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ABSTRACT

Background- To establish prevalence, risk factors and impact of work-related musculoskeletal disorders (WMSDs) among farmers in Ireland.

Methods- In summer 2009, a questionnaire was appended to the Teagasc (Irish Agricultural and Food Development Authority) National Farm Survey (n=1110) to obtain data on the prevalence, risk factors and impact of WMSDs amongst farm operators in Ireland. Data were collected by trained recorders and analyzed using chi-square tests, t-tests, Mann-Whitney tests and binary logistic regression.

Results- The prevalence of WMSDs in the previous year was 9.4% (n=103), with the most commonly affected body region being the low back 31% (n=32). Nearly 60% (n=57) of farmers reported missing at least a full day's work as a consequence of their WMSD. Personal factors evaluated using bivariate regression analysis, were found not to influence whether or not a farmer experienced a WMSD. However, work-related factors such as larger European Size Units (ESUs) (OR=1.007, CI=1.002-1.012), greater number of hectares farmed (OR=2.50, CI=1.208-4.920), higher income (OR=1.859, CI=1.088-3.177), dairy enterprise (OR=1.734, CI=1.081-2.781), and working on a fulltime farm (OR=2.156, CI=1.399-3.321) increased the likelihood of experiencing a WMSD. The variable 'fulltime farm' which was associated with a higher labour unit requirement to operate the farm, was the only factor found to independently predict WMSDs in the multivariate regression analyses.

Conclusions- This study suggests that the prevalence of WMSDs can be reduced by the application of improved farm management practices. A more detailed examination

of the risk factors associated with WMSDs is required to establish causality and hence, effective interventions.

Keywords: Work-related musculoskeletal disorders, Farm operators, Prevalence, Risk factors, Impact

INTRODUCTION:

Musculoskeletal disorders (MSDs) are the most commonly reported cause of work-related ill health in Ireland, costing business and the State approximately 750 million euro per year [Bevan et al., 2009]. Work-related musculoskeletal disorders (WMSDs) describe disorders and diseases of the musculoskeletal system that are a result of acute injuries from a one-time trauma or are associated with cumulative traumas such as repetitive motion, excessive force, awkward or sustained postures, prolonged sitting and standing in the course of work have been associated with WMSDs [Da Costa and Vieira, 2010]. The impact of MSDs on an individual's ability to work and the time they may require to be absent from work means that MSDs have significant associated costs to the individual, their family, and the wider economy [Bevan et al., 2009].

During the working day, farmers are exposed to a variety of physical hazards: lifting and carrying heavy loads, working with the trunk in sustained flexion, risk of trips and falls on slippery and uneven walkways, unpredictable actions of livestock, and exposure to vibration from farm vehicles and power hand tools [Walker-Bone and Palmer, 2002]. Farming is different to other occupations as it combines physically demanding labour in a variety of environments, i.e., in confined spaces and also outdoors. This increases the potential risk of developing MSDs compared with other workers [Walker-Bone and Palmer, 2002, Sandmark et al., 2000, Leino-Arjas et al., 1998, Thelin et al., 2009, Health and Safety Executive, 2007].

In Ireland, farmers have been subject to safety, health and welfare at work legislation since 1989. It provided for the establishment of the Irish Health and Safety Authority

(HSA), which is responsible for overseeing the implementation of Irish health and safety legislation governing employers, employees and the self-employed. This is implemented through the provision of guidance, site visits, advice and where warranted, enforcement. The HSA have also implemented secondary legislation on the manual handling of loads regulation which forms part of the Safety, Health and Welfare at Work (General Application) Regulations 1994 which were updated in 2007 [Health and Safety Authority, 2007]. In Ireland, it is mandatory that accidents and injuries be reported to the HSA when a person is injured at a place of work and cannot perform their normal work for more than 3 consecutive days [Health and Safety Authority, 2006]. This is the case for employers, employees and the self-employed and, hence, includes the population working in agriculture. However, comparisons of official injury figures recorded for all sectors in 2009 highlights significant discrepancies between data published by the HSA (7,161) and those of the Irish Central Statistics Office (31,774). The substantial difference in these figures suggests that workplace accidents are underreported in Ireland. This may explain the relative low figure reported for the agriculture, forestry and fishing sector, which accounted for 1.2% of injuries in 2010 despite having the highest number of occupational fatalities [Health and Safety Authority, 2011]. Thus, the current research aims to establish the extent of work-related MSDs amongst farm operators and estimate the number of days lost by farmers due to WMSDs.

