BIOMEDICAL SURVEY OF ATC FACILITIES

2. Experience and Age

George T. Hauty, Ph. D.
David K. Trites, Ph. D.
William J. Berkley

Approved by

Stanley R. Mohler

STANLEY R. MOHLER, M.D.
DIRECTOR, CARI

Released by

M. S. White

M. S. WHITE, M.D.
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I. Introduction.

A biomedical survey of six enroute and six terminal air traffic control (ATC) facilities selected on the basis of differences between shift-rotation schedules was conducted to appraise the possible effects of the different schedules upon the health and well-being of the controllers. It was found that while the facilities did differ to a statistically significant degree in the incidence of self-reported symptoms of stress, these differences could not be attributed to any basic difference between the shift-rotation schedules.[1] Also reported was the finding of a positive relationship between years of ATC experience and the incidence of the aforementioned symptoms; i.e., the greater the length of experience, the greater the number of stress-related symptoms reported.

Because of the practical implications of such a relationship, further analyses of the data were conducted for the purpose of examining the interaction between experience and age in such a way that a determination could be made of the relative importance of these two contributory factors. In other words, the question to be answered is whether the incidence of symptoms is primarily a function of length of experience in work alleged to be stressful or primarily a function of the processes of biological aging.

II. Methods.

A. *Selection of Facilities.*—As previously mentioned, the principal basis for selection of the ATC facilities to be surveyed was that of shift-rotation schedules that, for this report, need not be identified again.[1] A secondary basis for selection was that of traffic load, in that only those enroute facilities having a high traffic volume and only those terminal facilities having a high volume of instrument approaches were selected for consideration. With respect to the latter, the decision was based on the assumption that, in contrast to total traffic volume, volume of instrument approaches would be a more valid measure of controller workload since this imposes a more complex and broader spread of work upon the operating positions. Additionally, the use of instrument approach volume as a criterion for selection was expected to enhance the validity of comparisons between enroute and terminal facilities.

The facilities selected were the Atlanta, Boston, Cleveland, Fort Worth, Indianapolis, and Kansas City Centers and the Atlanta, Boston, Buffalo, Burlington, Milwaukee, and Philadelphia Towers.

B. *Development of the Data-Inventory Deck.*—Because of the additional work imposed upon a working population by any survey, the attempt is usually made to achieve the greatest ratio of data to cost-in-time for the subjects. Therefore, the decision was made to obtain a fairly complete, daily inventory of psychophysiological indexes relating to general health and well-being, job-induced stress, behavioral habits such as times and duration of sleep, and the use of commonly prescribed medications and their possible side effects. The indexes were constructed and scaled in such a manner that the time required for the subject to complete the inventories would be minimal. These were then assembled into preshift and postshift inventories, and given a 1-week trial run at the Oklahoma City RAPCON. Immediately following this trial run, individual critiques were held with each trial subject who had been instructed to complete the preshift and postshift inventories each day. The purpose was to evaluate the comprehensibility of terminology, completeness of instructions, and ease of completing the inventories, and to obtain whatever criticisms and suggestions that the subjects might have to offer. As a result of the interest and cooperation of these personnel, invaluable criticisms and suggestions were obtained and were incorporated in the makeup of the indexes. With

these revisions, the indexes were then printed on IBM cards. A reproduction of the data-inventory deck (DID) has been presented in the first report in this series.[1]

C. *Procurement of Subjects.*—Following the coordinative announcement of the survey by the Director, Bureau of Air Traffic Management (now called the Air Traffic Service), the chief of each selected facility was contacted directly for the purpose of making arangements for a visit to his facility by the research team. Essentially, these arrangements consisted of assembling on a given scheduled day the evening watch teams and any other available assistant and journeymen controllers for the period of 1500 to 1600 hours and the day watch teams for the period of 1600 to 1700 hours. The attendance of only journeymen and assistant controllers actually engaged in air traffic control was requested, and overtime pay for their attendance was authorized by the Air Traffic Service.

Of course, limiting the briefings to the two sets of watch teams meant that something less than 100% of the air traffic control specialists would be in attendance; but it was assumed that out of those attending, the desired number of volunteers would be obtained. Another assumption was that no significant bias in the samples would result from confining the briefings to only the day and evening watch teams.

Upon the arrival of the research team at a facility, the chief and his available staff were briefed on the nature of the project and the potential benefits to his facility. Subsequently, in most instances, the research team was introduced by the facility chief or his assistant to the assembled personnel. Here, the purposes of the research were again described with emphasis being placed upon (1) the potential benefits to the agency, the facility, and the controller group; (2) the dependence of the success of the research upon the cooperation of working assistant and journeymen controllers; (3) the dedication and perseverance that a subject must have in order to participate for the 90 days of the survey; and (4) the completely confidential nature of all personal information collected during the project.

Following this, all the duties to be assumed by the subjects were given, the use of the research material was described and illustrated with large replicas of the DID cards, and questions were solicited and answered. Finally, the request for volunteers was made.

Those who volunteered were asked to complete a short questionnaire indicating name, age, GS grade, time in grade, controller status (assistant, journeyman, senior, shift supervisor), number of years in each status level, and total amount of service with the CAA/FAA. The volunteers were then informed that the final selection of subjects would be made from the information on the questionnaire and that those selected would be notified and, on the following day, could obtain their initial packets of previously mailed research materials from the office of the chief. They were also informed that a summary instruction sheet describing the use of the materials was in the first packet and that additional materials would be mailed to each subject at his home address.

In all, 792 air traffic control specialists were briefed. Of these, 432 (55%) volunteered. Since the number and the nature of volunteers for the project could not be predicted in advance and independent decisions had to be made for each facility during the day it was visited, only general considerations for subject selection could be specified. These were that both assistant and journeymen controllers would be selected and that for each type of controller group an attempt would be made to obtain a variety of age and experience combinations.

Within this framework, the subjects were selected from among those who volunteered at each facility. The names of those selected were then given to the chief of the facility, who, in turn, notified the personnel concerned on the same or following day. In most cases, the requirement of filling out the data-inventory deck for 90 consecutive days was begun by the subjects on the day of their next work shift. On days off, only one card had to be completed. This card required entries pertaining to periodic oral-temperature readings, sleep, medication, etc.

D. *Characteristics of Subjects.*—A total of 300 subjects was selected. Of these, 292 began the 90-day survey, 273 continued for 30 days, 250 continued for 60 days, and 209 finished. Frequency distributions of the ages, experience at present facility, and total experience of the 292 subjects are given in Tables 1, 2, and 3, respectively.

Table 1. Age—All Facilities

Age	Assistant Controllers					Controllers					Cordinators				Total
GS	6	7	8	9	10	8	9	10	11	12	10	11	12	13	
22			3												3
23			6			1		5							12
24	1		5			4		5	3						18
25	1		7	1		2		4	2	1					18
26	1		8		1	2		8	6	1					27
27			10		1			6	9	1					27
28	1		3		1		1	2	8	2		1			19
29	1		6	1				5	8	3	1		2		27
30			3			1		3	6				1		14
31			2			2	1	2	6			1			14
32			2					1	2	1		1	1		8
33			4					1	2				1		8
34			2					1		1		1	1		6
35			1					1					2		4
36			3					1	5	2			1		12
37			2					2	4	1			1		10
38								3	5				1		9
39			2			1		3	5				3		14
40								3	3				3		9
41		1						1	2					1	5
42								1	1	1		1	3	1	8
43			1	1					3	1			1	1	8
44													1	1	2
45									1	1					2
46									1				1		2
47								1	1				1	1	4
48															0
49								1							1
50															0
51															0
52				1											1
Total	5	1	70	4	3	13	2	60	83	16	1	5	24	5	292

Table 2. Experience at Present Facility—All Facilities

Experience	Assistant Controllers					Controllers					Coordinators				Total
GS	6	7	8	9	10	8	9	10	11	12	10	11	12	13	
0–18 mo	4	1	26		1	2	1	2	4	1	1				43
19 mo–3 yr	1		44	3	1	11		52	27	5			1		145
4–5 yr					1		1	4	40	7		4	6		63
6–10 yr								1	6	2			11	2	22
11–15 yr								1	5	1		1	4	3	15
16–20 yr				1					1				2		4
Over 20 yr															0
Total	5	1	70	4	3	13	2	60	83	16	1	5	24	5	292

Table 3. Total Experience—All Facilities

Experience	Assistant Controllers					Controllers					Coordinators				Total
GS	6	7	8	9	10	8	9	10	11	12	10	11	12	13	
0–18 mo	3	----	24	----	----	2	----	----	----	----	----	----	----	----	29
19 mo–3 yr	2	1	46	3	----	11	----	42	20	----	1	----	----	----	126
4–5 yr	----	----	----	----	3	----	2	11	40	8	----	3	3	----	70
6–10 yr	----	----	----	----	----	----	----	3	6	2	----	1	4	----	16
11–15 yr	----	----	----	----	----	----	----	2	14	5	----	----	9	2	32
16–20 yr	----	----	----	1	----	----	----	----	2	1	----	1	8	3	16
Over 20 yr	----	----	----	----	----	----	----	2	1	----	----	----	----	----	3
Total	5	1	70	4	3	13	2	60	83	16	1	5	24	5	292

III. Results.

The symptoms reported by the subjects (preshift cards 3 and 4 and postshift cards 8 and 9)[1] during the 90-day period have been categorized as physical or mental symptoms. This was done for convenience of reporting rather than for any real need for meaningful distinction. Most, if not all, of the symptoms concerned may be regarded as being related to or induced by stress, and the only distinction of possible meaningfulness is that having to do with the nature of causal relationship; e.g., the symptom "aching or burning eyes" could be directly attributed to certain characteristics of the work situation, whereas the symptom "tenseness" must be regarded as a less direct and more general manifestation of stresses engendered by many conditions quite apart from those characterizing the work situation.

A. *Symptom Type and Incidence.*—To indicate the relative frequency with which each symptom was reported, the percentage of days that each symptom was reported was computed. These percentages are given in Figures 1 and 2 for the symptoms termed physical and mental, respectively. As might be expected, the highest rates of incidence generally occur for those symptoms most likely to be judged as being stress-induced or related, and, further, the incidence of these particular symptoms is generally greater following the work shift. Also expected were the high rates of reports of tiredness and drowsiness both prior to and following work, but somewhat unexpected was the incidence of "aching or burning eyes." More will be said about this later.

B. *Experience and Age.*—The respective roles of experience and age can be examined by several different methods. One method provides for a simple comparison such as that revealed by Figure 3. Here, the total population of subjects was assigned to three different age groupings, 20 to 29 years, 30 to 39 years, and 40 years and over. For each age group, the percentage of symptom days was computed; i.e., the percentage of the total reporting days for which the subjects comprising the age group reported one or more symptoms. Then, the total population of subjects was reassigned into three different experience groupings, 3 years or less of ATC experience, 4 to 10 years of ATC experience, and over 10 years of ATC experience. For each of these experience groups, the percentage of symptom days was computed.

As can be seen, the relationship between experience and the incidence of physical symptoms (reported immediately prior to work) is of a higher degree than is the relationship between age and incidence of physical symptoms; i.e., the percentage of reported physical symptoms increases as air traffic control experience increases, but a similar increase does not appear in the groupings of the subjects by age. Those in the 20 to 29 age group reported virtually the same percentage of symptom days as those in the 30 to 39 age group, whereas those 40 years of age and over reported a significantly higher percentage of symptoms.

In the case of mental symptoms, however, the two relationships concerned do not appear to differ.

Symptoms reported immediately following the work shift were treated in a similar manner. Comparison of the results provided by Figure 4 reveals now that not only physical but also mental symptoms appear to be more highly related with experience than with age. Further, for each age and experience grouping, the greatest postshift increase in incidence of symptoms occurs in the case of mental symptoms.

For a more definitive comprehension of the respective roles of experience and age, it is necessary to inspect their interaction relative to the incidence of reported symptoms. To provide for such an inspection, all subjects within each of the three experience groups were further assigned to one of the three age groups, and for each such age group or subgroup, the percentage of symptom days was computed. The results are given in Figure 5 for the physical symptoms reported and in Figure 6 for the mental symptoms reported. In these, one exception to the foregoing general explanation should be noted. Within the group having greater than 10 years of controller experience, there is no 20 to 29 age subgroup.

Figure 5 shows the clearly evident relationship between experience and incidence of reported symptoms that has been revealed in Figures 3 and 4. In addition, Figure 5 shows that (1) within the group of subjects who have had 3 years or less of ATC experience, a negative relationship exists between age and incidence of symptoms reported prior to and following work (i.e., the 20 to 29 year subgroup reports a higher incidence of symptoms than do those subjects who are 40 years of age or older); (2) within the group of subjects who have had 4 to 10 years of ATC experience, a positive relationship exists between age and incidence of symptoms reported following work; and (3) within the group of subjects who have had more than 10 years of ATC experience, a somewhat higher incidence of symptoms was reported prior to and following work for the 40 or older age subgroup.

Essentially the same relationships are shown in Figure 6. The most significant exception occurs in the case of the group of subjects having 10 years or more of experience in that the degree of positive relationship between age and incidence of symptoms appears to be lower.

C. *Specific Age Effects.*—As might be expected, certain specific symptoms were found to be more highly related to age than to experience. This is illustrated in part by Figures 7 to 9, which, in effect, reveal the incidence of physical symptoms when age is varied and experience is held constant. Figure 7 shows the relative rates of incidence for that group of subjects who are from 21 to 29 years of age and who have had 3 years or less of experience in the air traffic control field. Figure 9, on the other hand, shows the rates of incidence for that group of subjects who are 40 to 49 years of age and who, also, have had only 3 years or less of ATC experience. To be noted in the case of both extreme age groups as well as the intermediate age group (Figure 8) is the incidence of "aching or burning eyes." The rate of incidence of this particular symptom is nearly twice as great for the oldest group than for the youngest group. Since the age groups are equated in terms of controller experience (<3 years), it may be that the symptom concerned is primarily a function of age or, more specifically, of the sensory deficits normally occurring with aging.

D. *Specific Experience Effects.*—Certain specific symptoms were found to be more highly related to experience. This can be illustrated quite clearly by varying experience while holding age constant, which, in effect, is done in Figures 10 to 12. These present the relative rates of mental symptoms reported by subjects who have had different amounts of experience (less than 3 years in Figure 10, from 4 to 10 years in Figure 11, and over 10 years of ATC experience in Figure 12) but who comprise the single age group from 40 to 49 years of age.

