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## The British-Norwegian Migrant Study: 5-Year Mortality Differentials Due to Cigarette Smoking

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### Synopsis .....

*Cigarette smoking and 5-year survivorship of 20,017 British and 10,016 Norwegian migrants to*

*the United States were compared with 17,696 British and 26,155 Norwegian nonmigrants. The highest mortality ratios for 5-year age-adjusted death rates observed were of cigarette smokers to nonsmokers, ranging from 1.40 to 1.60 for men and from 1.18 to 1.36 for women.*

*Mortality ratios of nonmigrants to migrants ranged from 1.07 to 1.19 for men and from 1.22 to 1.36 for women. Mortality ratios for British to Norwegian groups ranged from 1.13 to 1.27. Some differences in mortality ratios for cardiovascular diseases contrasted with mortality ratios for noncardiovascular diseases were noted. The most important of these differences was the apparent lack of any consistent difference between nonmigrants and migrants in their 5-year cardiovascular mortality rates, although there were consistent differences for noncardiovascular diseases.*

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**B**EGINNING WITH REID (1) in 1966, morbidity and mortality studies of British and Norwegian migrants to the United States and related investigations have been described (2-10a). The present investigation follows that of Feinleib and coworkers (10a), which analyzed 5-year mortality for cohorts of British and Norwegian migrants to the United States and for their countrymen remaining in Great Britain and Norway. In that study, mortality differentials due to angina were analyzed for the calendar years 1963-70. The prevalence of angina, as well as possible infarction, persistent cough and phlegm, chronic bronchitis, and cigarette smoking, had been ascertained in the early 1960s for each of the study groups by a common mail questionnaire; the definitions of these symptoms are given subsequently.

Of the three countries, the United States had the highest death rates from coronary heart disease, while Great Britain had the highest rates for lung cancer and for chronic nonspecific lung disease. Norway had the lowest rates for all three diseases. Contrary to the authors' expectations, angina was

reported much more frequently by persons remaining in Great Britain and Norway than by migrants to the United States.

Mortality rates were determined for the 5 years after respondents completed the questionnaire on symptoms, and mortality patterns were evaluated according to the presence or absence of angina (10a). Angina was found to be a strong predictor of cardiovascular mortality. In the absence of angina, it was observed that migrants had similar mortality rates to nonmigrants regardless of country of origin. However, the British had higher mortality rates from cardiovascular causes and from noncardiovascular causes than did the Norwegians. The primary determinant of angina prevalence was migration status. This differential was thought to be determined primarily by selection of those who migrate—migrants to the United States were a healthier group than their counterparts remaining in their native country.

In the present paper, the role of cigarette smoking in mortality for the same cohorts is described. Our

*'Little difference is noted between British migrants and nonmigrants who smoked cigarettes regularly; among Norwegian migrants there were somewhat higher proportions of cigarette smokers than among nonmigrants (49 percent compared with 41 percent for men and 28 percent compared with 22 percent for women).'*

specific aims here are (a) to compare 5-year age-, sex-, and cause-specific mortality risks for British and Norwegian migrants to the United States with risks of their counterparts who remained in Britain and Norway, (b) to assess mortality levels in relation to cigarette smoking, and (c) to evaluate findings in the light of known national differences in mortality.

### **Definition of Symptoms**

The questionnaires sent to each member of the cohort inquired into the presence of certain cardiorespiratory symptoms. These were defined as follows.

**Angina**—Pain or chest discomfort in a person walking uphill or hurrying, causing him or her to stop or slow down; pain or chest discomfort goes away in 10 or fewer minutes if he or she stands still.

**Possible infarction**—Episode of severe pain across the front of the chest that last for half an hour or more.

**Persistent cough and phlegm**—Both cough and the production of phlegm on most days for at least 3 months each year.

**Chronic bronchitis**—Persistent cough and phlegm with shortness of breath while walking with other people at an ordinary pace, with at least one period of increased cough and phlegm production lasting 3 weeks or more during the 3 years preceding the inquiry.