A systematic review conducted by Osborne et al., in 2011 with the aim of establishing MSD prevalence among farmers highlights substantial heterogeneity between study methods including case definitions, data extraction and analysis methods making it difficult to establish single prevalence results for specific body regions. This issue

was compounded by the failure of most studies to account for both personal and work factors when evaluating MSD prevalence rates. The reported one-year prevalence of experiencing any MSD ranged from 60% - 92.9% with an overall pooled result of 76.9% (95% CI 69.8-82.7) [Osborne et al., 2011^a]. In order to address the issue of WMSDs, it is first necessary to measure the magnitude of the problem by establishing prevalence rates and then to identify risk factors, especially as some risk factors may be unique to farmers working within specific cultural, institutional and geographic contexts. In recent years a body of research exploring occupational health and safety amongst Irish farmers established that arthritis (31.4%) and back problems (17%) to be the most frequent illness reported and farm income was lower on farms where the operator had a MSD related disability [Whelan et al., 2009]. A further study exploring MSD prevalence among Irish farmers [Osborne et al., 2010] focused on all MSDs rather than specific work related MSDs and included both farm operators and farm workers. These studies differed in terms of population size and representation, limiting analysis of the extent of WMSDs and their impacts on farmers.

Farming is a highly heterogeneous occupation in terms of the type of enterprises and the type of work carried out on different types of farms. Therefore farmers can experience potentially different exposures to risk of a WMSD. Research on WMSDs among farmers is under researched both nationally and internationally. Large studies, like this one, that analyze statistically representative samples of different types of farms, in terms of occupation and farm enterprise, are essential to help understand the prevalence, risk factors and impact of WMSDs among farmers. This study aims to 1) establish the prevalence of WMSDs, 2) measure the impact of WMSDs, including number of work days lost, and 3) explore the relationship between WMSDs and

various personal (operator age, gender, martial status) and work-related factors (European Size Units, hectares farmed, farm income, days and hours worked in a year, full time or part time farmers and farm enterprise) among farm operators in Ireland.

MATERIAL AND METHODS:

Data source:

University College Dublin Research Ethics Committee granted ethical approval for this study. Subsequently, permission was then sought after and granted from Teagasc (Irish Agriculture and Food Development Authority) to include questions in their annual National Farm Survey (NFS) for the year 2009. In 2009 1,110 farms representing 102,398 farms enterprises nationally, were included in this survey [Connolly et al., 2010]. The primary purpose of the NFS is to collect and analyze information relating to farming activities in Ireland and report these results to the European Farm Accountancy Data Network [Connolly et al., 2010]. The NFS is conducted on a sample of farms identified by the Irish Central Statistics Office. The sample is stratified by main farming systems and farm size group to ensure that the data provide a representative profile of farms in Ireland [Connolly et al., 2010]. System refers to the primary enterprise on the farm business and is categorized according to the European Union farm typology. These enterprises include dairying, less intensive dairying with other farm systems, cattle rearing-suckler cows, other cattle systems-dry stock, mainly sheep, and mainly tillage. Pigs and poultry are not included in the sample, due to the inability to obtain a representative sample of these systems in Ireland. The NFS has been implemented on an annual basis since 1972 and therefore is a nationally representative, well-established and verified data collection system.

