Back pain among echocardiographers

Mina Solanki, Douglas Carr, Michael Martin

Abstract

Objective—By having to adopt unnatural postures, echocardiographers place themselves at risk of back injury. The present study sought to document the incidence and severity of back pain among echocardiographers, and to identify personal, lifestyle, and occupational characteristics that may predict risk of back pain.

Design—A questionnaire concerning occupational, personal, and lifestyle characteristics, as well as the extent and severity of back pain was completed and returned by 183 echocardiographers.

Results—The standard echocardiography examination position of “machine on the left, patient on the right, and transducer held in the right hand” (used by 66% of respondents) greatly increased the risk of back pain (odds ratio (OR) = 4.9; 95% confidence interval (95%CI) = 1.49–16.4). Echocardiographers with more than 11 years experience in the field were also at risk of back pain (OR = 3.4; 95%CI = 0.97–11.6). The intensity of back pain was strongly associated with the amount of time spent on echocardiography examinations ($P = 0.035$), limitation of lifestyle ($P \leq 0.001$), and interference with work ($P \leq 0.001$). There was a significantly higher relative risk of back pain for the respondents whose job involved frequent or occasional lifting compared with non-lifters ($P = 0.01$; OR = 4.8, 95%CI = 1.25–18.7). At least some limitation of lifestyle from back pain was reported by 56% of the respondents.

Conclusions—There is a high incidence of back pain among echocardiographers, and specific tasks and activities increase the risk of back pain. Further research should focus on preventative measures and optimum work station designs that may serve as a guide to echocardiography departments.

(Heart 1997;78:23–28)

Keywords: back pain; echocardiographers; echocardiography examinations; posture; occupational back pain

Back injury among nursing personnel has become a topic of great interest in occupational health. Individual risk factors include age, physical fitness,^{1,2} psychological factors, and previous back pain.³ Number of years spent on units where frequent lifting was

required,^{4,5} heaviness of lifting,⁶ and frequency of lifting,¹ are some of the lifting related causes identified by the studies.

Echocardiographers perform tasks that place them at risk of back pain. Because of having to adopt unnatural postures to perform echocardiography, high and low back, neck, shoulder, and wrist pain are frequent complaints among echocardiographers. Back pain may be a chronic and sometimes disabling condition.⁷ Poor postures sustained for prolonged periods can result in tissue damage and disc protrusion, causing longlasting symptoms.⁸ Successive injuries tend to be more severe, eventually resulting in financial implications from medical costs, decreased productivity, and absenteeism.^{9,10} To avoid occurrence and recurrence of back pain, echocardiographers should identify activities in the work environment that increase their risk of back pain. Lack of research in this area has hampered adequate risk assessment and improvement in the work environment to ensure safer working practices. To our knowledge, this is the first study to document the incidence of back pain among echocardiographers and to identify risk factors associated with performing echocardiography tasks.

The purposes of this study were to: (1) document the incidence of back pain among a sample of members of the British Society of Echocardiography; (2) identify demographic and lifestyle characteristics that best forecast back injury; (3) identify occupational characteristics related to back pain; and (4) document the extent and severity of back injury sustained by echocardiographers.

Methods

A survey was performed to assess the frequency of back pain among echocardiographers. The membership list of the British Society of Echocardiography contains 1300 members of whom 600 are echocardiographers (cardiac technicians). The remaining members are medical staff who are involved in echocardiography as part of their cardiology training and are relatively infrequent users of echocardiography equipment. They were considered unlikely to be at risk of back pain and were excluded from the study. Optimum sample size was calculated and 266 of the randomly selected members were sent a questionnaire.

The questionnaire was divided into four sections, which covered preferred echocardiography examination methods, personal charac-

Cardiology
Department,
Stockport Acute
Services (NHS) Trust,
Stepping Hill Hospital,
Poplar Grove,
Stockport SK2 7JB,
Cheshire, UK
M Solanki
M Martin

South West School of
Radiography,
University of Derby,
Devonshire House,
Derbyshire Royal
Infirmary, London
Road, Derby
DE1 2QY, UK
D Carr

Correspondence to:
Dr Solanki.

teristics, lifestyle, and prevalence and intensity of back pain (fig 1). The questionnaire was precoded for analysis. The questions on intensity of back pain were based on Likert-type scale and a few exploratory questions were open ended.