### **Materials and Methods**

The methods used have been described in detail elsewhere (1,2); a brief review follows.

The U.S. sample of migrants was selected from those persons classified in the U.S. census of 1960 as having been born in England, Wales, Scotland, or Norway. About three-fourths of the persons selected lived in 12 States—California, Illinois, Massachusetts, Michigan, Minnesota, New Jersey, New York, North Dakota, Ohio, Pennsylvania, Washington, and Wisconsin. Only persons from these States were used in the sample. The Bureau of the Census identified the sample and also took responsibility for sending out a mail questionnaire to secure information such as symptoms of chronic respiratory and cardiac disease and personal characteristics, smoking history, and residence history.

A two-stage questionnaire was used, and 86 percent of the sample responded to the stage 1 questionnaire. Of these, 42 percent answered "yes" to one or more of the screening questions about cardiorespiratory symptoms and received a more detailed symptoms questionnaire to which 85 percent responded. These questionnaires were sent between October 1962 and April 1963. Copies of death certificates listing England, Wales, Scotland, or Norway as the country of birth were supplied by the National Center for Health Statistics for all deaths occurring in the 12 States beginning in January 1963.

Meanwhile, two comparison samples were obtained in both Great Britain and Norway. The first sample consisted of siblings of the American subjects who were identified from the questionnaires. The second sample was made up of a random sample of the national population. Essentially similar questionnaires were sent to the control samples in Great Britain and Norway with modifications for the language difference in Norway. The questionnaire response rates for the British and Norwegian native groups were somewhat lower than those noted for the migrant groups, but were generally comparable. Mortality rates in the British and Norwegian cohorts during the period 1963–70 were obtained through the vital statistics offices of those countries. Because little difference was noted between the two types of comparison samples, they were pooled for each country for use in the present analysis.

The questionnaire items on smoking covered the use of cigarettes, cigars, and pipes in some detail (2b). The present report limits itself, however, to cigarette smoking, since this information was uniformly available for all groups and the numbers were considered sufficiently large to study. Also, cigarette smoking is a known major risk factor for disease, whereas cigar and pipe smoking are less important risk factors.

Table 1. Population of British-Norwegian Migrant Study by cigarette smoking, sex, and age

Population cohort	Cigarette smoking status	Men (age)					Women (age)				
		35-44	45-54	55-64	65-69	Total, 35-69	35-44	45-54	55-64	65-69	Total, 35-69
		British migrants	Current smokers <sup>1</sup>	859	1,386	2,204	704	5,153	1,252	1,006	1,017
	All others	559	970	2,377	979	4,885	1,159	1,141	2,778	1,378	6,456
British nonmigrants	Current smokers	1,405	1,484	1,343	348	4,580	1,279	1,281	742	157	3,459
	All others	940	1,105	1,063	401	3,509	1,333	1,734	2,200	881	6,148
Norwegian migrants	Current smokers	355	492	1,167	342	2,356	285	271	414	114	1,084
	All others	245	437	1,434	782	2,898	384	611	1,680	1,003	3,678
Norwegian nonmigrants	Current smokers	1,100	1,671	1,536	379	4,686	914	956	688	130	2,688
	All others	1,075	2,166	2,829	1,333	7,403	1,727	3,254	4,417	1,980	11,378

<sup>1</sup> Current, regular cigarette smokers.