To be noted in these figures is the striking relationship between the increase in the incidence of stress-related symptoms and the increase in ATC experience. For example, the symptom "tense" is reported less than 5% of the days by the 40 to 49 year old subjects who had 3 years or less of ATC experience, about 15% of the days by the 40 to 49 year old subjects who have had from 4 to 10 years of experience, and nearly 25% of the days by the 40 to 49 year old subjects who have had over 10 years of experience as an ATCS.

Similarly, plottings have been made for all age and all experience groups and for both physical and mental symptoms. These are presented in the Appendix, Figures A1 through A16.

IV. Discussion.

The attempt to determine the relative importance of experience and age as these factors relate to the incidence of symptoms of impaired health and well-being would seem to have yielded fairly clear-cut information. Both factors, since they are covariants, are related positively to the incidence of reported symptoms. The factor seen to be the most highly and systematically related to such symptoms, however, is length of experience in the air traffic control field, which is in agreement with the commonly heard claims concerning the stress inherent in the work of the air traffic controller.

The question that must now be raised and that cannot be answered is whether or not the stressful nature of the controller's work occasions health impairment of an extent or nature that will, at some point in years of service, tend to compromise his proficiency and reliability as an integral component in the air traffic system. To answer this question or, more importantly, to prevent such a possibility, periodic biomedical assessments speciafically designed for the air traffic control specialist would seem to be indicated.

REFERENCES

1. Hauty, G. T., Trites, D. K., and Beekley, W. J. Biomedical Survey of ATC Facilities: I. Incidence of Self-Reported Symptoms. Report No. AM 65-5, FAA Offce of Aviation Medicine, Civil Aeromedical Research Institute, Oklahoma City, Okla., 1965.

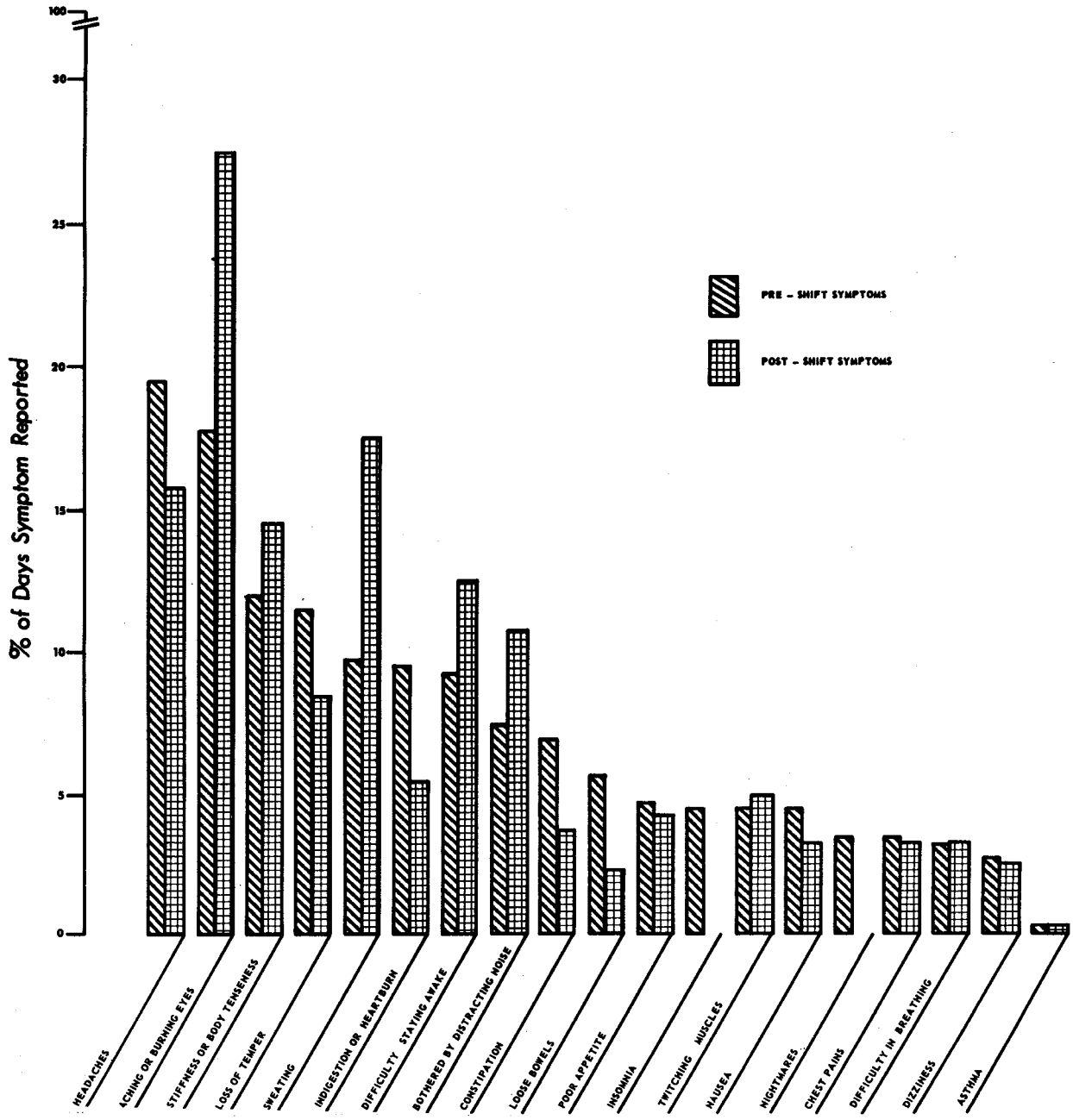

FIGURE 1. Percent of Symptoms (Physical)—Preshift and Postshift.

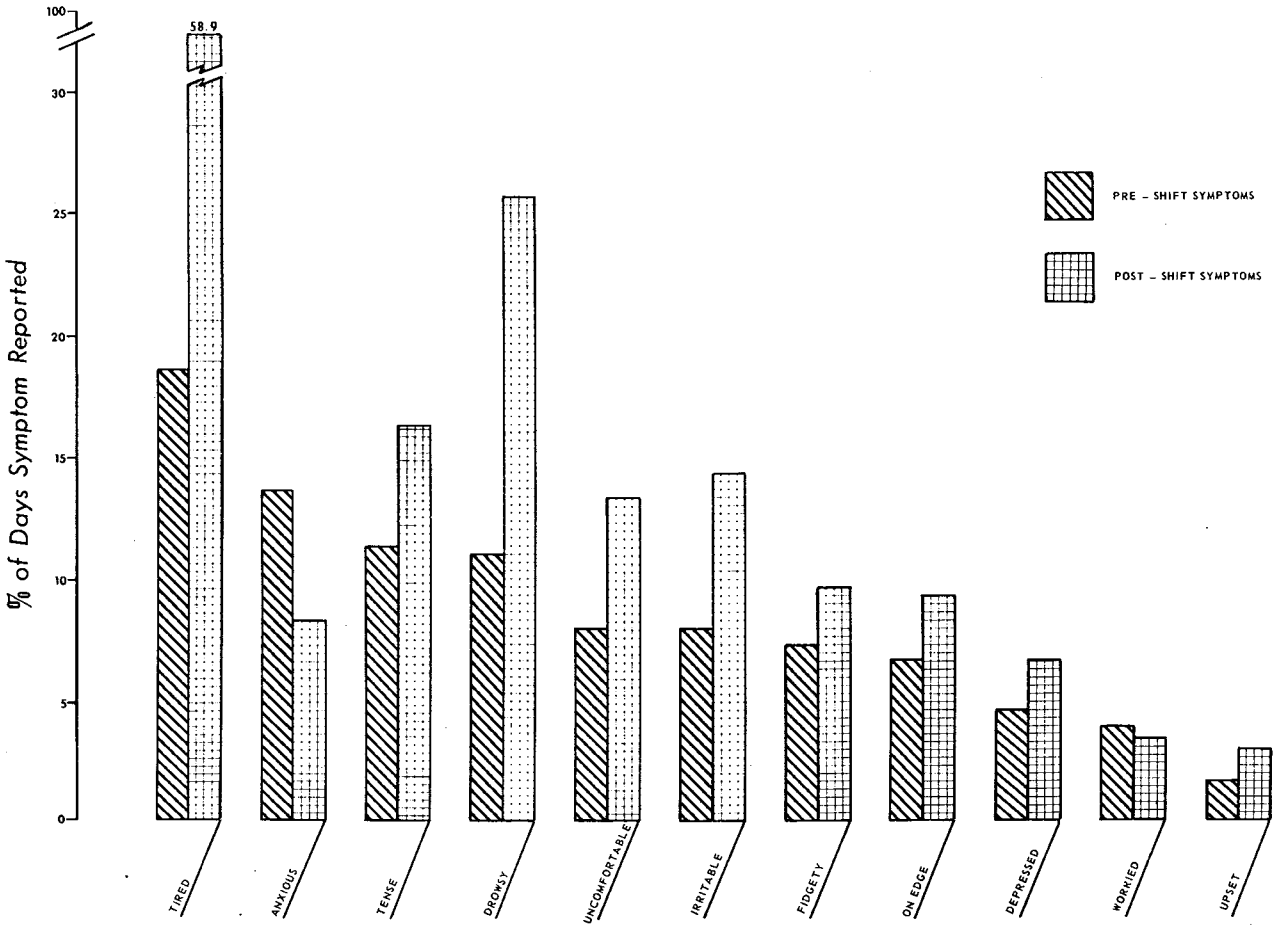

FIGURE 2. Percent of Symptoms (Mental)—Preshift and Postshift.

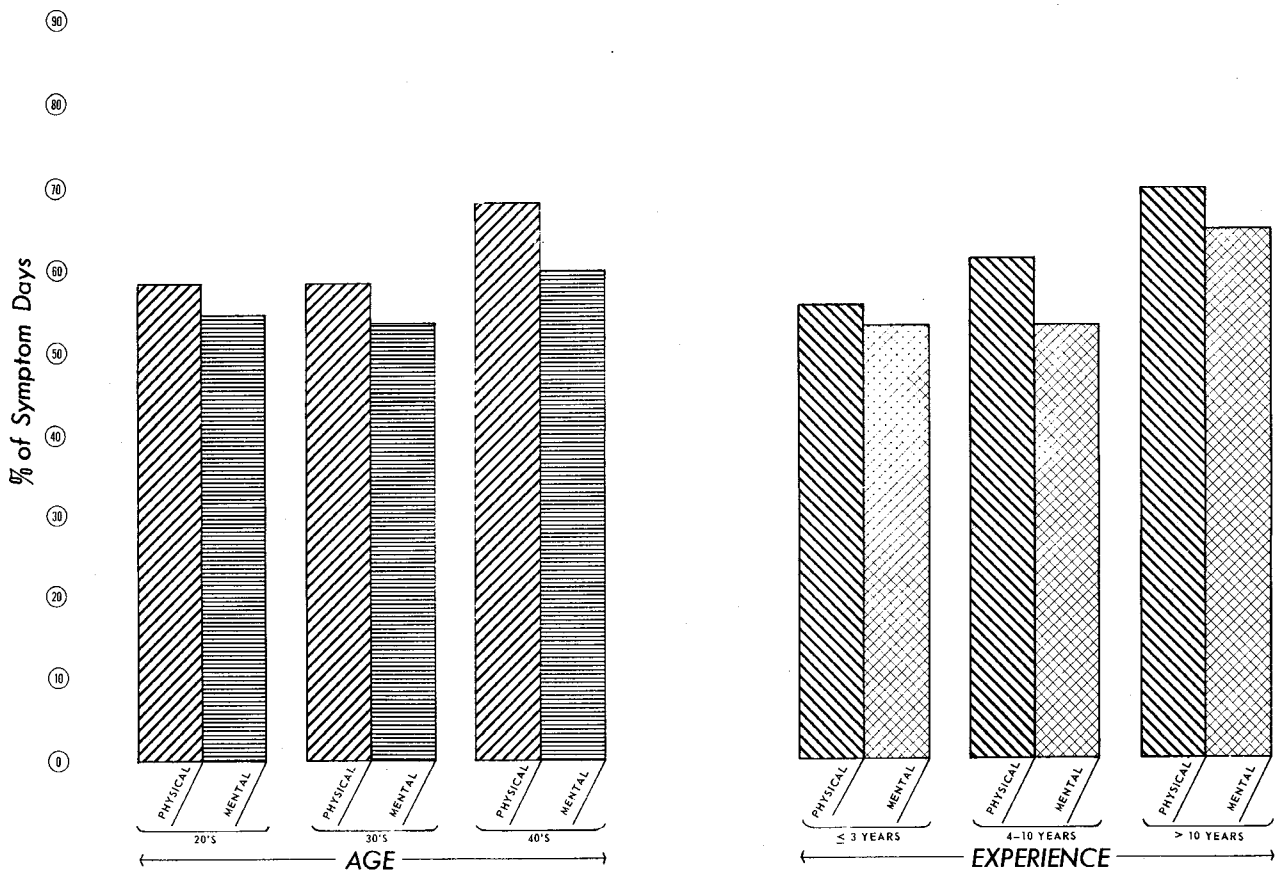

FIGURE 3. Percent of Symptom Days by Age and by Experience (Preshift).