Information on echocardiography experience was derived from the question "how long have you been involved in echocardiography?", which provided a list of options: less than 2 years; between 2 and 4 years; between 5 and 10 years; between 11 and 20 years; and more than 20 years. The amount of time spent scanning (per week) was indicated by the respondents by selecting from a list of nine options ranging from "less than 3 hours per week" to "more than 50 hours per week". Information on work postures or ergonomics was evaluated by a series of closed questions referring to the position of the operator in relation to the echocardiography machine and the patient, such as "where do you sit to conduct the examination?" and "where is the echo machine situated in relation to you?". Lifting was recorded as either the job involved lifting or not. Frequency of lifting was addressed by the question "how often do you lift?" (occasionally, frequently, rarely). Work satisfaction was evaluated by the following options: good, average, poor, and don't know. The above questions were derived from personal experience of the author in this field and from related studies of occupations involving similar work activities, such as radiography and nursing.^{5 11}

Questions on lifestyle parameters were based on review of studies on social and occupational history in the general population and the nursing population.²⁻¹² The question on level of exercise had the following options:

once a week, twice a week, three times a week, more than three times a week, hardly ever, and I don't exercise. The influence of preschool aged children on low back pain has been recognised and included in surveys by several researchers.^{12 13}

Questions on pain intensity were derived in part from a Million Visual Analogue,¹⁴ the Oswestry Scaled Back Pain Questionnaire,¹⁵ and from various instruments used in similar settings.¹⁶ The questionnaire contained scaled Likert-type response options pertaining to back pain at work and non-work activities. Close correlation between the disability score obtained from the Likert scale and clinically observed disability and symptoms have been reported.¹⁴⁻¹⁶

The questionnaire was pretested on 10 colleagues to determine clarity and ease of completion. Consistency questions were used to evaluate whether responses were consistent thus providing support for the internal consistency and reliability of the questionnaire.

STATISTICAL ANALYSIS

Categorical variables were analysed using χ^2 contingency table techniques. χ^2 was chosen for analysis of nominal data and Mann-Whitney U test for analysis of ordinal data such as height, weight, stress levels, and job satisfaction.

Univariate logistic regression analysis was undertaken to examine associations between the potential predictors and dependent variables, namely incidence of back pain, where the dependent variable was dichotomous (0 = no pain, 1 = pain). Based on the results of univariate logistic regression and correlation analysis, variables were selected to fit a multivariate logistic model. Relative risks were estimated as odds ratios and presented with their 95% confidence intervals (95%CI). A variable with an odds ratio of less than 1 was considered not to be a significant risk factor.

Results

The fully completed questionnaires were obtained from 183 of the 266 potential respondents, a response rate of 69%. The sample was 30.5% of the target population (cardiac technicians) of which 80% of respondents reported back pain. Thirty four males and 149 females responded, of whom 25 males (74%) and 121 females (81%) experienced back pain.

Lifestyle variables such as smoking ($P = 0.36$), exercise level ($P = 0.51$), and care of preschool children ($P = 0.21$) did not show any association with risk of back pain. At least some limitation of lifestyle from back pain was reported by 56% of the respondents.

Seventy five per cent of the respondents (137) reported having been involved in echocardiography for more than five years, of this group 38% reported more than 11 years of experience in the field. The number of years in echocardiography did not appear to be a significant risk factor when χ^2 analysis was applied ($P = 0.27$). However, logistic linear regression

Figure 1 Questionnaire design.

