Effects of drop out in a longitudinal study of musculoskeletal disorders

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Abstract

***Objectives*—The drop out rates in different longitudinal studies of musculoskeletal disorders range between 7% and 57%, and little is known about the characteristics of the subjects who dropped out. The aim was to analyse various consequences of drop out in a longitudinal study of musculoskeletal disorders and occupational risk factors during 1969–97.**

***Method*—Data about occupational conditions and health in 1969 and in 1993 were analysed. Differences between those who participated throughout (participants) and drop out subjects in these analyses formed the basis for recalculations of earlier reported analyses of associations between occupational conditions and low back pain. In the recalculation the data were weighted to compensate for the differences.**

***Results*—More female and male drop out subjects than participants in 1993 had monotonous work, fewer women and more male drop out subjects had heavy lifting in 1969. In 1997, more female and male drop out subjects had had heavy lifting and low stimulation at work in 1993. At both occasions, there were differences between the drop out subjects and participants in occurrence of musculoskeletal disorders. The weighted analyses resulted in changes in risk ratio of 0.1–0.2.**

***Conclusions*—Differences in occupational conditions and health among participants and drop out subjects in a longitudinal study of musculoskeletal disorders and occupational risk factors during 1969–97 did not markedly influence the risk ratios.**

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Keywords: panel study; non-response; survey method; methodological study

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Drop out is always a problem in studies with human participants, but especially so in longitudinal studies with repeated follow ups, as the number of subjects for whom the data set is incomplete often increases for each time point during the study. Although much can be done to reduce the rate of drop out, the loss to follow up can seriously reduce the generalisability of the findings as the drop out subjects are usually not representative of the whole study group.

During the past decades, there has been an increased drop out rate in studies performed in the industrialised part of the world.[1] This is particularly true for studies that take place in large cities.

Usually, the drop out rate is between 20% and 40%, partly depending on the duration of the follow up time.[2] Other factors that influence drop out are sample characteristics (some samples are easier than others to keep track of), the survey organisation (good training, high motivation, and competence in the surveyors decreases the drop out rate), availability of public records, and the frequency of follow ups (too frequent contacts exhaust the subjects and too few contacts decreases their motivation).

There are some very good examples of what can be done to minimise the drop out rate. For instance, in a longitudinal study of drug misusers (with an original participation rate of 96%),[3] a log of all attempted contacts was kept for each subject, including the date, time, and a description of the attempt and its outcome. All available sources of information, data from the baseline examination, public records, and field tracking were used to reach the subjects, and weekly meetings were held to coordinate all tracking efforts. This very systematic effort resulted in a very low drop out rate (3.4%) in the 18 month follow up.

Differences in characteristics between the drop out subjects and those who participated throughout (participants) may cause serious bias in a study. Drop out subjects in a longitudinal study on prevention of smoking were found to have lower academic achievement, less knowledge about tobacco and health, less social influence, less ability to resist social pressure, and were more likely to be smokers and marijuana users than the participants.[4] By taking into account the characteristics of drop out subjects, it is possible to reduce drop out bias with available procedures, and it is also possible to design appropriate strategies for reducing drop out rates in similar studies of prevention of smoking.

To be a source of bias in a study, differences in exposure conditions between participants and drop out subjects—and such are often found—must be related to the studied outcome.[5] Such a systematic bias may lead to underestimation or overestimation of the risk ratios. Differences in exposure conditions that are not related to the studied outcome will not affect the risk ratios. When differences between participants and drop out subjects are found—for example in educational levels—these may indicate differences in both exposure conditions and health, but it is very seldom possible to examine these. In the area of interest in the present study—epidemiological studies of work related musculoskeletal disorders—the rate differs greatly between studies performed. For

example, the drop out rate in large studies of musculoskeletal disorders during the past 10 years has ranged between 7% and 57%, mostly between 14% and 33%.[6–17] Some of these studies are population based and some are focused on an occupational group, but the drop out rate does not differ markedly between the different types of studies. To the best of our knowledge, no detailed studies have been done on differences in characteristics between those droping out and participants in longitudinal studies of musculoskeletal disorders, and of possible consequences of these differences. The drop out rate is (with a few exceptions) reported, and possible consequences are tentatively discussed.

The aim of the present study was to describe and to analyse the consequences of drop out in a longitudinal study of musculoskeletal disorders and occupational risk factors. Did the drop out subjects differ from the study participants in working conditions or musculoskeletal health? How did such differences influence the conclusions drawn about associations between exposure and outcomes? Were there trends in patterns of drop out at different examination points in the longitudinal study?

