

Brief Report

Part-time farmers and accidents with agricultural machinery: a moderated mediated model on the role played by frequency of use and unsafe beliefs

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Abstract: Objectives: We aimed at testing a model of the direct and indirect effects of being a part-time farmer on the probability of being involved in an agricultural machinery-related accident, considering the role played by unsafe beliefs and the frequency of use of machinery. **Methods:** Two-hundred and fifty-two Italian men, regular users of agricultural machinery (age: *Mean* = 45.1 years, *standard Deviation* = 17.5), were administered a paper-and-pencil questionnaire addressing their relation with work, unsafe beliefs, and previous experience of machinery-related accidents. **Results:** Being a part-time farmer showed a positive association with unsafe beliefs only among occasional machinery users. Unsafe beliefs in turn showed a positive association with accidents. **Conclusions:** The study gave a novel contribution to the knowledge of the chain of events connecting part-time farmers with machinery-related accidents. Preventive training interventions targeting part-timer farmers using agricultural machinery just occasionally should be developed.

(J Occup Health 2018; 60: 80-84)
doi: 10.1539/joh.17-0061-BR

Key words: Accident, Agricultural machinery, Ergonomics, Part-time farmer, Safety culture, Unsafe belief

Introduction

Part-time farming, i.e., farm work performed by non-

professional farmers who, in addition to their main occupation, spend time working in agriculture and using agricultural machinery, is a widespread practice worldwide¹. In various industry sectors across a number of countries part-time labor is associated with increased fatalities, occupational injuries, and illnesses². Despite these figures, just a few studies investigated the relationship between part-time farming and involvement in accidents in agriculture, and the obtained results are inconsistent. Some authors found non-professional farmers to be at higher risk of accidents and injuries³, whereas some others found the probability of injury to be greater for individuals working full-time on the farm⁴. Little explanation is available about the possible reasons of these inconsistencies. On the one hand, having less time to devote to farming may imply hurrying to complete the work. This likely leads to the development of unsafe beliefs, i.e., an underestimation of the importance of complying with safety rules and practices, perceived as costing in terms of time and money, and this could result in accidents⁵. On the other hand, being a part-timer may be a protective factor since farming full-time, with a wider range of activities to be performed, may lead to a higher disregard for safety rules and regulations and then to an increased probability of being injured⁴.

The frequency of interaction with machinery is known to be a critical variable in the chain of events leading to an agricultural machinery-related accident. However, the literature is inconsistent about the direction of the causal links involved in this chain of events. According to some studies, the frequent interaction with the machinery allows the operator to develop experience and increases the focus on possible risks and thus on safety regulations⁶. Conversely, according to other studies, the frequent interaction leads to an underestimation of the risks and then of safety warnings and rules⁷. Since part-time farmers are much diversified in terms of off-farm employment, they

Received February 28, 2017; Accepted October 19, 2017

Published online in J-STAGE November 1, 2017

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have also different patterns of use of agricultural machinery. Therefore, it might be that part-time farmers with a different frequency of use of machinery develop different unsafe beliefs, and thus different risk of being involved in accidents.

In Italy, almost a quarter of the about 4 million people employed in the agricultural sector is represented by part-time operators⁸⁾. The Italian government agency for the insurance against work-related injuries (INAIL) showed that about 50,000 machinery-related accidents took place in agriculture in 2010: of these, more than 100 were fatal accidents involving professional workers⁹⁾. To this data, 80 fatal accidents to part-time farmers should be added.

Based on the previous considerations and the relevance of part-timers in the Italian agricultural system, the purpose of this study was to test a model of the direct and indirect effects of being a part-time farmer on the probability of being involved in an agricultural machinery-related accident in a sample of Italian farm workers. In particular, based on Jadhav et al.⁴⁾, we hypothesized that unsafe beliefs will mediate the relationship between being a part-time farmer and being involved in a machinery-related accidents. Moreover, based on Elkind⁷⁾, we expected the relation between being a part-time agricultural worker and unsafe beliefs to be moderated by the frequency of use of machinery.

Materials and Methods

Participants

The study involved a sample of 252 men regular users of agricultural machinery (age: *Mean* = 45.1 years, *standard Deviation* = 17.5), recruited among the visitors of the 35th National Exhibition of Agricultural Mechanization in Savigliano (March 18-20, 2016), the largest agricultural machinery exhibition in the Piedmont region (Northwestern Italy). One hundred and fifty-nine participants were full-time farmers, and 93 were part-time farmers. The study was approved by the Research Advisory Group of the Institute for Agricultural and Earthmoving Machines of the National Research Council of Italy.

Trained research assistants handed out the questionnaire we describe below to people walking through the exhibition. They presented the aims of the study to the possible participants by telling them that we were studying agricultural operators' attitudes and perceptions toward safety at work, to identify the most urgent issues and suggest some guidelines for improvement. People were also informed that no sensitive data would be collected and that the questionnaire would be anonymous. Then the assistants distributed the questionnaire to people who consented to participate. The questionnaire was in Italian and its completion took approximately 5-6 minutes. We did not offer any incentive to induce visitors to participate in the survey. Two-hundred and ninety-seven

visitors were addressed, and the response rate was 85%.