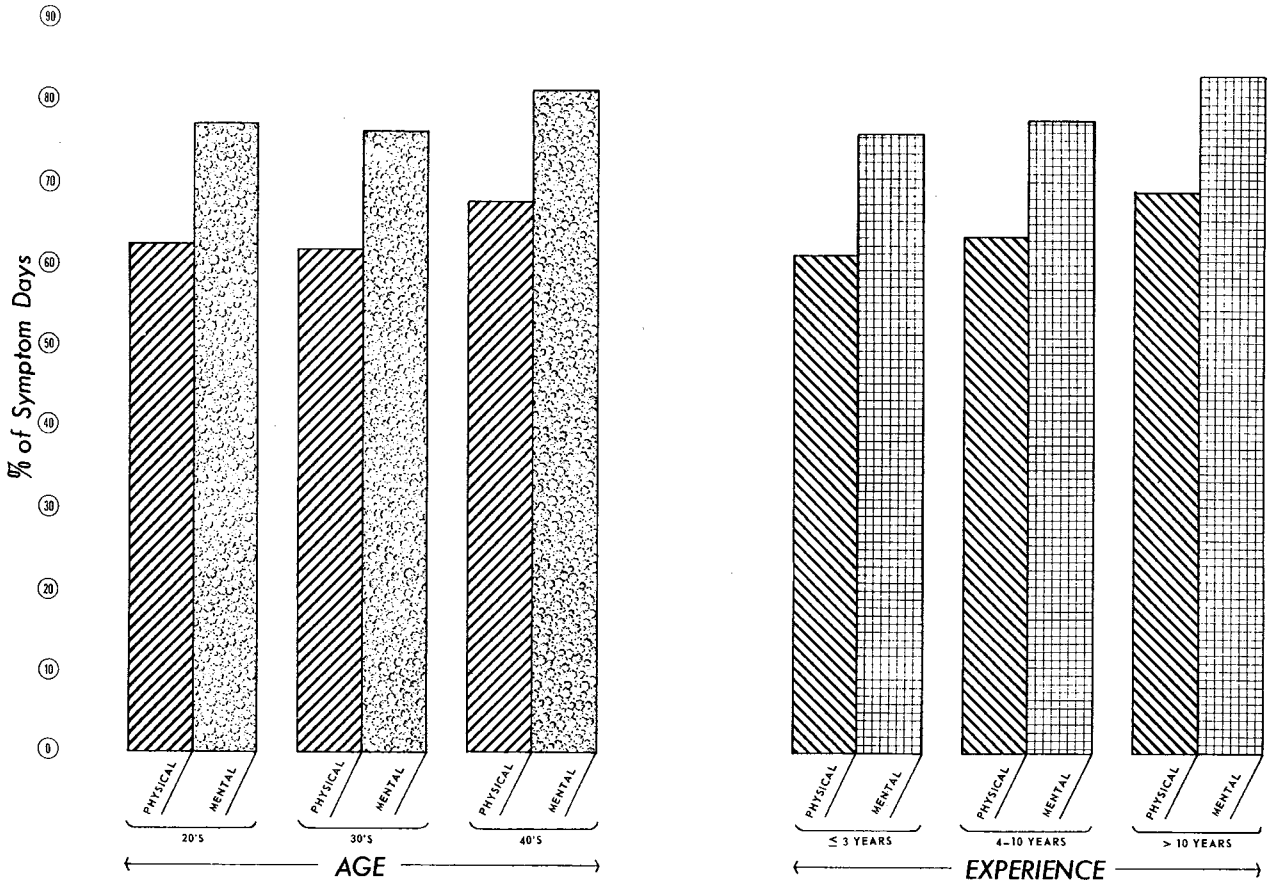

FIGURE 4. Percent of Symptom Days by Age and by Experience (Postshift).

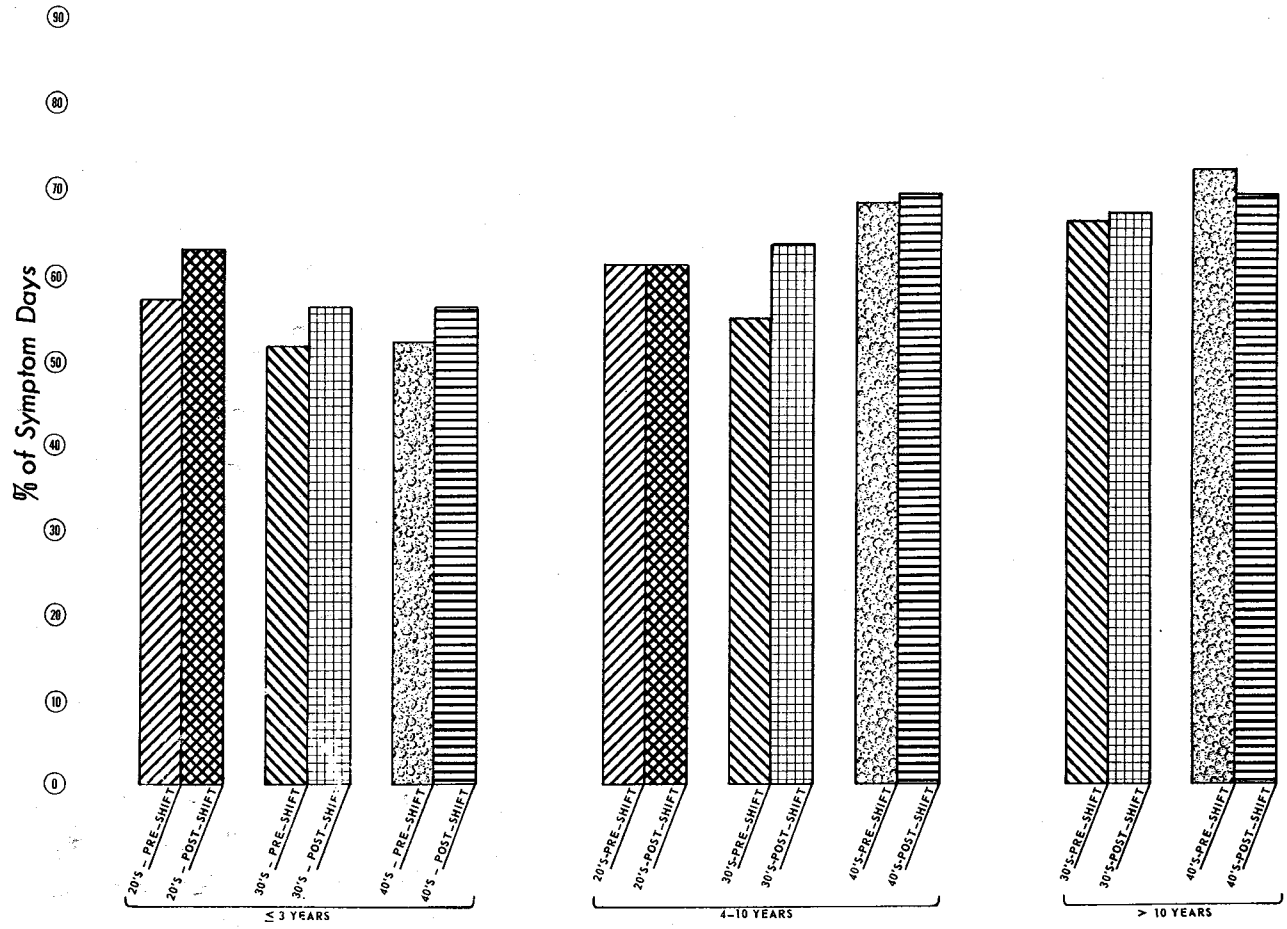

FIGURE 5. Percent of Symptom (Physical) Days by Experience and Age—Preshift and Postshift.

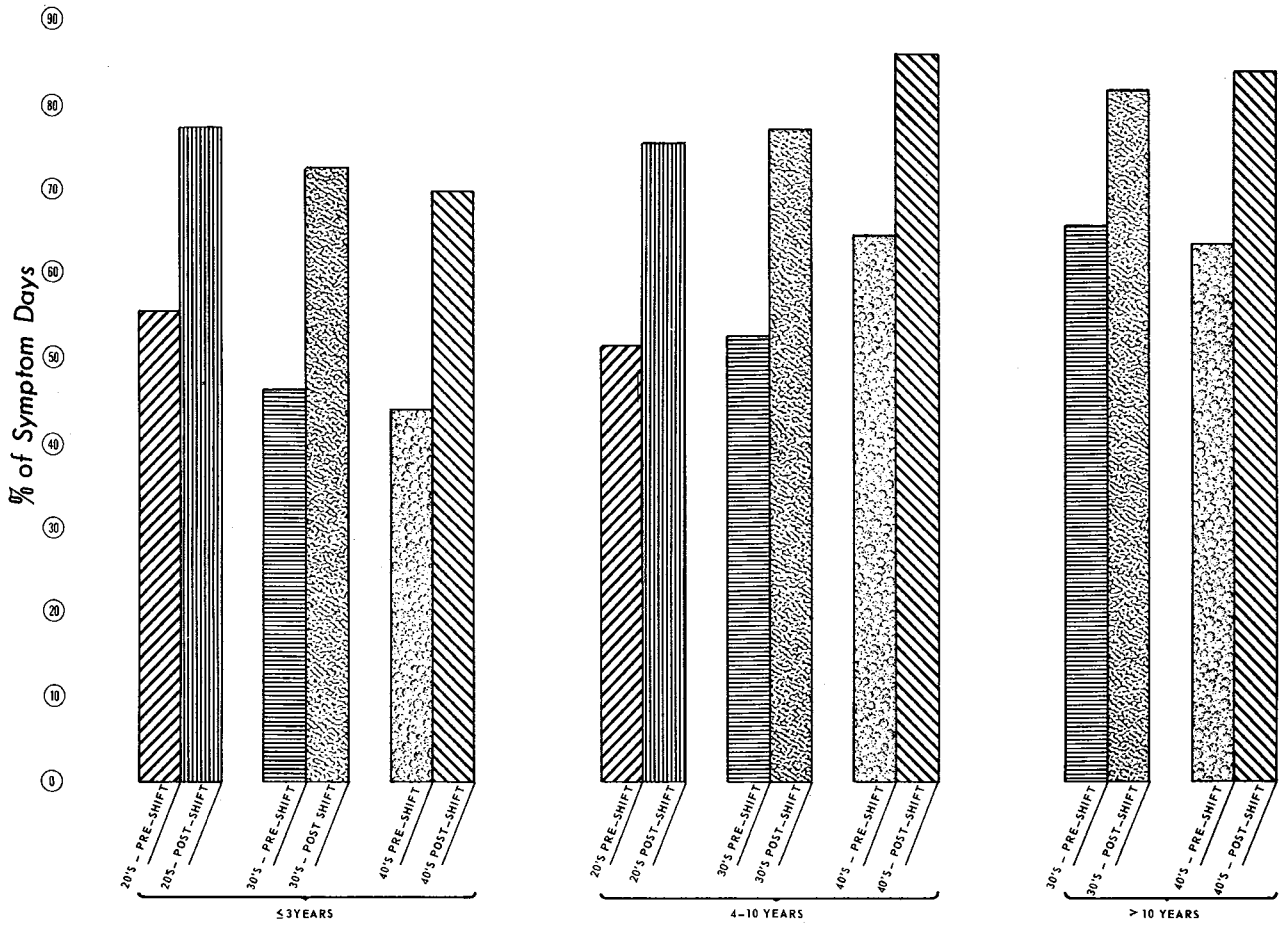

FIGURE 6. Percent of Symptom (Mental) Days by Experience and Age—Preshift and Postshift.

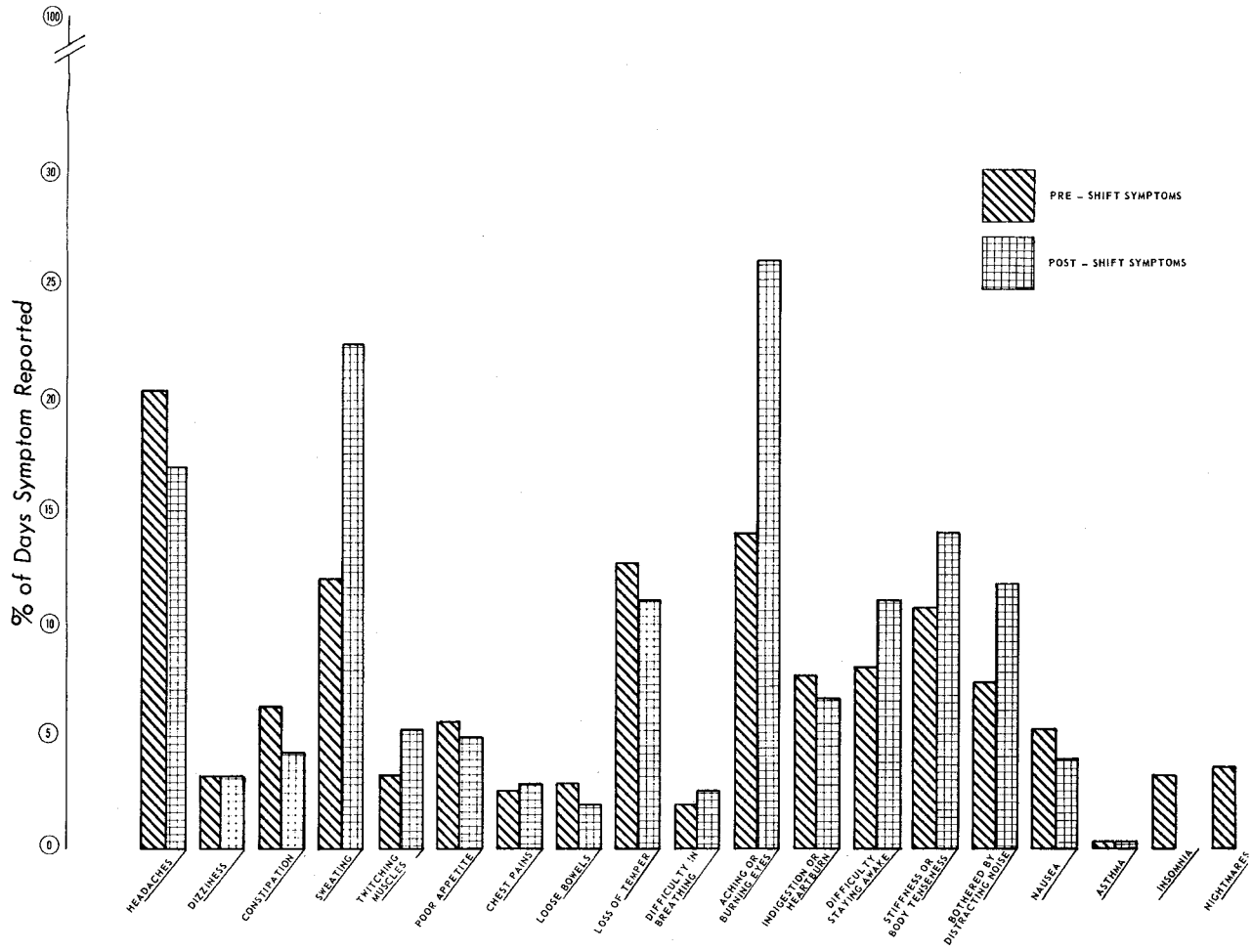

FIGURE 7. Percent of Symptoms (Physical)—Preshift and Postshift 21–29 Years—3 Years Experience.