Method

STUDY GROUP

Baseline in 1969

In 1969 an investigation of 2579 women and men (84% of the eligible study group), aged 18–65 years and living in the county of Stockholm, was undertaken (the REBUS study). The purpose was to investigate (*a*) the requirements for medical and social services, (*b*) differences between subgroups of the population in their actual needs for services, and (*c*) the steps taken so far to meet those needs.[18] The subjects were randomly selected in an age stratified manner where the number of subjects selected from the youngest age groups was enhanced to get enough occurrences of certain disorders.[19] All subjects underwent a medical examination and medical diagnoses were given whenever appropriate. For a musculoskeletal diagnosis, symptoms, signs, and also consequences for daily living were required. The non-respondents in 1969 (16%) were compared with the participants for sick leave and socioeconomic status, and the agreement between the groups was good.[18]

Follow up in 1993

During 1993, all REBUS subjects below the age of 59 years in 1993 without a musculoskeletal diagnosis in 1969, living in Sweden and available for contact, were identified and asked to participate in a re-examination (n=783). The re-examination aimed at identifying risk factors for musculoskeletal disorders. These REBUS subjects were 18–34 years of age in 1969. In 1993 they were 42–58 years of age, with a mean (SD) age of 48.1 (4.3) among women and 48.5 (4.5) among men. People who had had a diagnosis of low back pain—for example, lumbago, sciatica, or lumbago-sciatica—in 1969 were excluded, although those with mild low back pain not leading to a diagnosis were included. As well as serious musculoskeletal diagnoses, other criteria for exclusion were serious psychiatric diagnoses—such as schizophrenia and mental retardation, chronic alcoholism, diagnosed chronic diseases of the nervous or cardiovascular system, congenital malformation, and serious injuries due to external violence or poisoning.

To promote participation in the 1993 follow up, a second invitation was posted 2 weeks after the first to those who had not responded. Two months after the second request, eligible non-responders were contacted by phone and urged to participate in the re-examination. Out of 783 eligible subjects 484 (62%) finally participated in the follow up in 1993.

Follow up in 1997

In 1997, the subjects who participated in the follow up in 1993 were approached and asked to participate in a second follow up. To promote participation in this follow up, a second invitation was posted 2 weeks later to those who had not responded to the first. Almost 87% (88% and 85% among women and men, respectively) of the 1993 study group of 484 subjects participated in the follow up, resulting in 222 women and 198 men in a broad range of occupations. The main aim in 1997 was to examine the predictive value of the 1993 information on physical and psychosocial working conditions for musculoskeletal disorders in 1997. The subjects were included in the study after they had been fully informed about all parts of the study and had given their informed consent to participate. The study has been reviewed and approved by the ethics committee of human research at the Karolinska Institute, Stockholm, Sweden.

DATA COLLECTION

For 783 subjects (surveyed in 1993)

In the 1969 study, data on psychosocial and physical conditions at work were collected by a questionnaire based interview; and this information was available on all 783 eligible subjects. Occupational factors were heavy lifting, physical exhaustion, whole body vibrations, hectic work, mental exhaustion, monotonous work, poor social support at work, full time work, shift work, overtime work. Information was also collected on health (low back pain in 1969).

For 484 subjects (surveyed in 1997)

Exposure and health data from 1993 were analysed relative to drop out in 1997. Information about low back pain, neck and shoulder pain, and pain in the hands, arms, hips, legs, and feet during the 12 months before the examination in 1993 was of special interest. Occupational conditions in 1993 collected and analysed relative to drop out included heavy lifting, physical exhaustion, whole body vibrations, high mental demands, poor emotional climate, low stimulation at work, full time work, shift work, and overtime work.

Self reported reasons for not participating
Self reported reasons for not participating in the follow up in 1993 were collected in a telephone interview with 173 drop out subjects (98 women and 75 men).

DATA ANALYSIS
All analyses were done for women and men separately, and various measurements of association have been calculated. These measurements have been termed risk ratios in the text, regardless of whether they are prevalence ratios, cumulative incident ratios, or odds ratios.