Instrument

Participants were administered a 27-item paper-and-pencil questionnaire. The questionnaire was pilot-tested before being used in the present investigation. In the first section, participants were administered a list of 3 unsafe beliefs: "Experience with tractors can avoid accidents," "Safety costs too much," and "Following safety norms is too time-demanding." Participants had to indicate their level of agreement with these statements on a 4-point rating scale (1 = do not agree at all; 4 = completely agree). The two items about experience and time-demand came from Whitman and Field¹⁰⁾, who used them to measure the participants' tendencies to over-estimate their self-efficacy at work and to under-estimate the importance of safety work strategies. The high costs of safety emerged as a critical issue in promoting accidents in agriculture in a preliminary qualitative study¹¹⁾. Based on Cronbach's $\alpha = .69$, we computed the participants' unsafe beliefs as the mean of the responses participants gave to these items.

In the second section, five different accidents (fall/thrown from the vehicle; run over/crushed by the vehicle; struck by flying objects, broken parts, or hydraulic fluid; side/rear rollover; road accident with tractor/equipment) were listed. Participants had to indicate how often in the 12 months preceding the survey they were involved in those accidents when working with agricultural machinery using a 3-category item (0 = never; 1 = once; 2 = twice or more). Due to the low number of items, the alpha of the scale was under the usual threshold, $\alpha = .37$. However, a confirmatory factor analysis showed that the battery was unidimensional, $TLI = .999$, $CFI = 1.000$, $RMSEA = .003$ (90% $CI = .000, .088$). Thus, we computed an index of accident involvement as the mean of these five variables. This list of accidents was selected based on the most common types of accidents involving agricultural machinery according to the statistics from the Italian Workers' Compensation Authority⁹⁾. The time span of 12 months was chosen based on previous studies using the same cutoff⁵⁾.

A standard socio-demographic form assessing the participants' gender, age, a dummy variable assessing their relation with work in terms of being vs. not being a professional farmer, and the frequency of use of agricultural machinery (0 = never, 1 = sometimes, 2 = almost every day) closed the questionnaire. None of the participants answered 0 to the question.

Statistical analyses

We analyzed our data via a moderated mediated model, using being a part-time farmer as the exogenous variable, the number of machinery-related accidents as the dependent variable, unsafe beliefs as a mediator, and frequency

Table 1. Descriptive statistics for the variables we used.

	Mean	SD	Min	Max
1. Part-time worker	.37	.48	0	1
2. Unsafe beliefs	2.61	.80	1	4
3. Frequency of use of agricultural machinery	1.64	.48	1	2
4. Accidents involvement	.21	.71	0	6

of use of machinery as a moderator. We tested the model by resorting to Process, Model 7. We chose 0.05 as a priori α level to evaluate the significance of the relations we have analyzed.

Results

Table 1 reports the descriptive statistics for the variables we used, while Table 2 reports analytically the distribution of participants' accident involvement.

Being a part-time farmer showed a non-significant association with holding unsafe beliefs, $b = -.04$, $SE = .06$, $p = .527$. Moreover, frequency of use of agricultural machinery did not show a significant relation with unsafe beliefs, $b = .17$, $SE = .12$, $p = .135$. However, the interaction between the two independent variables showed a significant association with unsafe beliefs, $b = -.34$, $SE = .12$, $p = .003$, $R^2 = .04$. The simple slope analysis showed that the relation between being a part-time worker and holding unsafe beliefs was positive among people using agricultural machinery sometimes, *simple slope* = .18, $SE = .09$, $p = .04$, and negative among participants using them almost every day, *simple slope* = $-.16$, $SE = .07$, $p = .04$. Fig. 1 shows the moderation graphically.

In turn, unsafe beliefs showed a significant association with our index of accident involvement, $b = .26$, $SE = .19$, $p = .045$, $R^2 = .02$.

Discussion

In the present study, we tested a model of the relationship between being a part-time farmer and being involved in a machinery-related accident, considering the mediation played by unsafe beliefs and the moderation of the frequency of use of machinery. Consistent with our hypotheses, the results showed that farmers that were more likely to be involved in machinery-related accidents were part-timers having more unsafe beliefs, which happened in case of an occasional use of agricultural machinery.

Regarding the mediating role of unsafe beliefs, the present study pointed out that underestimating the importance of safety regulations and legitimating non-compliance represents an important risk factor for accidents, consistent with previous studies performed in different sectors¹². Part-time farmers, having also another

Table 2. Distribution of participants' accidents involvement.

Number of accidents	Frequency	Percentage
0	221	87.7
1	21	8.3
2	4	1.6
3	2	.8
4	3	1.2
6	1	.4
Total	252	100.0

job, may be more tired and more hurried to finish their farm work³, thus overlooking the adoption of safety practices. The results of the present study showing that part-time farmers who sometimes use the machinery have the highest probability of being involved in an accident, via the mediation of unsafe beliefs, raise some considerations about the importance of developing focused training interventions to promote a correct safety culture, primarily among those not having farming as their primary occupation.