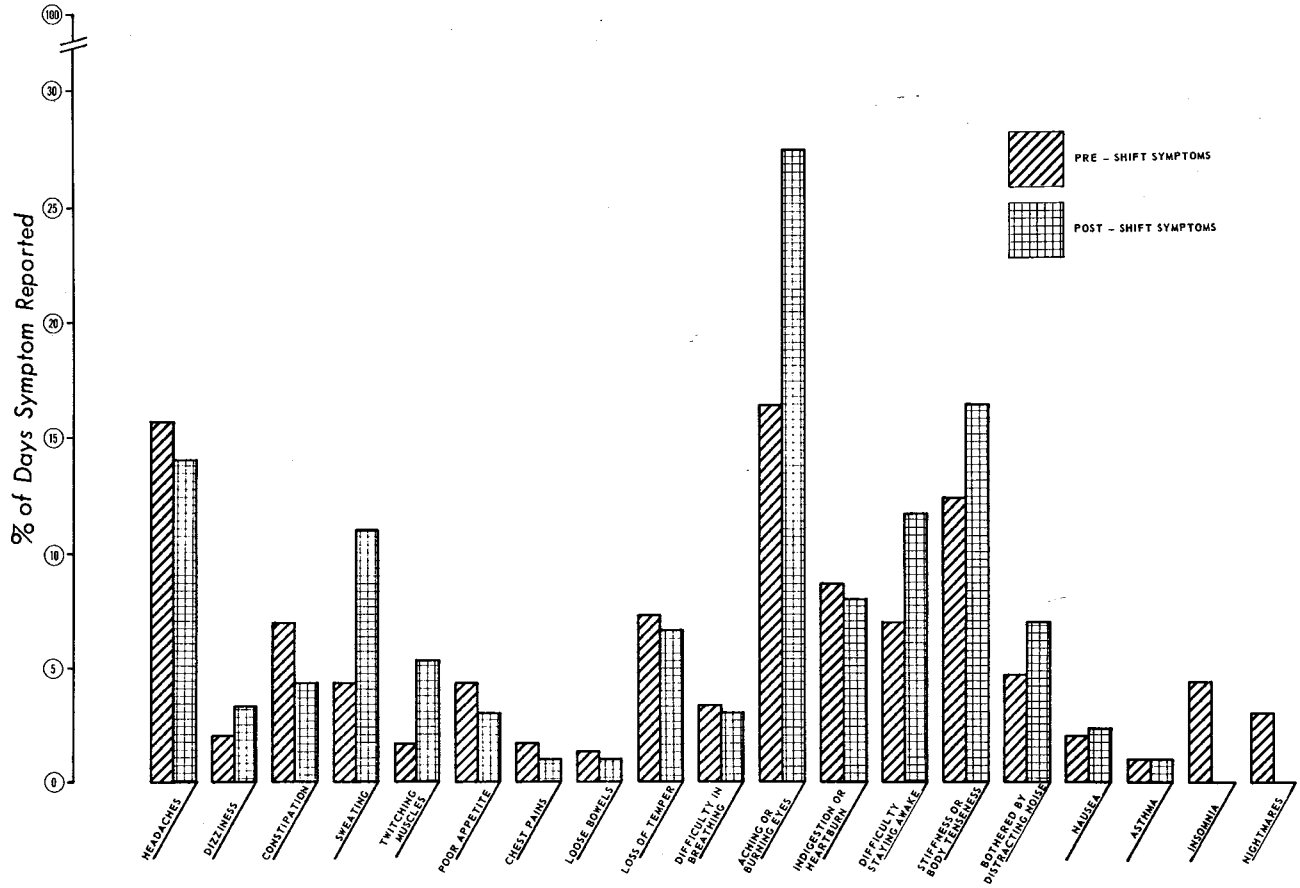

FIGURE 8. Percent of Symptoms (Physical)—Preshift and Postshift 30–39 Years—3 Years Experience.

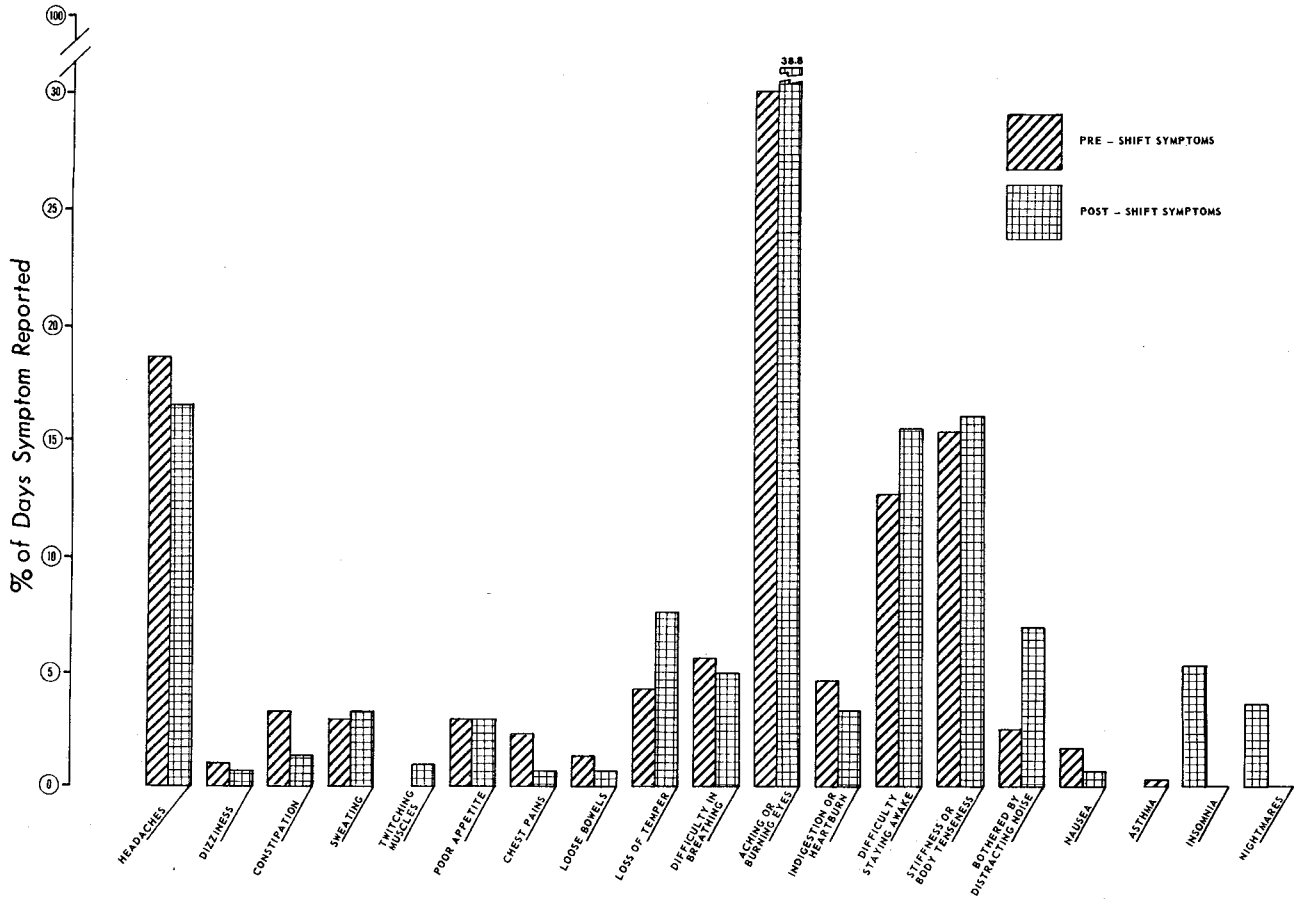

FIGURE 9. Percent of Symptoms (Physical)—Preshift and Postshift 40–49 Years—3 Years Experience.

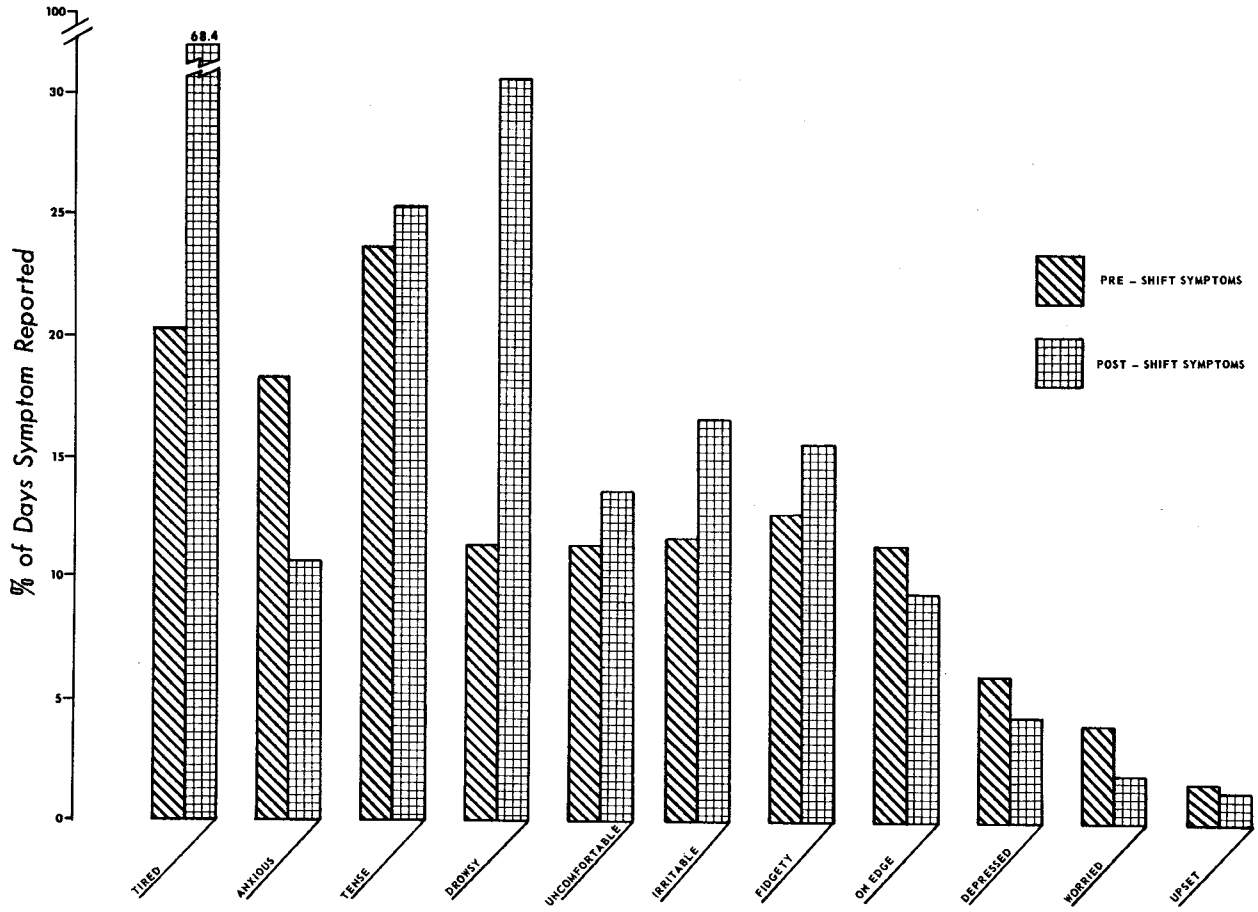

FIGURE 12. Percent of Symptoms (Mental)—Preshift and Postshift 40–49 Years—>10 Years Experience.

APPENDIX

The two subsequent tables provide a key to the 16 figures appearing in this appendix. The first table is for physical symptoms, the second for mental symptoms. Each table contains three columns representing the three degrees of ATC experience in years (<3, 4 to 10, and >10) and three rows representing the three age groupings in years (21 to 29, 30 to 39, and 40 to 49). Entries in the body of the tables refer to the figure numbers in the appendix. For example, in the table for physical symptoms the entry A7 appears in the column headed "4–10" and row "30–39". This means that Figure A7 contains data for subjects with between 4 and 10 years of experience who are in the 30 to 39 age range.

The tables may be used to select the appropriate figures for various comparisons. For example, in the text, physical symptoms of the three age groups were compared with experience held constant at the <3–year level. By referring to the physical-sympton table, it can be seen that Figures A1, A5, and A11 are those appropriate for this comparison and in the text Figures 7, 8, and 9 are simply duplicates of A1, A5, and A11. As another example, if a comparison of mental symptoms for the various levels of experience were desired for the 30 to 39 age group, Figures A6, A8, and A10 would be appropriate.

PHYSICAL SYMPTOMS

	Experience Groups		
Age Groups	*<3 yr.*	*4–10 yr.*	*>10 yr.*
21–29	A1	A3	----
30–39	A5	A7	A9
40–49	A11	A13	A15

MENTAL SYMPTOMS

	Experience Groups		
Age Groups	*<3 yr.*	*4–10 yr.*	*>10 yr.*
21–29	A2	A4	----
30–39	A6	A8	A10
40–49	A12	A14	A16

FIGURE A1. Percent of Symptoms (Physical)—Preshift and Postshift 21-29 Years—<3 Years Experience.