Weighted analyses
When the difference in exposure or health was more than five percentage points between the participants and the drop out subjects, the cell frequencies were recalculated to those that should have been, were there no people dropping out of the study. Hopefully, this resulted in similar proportions of exposure conditions and health as in the whole eligible study group. The study group resulting from these recalculations is presented in the tables of results as the estimated full study group. Then the associations between occupational factors and low back pain within the REBUS study[8 20] were calculated once again (weighted analysis), with the module PROC FREQ in the SAS statistical software.[21]

Two different subsets of weighted analyses were made. In the first, exposure data from 1969 were examined relative to prevalence of low back pain in 1969 and 1993, and cumulative incidence of low back pain in 1970–92.[8] When the prevalence in 1969 was calculated, a subject was considered to be a case of low back pain if he or she reported pain, aching, or stiffness in the lower back at that interview. At the 1993 re-examination, a retrospective questionnaire about musculoskeletal symptoms during 1971–92 was filled out. When the cumulative incidence of low back pain in 1970–92 was calculated, subjects were considered to be cases if they had reported medical consultation and treatment (by doctor, physiotherapist, or chiropractor) for pain in the lower back during that period, in the questionnaire. At the 1993 re-examination, data on musculoskeletal disorders during the last 12 months before the re-examination were obtained through a standardised interview. On the basis of this interview, the prevalence of having had low back pain defined by pain, aching, or stiffness in the lower back in the past 12 months was calculated. The occurrence of low back pain was calculated among exposed and non-exposed subjects and risk ratios were calculated.

In the second subset, low back pain in 1997 was compared between exposed and non-exposed subjects in 1993. Low back pain in 1993 was defined as medical consultation and treatment by a doctor, physiotherapist, or chiropractor because of low back pain (questionnaire), or pain in the lower back more than 7 consecutive days during the 12 month period preceding the examination in 1993 (data from an interview). Similarly, low back pain in 1997 was defined as medical consultation and treatment by a doctor, physiotherapist, or chiropractor because of low back pain at any time during the 12 months preceding the follow up in 1997, or pain in the lower back for more than 7 consecutive days during the 12 months before answering the questionnaire in 1997. Subjects with incident low back pain were defined as having had low back pain in 1997 but not in 1993–6 and in 1970–92. Subjects with chronic low back pain were defined as having had low back pain both in 1993 and in 1997, as well as pain in the lower back at some time in 1994–6. Healthy subjects had not had low back pain during 1970–97. Age adjusted risk ratios were calculated for incident and chronic low back pain.[20]

Table 1 Occupational conditions and musculoskeletal health in 1969: by percentage of 1993 female and male participants and dropout subjects

	Women		*Men*	
	Participants n=252	*Dropouts n=168*	*Participants n=232*	*Dropouts n=131*
Occupational conditions:				
Heavy lifting	13	7	28	35
Physical exhaustion	20	24	17	16
Whole body vibrations	1	2	16	15
Hectic work	37	33	53	54
Mental exhaustion	18	22	20	14
Monotonous work	10	17	10	16
Poor social support	37	38	38	37
Full time work	84	83	98	98
Shift work	6	5	8	12
Overtime work	0	2	5	7
Health:				
Low back pain	34	28	24	35

Results

PARTICIPANTS AND DROP OUT SUBJECTS IN 1993
More female drop out subjects than participants in 1993 had monotonous work and fewer had overtime work and heavy lifting in 1969 (table 1). Among male subjects more subjects among those that dropped out had monotonous work and heavy lifting, and fewer reported mental exhaustion in 1969. Among women fewer, and among men more, drop out subjects had low back pain in 1969.

Self reported reasons for not participating in the follow up in 1993
The reasons for not participating in the follow up in 1993 were: lack of time (37%), illness (8%), family demands (3%), did not want to travel to Stockholm (8%), forgetting the baseline study in 1969 (10%), and that they just did not want to participate (34%).

PARTICIPANTS AND DROP OUT SUBJECTS IN 1997
More drop out subjects than participants in 1997 among both women and men did heavy lifting at work, and had low stimulation at work in 1993 (table 2). More female and male participants than drop out subjects had overtime work and higher mental demands. Among the drop out subjects, both women and men had musculoskeletal pain in 1993.

