An Application of Logistic Regression to Occupational Health Data

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1. Introduction

The Occupational Safety and Health Act of 1970 focused national attention on the problems of occupationally related diseases and helped to energize a flurry of activity investigating the location, cause, and prevention of these diseases. Because of the relatively recent widespread interest in studying occupational diseases and the expense associated with such studies, most of the epidemiological investigations have relied on essentially cross-sectional surveys of disease prevalence.

In the cotton textile industry, investigators have concentrated on byssinosis or "brown lung" disease. The existence of a dose-response relationship between extended exposure to respirable cotton dust and the chest tightness syndrome of byssinosis has been well documented in studies by Marchant, et al. (1973) and Martin and Higgins (1976), among others. Of further interest are the effects on byssinosis prevalence of other variables such as length of exposure, smoking habits, sex, and race. Recently, Higgins and Koch (1977) offered a variable selection scheme to reduce the number of independent variables before applying weighted least squares methodology to analyze byssinosis prevalence in a large data set.

This paper applies logistic regression for the analysis and operates with the complete set of independent variables. The method employs the simultaneous implementation of maximum likelihood and weighted least squares estimation procedures in a way which emphasizes their respective strengths.

2. Data

The data for analysis were drawn from a 1973 survey of pulmonary function among employees of a large cotton textile company (Martin and Higgins, 1976). Byssinosis was classified at two levels, complaint of byssinosis symptoms and no complaint, and the responses were observed among seventy-two sub-populations of employees defined by:

- Dustiness of work area (W): workplace 1 (most dusty), workplace 2 (less dusty), workplace 3 (least dusty);
- Smoking habit (Sm): smoker or non-smoker at the time of the survey;
- Length of employment (E): <10 years (1), 10-20 years (2), and ≥20 years (3);
- Sex (Sx): male or female;
- Race (R): white or other races.

Since each of the 5419 employees under study spent their entire period of employment in only one of the three workplace classifications, this categorical variable was considered to be a reasonable measure of their relative degree of dust exposure.

3. Analysis

The observed data are given in Table 1. There are seven sub-populations in which no employees were observed, and twenty-seven of the remaining sixty-five sub-populations had no complaints of byssinosis.

The Functional Asymptotic Regression Methodology (FARM) given by Koch, Imrey, Freeman, and Tolley (1977) can be used to model the sixty-five sub-populations. FARM is a class of two-stage procedures for categorical data analysis which obtains efficient parameter estimates and consistent covariance estimates from some underlying first stage model and employs weighted least squares (WLS) methods to examine these at a second stage.

For a first stage model, assume that π_{i1}, the probability that an individual in the i-th sub-population has a complaint of byssinosis, can be adequately represented by the logistic function

$$\pi_{i1} = (1+\exp(-x_i'\beta))^{-1} = \exp(x_i'\beta)/(1+\exp(x_i'\beta)) ,$$

where $i = 1, 2, \ldots, 65$, x_i is a $1\times t$ "design vector" and β is a $t\times 1$ vector of model parameters. Since it is assumed that $\pi_{i1} + \pi_{i2} = 1$, where π_{i2} is the probability that an individual in the i-th sub-population does not have a complaint of byssinosis, we have that $\pi_{i2} = (1+\exp(x_i'\beta))^{-1}$ and

$$\log_e(\pi_{i1}/\pi_{i2}) = x_i'\beta \quad . \tag{1}$$

At the first stage, assuming that the sub-populations are independent and follow the binomial distribution, the log-likelihood for the observed table is

$$\sum_{i=1}^{65} \log_e(n_i!/n_{i1}!\, n_{i2}!) + \sum_{i=1}^{65} n_{i1}\, x_i'\,\beta - \sum_{i=1}^{65} n_i(1+\exp(x_i'\beta)) \quad , \tag{2}$$

where n_{ij} represents the number of employees observed in the i-th sub-population with byssinosis complaint j and $n_i = n_{i1} + n_{i2}$. For a given set of design vectors x_i, the expression (2) can be maximized by successive approximation numerical methods like those given in Kaplan and Elston (1972) to calculate maximum likelihood estimators (MLE) $\hat{\beta}$ for β. These estimators, in turn, may be converted to a corresponding predicted frequency vector and analyzed by an extension of the WLS approach of Grizzle, Starmer, and Koch (1969), which provides a consistent estimator (based on the inverse of the Fisher information matrix) of the covariance matrix $V_{\hat{\beta}}$. Computer software for the WLS analysis is provided by the program GENCAT (Landis, Stanish, Freeman, and Koch, 1976).