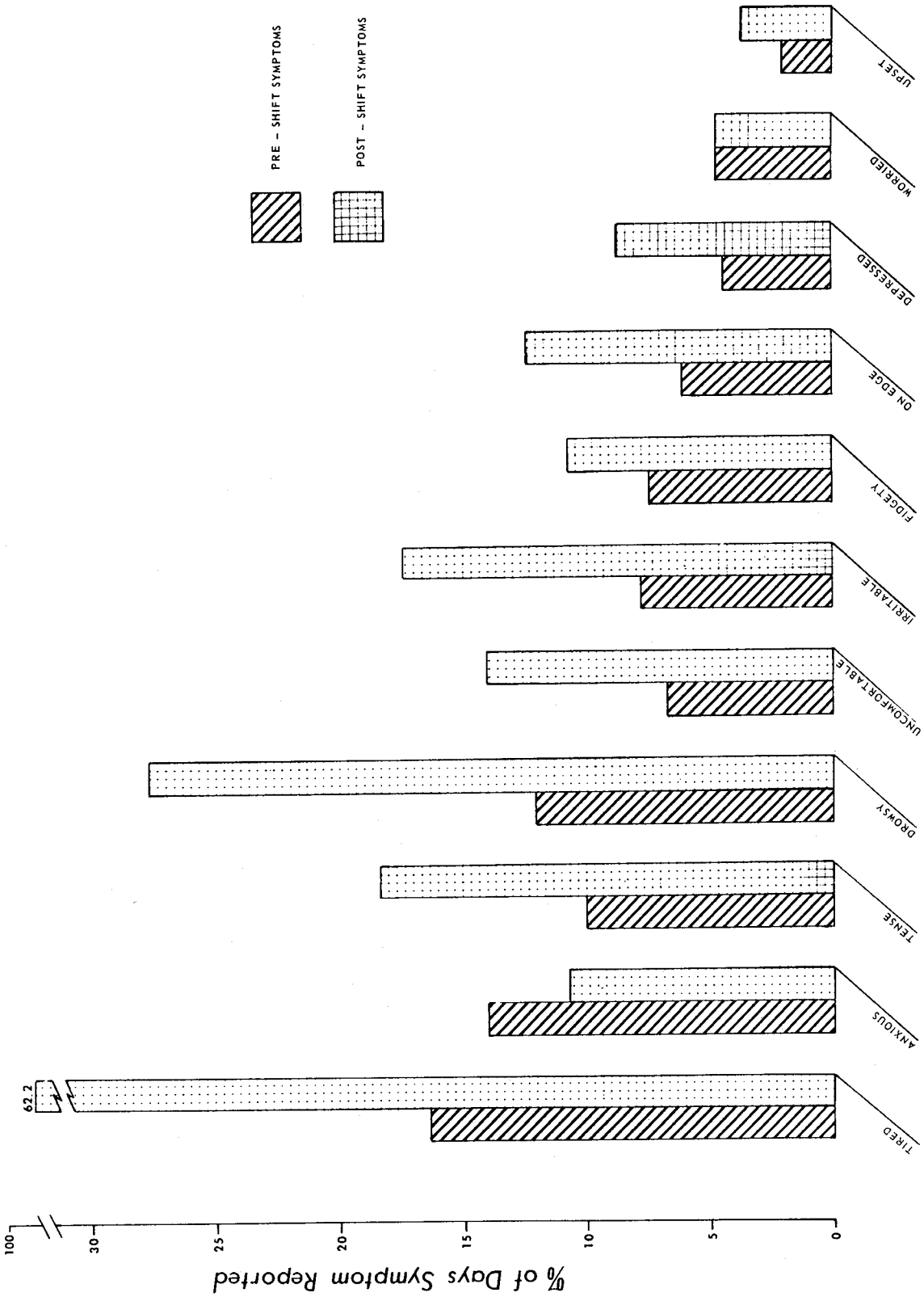

FIGURE A2. Percent of Symptoms (Mental)—Preshift and Postshift 21–29 Years—<3 Years Experience.

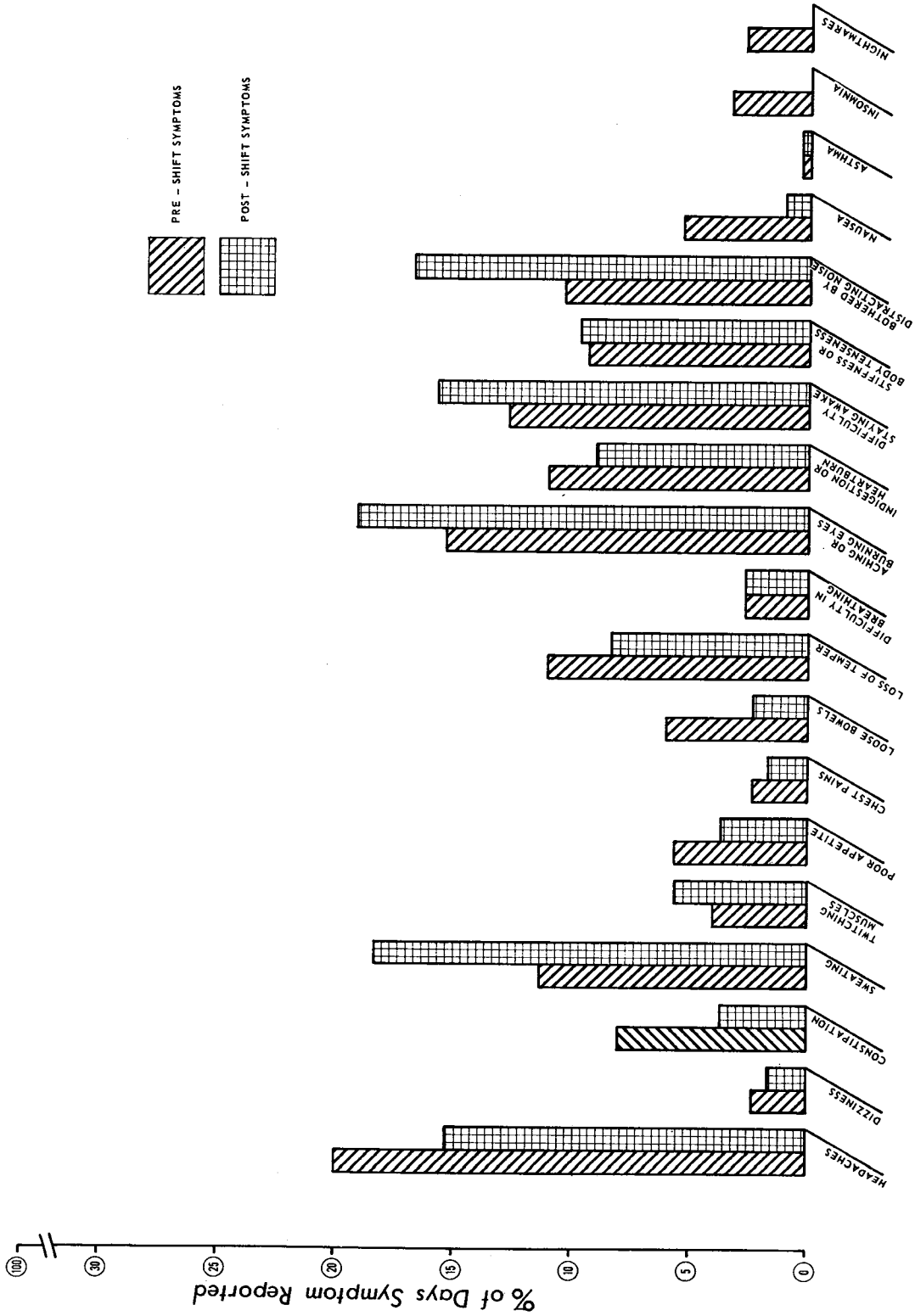

FIGURE A3. Percent of Symptoms (Physical)—Preshift and Postshift 21–29 Years—4–10 Years Experience.

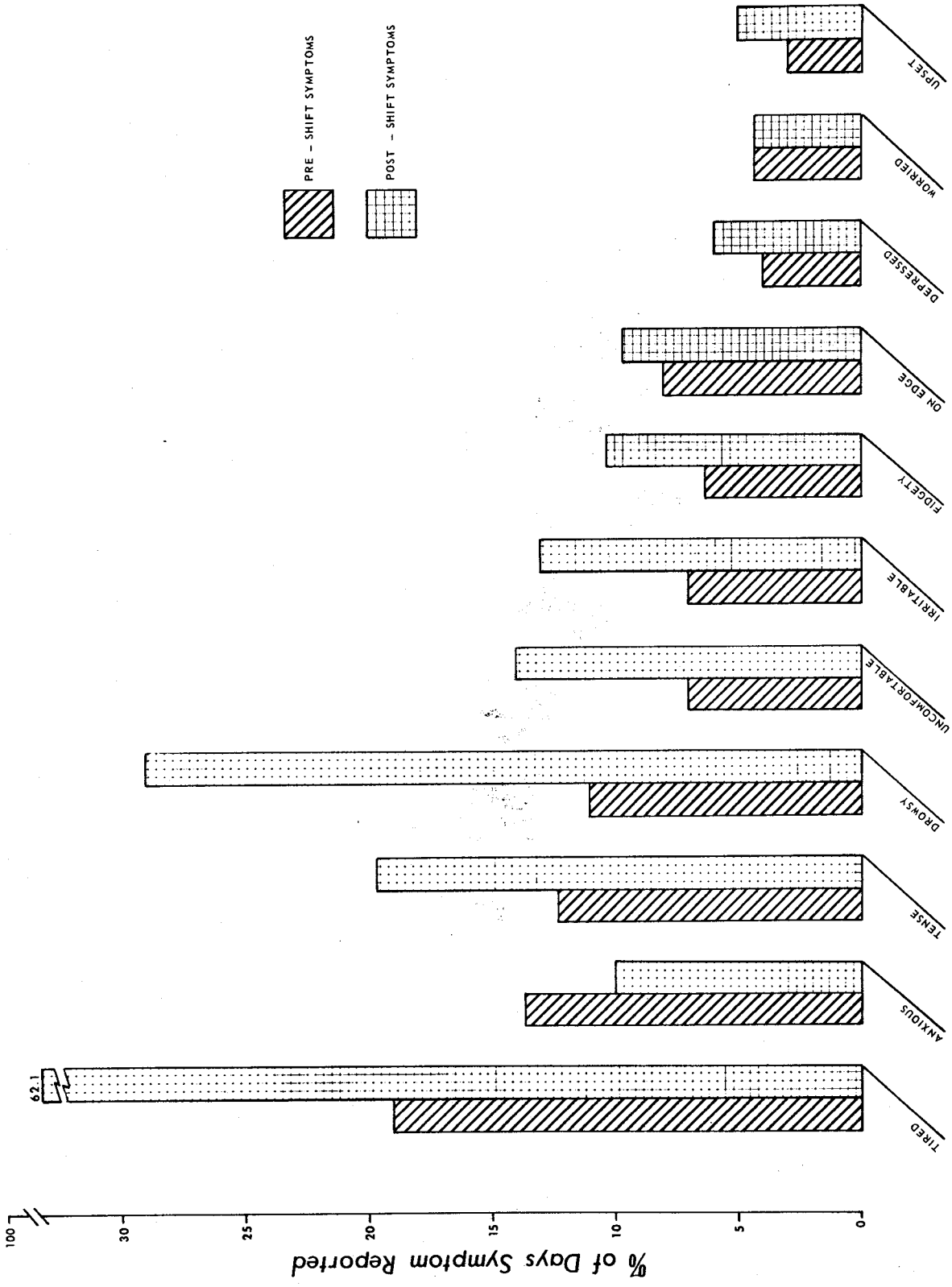

FIGURE A4. Percent of Symptoms (Mental)—Preshift and Postshift 21–29 Years—4–10 Years Experience.

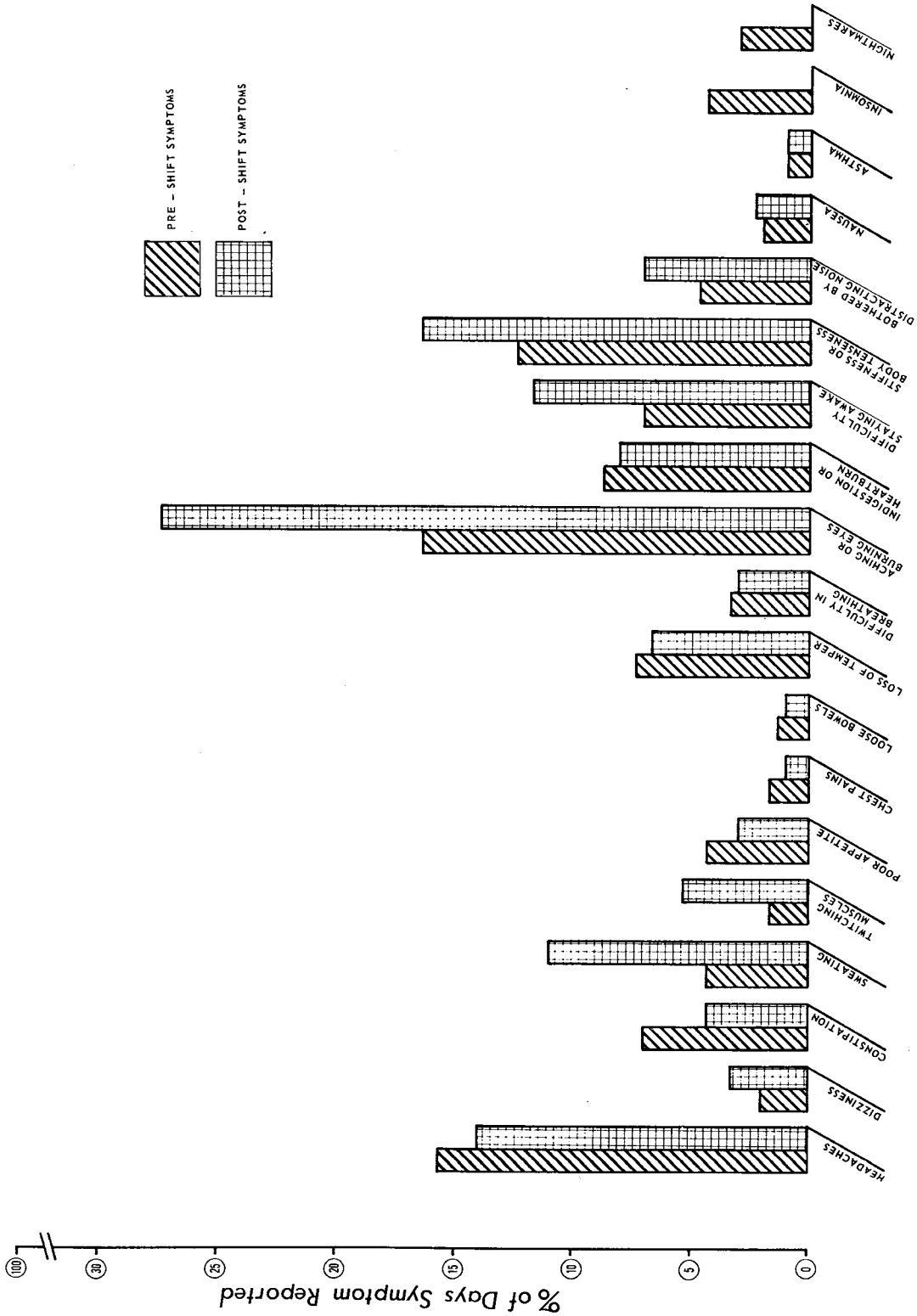

FIGURE A5. Percent of Symptoms (Physical)—Preshift and Postshift 30–39 Years—<3 Years Experience.