WEIGHTED ANALYSES OF ASSOCIATIONS
In this first set of weighted analyses, very few changes were found in the risk ratios for the

Table 2 Occupational conditions and health in 1993: by percentage of 1997 female and male participants and dropout subjects

	Women		*Men*	
	Participants n=222	*Dropouts n=30*	*Participants n=198*	*Dropouts n=34*
Occupational conditions:				
Lifting 5–15 kg	35	50	42	54
Physical exhaustion	35	37	31	36
Whole body vibrations	26	38	45	48
High mental demands	33	24	22	24
Poor emotional climate	21	20	29	29
Stimulation at work	36	45	24	30
Full time work	68	66	86	86
Shift work	20	21	19	16
Overtime work	32	25	45	38
Health:				
Foot pain	6	8	6	12
Knee pain	5	5	8	3
Hip pain	6	5	5	5
Hand and arm pain	14	23	11	22
Upper back pain	10	16	5	5
Low back pain	15	27	18	17
Neck and shoulder pain	27	40	14	26

effects of exposures in 1969 (table 3). At most, the risk ratios increased or decreased by only 0.1, 0.2, or 0.3.

In the second set of weighted analyses, very few changes in the level of risk ratio were found (table 4). An increase or decrease of 0.1 or 0.2 was the most usual, when a change occurred at all.

Discussion

In this long term follow up of a sample of the general population, some characteristics differed between the participants and the drop out subjects. Some known occupational risk factors for musculoskeletal disorders were more common among the drop out subjects and others among the participants. The drop out subjects had, in general, more self reported musculoskeletal problems than the participants.

The differences between the participants and the drop out subjects had a very modest influence on the risk ratios for effects of occupational exposures. This is reassuring (if these results can be generalised) as many intervention strategies have been designed on the basis of studies where very limited data about the drop out characteristics have been available. Systematic bias because of differences between participants and drop out subjects did not seem to be present. However, it is possible that the influence on the risk ratios would have been different if the drop out rate had been larger than in the present study. It is also possible that the influence on the risk ratios would be different in studies of other end points than musculoskeletal disorders.

The results suggest that people dropped out from the study for reasons that were mostly unrelated to the exposures and end points under study. Issues such as temporarily living abroad, being busy at work, and demanding family obligations were indicated in the self reported reasons for not participating in the follow up in 1993. Even at the baseline examination, reasons like these were given for not participating.[18] Such reasons are not connected to the studied variables, maybe with the exception of studies focusing on interest or motivation.

Table 3 Associations between potential risk factors in 1969 and low back pain 1969, in 1979–92, and in 1993; age adjusted and weighted analyses by sex

	Low back pain in 1969				*Low back pain in 1970–92*				*Low back pain in 1993*			
		Estimated full study group weighted PR				*Estimated full study group weighted CIR*				*Estimated full study group weighted PR*		
Potential risk factors	*Actual study group PR*	*Exposure*	*Health*	*Exposure +health*	*Actual study group CIR*	*Exposure*	*Health*	*Exposure +health*	*Actual study group PR*	*Exposure*	*Health*	*Exposure +health*
Women:												
Heavy physical load	1.4	1.4	1.4	1.4	1.1	1.1	1.2	1.1	1.0	0.9	1.0	1.0
High mental load	0.8	1.1	1.0	1.1	1.4	1.2	1.4	1.4	1.1	0.9	1.1	1.1
Monotonous work	1.6	1.5	1.6	1.7	1.1	1.3	1.1	1.2	0.9	0.9	0.8	0.9
Men:												
Heavy physical load	1.4	1.3	1.3	1.4	1.4	1.5	1.5	1.4	1.1	1.3	1.2	1.2
High mental load	1.2	1.2	1.3	1.3	1.0	1.0	1.0	0.9	1.1	1.0	1.0	1.0
Vibrations	0.9	0.9	0.9	0.9	1.4	1.4	1.3	1.4	1.3	1.5	1.4	1.4
Monotonous work	0.8	0.7	0.9	0.9	1.0	1.0	0.9	0.9	1.5	1.6	1.4	1.4

PR=prevalence ratio, adjusted for age; CIR=cumulative incidence ratio, adjusted for age.

Table 4 Associations between potential risk factors in 1993 and incident and chronic low back pain in 1997, in 1979–92, and in 1993; age adjusted and weighted analyses by sex

	Incident low back pain				*Chronic low back pain*			
		Estimated full study group weighted OR				*Estimated full study group weighted OR*		
Potential risk factors	*Actual study group OR*	*Exposure*	*Health*	*Exposure +health*	*Actual study group OR*	*Exposure*	*Health*	*Exposure +health*
Women:								
High perceived workload	1.4	1.4	1.4	1.4	1.9	1.8	1.9	1.8
Shift work	1.9	1.8	1.9	1.9	2.1	2.0	2.1	2.0
Job strain	2.3	2.4	2.3	2.3	1.7	1.8	1.7	1.7
Few possibilities to gain new knowledge	2.6	2.9	2.5	2.6	1.9	1.9	1.9	1.9
Men:								
Whole body vibrations	2.0	1.9	2.0	1.9	1.0	1.0	1.0	1.0
Work with hands below knee level	1.9	1.8	1.8	1.7	4.5	4.5	4.4	4.5
Lifting 5–15 kg	4.0	4.0	3.9	3.8	3.7	3.7	3.6	3.6
High perceived workload	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.7

OR=odds ratio, adjusted for age.