The NFS collects a large number of variables, which facilitates the exploration of various risk factors and consequences arising from WMSDs. Based on a review of the literature, the following variables were selected for this study: age, gender, marital

status, European Size Units (ESUs), hectares farmed, Farm Family Income, days worked per year, full or part time farm and farm enterprise. Variables such as age, gender, days worked per year, full or part time farm, and farm enterprise were identified within the literature as significant in understanding the risk factors of MSDs [Osborne et al., 2011^b]. Hectares farmed, ESUs, and Farm Family Income were identified as gaps in the literature. European Size Unit is a gross margin denominator of €1200 that is used to express the economic size of an agricultural holding or farm in a standardized manner. For each enterprise on a farm, the standard gross margin is estimated based on the area used for the particular activity (or the number of livestock) and a regional coefficient. The sum of all such margins derived from activities on a particular farm is its economic size, which is then expressed by dividing the total standard gross margin in euro by 1200, thus converting it to ESUs [Eurostat, 2012]. A part time farm is defined for the purpose of the NFS as one which requires less than 0.75 standard labour units to operate. This is calculated on a standard man day basis (eight hours of work supplied by a person over 18 years of age). Standard man day coefficients, based on the labour input required per hectare for the different crops or per head for various categories of livestock, are used to calculate the total number of standard man days required to operate a farm. A full time farm requires at least 0.75 standard labour units to function, as calculated on a standard man day basis [Connolly et al., 2010]. The distinction between a full and part time farm is based on the estimated labour input required rather than the actual work time input.

The NFS is implemented by trained recorders through an interview process. Implementation of the survey takes place on individual farms. Questions relating to

WMSDs were incorporated into the NFS taken during the summer of 2009. These questions were answered by the principal farm operator. In Ireland the principal farm operator is usually the farm owner but in a small number of cases it might be a hired farm manager. For this survey WMSDs were defined as ‘any significant bone, joint or muscle problem lasting 24 hours or more in the last 12 months, that the farmer believes was related to farming’. Standard cues were used by the interviewer to clarify this definition where necessary in order to capture significant WMSDs and not just minor aches and pains. Also recorded were the body part affected, number of days unable to do normal farm work due to the WMSD and the farm activity to which farmers attributed their WMSD.

Statistical Analysis

Questionnaire responses were entered onto the Statistical Package for the Social Sciences (SPSS V.18) for analysis. Initial analysis was conducted using descriptive statistics. A Kolmogorov-Smirnov statistical test was performed to determine if age, ESUs, hectares farmed, farm income data, and days worked were normally distributed. Only age met this assumption. Independent t-tests were used to explore the relationship between WMSD prevalence and the normal distributed variable, age. Where variables were not normally distributed, a Mann-Whitney U test was used to explore relationships between WMSD and ESUs, hectares, income, and days worked. A chi-square test was used to compare proportions of farmers with and without a WMSD in subgroups based on farm enterprise, full or part time farmer, gender, and marital status. As the dependent variable (WMSDs yes/no) is categorical, further analysis using binary logistic regression techniques was conducted to determine odds ratios with 95% confidence intervals, following which multiple logistic regression

explored independent predictors of WMSDs. Continuous variables such as age, hectares, and income were collapsed into categories for regression analysis. Hectares and income were grouped in accordance with NFS classifications and age was broken into 5 year cohorts. Each of these variables was then divided into three groups. Farm enterprises were grouped into cattle (cattle rearing and other cattle system), dairy (dairying and dairying with other farm systems), sheep and tillage (Table IV).

RESULTS

NFS results

Respondents were aged between 23 and 85 years (median = 53), farmed a median of 46 hectares of land and were predominantly male (95%). Farm enterprise groups were represented as follows: 26% (n=285) dairy, 8% (n=83) dairy and other, 22% (n=247) cattle rearing, 24% (n=272) cattle other, 11% (n=126) mainly sheep and 9% (n=97) mainly tillage.

Prevalence and impact of WMSDs

Of the respondents, 9.4% (n=103) of farm operators, corresponding to an estimated 9,629 farmers nationally, reported having had a WMSD in the previous 12 months prior to the survey. Table I illustrates the body regions and attributed causes of WMSD. The most commonly affected body regions were low back 31% (n=32), knee 15% (n=15) and hip 12% (n=12). Of the farmers who had a WMSD (n=103), 55% (n=55) attributed this to a specific farm injury. The most commonly attributed cause of WMSD was 'general lifting /pulling /pushing' (n=51) (50%).

In the previous 12 months, 57% (n=59) of farmers with a WMSD reported entire days where they were unable to work due to their WMSD with the number of days ranging from 1-300 (median = 7) (Table II). A further 87% (n=90) of farmers with a WMSD reported having days when they were able to perform only 50% or less of their normal farm work with the number of days ranging from 1-365 (median = 20) (Table II).