Alternatively, if the design vectors x_i used in the direct maximization are of an appropriate form, the MLE can be generated by Iterative Proportional Fitting (IPF) of hierarchical models to marginal tables which are sufficient for model parameters. (IPF is discussed in detail in Bishop, Fienberg, and Holland (1975), as well as elsewhere, and computer software is available through the program ECTA (1974).) In particular, the $65\times t$ design matrix X provided by $X' = (x_1, x_2, \ldots, x_{65})$ must be such that when transformed by an appropriate linear transformation, it is hierarchical with respect to the set of byssinosis complaint responses together with the independent variables which define the sub-populations (for details see Koch, et al., 1977).

Thus, regardless of whether β is estimated by direct maximization of expression (2) or IPF, logit functions of the form of expression (1) of the predicted byssinosis proportions $\hat{\pi}_{ij}$, instead of the observed proportions p_{ij}, can be operated on by WLS computational algorithms and consistent estimators for the covariance matrices of $\hat{\beta}$ and the π_{i1} can be determined for use in subsequent FARM analyses.

Based on prior experience with the data, a first stage analysis is formulated in terms of a six module main effect model. The six modules are formed by the six combinations of workplace and smoking levels. Within each module, main effect designs including a module mean, two employment effects, and single sex and race effects are constructed so that the overall design X_1 contains 30 parameters. The MLE predicted frequencies given in Table 1 were actually obtained by direct maximization of the log-likelihood expression (2). However, the predicted frequencies could be obtained by IPF, with a slight modification to the standard ECTA program, by fitting the Employment vs. Sex vs. Race, Employment vs. Byssinosis, Sex vs. Byssinosis, and Race vs. Byssinosis marginal configurations for each module and using zero starting values for null sub-populations. The logits of the predicted frequencies are then analyzed in a second stage using WLS and FARM chi-square test statistics.

The design is reduced to a three module main effect model, with the modules formed by the three workplace levels. Each of the modules is a main effect design including a module mean, two employment effects, and single smoking, sex, and race effects so that the overall design X_2 employs 18 parameters. Using FARM test statistics, design X_2 can be further reduced to an 8 parameter complete main effect design X_3 with an overall mean, two effects each for workplace and employment, and single effects for smoking, sex, and race.

Alternatively, new MLE predicted frequencies can be generated based on X_2 or X_3 and logits formed from them can be analyzed using FARM test statistics. Table 2 displays three sets of parameter estimates and FARM test statistics for design X_3 that result from using MLE predicted frequencies from the 30 parameter design X_1, the 18 parameter design X_2, and the 8 parameter design X_3. The X_3 parameter estimates resulting from using X_1 and X_2 MLE predicted frequencies are obtained from consistent estimators based on FARM methodology, while the estimates resulting from using X_3 MLE predicted frequencies are MLE. Test statistics for X_3 based on each of the three sets of MLE predicted frequencies indicate that sex and race can be dropped from the model and that workplace and employment can each be adequately represented by single effects. Further, parameter estimates for smoking and employment are roughly equal so that a single parameter can be formed to represent a smoking-employment effect.

The final model indicated, X_4, is a 3 parameter main effect design with an overall mean, a workplace effect, and a combined smoking-employment effect. The parametrization and parameter estimates for X_4 are displayed in Table 3 for three sets of MLE-predicted frequencies and predicted byssinosis prevalences are given in columns 11 and 12 of Table 4 for X_4 reduced from the 8 parameter MLE design X_3.

An alternative 3 parameter design X_5 is given in Table 4 with corresponding parameter estimates. Model X_5, a refinement of the module designs X_1 and X_2, estimates workplace 2 and 3 byssinosis logits by an overall mean while workplace 1 logits are estimated with the addition of a combined smoking-employment effect. Predicted byssinosis prevalences for X_5 reduced from the X_2 MLE predicted frequencies are given in columns 9 and 10 of Table 4 along with predicted prevalences for design X_5 using observed prevalences (without log transform) of byssinosis complaints from an 8 sub-population table formed by collapsing the original 72 sub-population table into 2 workplace levels, 2 employment levels, and 2 smoking levels. A more complete documentation of the analysis stages is given in Higgins and Koch (1977a).