Table 1 Relative risk of back pain with echo experience (n = 183)

Echo experience (years)	Significance	Odds ratio (95%CI)
2-4	0.33	1.8 (0.5-7.02)
5-10	0.11	2.5 (0.7-8.6)
11-20	0.05	3.2 (0.97-11.5)

analysis showed that compared with respondents with less than two years echocardiography experience, there was a trend towards increased risk of back pain with increase in years of experience. Respondents in the 11-20 years group were at three times greater risk ($P = 0.05$) of back pain than those with less than two years' experience (table 1). Similarly, the amount of time spent scanning (echotime) did not show significant ($P = 0.55$) association with the risk of back pain, although the intensity of back pain for sufferers showed a significant correlation with echotime ($P = 0.035$) (fig 2), interference with work ($P \leq 0.01$), and limitation of lifestyle ($P \leq 0.01$), even when controlled for back pain history, age, reduced job satisfaction, and number of years in echocardiography.

For the question regarding job satisfaction, 68% replied good, 31% replied average, and only 1% replied poor. Mann-Whitney U tests showed an inverse relation between back pain and job satisfaction ($P = 0.04$). Logistic regression analysis confirmed that for the respondents who rated their job satisfaction as average or poor there was a greater risk of back pain ($OR = 2.4$; $95\%CI = 0.96-5.9$).

Figure 2 Relation between the amount of time (hours per week) spent on echocardiography examinations and intensity of back pain.

Figure 3 Frequency of lifting involved for the respondents whose jobs required lifting (n = 144). (Lifting, $P = 0.07$; occasional and frequent lifting, $P = 0.04$).

When ergonomic variables were examined, 76% replied yes to the question “does your job require lifting?” and 24% replied no. Association between lifting and back pain showed χ^2 borderline significance ($P = 0.07$) but logistic regression analysis showed a significantly greater risk for respondents who lifted occasionally, 62% ($P = 0.01$; $OR = 4.8$; $95\%CI = 1.25-18.7$), and frequently, 31% ($P = 0.04$; $OR = 4.4$; $95\%CI = 1.02-18.9$), compared with non-lifters (fig 3). Eight per cent reported that their jobs rarely required them to lift. χ^2 analyses did not show any significant relation between back pain and type of lifting (lift patient $P = 0.22$, lift equipment $P = 0.4$).

Figure 4 shows the frequency distribution for each chosen method for echocardiography examination as derived from the questionnaire data. Method 1 emerged to be the most popular, used by 66% of the respondents. The respondents in the method 6 group (machine on the right, transducer in the left hand, and patient on the left), used by 7% of the respondents, emerged to be the group least at risk from back pain ($P = 0.008$, $95\%CI = 0.06-0.67$) (table 2).

When method 1 was compared with method 6, logistic regression analyses showed that respondents in the method 1 group were five times at greater risk from back pain than respondents in the method 6 group ($P = 0.008$; $95\%CI = 1.5-16.4$) (table 2). Method 5 was not included in the analysis because only one respondent indicated the use of this method. Analysis on method 4 was incomplete because it was not clear from the questionnaire replies whether this group required more than one echocardiographer to conduct the examination. Logistic regression analysis based on a single operator, however, showed an increase in risk of back pain ($OR = 24.4$; $P = 0.006$; $95\%CI = 6.5-247$).

Descriptive data showed that of the respondents with back pain (n = 146), 92% reported multiple incidences of back pain, and 63% reported pain occurring once a month or more. Spearman correlation tests showed significant association ($P \leq 0.001$) between the intensity of back pain and multiple incidences of pain ($P \leq 0.001$) and frequency of back pain ($P \leq 0.001$). When asked “did you report your back pain?”, 57% replied no, and to the question “have you ever claimed compensation from your employer”, 77% replied no, and 2.7% replied yes. Previous history of back pain was reported by 21% of the respondents, which showed significant ($P = 0.001$) association with back pain when χ^2 analysis was applied.

For the purpose of this study, upper back and neck pain were combined and included in the variable “upper back”. Low back pain was reported by 54.1%, upper back pain by 17.8%, and 28.1% reported both upper and lower back pain. The respondents indicated similar anatomical distribution of back pain in males and females; upper back, 9% males and 15% females; lower back, 44% males and 43% females; upper and lower back, 20% males and 23% females.

Figure 4 Influence of examination methods used on back pain (n = 183).