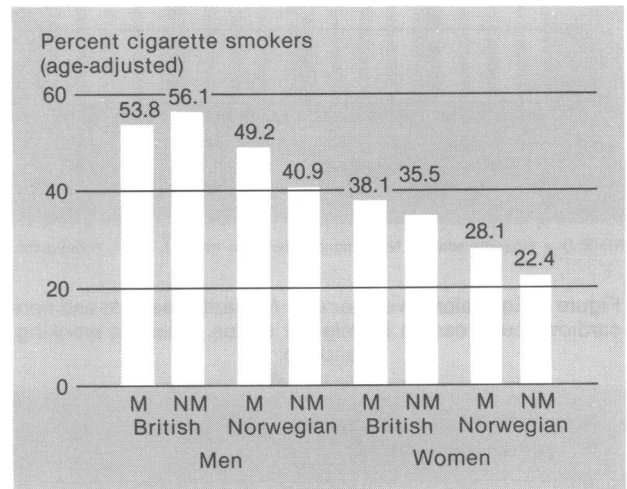
In this report, a simple dichotomy is used to classify smoking:

- **Current, regular cigarette smokers**—Persons who reported themselves as smoking cigarettes regularly at the time they completed the questionnaire.
- **All others**—Persons who never smoked any form of tobacco as well as occasional smokers, cigar or pipe smokers, ex-smokers, and those of unknown smoking status.

The final populations at risk, which formed the baseline for subsequent analyses, are shown in table 1 by cigarette smoking status, sex, and age. More than 73,000 responses to the questionnaire were obtained: 30,033 in the United States, 17,696 in Great Britain, and 26,155 in Norway. Only respondents who were ages 35-69 were included in the analysis because data for this age group were available for all groups. Among the U.S. migrants there were approximately twice as many persons from Great Britain as from Norway. The British nonmigrant groups were about the same size as the British migrant samples in the United States, while the comparison samples in Norway were appreciably larger than the migrant samples in the United States. There were about as many women as men in the analysis.

Mortality rates were age adjusted by use of the procedure called equivalent average rates in which equal weights are given to equal-size age groups (11). The chief advantage of this method is that it is independent of any standard population and for this reason is especially useful in international comparisons. The age groups used were 35-44, 45-54, 55-64, and 65-69, and the weights used were 2/7, 2/7, and 1/7, respectively.

Figure 1. Percent cigarette smokers (age-adjusted) by migrant status and sex



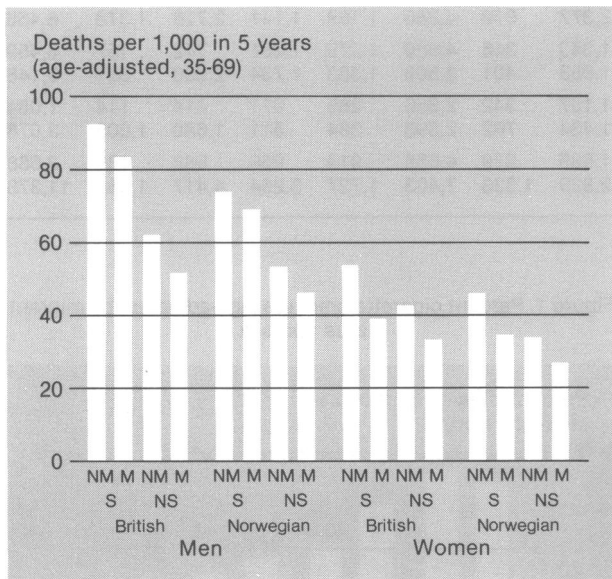
NOTE: M = Migrant, NM = nonmigrant.

## Results

The populations followed are shown by cigarette smoking, sex, and age in table 1; age-adjusted proportions of current, regular cigarette smokers at the start of the study in 1962-63 are shown by cohort in figure 1. Little difference is noted between British migrants and nonmigrants who smoked cigarettes regularly; among Norwegian migrants there were somewhat higher proportions of cigarette smokers than among nonmigrants (49 percent compared with 41 percent for men and 28 percent compared with 22 percent for women). These differences are not very large but may reflect to some extent the known difference in type of tobacco preference between persons in Norway and the United States. (For example, pipe smoking is much more common in Norway than in the United States or Great Britain.) The prevalence of cigarette smoking among the