The characteristics of the drop out subjects were not exactly the same in the follow ups in 1993 and 1997, indicating that different factors influenced the drop out process. This could be expected as the time intervals between the two follow ups differed considerably. As the drop out subjects in 1997 distinguish themselves from those in 1993 that dropped out by not dropping out in 1993, they are of course different from the drop out subjects in 1993. The drop out rate was much higher in 1993. This was probably caused both by the long follow up time and the difference already mentioned between the drop out group in 1993 and the one in 1997. Thus, the main impression from these analyses is that there seems to be a higher proportion of drop out subjects than participants among manual workers than white collar workers, but this is not entirely true as heavy lifting was more common among participants than among those dropping out in 1993. As a main trend, the drop out rate seems to be higher among subjects with low qualifications.

Another question of interest is how far a researcher can go in attempts to reduce the drop out rate without seriously intruding on the person's integrity. The quality of the data offered by a person who would rather not participate in the follow up might be poorer than the data offered by a more enthusiastic participant. One indicator of this might be the internal loss of data when the subjects do not answer all the questions put to them. In the present study, there was no more internal loss of data in the baseline examination in 1969 among the drop out subjects than among the participants in the follow up in 1993. About 30% of the drop out subjects in 1997 had some internal loss of data in the follow up in 1993, which should be compared with about 10% among the subjects who participated in the follow up in 1997. The psychosocial occupational data in 1993 were collected in an interview, and the quality of the data offered by the subjects was estimated. No differences in quality of data between the drop out subjects to be and the participants were found.

METHODOLOGICAL CONSIDERATIONS

We concluded that there were differences between drop out subjects and participants, both in exposure to certain occupational conditions and musculoskeletal health, and therefore it was important in our study to examine the consequences of these differences. The weighted analyses performed were intended to reflect the conditions in the whole eligible study group—that is, the conditions if no drop out had occurred. This is not as good as if we really had been able to persuade all eligible subjects to participate in the follow ups, but may serve as an approximation of the true conditions. We chose a mathematical weighting procedure, but other procedures are also possible.

In Sweden, earned income has relatively little impact on disposable income and thereby on living circumstances. This has probably reduced the importance of differences in education and income level between female participants and drop out subjects in the present study. In Sweden, as in several other countries (especially the Scandinavian countries), women receive more of the family related allowances or means tested allowances and men more of the earnings related allowances in the social security system.[22] There are differences in how much of the average gross income among women and men derives from the market or from the welfare state, where women in 1994 received 29% and men 19% of their average income from the welfare state. The purpose of these allowances is to guarantee a basic security or a certain minimum standard, particularly for subjects with very low earnings, thereby the effect of having low earnings decreases. The living conditions probably differ much more between participants and drop out subjects in societies with fewer social services and social allowance benefits, resulting in larger differences in health and maybe also in working conditions (as some people may be forced to work under extremely demanding conditions for poor wages). Such differences between types of societies have implications for the possibility of generalising from these results to other countries and other parts of the world.

Another aspect to take into consideration, relative to dropping out, is the cultural attitude to offering information to research organisations and governments. In Sweden, much information about the inhabitants is collected on a regular basis. In countries where there is previous negative experience with researchers or governments or a negative attitude to societal interventions in general, a larger drop out rate could be expected and it might result in larger differential bias than was found here.

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Answers to multiple choice questions on *Ultrafine particles* by K Donaldson *et al* on pages 211–16.

(1) (a) Incorrect (b) Correct (c) Incorrect (d) Incorrect (e) Incorrect
(2) (a) Yes (b) No (c) Yes (d) Yes (e) Yes
(3) (a) Untrue (b) Untrue (c) Untrue (d) True (e) Untrue
(4) (a) Correct (b) Correct (c) Correct (d) Incorrect (e) Correct
(5) (a) Susceptible (b) Not susceptible (c) Susceptible (d) Susceptible (e) Not-susceptible