Table 2 Relative risk for methods used for echo examinations (n = 183)

Method	Description	Odds ratio (95%CI)
1	machine left, right handed, patient on the right	4.9 (1.49–16.4)
2	machine in front, right handed, patient on the right	3.9 (0.69–21.7)
3	machine in front, left handed, patient on the right	7.0 (1.07–46.4)
4	machine right, right handed, patient on the right	24.4 (6.5–249)
5	machine on the left, left handed, patient on the left	not computed
6	machine on the right, left handed, patient on the left	0.20 (0.06–0.67)

Spearman correlation tests showed highly significant correlation between multiple incidences of back pain and the following variables: how would you rate your back pain while performing echocardiography? ($P = 0.001$); in the last month has your back pain interfered with your work? ($P = 0.03$); and location of back pain ($P = 0.026$). The intensity of back pain showed significant correlation with the variables: amount of time spent scanning per week ($P = 0.035$); interference with work ($P \leq 0.001$); and limitation of lifestyle ($P \leq 0.001$). Of the 56% of the back pain sufferers who reported limitation of lifestyle, 24% reported moderately severe limitation. When intensity of back pain while performing echocardiography was examined, 69% reported some interference with work because of back pain. Intensity of back pain scores of moderately severe and severe while performing echocardiography were reported by 19% and 8%, respectively.

Unfortunately, the pattern for time lost because of sickness was difficult to establish owing to the complexity of the question, which was included in the question "did you report your back pain?". A significant number of respondents reported taking sick leave but did not report the number of days.

Discussion

Because back pain is common in the general population and the aetiology of back pain is multifactorial, indication of the risk factors in back pain surveys can be difficult. When planning for prevention, however, a distinction has to be made between occupational and non-occupational origins of back pain. The present study has identified several risk factors affecting the echocardiographer, of which the traditional echocardiography examination method and frequent lifting were the main risks for back pain.

In the present study, 80% of the respondents reported back pain. These findings were

similar to the incidence rates from the study of back pain among radiographers,¹⁷ but significantly higher than the incidence rates reported by a study on back pain in the general population, which reported 22% for males and 26% for females,¹⁸ and even the nursing profession (69%).¹⁹

Identification of job satisfaction was clearly associated with back pain in the present study. These findings were consistent with other investigations.^{1,20} Logistic regression analysis showed a relation between back pain and average or poor job satisfaction, however, the reason for this association is less clear cut. It is possible that a dissatisfied worker would be more likely to complain of back pain to avoid work; however, it is quite likely that the echocardiographer may feel under stress trying to keep pace with the increasing workload. This stress could be further increased if the echocardiographer suffers back pain while scanning and experiences increased intensity of pain with prolonged periods of scanning (as the data from this study has shown to be the case).

The most striking findings of this study have been the influence of occupational and ergonomic aspects of echocardiography on back pain. In the present study, the risk of back pain was shown to increase with the length of service. For those in the field for five or more years the risk was more than two times greater, and for those in the field for 11 years or more the risk was more than three times greater than the group with less than four years' experience. These results support the findings of a study by Seccombe and Ball⁵ that reported that the proportion of nurses suffering from back pain rose from 5% for those with five or fewer years' service to 10% for those with 10 or more years' service. This may in part be explained by the fact that the greater the length of time spent in a high risk profession, such as nursing, the greater the number of opportunities for injuries to have occurred. These findings were supported by Feldstien *et al*¹⁹ who found that new nurses were injured more frequently than veteran nurses, but there was a higher incidence of re-injury and more disabling injury among veteran nurses. The present study found a similar pattern to the results of Feldstien *et al*,¹⁹ as indicated by the strong relation between the frequency and the intensity of back pain among the more experienced echocardiographers.

Lifting as a predictor of back injury is consistent with current thought. The hypothesis has biological sense and is well supported by basic science research.²¹ The present study did not identify lifting as a risk factor per se but frequency of lifting was significantly associated with back pain. These results are consistent with other investigations where frequent lifting,¹ job category requiring frequent lifting,¹¹ and lack of ergonomic training in patient handling³ were identified as the main risk factors for back pain in the nursing profession. Clearly, the provision of lifting training for echocardiographers is indicated by the present study.