Risk factors for WMSDs

None of the personal factors (age, gender or marital status) showed any significant relationship with WMSDs in the univariate analysis (Table III). However, an association was found between the scale of the farm business, measured in terms of ESUs, hectares farmed, farm income and full or part time farm, and having a WMSD (Table III). Farmers who reported a WMSD operated farms that had significantly higher ESUs ($p<0.01$), farmed more hectares of land ($p<0.01$), and had greater income ($p<0.05$) than farmers without a WMSD. More farmers operating full time farms (12.4%) reported having a WMSD than part time farms (6.2%) ($p<0.01$).

Regression analysis was performed to determine odds ratios for WMSDs. Variables found to be significant on the bivariate logistic regression analysis were analyzed in a multiple binary logistic regression model to explore for independent predictors along with age, which was considered to be a potentially important factor. Age, however did not alter the ultimate outcome of the analysis and therefore is not reported in tables. Collinearity diagnostic tests were carried out on ESUs, hectares farmed and income, to explore for potential multicollinearity between these variables and thresholds were not exceeded. Therefore all were retained in regression models. Farmers operating full time farms were the only factor found to independently predict WMSD across all analyses.

In the bivariate regression analysis (Table IV) ESUs, hectares, income, full time farm operator and farm system were shown to have a significant association with WMSD. The variables hectares and income were each collapsed into three categories respectively and farm systems were grouped into cattle, dairy, sheep and tillage.

Farmers who reported a WMSD had significantly higher ESUs ($p < 0.01$), worked farms greater than 100 hectares ($p < 0.05$) and had an income greater than €30,000 ($p < 0.05$) compared to farmers without a WMSD. In addition, dairy farmers recorded a greater risk of WMSD compared to the other enterprises ($p < 0.05$). The analysis also established that full time farm operators had a greater risk of WMSD compared to operators of part time farms ($p < 0.01$). The variables found to predict WMSDs include farming greater than 100 hectares of land (OR 2.501) and being the operator of a full time farm (OR 2.156).

DISCUSSION

This research, using a statistically nationally representative sample to compare different farm enterprises, is the first of its kind to report on WMSD among farmers in Ireland. This is also the first study to report on prevalence, risk factors and impact of WMSDs among farm operators in Ireland and builds on previous research investigating “Musculoskeletal disorders among Irish farmers” [Osborne et al., 2010]. Furthermore, the current study quantifies the number of days lost by farmers due to a WMSD, which have been previously under reported. This WMSD research found that 9.4% (n=103) of Irish farm operators reported having a WMSD in the previous year, with the most commonly affected body region being the low back 31% (n=32). The research established that personal factors did not influence whether or not a farmer experienced a WMSD, although some previously reported MSD risk factors e.g., body mass index [Holmberg et al., 2004], height [Kolstrup et al., 2006], weight [Gustafsson et al., 1994] were not explored here. However, work-related factors such as ESUs, hectares farmed, income, dairy and working full time on the farm were found to be associated with higher odds of experiencing a WMSD.

Using multivariate analysis, working as a farm operator on a full time farm was the only factor found to independently predict WMSD. In a previous Irish study [Osborne et al., 2010] MSDs were found to be more common amongst farmers who worked longer hours. International studies have also identified work hours as a potential risk factor for MSDs among farmers [Gustafsson et al., 1994, Holmberg et al., 2002]. In addition, a study investigating ‘a shorter workday as a means of reducing the occurrence of MSDs’ in physically demanding care work, found that shortening the regular workday from ≥ 7 hours to 6 hours was associated with a reduced prevalence

