrist tendon), bursitis (inflammation of the shoulder joint fluid sac (bursa), and osteoarthritis of the knee (degeneration of the knee joint cartilage) are common among agricultural workers [1–14,24].

The findings from our study showed that 96% reported shoulder pain as an ergonomic injury experienced during farming operations. We found that wrist/hands injury prevalence was 43% as reported by respondents. We found 85% prevalence in lower back pain and 82% prevalence in upper back pain as reported by farmers. The prevalence of shoulder pain and back pain among respondents were found to be high. This implied that ergonomic injuries in the shoulder, back, and neck were prominent among the respondents. This high prevalence may be attributed to manual operations which includes bad postures and heavy load lifting among farmers. This finding was corroborated by Walker-Bone and Palmer who reported shoulder pain was found to be greater in farming (14%) than either other manual labour 9.7% or non-manual labour 7.1% jobs [25]. Additionally, Kang et al. [26] interviewed 16,113 Korean farmers concerning their agricultural characteristics, demographic profiles, and self-reported musculoskeletal discomfort with the use of specific questionnaires. Participants reported pain in the back (26.9%), lower extremities (19.62%), and on the regions of neck or muscles. Other studies have shown that upper extremity injuries have plagued dairy farmers with 27% of all injuries and tobacco farmers with 25% [27].

A study by Fathalah [15] reported that ergonomics risks are so common among experienced farmers that most of them perceived it as an inevitable consequence of farm labour. Previous research by the New York Centre for Agricultural Medicine and Health (NYCAMH) suggests that back, neck, and shoulder strain is a common problem among farmworkers [28]. The study by Vyas et al. [29] also reported that weeding and handling of heavy loads and prolonged work activities are known as the main risk factors of muscloskeletal disorders (MSDs) in crop production. In their study, they found that farmers reported work-related muscloskeletal disorder (WMSD) most often in conjunction with the equipment (e.g., climbing up/down equipment; equipment coupling; and equipment operation). Farmworkers have been reported to be experiencing increased WMSD with higher rates of knee and hip arthritis identified in farmers in stanchion dairies; tobacco topping (e.g., shoulder WMSD; forearm and wrist tendonitis); tobacco leaf harvesting and curing barn work (e.g., neck, shoulder, back, and lower extremity WMSD); sweet potato harvesting (e.g., neck, shoulder, back, and lower extremity WMSD; and fingernail tearing); cucumber harvesting (e.g., neck, shoulder, back, and lower extremity WMSD); and watermelon harvesting (e.g., neck, shoulder, and upper extremity WMSD) [30].

Oranusi et al. [31] found in their study that disorders of muscles, bone, and joints as the most common occupational-health issues]. This is similar to the findings by Morse and Schenck, who observed about 64% of chronic musculoskeletal injuries among workers [32]. Oduwaiye et al., assessed crop farmers' health-related hazards and found that about 83.8% of the respondents experienced general body pain which forced farmers to take days off from the farm [33].

As shown in Table 3, further findings from our study on the frequency of the self-reported ergonomic related body pain showed that about (29%) of the farmers experienced neck pain twice a week, 52% had shoulder pain twice a week, elbow and wrist/hand pain was reported twice a week by 28% of the respondents. Upper and lower back pain was reported twice a week by 43% and 35%, respectively. The frequency of self-reported ergonomic injuries among farmers weekly showed that these injuries were notable health issues among crop farmers. This finding corroborated the report of Scutter et al. [34], which reported that one-third of agricultural workers surveyed reported neck pain at least once a week. Considering the rate of ergonomic injuries reported by farmers, we could conclude that ergonomic injuries prevalence among farmers is high. This has a considerable number

of implications on farmers' health and farmers' labour productivity. These injuries have been identified to lead to the loss of time and money [11].

Results from Table 4 showed that age of farmers and number of hours engaged in the chemical spray were associated with increased ergonomic risks. This implied that older farmers are at a higher-risks. This could be linked to aging-related issues which could have exacerbated ergonomic-related health risks among older farmers. This finding is corroborated by Tonelli et al. [35]. These authors reported that aging farmers are at high risk of musculoskeletal disorders due to occupational exposures. They opined that the development of musculoskeletal conditions can increase older farmers' risk for additional injuries because many older farmers continue to work past typical retirement age [35]. The risk factor of inreased hours of chemical spray could be attributed to the chemical handling and spray for long hours with repetitive awkward bending positions. Our study showed that farmers spent on average 6–7 h of spray with about 16 L of sprayer on their back. This unsafe practice by farmers could lead to intense negative health outcomes which affect farmers' productivity. However, previous exposure to safety training in the safe use and application of farm chemicals was found to be associated with a reduction in ergonomic health risks. This finding showed the potential of engaging targeted training as a tool to reduce exposure to ergonomic risks factors among crop farmers. The finding of this study was further substantiated by Surabhi and Renu, who reported that musculoskeletal injuries and diseases affect the production agriculture workforce more frequently during their working years than any other safety and health problem [36]. Some causes of back pain include poor posture, bad lifting, pushing, and pulling techniques. Neck pain is usually caused by bad habits including poor posture, poor lifting techniques, and overexertion on the job [36]. Some common symptoms of neck pain are persistent aching and stiffness and sharp pain. While the prevalence in specific specialties of farming has not been completely identified, there is no doubt that tasks being performed by farm workers contribute significantly to the development of low back pain. Kaur and Sharma [37] in a study conducted on 200 farm women in Punjab State found that work-related body disorders in agriculture included pain in many parts of the body followed by numbness or stiffness. Emerging empirical information shows that musculoskeletal disorders have been a widespread problem in agriculture for decades. The risk factors include static positioning, forward bending, heavy lifting and carrying, kneeling, and vibration in agriculture [36].