Low back pain is widely documented among the general and nursing population. The incidence rate of 54% of echocardiographers reporting pain in the lower back only may be explained by the link between lifting and lower back pain. The finding, however, of 46% of echocardiographers reporting upper back problems suggests factors other than lifting may be involved. Research on repetitive strain injury suggests that neck strain results from activities in which the neck is moved up and down or rotated, and upper back strain results from improper static postures.⁸

The present study found that operators using the traditional echocardiography position (method 1) of machine on their left, transducer in the right hand, and patient on their right were five times more likely to be at risk from back pain (table 2). Although the other positions were used by a relatively smaller number of respondents, the results indicate that an examination position is least likely to present risk of back pain when the operator is able to reach the patient and the equipment without having to sit or stand with the spine out of the neutral position, such as method 6. The influence of other examination positions, although having significant association with back pain, was less clear cut because it was not clear from the questionnaire replies whether this group required more than one echocardiographer to conduct examinations. For a single operator, however, there would be greater requirement to adopt awkward postures, thus increasing the risk of back pain by a factor of 24.

Isernhagen⁸ suggests that postures, especially those where the spine is out of neutral position, result in damage of tissue and prolonged flexion may cause disc protrusion. He adds that although flexion itself is not harmful, unequal stresses on the disc and spine cause longlasting symptoms. The present study supports Isernhagen's hypothesis because the results show that at least 73% of echocardiographers adopt postures that involve some degree of flexion of the spine, and 55% of echocardiographers report having back pain for more than five years.

Intensity of back pain and limitation of work or lifestyle has been shown to be an indicator of total work disability by previous research.²² The results of the present study show strong statistical association in sufferers between the intensity of back pain and the amount of time spent on echocardiography examination, interference with work, and limitation of lifestyle. These indicators can be valuable in targeting interventions aimed at preventing the worsening of the early stages of back pain trouble. In the authors' department, back pain has led to a change of examination methods, from method 1 to method 6 or a variation of method 6 for staff who were uncomfortable with a left handed scanning position. This has resulted in symptomatic relief from back pain.

STUDY LIMITATIONS

This study design contains some limitations,

including lack of availability of certain information that could help to focus more specifically on selected risk factors. For example, knowledge of actual age rather than age range may have been valuable, as would more specific information on body build and fitness level, rather than using height, weight, and self reported exercise levels.

As with any voluntary survey, the respondents are self selected. The study has the potential flaw of representing only those individuals with a possible vested interest in the topic, and it may have overestimated the prevalence of back pain among the target population. The questionnaire design has resulted in some ambiguity in interpretation of some of the ergonomic data. For example, questions on echocardiography examination methods or positions could have been ambiguous, and could have been clarified by the use of diagrams instead of closed questions. Nevertheless, the design used here has decided advantages in terms of expense, time, and flexibility, and allowed a complete analysis of a large group of risk factors.

CONCLUSIONS

This study examined four research questions to reach the following conclusions:

- 80% of echocardiographers in the sample reported back pain
- Lifestyle and personal characteristics did not show significant association with back pain
- The traditional echocardiography examination method (method 1; transducer held in the right hand, patient on the right, machine on the left of the echocardiographer) was shown to be the most significant risk factor. Frequent lifting was also a contributory factor to back pain
- 11 or more years in echocardiography was positively associated with back pain and the amount of time spent in echocardiography examination was linearly related to the intensity of back pain; 56% of echocardiographers reported some limitation of lifestyle due to back pain; 69% of respondents reported some interference with work due to back pain; intensity of back pain scores of moderately severe and severe while performing echocardiography were reported by 19% and 8% of echocardiographers, respectively.

Any form of prevention depends on reliable sources of information. There is usually no formal source of such information unless a survey, such as this questionnaire, is deliberately made. The present study has focused only on back pain. Future studies should cover a wider range of basic health, safety, and welfare issues such as: risk of injury to other parts of the body (wrist, shoulders, legs); space requirements; and requirements for work with visual display units. Further research should also focus on preventative measures and optimal workstation designs that may serve as a guide to all echocardiography departments.