of neck-shoulder pain [Wergeland et al., 2003]. The latter study also reported that shorter workdays could reduce the amount of sustained muscular activity at work, but this effect has relatively little impact on the risk of overexertion injuries such as back injury, the most commonly reported WMSD amongst farmers. Additionally, other factors such as the need for manual handling of heavy loads and the possibilities for safe lifting may be of greater relative importance for the occurrence of back pain [Wergeland et al., 2003]. Results from the current study indicated that 55% of farm operators who reported a WMSD in the previous year attributed the cause to a specific farm injury, suggesting acute overexertion injury rather than insidious work damage from sustained injury. This highlights the need to develop better working routines such as eliminating heavy lifting and alternating work tasks, the maximum time spent working on specific tasks and the resting time in between tasks which have been suggested by Kolstrup, C. 2008 [Kolstrup, 2008]. In Ireland, studies related to effective use of work time have indicated that both technology and practice adoption were required to reduce working time [O'Brien et al., 2006, Ruane et al., 2007]. A previous case study analysis on "A farm Safety Model for Irish Farms" reported that farmers with higher levels of management skills also applied these skills to the management of safety [Phelan et al., 2007]. They found that safety management on the farm is a function of farm management and the farmer's ability to successfully manage all aspects of the farm business. Therefore, improving farm management skills, in particular planning work activities, routines and technology adoption relevant to WMSD prevention could be more beneficial to farmers as well as reducing daily hours worked.

The results established that operators farming greater than 100 hectares and with incomes greater than 30,000 Euros i.e. farms with higher ESUs, were at a greater risk of WMSDs. This has not been reported previously for WMSDs. However, research by Pickett et al., in 1995 supports the association between injury and larger farm size and also higher farm income. Larger farms tend to have higher activity levels and require greater labour inputs thereby exposing their operators to more physical hazards or possibly greater work time constraints. In the current WMSD study, dairy farmers made up a higher proportion in the larger farm group (>100 hectares) and the higher income group (>30,000 Euros). They also had more ESUs compared with the other farm enterprises. It is therefore unsurprising that Dairy farmers also reported a greater risk of WMSD compared to the other enterprises. Dairy farmers are exposed to the added hazard of milking and regularly handling dairy cows in comparison to other farm enterprises. Milking cows has been described as physically demanding and can be associated with repetitive and monotonous work, difficult working postures and movements [Stal et al., 1996, Stal et al., 2003, Pinzke et al., 2001]. Therefore the characteristics of this enterprise, in terms of physical farm size, scale of the farm enterprise and the number and variety of farm tasks, increases their risk of experiencing a WMSD. However, it is important not to omit small farms or other farming systems completely as WMSDs arises on these farms also. A more detailed examination is required to understand what factors make farm enterprise, size and scale risk factors for WMSDs.

The current study is the first study in Ireland to report work days lost by farm operators due to a WMSD, which were identified in the introduction as being under reported. These results illustrate the impact of WMSD on Irish farmers, where nearly

60% of those with a WMSD reported being unable to conduct their farm work for, at least, a full day due to their WMSD and 39% were not able to work for 4 or more consecutive days. Also, nearly 90% of those with a WMSD reported that in the previous year they had days where they were able to perform only 50% or less of their normal farm work. As this study only investigated impact as regards days lost, further research is required to establish the economic and social impacts of WMSDs on the farm operator and implications for the viability of the farm enterprise. This research is possible using annual surveys like the NFS as it can follow subjects over time. Taking a longitudinal approach would also help reduce limitations like the 'healthy worker effect' as it would capture farmers with more severe WMSDs who had to cease farming as a result of a WMSD.

The consolidation and specialization of farming is resulting in fewer, larger farms internationally. Associated with these developments are changes in the nature of work undertaken by farmers resulting in an increase in the intensity and longevity of repetitive tasks, e.g., milking. In the absence of appropriate and sufficient intervention, it is expected that the number and rate of WMSDs will increase in the coming years. If agricultural development of this nature is to be socially sustainable prevention interventions will be necessary to support the continued expansion of farming in the future. Overall this study suggests that the prevalence of WMSDs can be reduced by application of improved farm management practices, by minimizing the risk of WMSDs through technology and practice adaption, as was suggested for injury prevention by an NFS study in Ireland [Phelan et al., 2007]. A more detailed examination of the risk factors associated with WMSDs is required to establish causality and hence, effective interventions. The methodology developed by this study

can be used in the future to monitor progress with WMSDs among farmers both in Ireland and internationally.