4. Discussion

The two-stage approach taken here to log-linear model analysis represents one method of dealing with a large, complete contingency table that is complicated by numerous cell frequencies that are small or zero. A previous approach by Higgins and Koch (1977) avoided this complication by eliminating some independent variables through variable selection and further increasing cell frequencies by collapsing to permit WLS analysis on the linear prevalence scale since cell frequencies were of adequate size (i.e., ≥ 5). On the other hand, the numerous small cell sizes in the complete table may invalidate the inferential procedures of the WLS methodology since they depend on the multinormality of the observed cell proportions. In this regard, if hierarchical log-linear models are considered appropriate, as is the case here, IPF may be preferable inasmuch as the asymptotic theory for the MLE depends on the multinormality of selected marginal configurations.

The initial 30 parameter model X_1 has problems with small frequency counts in some of the marginal tables required for generating MLE predicted frequencies. Consequently, the statistical validity of all the results based on design X_1 MLE predicted frequencies may not be ensured but the results are of interest as a procedure for identifying "unimportant" sources of variation for elimination from the model. However, the two sets of MLE predicted frequencies which are obtained on the basis of X_2 and X_3 can reasonably be presumed as appropriate (in terms of marginal cell frequencies) for ensuring statistical validity. Nonetheless, parameter estimates and corresponding standard errors based on all three sets of MLE predicted frequencies are quite similar at the various stages of model reduction (see Tables 2 and 3).

Finally, the relative merits of designs X_4 and X_5 need to be considered before choosing one as a final model. Since no interaction is detected among the variables workplace, employment and smoking, model X_4 supports the choice of a log-linear model based on dose-response considerations, if one is willing to make certain assumptions about the nature of the data taken from this cross-sectional survey (as they pertain to the longitudinal etiology of the disease, for which further discussion is given in Higgins and Koch, 1977a). With model X_4, the conceptual "dose" is an additive function of the pertinent main effect parameters for the respective sub-populations, and the parameters can be interpreted as measures of relative risk that are associated with the specific effects of one of the occupational disease environment variables after controlling for the others. On the other hand, design X_5 can be interpreted as considering the combined smoking-employment effect at workplaces 2 and 3 to be medically insignificant, although statistically significant, when compared to the effect at workplace 1. Thus, model X_5 indicates that the effects of smoking and length of employment need only be considered important for employees at workplace 1.

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TABLE 1. CONTINGENCY TABLES BASED ON OBSERVED AND LOG-LINEAR MODEL PREDICTED (MLE FOR DESIGN X_1) FREQUENCIES

				Observed Frequencies				MLE Log-Linear Model Predicted Frequencies for Design X_1			
				Smokers byssinosis		Non-Smokers byssinosis		Smokers byssinosis		Non-Smokers byssinosis	
W	E	Sx	R	Yes	No	Yes	No	Yes	No	Yes	No
1	1	M	W	3	37	0	16	5.41680	34.58320	0.63328	15.36672
1	1	M	OR	25	139	6	75	22.84520	141.15480	5.46345	75.53655
1	1	F	W	0	5	0	4	0.29220	4.70780	0.07644	3.92356
1	1	F	OR	2	22	1	24	1.44648	22.55352	0.82675	24.17325
1	2	M	W	8	21	2	8	6.82747	22.17253	1.14710	8.85290
1	2	M	OR	8	30	1	9	9.17244	28.82756	1.85290	8.14710
1	2	F	W	0	0	0	0	0.00000	0.00000	0.00000	0.00000
1	2	F	OR	0	0	0	0	0.00000	0.00000	0.00000	0.00000
1	3	M	W	31	77	5	47	29.33496	78.66504	5.04660	46.95340
1	3	M	OR	10	31	3	15	11.40374	29.59626	2.85678	15.14322
1	3	F	W	0	1	0	2	0.12876	0.87124	0.09674	1.90326
1	3	F	OR	0	1	0	0	0.13248	0.86752	0.00000	0.00000
2	1	M	W	0	74	0	35	0.18870	73.81130	0.41300	34.58700
2	1	M	OR	0	88	1	47	0.22088	87.77912	0.84335	47.15664
2	1	F	W	1	93	1	54	1.01896	92.98104	0.76065	54.23935
2	1	F	OR	2	145	3	142	1.57143	145.42857	2.98265	142.01735
2	2	M	W	1	50	1	16	0.47736	50.52264	0.28781	16.71219
2	2	M	OR	0	5	0	0	0.04615	4.95385	0.00000	0.00000
2	2	F	W	1	33	0	30	1.32294	32.67706	0.59460	29.40540
2	2	F	OR	0	4	0	4	0.15364	3.84636	0.11760	3.88240
2	3	M	W	1	141	0	39	1.05932	140.94068	0.43875	38.56125
2	3	M	OR	0	1	0	1	0.00736	0.99261	0.01676	0.98324
2	3	F	W	3	91	3	187	2.93374	91.06626	2.50610	187.49390
2	3	F	OR	0	0	0	2	0.00000	0.00000	0.03924	1.96076
3	1	M	W	2	258	0	134	3.19800	256.80200	0.89646	133.10345
3	1	M	OR	3	242	1	122	2.20255	242.79745	1.11192	121.88808
3	1	F	W	3	180	2	169	2.73036	180.26964	1.46547	169.53453
3	1	F	OR	3	260	4	301	2.86933	260.13067	3.52885	301.47115
3	2	M	W	1	187	0	58	1.70328	186.29672	0.30392	57.69608
3	2	M	OR	0	33	0	7	0.21813	32.78187	0.04956	6.95044
3	2	F	W	2	94	1	90	1.05504	94.94496	0.61061	90.38939
3	2	F	OR	0	3	0	4	0.02409	2.97591	0.03628	3.96372
3	3	M	W	12	495	3	182	10.02846	496.97154	1.40415	183.59585
3	3	M	OR	0	45	0	23	0.65160	44.34840	0.23575	22.76425
3	3	F	W	3	176	2	340	4.28705	174.71295	3.32082	338.67918
3	3	F	OR	0	2	0	3	0.03510	1.96490	0.03933	2.96067