We also found that farmers were constrained to adopting relevant farm safety measures by cost and affordability, poor access to safety information, and absence of legal framework. See Table 5. This implied that economic reasons constrain farmers from adopting safe farm practices. This study was corroborated by Kaustell et al. [38] that reported the major barriers to the adoption and implementation of safety information include farmers' characteristics and limited resources to make safety improvements. Poor access to relevant safety information was rated high among the constraints; this creates the vacuum for the provision of relevant safety information to farmers. Farmers also rated the absence of a legal framework as a constraint to farmers' adoption of safety measures. It could be implied that there is a need for policy support to effectively implement relevant interventions in this regard.

5. Conclusions and Recommendations

In this present study, we used surveyed data to provide empirical evidence on ergonomic risk factors among Nigerian crop farmers and insights into interventions based on the identified risk factors among the respondents. We found that shoulder pain, back pain and neck pain were prominent ergonomic injuries among crop farmers in the study area. This could be attributed to the nature of work in farm workplaces and, in particular, cassava farm operations, which involves repetitive bending, placement of heavy sprayers on the back and engaging the back in pulling cassava tubers at harvest. The study showed that previous agricultural health training on the safe use of farm chemicals was found to be a protective factor against ergonomic risks. This implied that efficiently delivered

training that is utilized by farmers could help reduce ergonomic injuries among farmers. Government and development partners should provide co-designed specialized ergonomic interventions for crop farmers. This is to address associated ergonomic risks, along with crop operations, with a focus on safe manual lifting, carrying, ergonomics break (micro pausing which reduces pain and discomfort by reducing muscle and nerve tension) of 10–15 min for every 2 h work span to stretch during tasks; carrying smaller ergonomic modified shoulder padded sprayers, compared to the present 16 L sprayers commonly used in the study area. The co-designed ergonomic intervention should include joint effort among researchers, policy makers, private sector, and the end users (farmers). This model will aid the uptake and sustainability of such interventions, while addressing the drivers and barriers to the uptake of such interventions. Constraints to farmers' adoption of farm safe practices should be addressed by making available ergonomic suitable interventions to farmers at a subsidized rate. Additionally, forming farm safety and health advisory boards/groups at the village level to aid peer-to-peer dissemination of farm safety knowledge. Policy support in developing and implementing targeted ergonomic interventions in Nigeria is also critical for success and sustainability. While this present study is a modest effort at addressing the identified research gap, a combination of surveys and medical examinations for respondents could be a future research direction in quantifying ergonomic risks factors in agricultural workplaces.

Practical implications: Targeted awareness creation and training aimed at reducing ergonomic risks among Nigerian crop farmers has key practical implications. Additionally, the designed interventions should engage in a transformational approach that could enhance the uptake and sustainability of such interventions.

Theoretical implications: Although ergonomic interventions are usually designed on a case-dependent basis, ergonomic risks in the cassava production chain as identified in this study with the need for co-designed interventions to aid uptake and sustainability has an implication for principles and theory in the design of ergonomic interventions.

6. Limitation of the Study and Future Research Opportunities

The study was a modest effort that assessed the prevalence of ergonomic injuries and exposure to ergonomic risks factors among cassava farmers in Nigeria. Though the ergonomic symptoms and injuries were self-reported, we probed responses for seven days, thirty days, and three months to validate them. However, the study relied on self-reporting, which may have some memory loss constraints, as a detailed medical examination of sampled farmers was not carried out in the study. Future studies may carry out detailed medical examinations to complement the self-reported method. Additionally, an enhanced version of the study could be conducted engaging other ergonomic-prone crops such as rice.

Author Contributions: Conceptualization, T.S.O., R.O.B. and A.M.Y.; methodology, T.S.O., R.O.B., E.A. and A.M.Y.; Investigation, T.S.O., R.O.B. and E.A.; writing—original draft preparation, T.S.O. and R.O.B.; writing—review and editing and submission, T.S.O. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Study was approved by the Research Ethical Committee of the University of Ilorin, Ilorin, Nigeria.

Informed Consent Statement: Informed consent was obtained from all for participants in the Study.

Data Availability Statement: The submitted article contains all the data collected during the study and raw data is not publicly available due to privacy restrictions.

Conflicts of Interest: The authors declare no conflict of interest.

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