As concerns the moderating effects of the frequency of use of machinery, the results of the study contribute to the discussion about the consequences of experience with tasks and machinery^{6,7}. Indeed, routine operation and upkeep may make hazards more visible and noticeable for the frequent user, enhancing risk awareness, and stressing the importance of safety practices and regulations in the use of machinery. Conversely, an occasional use of machinery represents a risk factor, since in this way farmers (and especially part-time farmers, as pointed out by the present results) are not able to develop the necessary skills to perform mechanical operations on field safely. Furthermore, it has to be considered that part-time farmers often have inadequate training periods², thus lacking the knowledge about the specific machines and tools to be used that can be acquired from a training program. Preventive interventions could be designed to enhance part-time farmers' expertise, especially for those using machinery less frequently who cannot even count on the knowledge acquired from experience. These farmers should be trained to incorporate the correct safety practices into their daily work, making the compliance with safety regulations a fundamental part of their routine behaviors. Engaging training methods as behavioral modeling techniques—as hands-on demonstrations and behavioral simulations¹³—may be adopted to promote a correct and safe use of machinery and therefore reduce accidents. In addition, training should be administered by people who have experienced the job and are able to make the potential risks and dangers real by using anecdotes of personal and colleagues' experiences.

In addition, considering the present results about part-

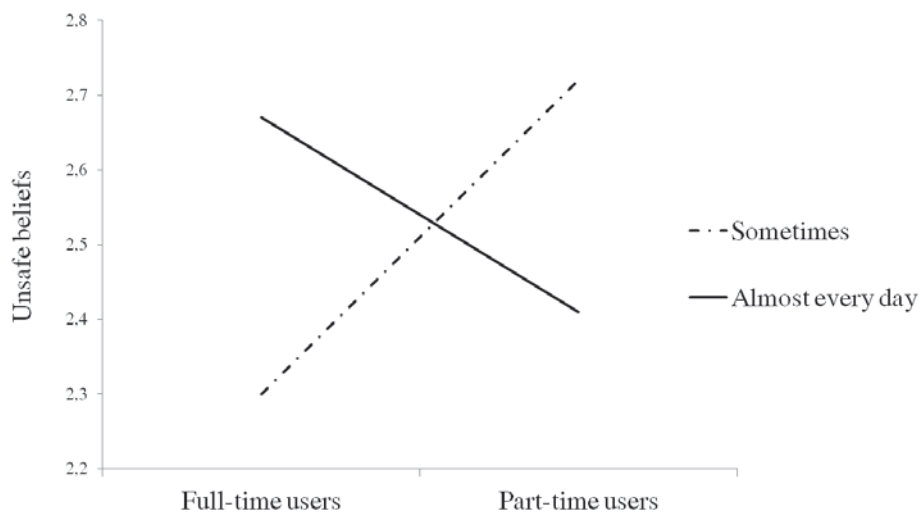


Fig. 1. Effect exerted on reporting unsafe beliefs by the interaction between being vs. not being a part-time farmer and declaring to use agricultural machinery sometimes vs. almost every day. Regression of declaring unsafe beliefs (y) on being vs. not being a part-time farmer (x) for frequency of use (z). Simple slopes were calculated after centering the independent (i.e., recoding -1 the full-time users and 1 the part-time users) and the moderator (i.e., recoding -1 the participants using agricultural machinery sometimes and 1 the participants using agricultural machinery almost every day) variables.

timers, it could be interesting to expand this research also to temporary and seasonal farm workers, who are usually exposed to a high rate of accidents¹⁴), to investigate the role played by unsafe beliefs in their being particularly at risk and develop targeted preventive measures.

Limitations of the present study and future research development

Some limitations of the present study should be noticed. The interviewed sample was relatively small and participants were selected among the visitors of an exhibition. This, together with the fact that not all the people who were addressed agreed to participate, means that our participants are not representative of the entire Piedmont agricultural population. Thus, we should be cautious in generalizing the present results to the total agricultural population.

The study focused on the role played by frequency of use of machinery and unsafe beliefs. Subjective beliefs are known to play an important role in the occurrence of a farm accidents⁵). In this light, our focus on the mediator role of unsafe beliefs is a “plus” of this study. However, our research was based on qualitative methods only.

With regards to the report of previous accidents, two methodological issues should be highlighted. The first is that in the present study, we chose to investigate accidents that occurred within the previous 12 months. This is a typical cut-off, often used in previous studies⁵). However, we acknowledge that this choice limited the analysis of the previous history of accidents, not allowing to gather

the variability and time courses of this phenomenon. The second issue is related to the retrospective recall of accidents. Indeed, in research investigating relations between risk factors and accidents, this has often been the case. However, in this way, the sample as a whole is likely to recall more serious accidents with greater ease than minor accidents. This trend will increase with increasingly long recall periods⁵), thus reducing the number of accidents reported. In addition, this may mean that some participants are classified as accident-free when in fact they have been involved in an accident. Further studies are required to address these limitations.

In spite of these limitations, however, we believe that the present research shed a new and interesting light on the direct and indirect associations between being a part-time farmer and the probability of being involved in an agricultural machinery-related accident, considering the role played by unsafe beliefs and the frequency of use of machinery.

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

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