TABLE 2

PARAMETER ESTIMATES AND CHI-SQUARE TEST STATISTICS (Q) FOR MAIN EFFECT DESIGN $\underset{\sim}{X}_3$ WITH THREE SETS OF PREDICTED (MLE) FREQUENCIES

1. Parameterization of $\underset{\sim}{X}_3$ $_{65x8}$

Source of Variation	Estimated Incremental Parameter	Indicator Variable
mean	b_1	$x_1 = 1$ always
main effect: Workplace	b_2, b_3	$x_2 = \begin{cases} 1 & \text{high dust} \\ -1 & \text{moderate dust} \\ 0 & \text{low dust} \end{cases}$, $x_3 = \begin{cases} 1 & \text{high dust} \\ 0 & \text{moderate dust} \\ -1 & \text{low dust} \end{cases}$
main effect: Smoking	b_4	$x_4 = \begin{cases} 1 & \text{smoker} \\ -1 & \text{non-smoker} \end{cases}$
main effect: Employment (years)	b_5, b_6	$x_5 = \begin{cases} 1 & <10 \\ -1 & 10 \text{ to } 20 \\ 0 & \geq 20 \end{cases}$, $x_6 = \begin{cases} 1 & <10 \\ 0 & 10 \text{ to } 20 \\ -1 & \geq 20 \end{cases}$
main effect: Sex	b_7	$x_7 = \begin{cases} 1 & \text{male} \\ -1 & \text{female} \end{cases}$
main effect: Race	b_8	$x_8 = \begin{cases} 1 & \text{white} \\ -1 & \text{other races} \end{cases}$

2. Parameter estimates and corresponding standard errors

Frequencies Predicted by Design	b_1	Workplace b_2	Workplace b_3	Smoking b_4	Employment b_5	Employment b_6	Sex b_7	Race b_8
$\underset{\sim}{X}_1$	-3.362	0.689	1.013	0.304	-0.129	-0.286	-0.065	-0.062
(30 parameter)	(0.120)	(0.194)	(0.139)	(0.099)	(0.157)	(0.130)	(0.127)	(0.103)
$\underset{\sim}{X}_2$	-3.395	0.756	0.998	0.312	-0.141	-0.292	-0.093	-0.055
(18 parameter)	(0.120)	(0.193)	(0.139)	(0.099)	(0.157)	(0.130)	(0.128)	(0.102)
$\underset{\sim}{X}_3$	-3.477	0.810	0.960	0.321	-0.125	-0.314	-0.062	-0.058
(8 parameter)	(0.124)	(0.179)	(0.138)	(0.097)	(0.154)	(0.128)	(0.114)	(0.104)