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Table I. WMSDs among farm operators: body parts affected and attributed causes

(n=103)

Body part affected	n	(%)
Low back	32	(31)
Knee	15	(15)
Hip	12	(12)
Ankle/foot	8	(8)
Hand/wrist	7	(7)
Shoulder	6	(6)
Upper back	4	(4)
Neck	2	(2)
Elbow	1	(1)
Other	16	(16)
Attributed causes	n	(%)
General lifting/pushing/pulling	51	(50)
Animal handling	13	(13)
Trips and falls	12	(12)
Using machinery/tools/implements	11	(11)
Other	16	(15)

Table II. Farm operators with WMSDs and resultant reduced productivity days
(n=103)

	Full days unable to work	50% or less farm work
	n (%)	n (%)
1-3 days	19 (18.4)	9 (8.7)
4-7 days	13 (12.6)	19 (18.4)
8-14 days	4 (3.9)	13 (12.6)
15-30 days	8 (7.8)	23 (22.3)
31-180 days	14 (13.6)	22 (21.4)
> 180 days	1 (1.0)	4 (3.9)
	59 (57.0)	90 (87.0)

Table III: Factors associated with WMSD among farmers (n=1110)

		WMSD yes	WMSD no	Test	p
Age	Median (Range)	52.78 (30-85)	53.67 (23-84)	0.690 ^a	0.491
	Interquartile range	15	17		
Gender	Male n (%)	102 (9.6)	955 (90.4)	2.910 ^b	0.088
	Female n (%)	1 (2.2)	45 (97.8)		
Marital Status	Single n (%)	21 (8.2)	234 (91.8)	2.427 ^b	0.489
	Married n (%)	79 (9.9)	721 (90.1)		
	Widowed n (%)	1 (2.9)	34 (97.1)		
	Separated n (%)	1 (7.7)	12 (92.3)		
ESU	Median (Range)	32.53 (2.01-206.98)	17.21 (2.07-258.19)	-3.952 ^c	0.001
	Interquartile range	50.96	35.55		
Hectares	Median (Range)	59.10 (8.90-228.00)	45.00 (4.00-418.00)	-2.89 ^c	0.004
	Interquartile range	53.20	39.70		
Income	Median (Range)	16,385.42 (-12,375.52- 88,849.31)	12,281.00 (-69,612.62-329,076.00)	-2.450 ^c	0.014
	Interquartile range	28,594.39	21,888.68		
Days worked per year					
	Median (Range)	300 (1-365)	300 (0-365)	-1.145 ^c	0.252
	Interquartile range	60	42		
Full time/part time					
Full time	n (%)	70 (12.4)	493 (87.6)	12.598 ^b	0.001
Part time	n (%)	33 (6.2)	501 (93.8)		
Farm Enterprise					
Cattle	n (%)	35 (6.7)	484 (93.3)	7.612 ^b	0.055
Dairy	n (%)	41 (11.1)	327 (88.9)		
Sheep	n (%)	15 (11.9)	111 (88.1)		
Tillage	n (%)	12 (12.4)	85 (87.6)		

^a T-test^b Chi Square Test^c Mann-Whitney Test

Table IV. Regression analysis used to explore factors associated with WMSDs
(n=1110)

		Binary Regression			Multiple Regression		
		OR	95% CI	p	OR	95% CI	p
ESU		1.007	1.002-1.012	0.004	1.002	0.994-1.011	0.631
Hectares	0-30	(indicator variable)					
	31-100	1.501	0.872-2.584	0.143	0.942	0.486-1.824	0.860
	>100	2.501	1.208-4.920	0.007	1.070	0.419-2.734	0.887
Income	<6,499	(indicator variable)					
	6,500- 29,999	1.140	0.694-1.873	0.605	0.977	0.571-1.671	0.932
	>30,000	1.859	1.088-3.177	0.023	1.162	0.615-2.198	0.643
Days worked		1.001	0.998-1.005	0.457			
Part time		(indicator variable)					
Full time		2.156	1.399-3.321	0.001	2.048	1.085-3.864	0.027
Farm Enterprise	Cattle	(indicator variable)					
	Dairy	1.734	1.081-2.781	0.022	0.947	0.488-1.835	0.871
	Sheep	1.869	0.986-3.541	0.055	1.547	0.790-3.030	0.204
	Tillage	1.952	0.974-3.912	0.059	1.353	0.641-2.857	0.427