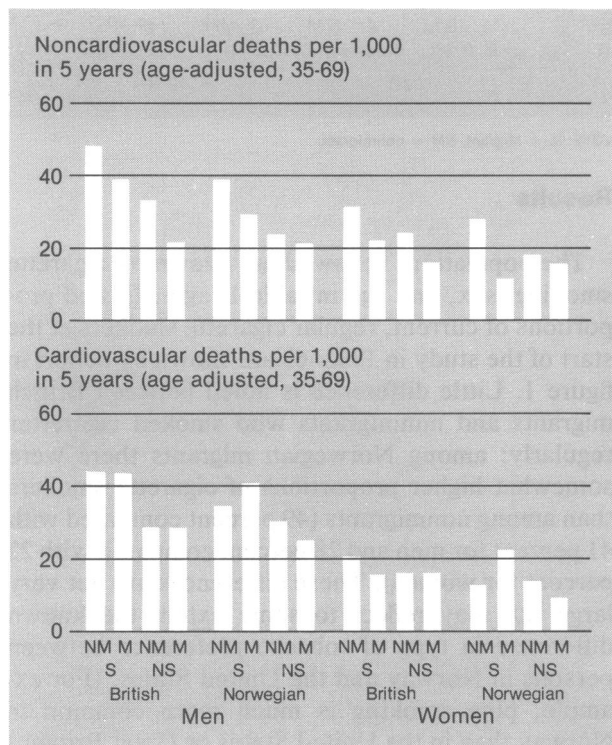
British was higher than among Norwegians; a substantially greater proportion of men than women smoked in each group.

Figure 2. Equivalent average death rates for all causes by migrant status, cigarette smoking, and sex



NOTE: S = cigarette smoker, NS = nonsmoker, M = migrant, NM = nonmigrant.

Figure 3. Equivalent average rates for cardiovascular and noncardiovascular deaths by migrant status, cigarette smoking, and sex



NOTE: S = cigarette smoker, NS = nonsmoker, M = migrant, NM = nonmigrant.

The overall age-adjusted probability of death in the 5 years following response to the questionnaire for persons ages 35–69, using the method of equivalent averages, is shown in figure 2 for each cohort by sex and smoking status. Similar information is given in figure 3 for cardiovascular deaths and noncardiovascular deaths. The numbers of cardiovascular and noncardiovascular deaths and probabilities of death in 5 years by cigarette smoking status, sex, and age are given in tables 2 and 3 for each cohort. Selected mortality ratios are given in table 4.

For all causes of death, figure 2 shows a clear and generally consistent gradient of highest mortality levels for nonmigrants who smoked cigarettes, next highest for migrants who smoked, followed by nonmigrant smokers, and lowest rates for migrant nonsmokers.

Differences in this gradient for cardiovascular deaths compared with noncardiovascular deaths are shown in figure 3. Noncardiovascular mortality levels show about the same gradient as noted for all causes of death in figure 2. However, the gradient for cardiovascular mortality differs in that the nonmigrant probability of death in 5 years is greater than that for the migrant group in only three of the eight comparisons. For noncardiovascular and for all causes, nonmigrant mortality levels are higher than the corresponding migrant group levels in all eight instances. For cardiovascular deaths, there was no consistent difference between migrant and nonmigrant groups. The probability of death from cardiovascular disease in 5 years is about the same for the migrant to the United States as for his or her counterpart in Great Britain or Norway.

The other major feature of the gradient in figure 2—a much higher mortality level for cigarette smokers compared with nonsmokers—exists in figure 3 in all but one category (Norwegian migrant women) for noncardiovascular deaths and in all but one category (British migrant women) for cardiovascular deaths.