Q_R(22 D.F.) = 17.36 for $\underset{\sim}{X}_1$ reduced to $\underset{\sim}{X}_3$; Q_R(10 D.F.) = 12.41 for $\underset{\sim}{X}_2$ reduced to $\underset{\sim}{X}_3$

Q_R: WLS chi-square reduction goodness of fit statistic

3. Chi-square statistics (Q) for design $\underset{\sim}{X}_3$ effects

Effect	D.F.	Q for frequencies predicted by design $\underset{\sim}{X}_1$ (30 parameter)	$\underset{\sim}{X}_2$ (18 parameter)	$\underset{\sim}{X}_3$ (8 parameter)
Workplace	2	143.44**	150.25**	177.99**
Smoking	1	9.40**	9.92**	10.88**
Employment	2	11.13**	12.03**	12.47**
Sex	1	0.26	0.53	0.29
Race	1	0.36	0.29	0.32

** significant at the 0.01 level

TABLE 3

PARAMETER ESTIMATES FOR MAIN EFFECT DESIGN $\underset{\sim}{X}_4$ AND REDUCED MODULE DESIGN $\underset{\sim}{X}_5$ WITH THREE SETS OF PREDICTED MLE FREQUENCIES

1. Parameterization of $\underset{65\times 3}{\underset{\sim}{X}_4}$ and $\underset{65\times 3}{\underset{\sim}{X}_5}$

	Design $\underset{\sim}{X}_4$		Design $\underset{\sim}{X}_5$	
Source of Variation	Estimated Incremental Parameter	Indicator Variable	Estimated Incremental Parameter	Indicator Variable
mean	b_1	x_1 = 1 always	b_1'	x_1 = 1 always
Workplace effect	b_2	$x_2 = \begin{cases} 1 \text{ high dust} \\ 0 \text{ moderate \& low dust} \end{cases}$	b_2'	$x_2 = \begin{cases} 1 \text{ high dust} \\ 0 \text{ moderate \& low dust} \end{cases}$
Smoking-Employment effect	b_3	$x_3 = \begin{cases} 2 \text{ smoker employed} \geq 10 \text{ years} \\ 1 \text{ smoker employed} < 10 \text{ years or non-smoker employed} \geq 10 \text{ years} \\ 0 \text{ non-smoker employed} < 10 \text{ years} \end{cases}$	b_3'	$x_3 = \begin{cases} 2 \text{ smoker employed} \geq 10 \text{ years at workplace 1} \\ 1 \text{ smoker employed} < 10 \text{ years or non-smoker employed} \geq 10 \text{ years at workplace 1} \\ 0 \text{ other employees} \end{cases}$

2. Parameter estimates and corresponding standard errors for $\underset{\sim}{X}_4$ and $\underset{\sim}{X}_5$

	Design $\underset{\sim}{X}_4$			Design $\underset{\sim}{X}_5$		
Frequencies Predicted by Design	b_1	Workplace b_2	Smoking-Employment b_3	b_1'	Workplace b_2'	Smoking-Employment b_3'
$\underset{\sim}{X}_1$ (30 parameter)	-4.939 (0.196)	2.586 (0.172)	0.572 (0.122)	-4.253 (0.130)	1.474 (0.298)	0.873 (0.173)
$\underset{\sim}{X}_2$ (18 parameter)	-5.001 (0.201)	2.614 (0.172)	0.593 (0.128)	-4.290 (0.130)	1.499 (0.300)	0.878 (0.174)
$\underset{\sim}{X}_3$ (8 parameter)	-5.109 (0.214)	2.662 (0.169)	0.619 (0.126)	-- --	-- --	-- --

Q_R^*(27 D.F.) = 19.80 for $\underset{\sim}{X}_1$ reduced to $\underset{\sim}{X}_4$

Q_R(15 D.F.) = 14.54 for $\underset{\sim}{X}_2$ reduced to $\underset{\sim}{X}_4$

Q_R(5.D.F.) = 1.44 for $\underset{\sim}{X}_3$ reduced to $\underset{\sim}{X}_4$

Q_R(27 D.F.) = 16.02 for $\underset{\sim}{X}_1$ reduced to $\underset{\sim}{X}_5$

Q_R(15 D.F.) = 10.43 for $\underset{\sim}{X}_2$ reduced to $\underset{\sim}{X}_5$