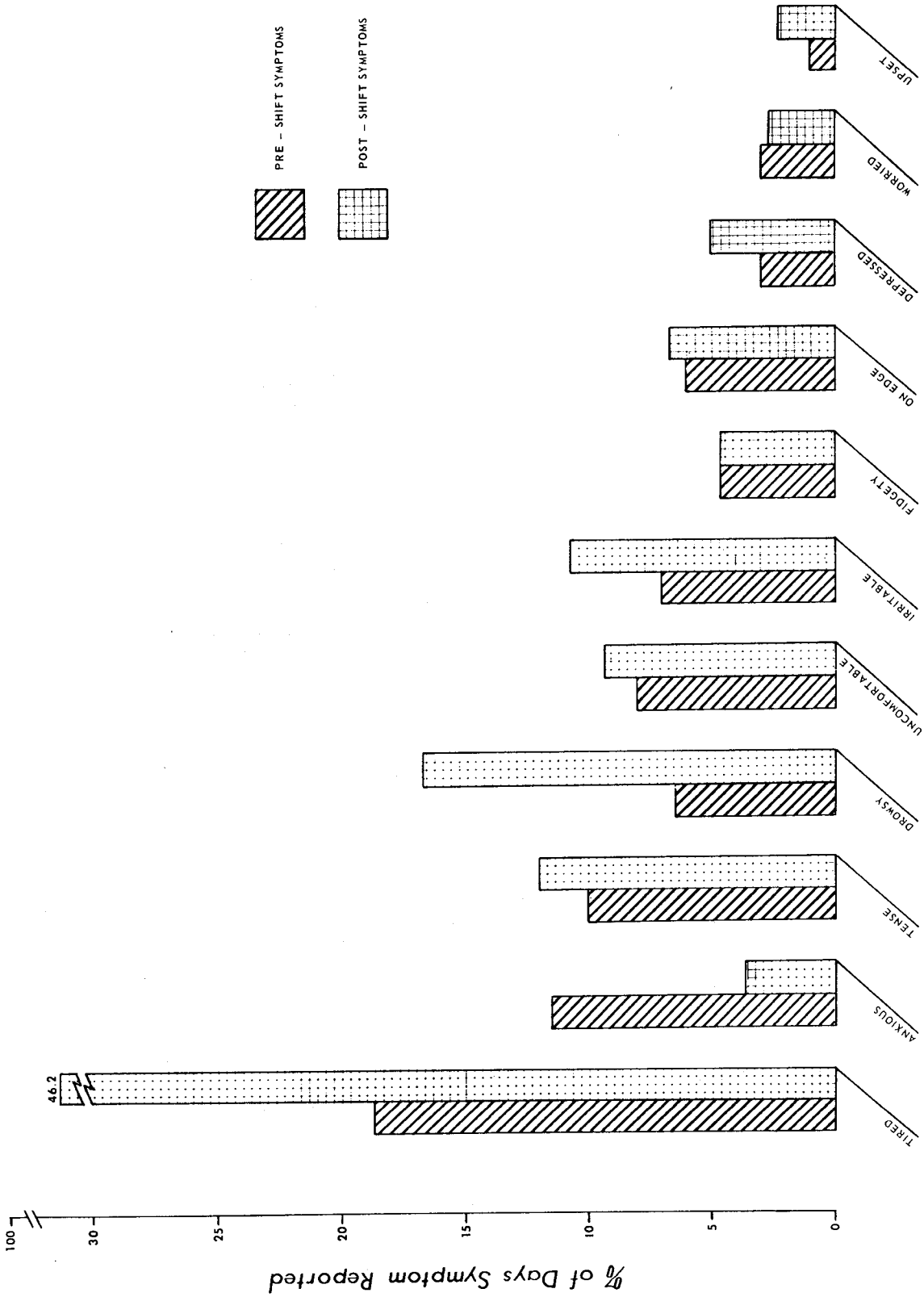

FIGURE A6. Percent of Symptoms (Mental)—Preshift and Postshift 30–39 Years—<3 Years Experience.

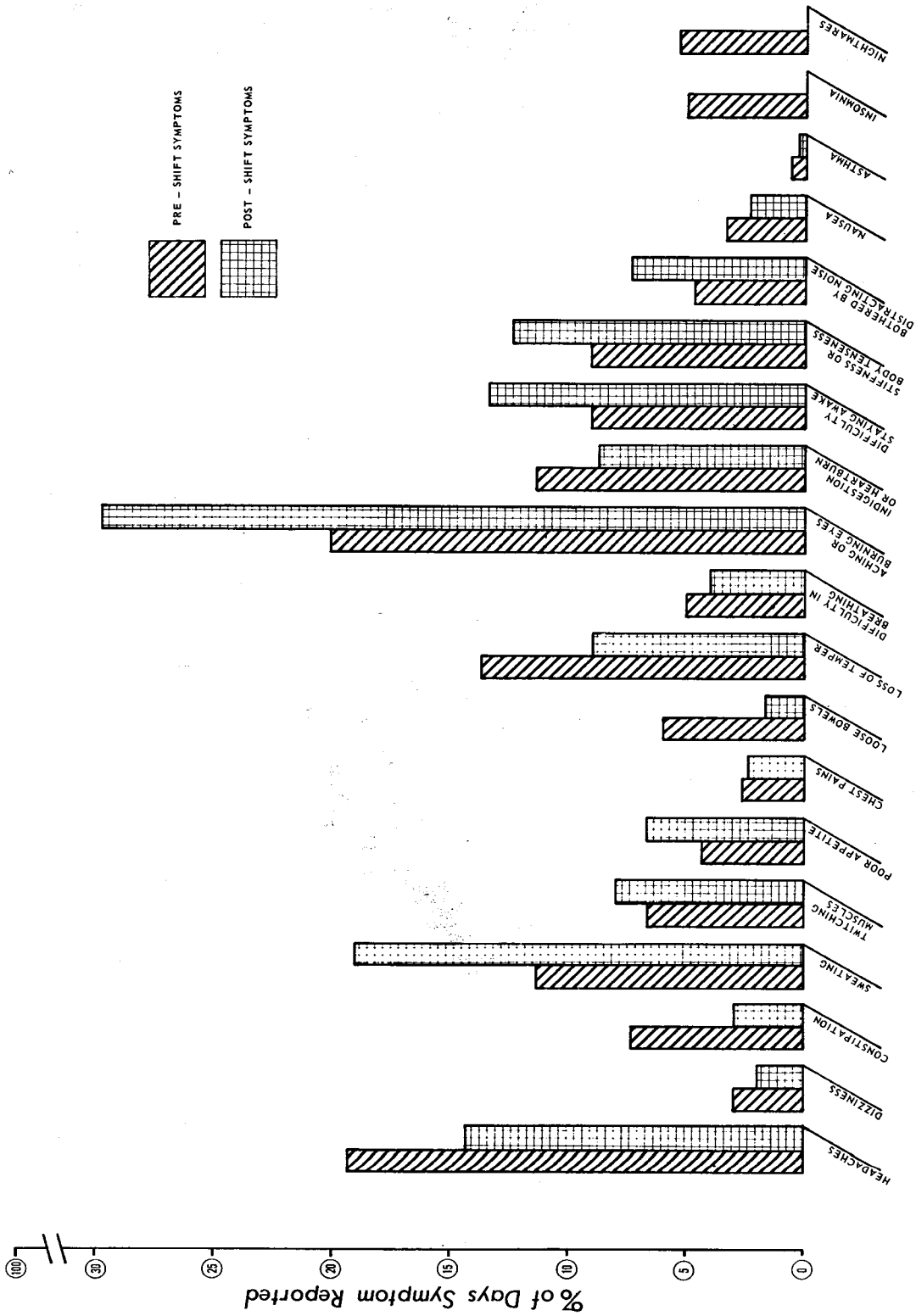

FIGURE A7. Percent of Symptoms (Physical)—Preshift and Postshift 30–39 Years—4–10 Years Experience.

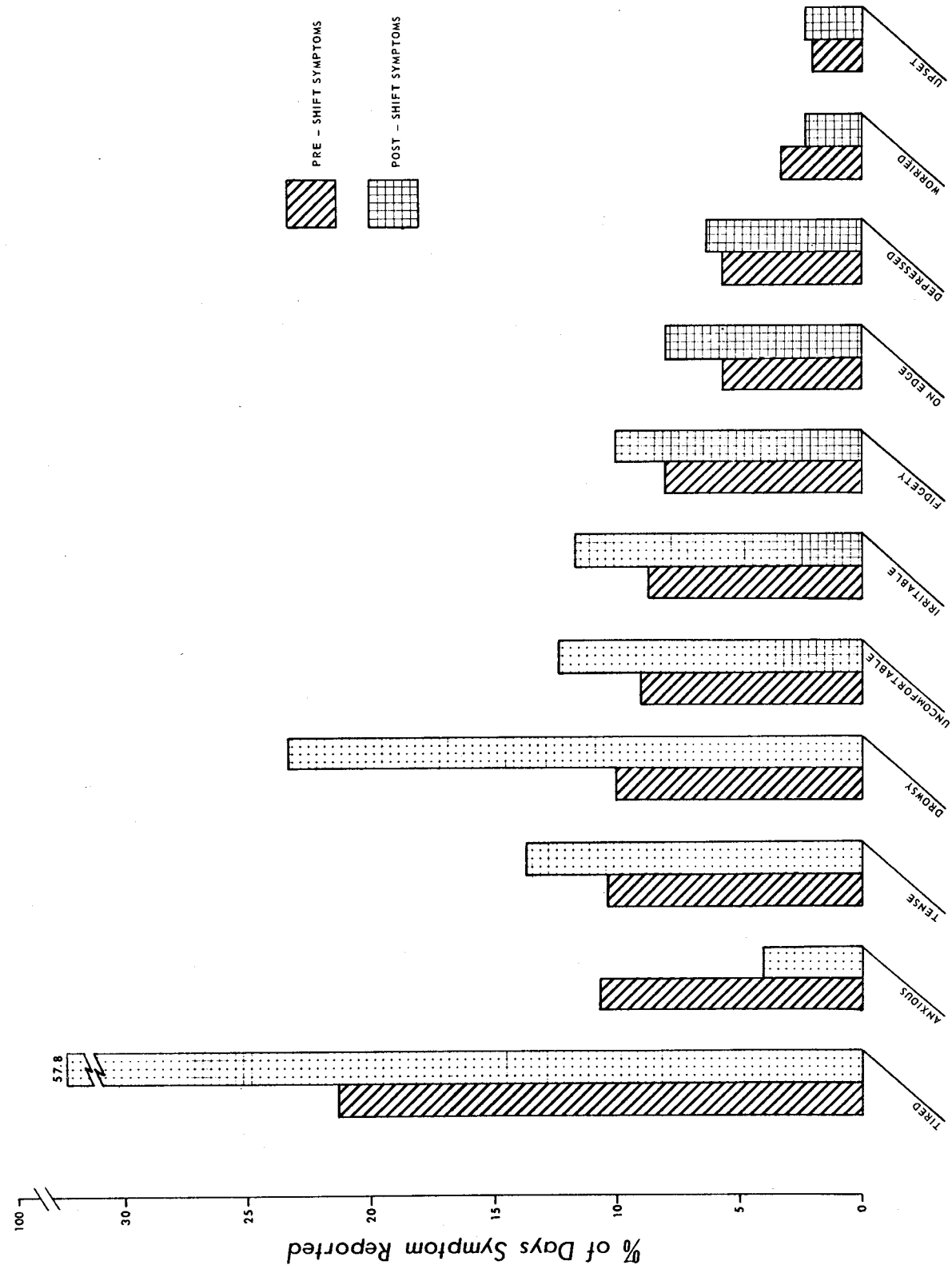

FIGURE A8. Percent of Symptoms (Mental)—Preshift and Postshift 30–39 Years—4–10 Years Experience.

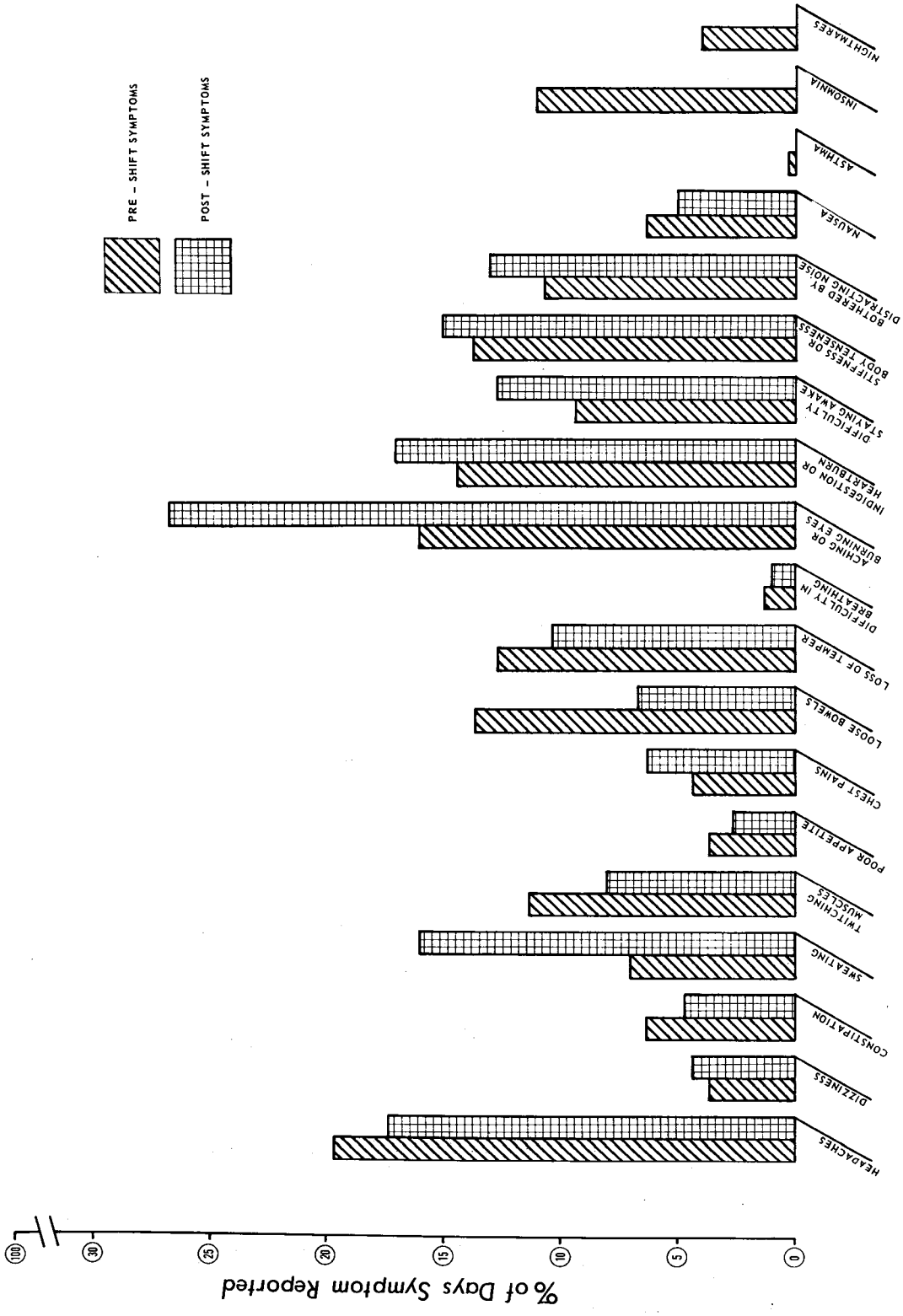

FIGURE A9. Percent of Symptoms (Physical)—Preshift and Postshift 30–39 Years—>10 Years Experience.