The ratios of 5-year age-adjusted death rates for cigarette smokers compared with nonsmokers, nonmigrants compared with migrants, and British compared with Norwegian groups are set out in table 4 for each sex by cause of death. The highest mortality ratios observed are cigarette smokers to nonsmokers, ranging from 1.40 to 1.60 for men and 1.18 to 1.36 for women. Mortality ratios for nonmigrants to migrants ranged from 1.07 to 1.19 for men and from 1.22 to 1.36 for women. Mortality ratios for British to Norwegian groups ranged from 1.13 to 1.24 for men and from 1.15 to 1.27 for women. Some

Table 2. Cardiovascular deaths and probability of death in 5 years by migrant status, cigarette smoking, sex, and age

Population cohort	Cigarette smoking status	Men (age)					Women (age)						
		35-44	45-54	55-64	65-69	Total, 35-69	35-44	45-54	55-64	65-69	Total, 35-69		
<i>Number of cardiovascular deaths</i>													
British migrants	Current smokers <sup>1</sup>	7	32	145	78	262	4	4	27	11	46		
	All others	3	14	95	86	198	...	9	62	79	150		
British nonmigrants	Current smokers	10	36	85	42	173	2	13	26	9	50		
	All others	4	23	47	26	100	4	11	51	48	114		
Norwegian migrants	Current smokers	3	14	63	36	116	...	3	19	5	27		
	All others	...	4	58	58	120	1	...	25	37	63		
Norwegian nonmigrants	Current smokers	8	34	81	32	155	1	3	17	8	29		
	All others	7	27	122	110	266	2	14	79	101	196		
<i>Cardiovascular deaths per 1,000</i>													
						<i>Crude</i>	<i>Adj. <sup>2</sup></i>				<i>Crude</i>	<i>Adj. <sup>2</sup></i>	
British migrants	Current smokers <sup>1</sup>	8	23	66	111	51	44	3	4	27	44	13	16
	All others	5	14	40	88	41	29	0	8	22	57	23	17
British nonmigrants	Current smokers	7	24	63	121	38	44	2	10	35	57	14	22
	All others	4	21	44	65	28	29	2	6	23	54	19	17
Norwegian migrants	Current smokers	8	28	54	105	49	41	0	11	46	44	25	23
	All others	0	9	40	74	41	25	3	0	15	37	17	10
Norwegian nonmigrants	Current smokers	7	20	53	84	33	35	1	3	25	62	11	17
	All others	7	12	43	83	36	30	1	4	18	51	17	14

<sup>1</sup> Current, regular cigarette smokers.

<sup>2</sup> Adj. = Age-adjusted by the method of equivalent averages, for ages 35-69.

Table 3. Noncardiovascular deaths and probability of death in 5 years by migrant status, cigarette smoking, sex, and age

Population cohort	Cigarette smoking status	Men (age)					Women (age)						
		35-44	45-54	55-64	65-69	Total, 35-69	35-44	45-54	55-64	65-69	Total, 35-69		
<i>Number of noncardiovascular deaths</i>													
British migrants	Current smokers <sup>1</sup>	12	31	124	64	231	9	22	31	11	73		
	All others	1	15	77	59	152	9	8	65	47	129		
British nonmigrants	Current smokers	14	37	84	48	183	9	29	24	15	77		
	All others	9	13	49	39	110	16	25	82	43	166		
Norwegian migrants	Current smokers	2	9	55	22	88	...	1	8	4	13		
	All others	4	1	40	45	90	2	7	40	37	86		
Norwegian nonmigrants	Current smokers	16	33	62	46	157	5	21	27	8	61		
	All others	6	39	91	73	209	16	41	114	80	251		
<i>Noncardiovascular deaths per 1,000</i>													
						<i>Crude</i>	<i>Adj. <sup>2</sup></i>				<i>Crude</i>	<i>Adj. <sup>2</sup></i>	
British migrants	Current smokers <sup>1</sup>	14	22	56	91	45	39	7	22	30	44	21	23
	All others	2	15	32	60	31	23	8	7	23	34	20	16
British nonmigrants	Current smokers	10	25	63	138	40	48	7	23	32	96	22	31
	All others	10	12	46	97	31	33	12	14	37	49	27	25
Norwegian migrants	Current smokers	6	18	47	64	37	30	0	4	19	35	12	12
	All others	16	2	28	58	31	22	5	11	24	37	23	17
Norwegian nonmigrants	Current smokers	15	20	40	121	34	39	5	22	39	62	23	28
	All others	6	18	32	55	28	24	9	13	26	40	22	19

<sup>1</sup> Current, regular cigarette smokers.