* Q_R: WLS chi-square reduction goodness of fit statistic

TABLE 4

OBSERVED, LINEAR, AND LOG-LINEAR MODEL PREDICTED BYSSINOSIS PREVALENCES WITH CORRESPONDING STANDARD ERRORS

				Observed Byssinosis Prevalence (Estimated s.e. x 10^3)		Predicted Byssinosis Prevalences: Reduced Module Design X_5: WLS Linear Collapsed Observed Table (Estimated s.e. x 10^3)		Predicted Byssinosis Prevalences: Reduced Module Design X_5: FARM Log-Linear Reduced From X_2 MLE (Estimated s.e. x 10^3)		Predicted Byssinosis Prevalences: Main Effect Design X_4: FARM Log-Linear Reduced From X_3 MLE (Estimated s.e. x 10^3)	
W	E	Sx	R	Smokers	Non-Smokers	Smokers	Non-Smokers	Smokers	Non-Smokers	Smokers	Non-Smokers
1	1	M	W	0.075(42)	0.000	0.143(13)	0.045(19)	0.129(15)	0.058(15)	0.139(14)	0.080(15)
1	1	M	OR	0.152(28)	0.074(29)	0.143(13)	0.045(19)	0.129(15)	0.058(15)	0.139(14)	0.080(15)
1	1	F	W	0.000	0.000	0.143(13)	0.045(19)	0.129(15)	0.058(15)	0.139(14)	0.080(15)
1	1	F	OR	0.083(56)	0.040(39)	0.143(13)	0.045(19)	0.129(15)	0.058(15)	0.139(14)	0.080(15)
1	2	M	W	0.276(83)	0.200(126)	0.240(24)	0.143(13)	0.262(29)	0.129(15)	0.230(24)	0.139(14)
1	2	M	OR	0.211(66)	0.100(95)	0.240(24)	0.143(13)	0.262(29)	0.129(15)	0.230(24)	0.139(14)
1	2	F	W	*	*	0.240(24)	0.143(13)	0.262(29)	0.129(15)	0.230(24)	0.139(14)
1	2	F	OR	*	*	0.240(24)	0.143(13)	0.262(29)	0.129(15)	0.230(24)	0.139(14)
1	3	M	W	0.287(44)	0.096(41)	0.240(24)	0.143(13)	0.262(29)	0.129(15)	0.230(24)	0.139(14)
1	3	M	OR	0.244(67)	0.167(88)	0.240(24)	0.143(13)	0.262(29)	0.129(15)	0.230(24)	0.139(14)
1	3	F	W	0.000	0.000	0.240(24)	0.143(13)	0.262(29)	0.129(15)	0.230(24)	0.139(14)
1	3	F	OR	0.000	*	0.240(24)	0.143(13)	0.262(29)	0.129(15)	0.230(24)	0.139(14)
2	1	M	W	0.000	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.011(02)	0.006(01)
2	1	M	OR	0.000	0.021(21)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.011(02)	0.006(01)
2	1	F	W	0.011(11)	0.018(18)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.011(02)	0.006(01)
2	1	F	OR	0.014(09)	0.021(12)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.011(02)	0.006(01)
2	2	M	W	0.020(19)	0.059(57)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
2	2	M	OR	0.000	*	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
2	2	F	W	0.029(29)	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
2	2	F	OR	0.000	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
2	3	M	W	0.007(07)	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
2	3	M	OR	0.000	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
2	3	F	W	0.032(18)	0.016(09)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
2	3	F	OR	*	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
3	1	M	W	0.008(05)	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.011(02)	0.006(01)
3	1	M	OR	0.012(07)	0.008(08)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.011(02)	0.006(01)
3	1	F	W	0.016(09)	0.012(08)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.011(02)	0.006(01)
3	1	F	OR	0.011(06)	0.013(07)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.011(02)	0.006(01)
3	2	M	W	0.005(05)	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
3	2	M	OR	0.000	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
3	2	F	W	0.021(15)	0.011(11)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
3	3	F	OR	0.000	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
3	3	M	W	0.024(07)	0.016(09)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
3	3	M	OR	0.000	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
3	3	F	W	0.017(10)	0.006(04)	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)
3	3	F	OR	0.000	0.000	0.012(02)	0.012(02)	0.014(02)	0.014(02)	0.020(03)	0.011(02)

* No employees were observed in this sub-population