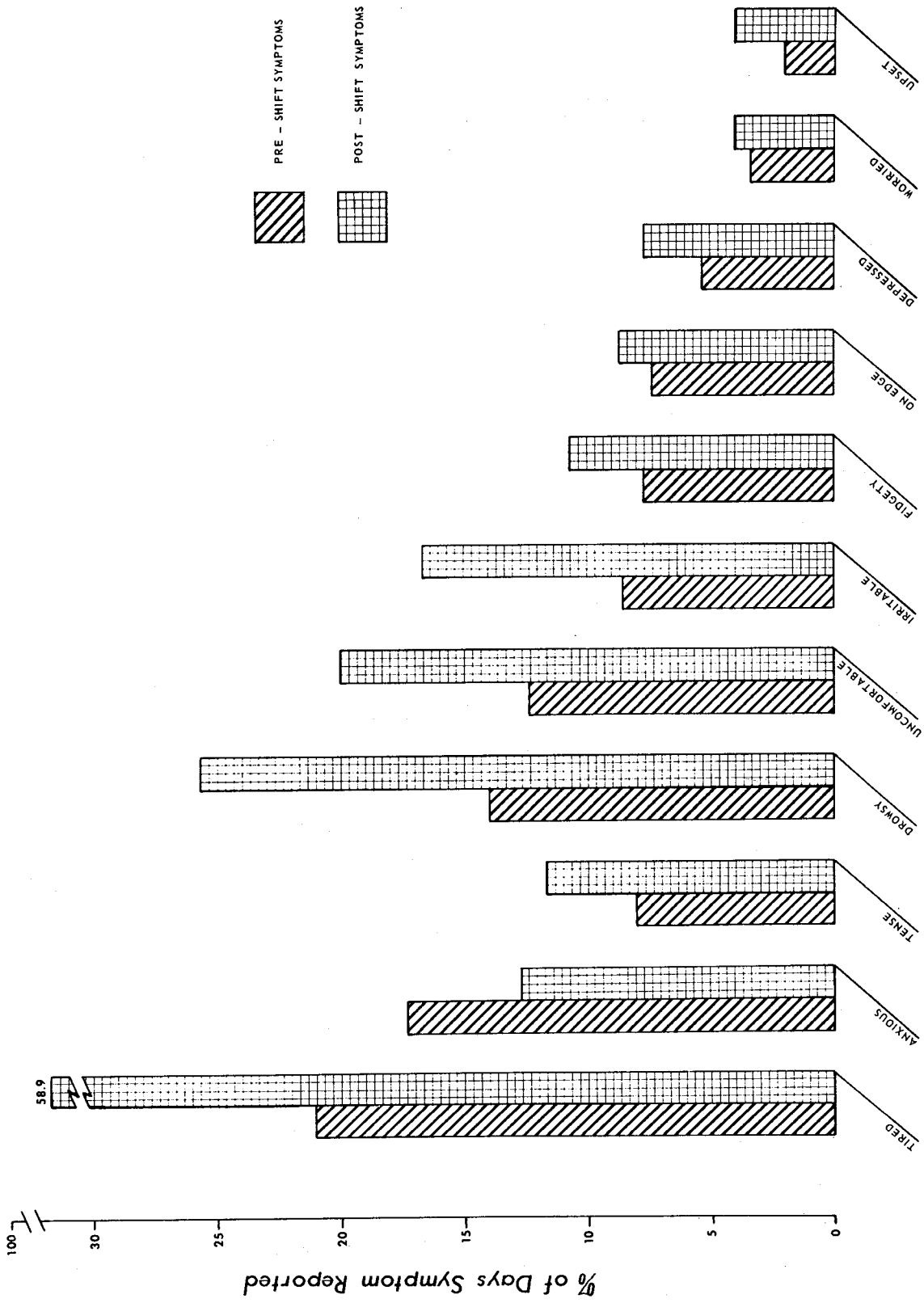

FIGURE A10. Percent of Symptoms (Mental)—Preshift and Postshift 30–39 Years—>10 Years Experience.

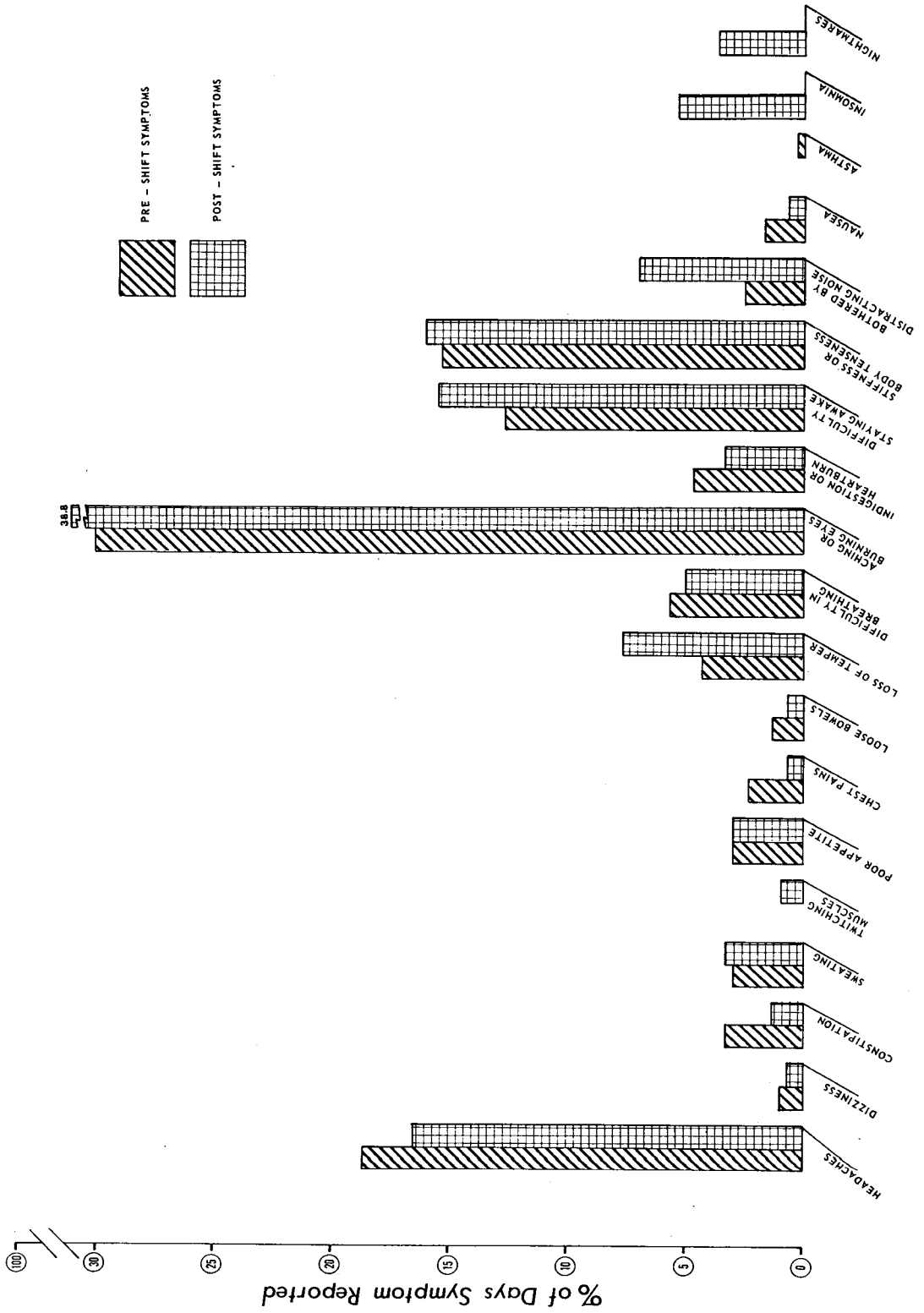

FIGURE A11. Percent of Symptoms (Physical)—Preshift and Postshift 40–49 Years—<3 Years Experience.

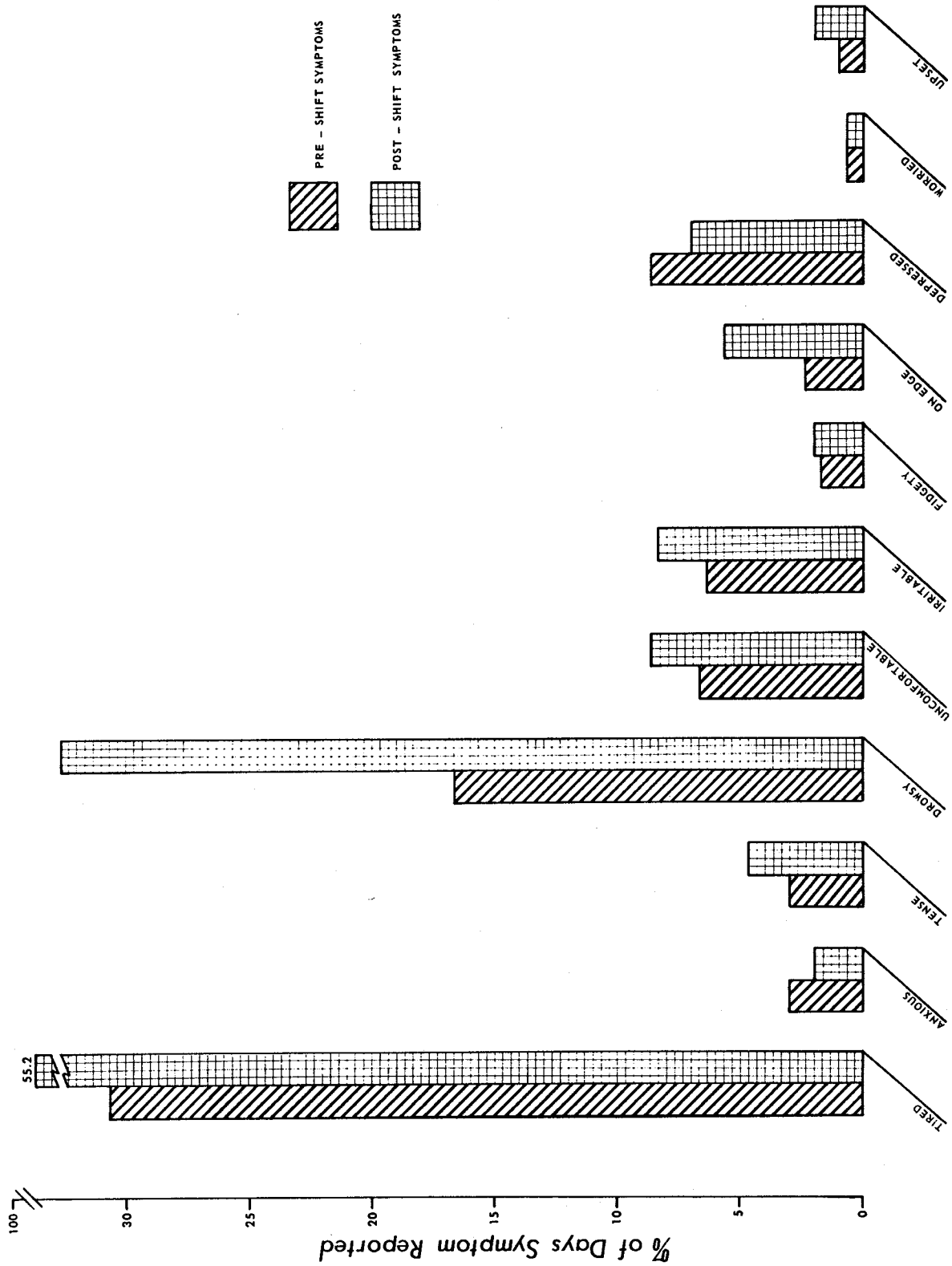

FIGURE A12. Percent of Symptoms (Mental)—Preshift and Postshift 40–49 Years—<3 Years Experience.