The authors acknowledge the support of the British Society of Echocardiography for this study, and echocardiographers, physiotherapists, and academic staff for their assistance and feedback during the pilot study.

- 1 Owen B. Personal characteristics important to back injury. *Rehab Nursing* 1986;11:14-16.
- 2 Ready A, Boreskie S, Law S, Russell R. Fitness and lifestyle parameters fail to predict back injury in nurses. *Can J Appl Physiol* 1993;18:80-90.
- 3 Ryden A, Molgaard C, Bobbitt S, Conway J. Occupational low back injury in a hospital employee population: an epidemic analysis of multiple risk factors of a high risk occupational group. *Spine* 1989;4:315-20.
- 4 Owen B, Damron C. Personal characteristics and back injury amongst nurses. *Res Nursing Health* 1984;7:305-13.
- 5 Seccombe I, Ball J. Back injured nurses: a profile. *A discussion paper for the Royal College of Nursing*. London: Institute of Manpower Studies, 1992.
- 6 Videman T, Nurminen T, Tola S, Kuorinka I, Vanharanta V, Troup J. Low back pain in nurses and some loading factors of work. *Spine* 1984;9:400-4.
- 7 Deyo R, Tsui-Wu Y. Descriptive epidemiology of low back pain and its related medical care in the United States. *Spine* 1987;12:264-8.
- 8 Iserhagen S. Principles of prevention for cumulative traumas. In: White L, ed. *Occupational medicine; back school programmes*. Vol 7. Philadelphia: Hanley & Belfus, Inc, 1992:147-54.
- 9 McKenzie R. *The lumbar spine: mechanical diagnosis and therapy*. New Zealand: Spine Publications Limited, 1981:1-3.
- 10 Mandell P, Lipton M, Bernstein G. *Low back pain*. New Jersey: Slack Incorporated, 1989:1-37.
- 11 May J, Gale A, Haslegrave C. Investigation of postures adopted by breast screening radiographers. In: Robertson S, ed. *Contemporary ergonomics*. London: Taylor and Francis, 1995:422-7.
- 12 Biering-Sorensen F, Thomsen C. Medical, social and occupational history as risk indicators for low-back trouble in a general population. *Spine* 1986;11:720-5.
- 13 Venning P, Walter D, Lawrence W. Personal and job related factors as determinants of incidence of back injuries among nursing personnel. *J Occup Med* 1987;29:820-5.
- 14 Capra P, Mayer T, Gatchell R. Adding psychological scales to your back pain assessment. *J Musculoskelet Med* 1985;2:41-52.
- 15 Fairbanks J, Couper J, Davies J, O'Brien D. Owestry low back pain disability questionnaire. *Physiotherapy* 1980;60:270-3.
- 16 Miller S, O'Brien J. Prevalence of back pain among radiation therapists. *Radiology Technology* 1991;62:460-6.
- 17 Wright D, Witt P. Initial study of back pain among radiographers. *Radiology Technology* 1993;64:283-9.
- 18 Wright S, Fisher A, Horsley S, Jayson M. Influence of physical, psychological and behavioural factors on consultations for back pain. *Br J Rheumatol* 1995;34:156-61.
- 19 Feldstein A, Valanis B, Volter W, Stevens N, Overton C. The back injury prevention project—pilot study. *J Occup Med* 1993;35:114-19.
- 20 Dehlin O, Stig B, Gunnar B. Effects of physical training and ergonomic counselling on the psychological perception of work and on the subjective assessment of low back insufficiency. *Scand J Rehab Med* 1981;13:1-9.
- 21 Pope M, Lehmann T, Frymore J. Structure and function of the lower spine. In: Pope M, Frymore J, Anderson G, eds. *Occupational low back pain*. New York: Praeger, 1984:chapter 7.
- 22 Rossingnol M, Lortie M, Ledoux E. Comparison of spinal health indicators in predicting spinal status in a 1 year longitudinal study. *Spine* 1993;18:54-60.