<sup>2</sup> Adj. = Age-adjusted by the method of equivalent averages, for ages 35-69.

Table 4. Selected mortality ratios<sup>1</sup> in British-Norwegian Migrant Study

Country, migrant status, and smoker status	Men			Women		
	Total	Cardio-vascular deaths	Noncardio-vascular deaths	Total	Cardio-vascular deaths	Noncardio-vascular deaths
<i>Ratio of cigarette smokers to nonsmokers</i>						
British migrants	<sup>2</sup> 1.60	<sup>2</sup> 1.52	<sup>2</sup> 1.70	1.18	.94	<sup>2</sup> 1.44
British nonmigrants	<sup>2</sup> 1.48	<sup>2</sup> 1.52	<sup>2</sup> 1.45	<sup>2</sup> 1.26	1.29	1.24
Norwegian migrants	<sup>2</sup> 1.50	<sup>2</sup> 1.64	1.36	1.26	<sup>2</sup> 2.30	.71
Norwegian nonmigrants	<sup>2</sup> 1.40	1.17	<sup>2</sup> 1.63	<sup>2</sup> 1.36	1.21	<sup>2</sup> 1.47
<i>Ratio of nonmigrants to migrants</i>						
British cigarette smokers	1.11	1.00	<sup>2</sup> 1.23	<sup>2</sup> 1.36	1.38	<sup>2</sup> 1.35
British nonsmokers	1.19	1.00	<sup>2</sup> 1.43	<sup>2</sup> 1.27	1.00	<sup>2</sup> 1.56
Norwegian cigarette smokers	1.07	.85	<sup>2</sup> 1.30	1.32	.74	<sup>2</sup> 2.33
Norwegian nonsmokers	1.13	1.20	1.09	1.22	1.40	1.12
<i>Ratio of British to Norwegian</i>						
Migrant cigarette smokers	<sup>2</sup> 1.20	1.07	<sup>2</sup> 1.30	1.15	.70	<sup>2</sup> 1.92
Migrant nonsmokers	1.13	1.16	1.05	1.22	<sup>2</sup> 1.70	.94
Nonmigrant cigarette smokers	<sup>2</sup> 1.24	<sup>2</sup> 1.26	<sup>2</sup> 1.23	1.18	1.29	1.11
Nonmigrant nonsmokers	1.17	.97	<sup>2</sup> 1.38	<sup>2</sup> 1.27	1.21	<sup>2</sup> 1.32

<sup>1</sup> Ratios of 5-year age-adjusted death rates for ages 35–69.

<sup>2</sup> Significantly different from 1.00 at the 5 percent level.

differences in mortality ratios for cardiovascular diseases contrasted to mortality ratios for noncardiovascular diseases were noted.

The most important of these differences in this study is the apparent lack of any consistent difference between nonmigrants and migrants in their 5-year cardiovascular mortality rate, although consistent differences for noncardiovascular diseases were noted.

## Discussion

As anticipated, of the three major factors studied—country of birth, migrant status, and cigarette smoking—the strongest as well as the most consistent association with general mortality was found for cigarette smoking. For men, mortality ratios for cigarette smokers (compared with noncigarette smokers and those of unknown smoking status) ranged from 1.40 to 1.60. For women, mortality ratios for cigarette smokers ranged from 1.18 to 1.36 (table 4). These figures may be compared with ratios of 1.7 for men and 1.2 or 1.3 for women taken from the two most recent reports on smoking and health by the Surgeon General of the Public Health Service (12,13). Agreement for women is striking. The ratios for men are somewhat lower than expected, especially for the nonmigrants.