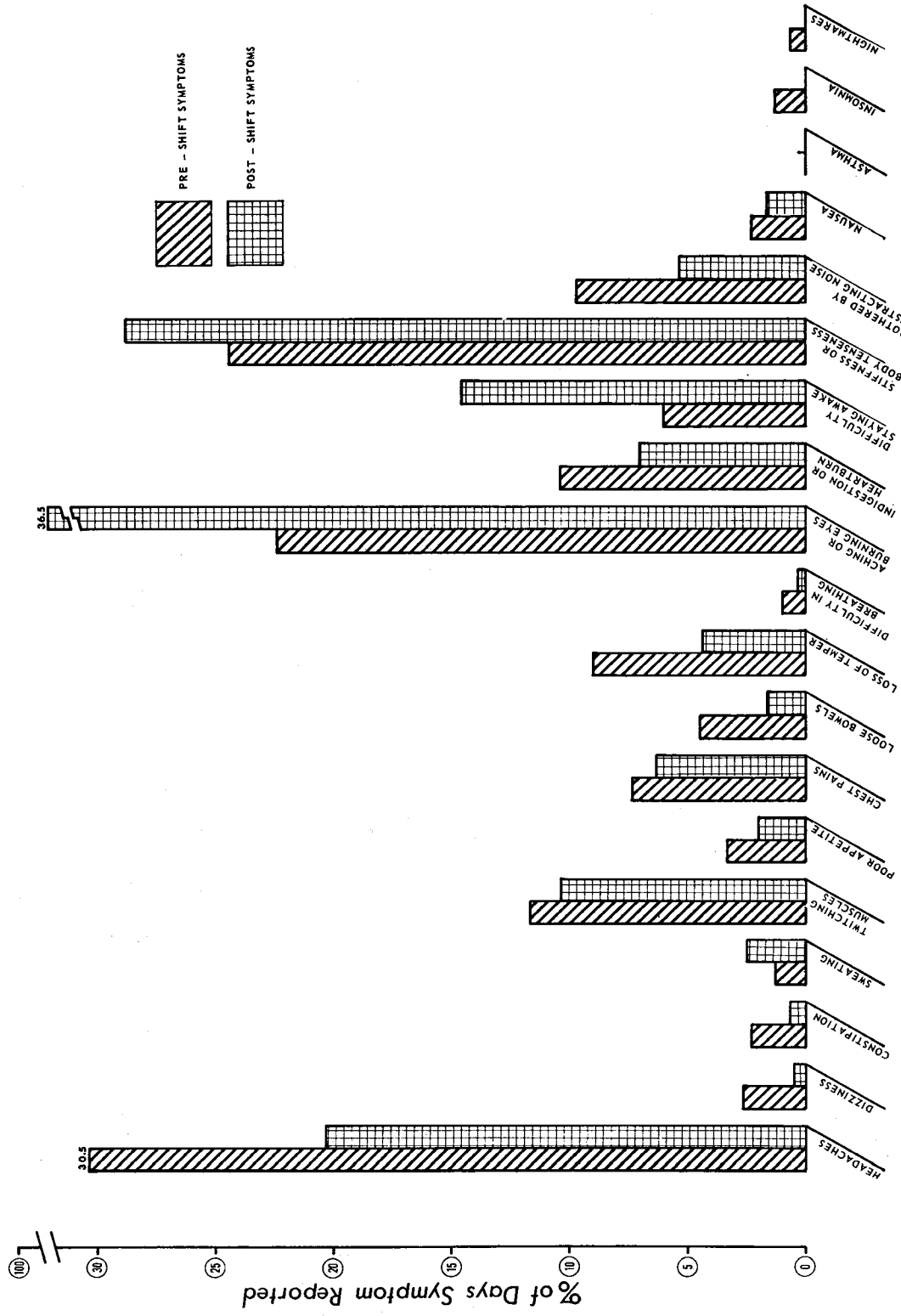

FIGURE A13. Percent of Symptoms (Physical)—Preshift and Postshift 40–49 Years—4–10 Years Experience.

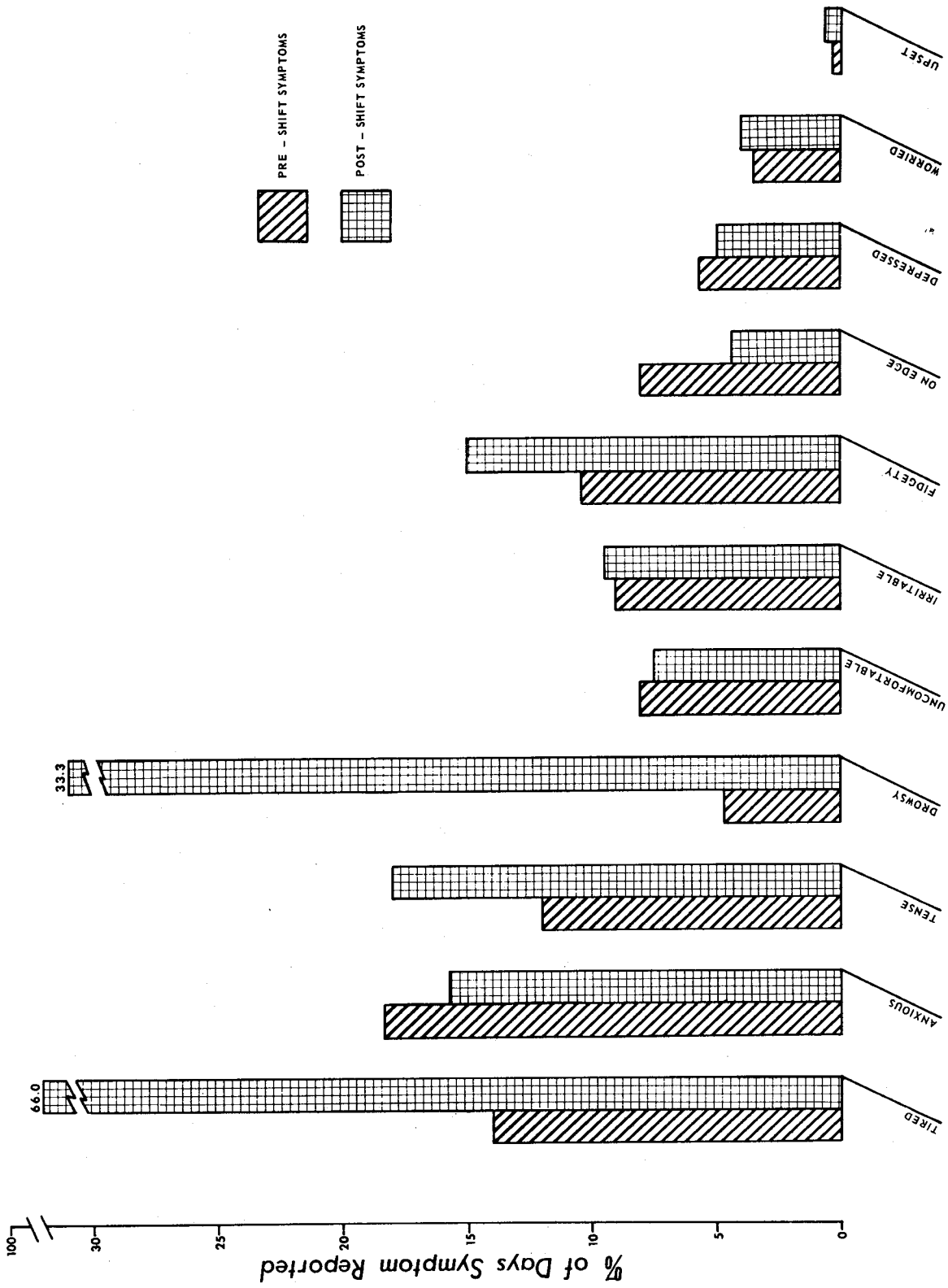

FIGURE A14. Percent of Symptoms (Mental)—Preshift and Postshift 40–49 Years—4–10 Years Experience.

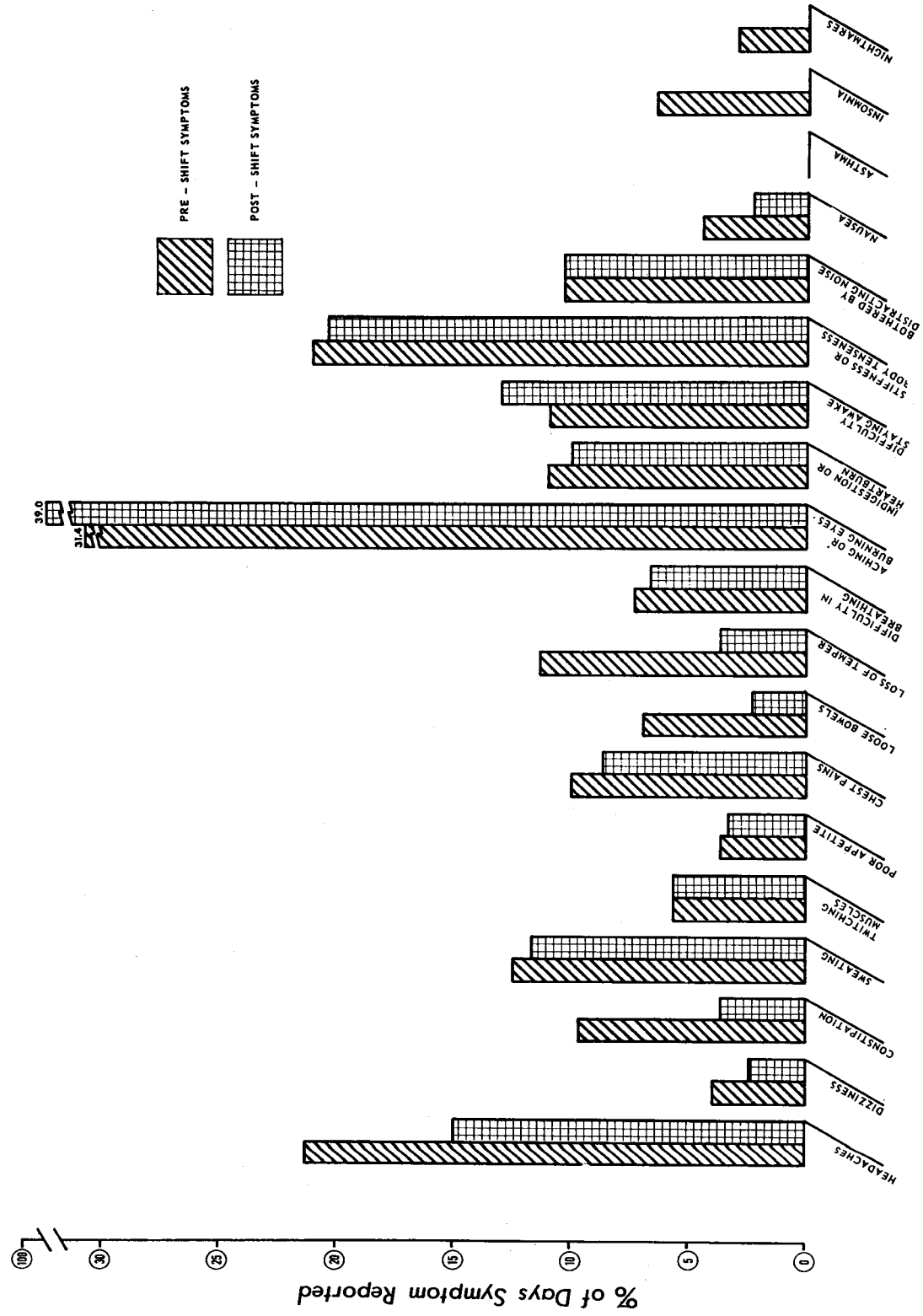

FIGURE A15. Percent of Symptoms (Physical)—Preshift and Postshift 40–49 Years—>10 Years Experience.

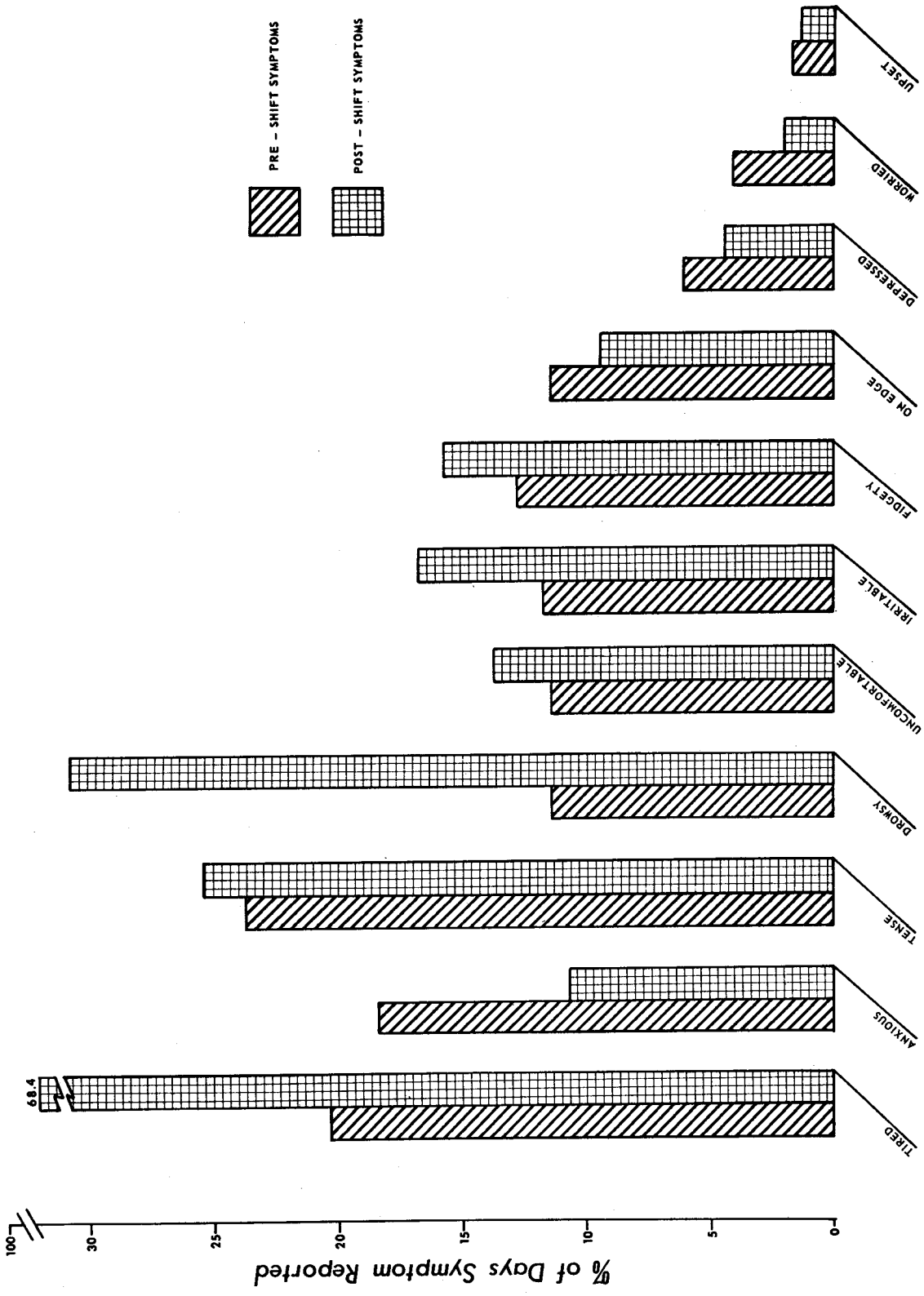

FIGURE A16. Percent of Symptoms (Mental)—Preshift and Postshift 40–49 Years—>10 Years Experience.