At least part of the difference can be accounted for by the difference in the denominators used in calculating the mortality ratios. In our report, the

denominator includes noncigarette smokers plus ex-smokers, pipe smokers, cigar smokers, and unknowns as contrasted to nontobacco smokers used in the Surgeon General's reports. Thus, our mortality ratios will tend to be lower for men because the denominator includes ex-smokers and cigar and pipe smokers, who are known to have higher mortality rates than persons who smoked no tobacco at all. The same argument holds for women, but the net effect would probably be small because few women smoke cigars or pipes.

Another important finding in this study was the consistently higher general mortality levels observed for British groups compared with Norwegian groups, with mortality ratios ranging from 1.13 to 1.27 for comparisons controlling migrant status, smoking status, and sex. Similar results were noted for comparisons of the British to Norwegian groups on cardiovascular mortality and noncardiovascular mortality levels.

Perhaps the most important finding of this study is that migrant death rates for all causes were found to be lower than nonmigrant death rates. This has already been reported by Feinleib and coworkers (10a), who contended that the migrants to the United States were in fact a healthier group than their counterparts in the old country. This is demonstrated by lower prevalence rates of angina, possible infarction, persistent cough and phlegm, and chronic bronchitis for migrants compared with nonmigrants, controlling age, sex, and country (10b).

We had not expected to find—in spite of lower prevalence rates, especially for possible infarction and angina—that migrant death rates for cardiovascular diseases were about the same as for nonmigrants. On the other hand, rates for noncardiovascular diseases were, as anticipated, lower for migrants than nonmigrants. These apparently anomalous findings need further study.

To see how consistent the differences were between migrant and nonmigrant death rates by age group, sex, country, and cigarette smoking status (tables 2 and 3), we have made 32 comparisons of all age, sex, country, and smoking classifications for each cause of death.

Comparison	Cause of death	
	Cardiovascular	Noncardiovascular
Higher migrant than nonmigrant rate . . .	14	6
Lower migrant than nonmigrant rate . . .	18	26
Total . . . . .	32	32

Noncardiovascular death rates for migrants are consistently lower than for nonmigrants (26 of 32 comparisons), and cardiovascular death rates do not show consistent differences between migrants and nonmigrants.

Can cigarette smoking in any way account for these findings? This does not appear to be the case, because migrants differed little from nonmigrants with respect to cigarette smoking habits and because cigarette smoking is a known risk factor for both cardiovascular and noncardiovascular disease.

The lower prevalence rates of angina, possible infarction, persistent cough and phlegm, and chronic bronchitis for migrants compared with nonmigrants suggest lower cardiovascular as well as noncardiovascular death rates for migrants compared with nonmigrants. Because the cardiovascular death rates were about the same in both groups, other compensatory factors must be at work here. Such factors must be specific for cardiovascular disease. There is an implication that, during the period covered here, cardiovascular death rates were higher in the United States than in Norway or Great Britain, and noncardiovascular death rates were about the same or lower in the United States compared with Great Britain and Norway; this could account for the preceding findings. The only difference not in accord with prior knowledge here is that the U.S. rates for noncardiovascular disease are generally believed to be higher than those for Norway.

Setting aside this one exception, the British and Norwegian migrants to the United States, who were

healthier than their countrymen remaining in Europe, experienced higher cardiovascular death rates than their countrymen (presumably because of an unfavorable U.S. environment), offsetting their initial health advantage. For noncardiovascular disease, the initial advantage of the migrant was not affected by an adverse environment in the United States, so that the net result was a lower noncardiovascular death rate for migrants compared with nonmigrants.

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