

Follow-up Study of Patients Treated by X-ray Epilation for Tinea Capitis: Psychiatric and Psychometric Evaluation

ABDEL R. OMRAN, MD, DRPH, ROY E. SHORE, PHD, RICHARD A. MARKOFF, MD, ARNOLD FRIEDHOFF, MD, ROY E. ALBERT, MD, HARRIET BARR, PHD, W. GRANT DAHLSTROM, PHD, AND BERNARD S. PASTERNAK, PHD

Abstract: To investigate the late effects of radiation to the head upon subclinical mental disorders, a psychiatric and psychometric evaluation was performed on 177 cases treated 10–29 years earlier for ringworm of the scalp by X-ray therapy (N : 109) or, by chemotherapy (N : 68). Analyses which controlled for educational level and family psychiatric disorders showed that, among whites, the irradiated group manifested more psychiatric symptoms and more deviant

MMPI (Minnesota Multiphasic Personality Inventory) scores. They were also judged more maladjusted from their MMPI profiles, and more frequently had a history of treated psychiatric disorders; however, the psychiatrist's overall rating of current psychiatric status showed only a borderline difference between the two groups. There were no significant differences between irradiated and chemotherapy treated blacks. (*Am. J. Public Health* 68:561–567, 1978)

This study is part of an investigation of the nature and magnitude of long-term radiation effects in children treated by X-radiation for ringworm of the scalp.^{1–3} Treatment for tinea capitis by X-ray epilation was used extensively between 1910 and 1959, and approximately 200,000 children worldwide received this form of treatment.⁴ The population of individuals who received X-ray epilation in childhood is one of the few groups available for assessing the long-term effects of moderate levels of radiation upon the central nervous system (CNS). Dosimetric studies of the Adamson-Keinbock treatment regimen, utilizing unfiltered 100 KVP X-rays, indicated that the brain received a dose of 150–175 rads at its surface, decreasing to 70 rads at the base.⁵

Between 1940 and 1959 at the Skin and Cancer Unit of the New York University Hospital, about 2,500 children received X-ray epilation and another 1,800 children received topical chemotherapy treatment of scalp ringworm. During this period, a number of topical treatments were being tried

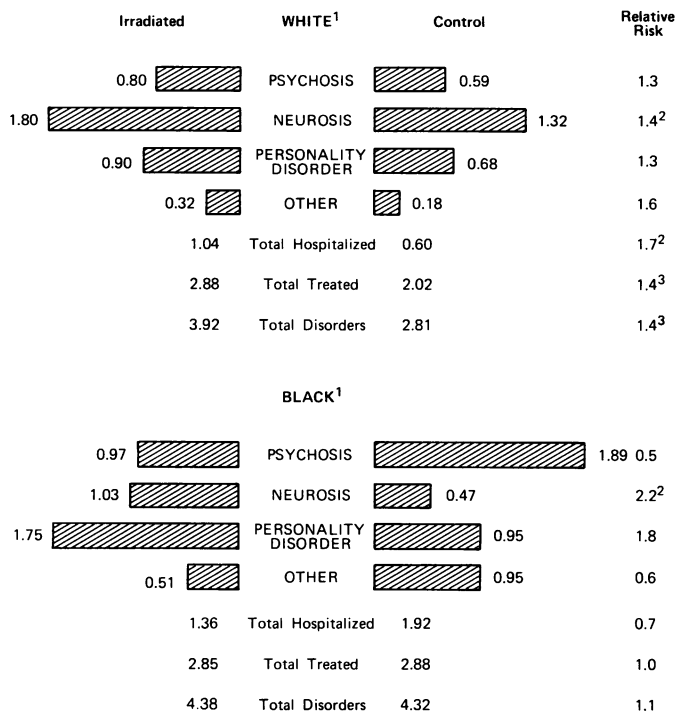
as substitutes for X-ray therapy for ringworm of the scalp. Both the irradiated and topically treated cases (henceforth called controls) were briefly observed for immediate effects of therapy. No long term follow-up was done until this study was initiated in 1962 as a retrospective-prospective cohort study.¹ One feature of this study is the availability of control cases of tinea capitis, so that selection biases for the disease or possible long-term effects of the disease process can be ruled out as biasing factors. Such controls are lacking in a number of radiation injury studies.

The study consisted of: 1) location of the former patients (85 per cent of the irradiated and 79 per cent of the controls were successfully located); 2) an evaluation of post-treatment experience by means of mailed questionnaire (almost all those located responded) with diagnostic confirmation obtained from physicians and hospitals for the period ending in 1968.¹ A resurvey of the located former patients was made for the period 1968–1973, using the same procedures,³ and information was obtained on 96 per cent of the irradiated and 95 per cent of the controls; 3) a direct evaluation of current medical status of subgroups of the irradiated and control groups by clinical and laboratory examinations;² and 4) dosimetric studies of the radiation exposure to various structures of the head associated with the Adamson-Kienbock epilation procedure^{5, 6} have been carried out.

In our study the irradiated and control groups were all matched for age, sex, race, and social class and have been followed as epidemiologic cohorts. The average age (\pm one standard deviation) at treatment for the irradiated group was 7.8 ± 3.7 years, and for the control group 7.5 ± 4.4 years.

From the Institute of Environmental Medicine (Drs. Omran, Shore, Albert, and Pasternack) and Department of Psychiatry (Drs. Markoff and Friedhoff), New York University Medical Center, New York (Dr. Barr); Department of Psychology, University of North Carolina, Chapel Hill (Dr. Dahlstrom). Dr. Omran is currently in the Department of Epidemiology at the School of Public Health, University of North Carolina, Chapel Hill and Dr. Markoff is currently at the School of Medicine, University of Hawaii at Manoa.

Address reprint requests to Dr. Roy E. Shore, Institute of Environmental Medicine, New York University Medical Center, 550 First Avenue, New York, 10016. This paper, submitted to the *Journal* December 29, 1976, was revised and accepted for publication October 17, 1977.



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¹Incidence per 1,000 person years, adjusted for the sex, socioeconomic status, age at time of treatment, and elapsed year distribution of the control group. Relative risk is the Mantel-Haenszel adjusted relative risk.
²p < .10.
³p < .05.

FIGURE 1—Annual Incidence of Diagnosed Psychiatric Disorders in the Irradiated and Control Groups by Race

The mean annual income of the two treatment groups was equally low at approximately \$3,200 (normalized to the 1957-1959 consumer price index). The two groups, which are both about 75 per cent white and 85 per cent male have been followed an average of 20 years since treatment. The two questionnaire surveys of this population have shown higher rates of cancer of the head and neck in the irradiated group compared to the controls.^{1, 3} Because radiation effects on the CNS at low-to-moderate doses had not been reported before in human populations, the finding of a higher incidence of diagnosed mental illness in the irradiated group on the first survey¹ was unanticipated. Analysis of the combined psychiatric data from both surveys has shown that the elevated incidence has persisted for 30 years post-radiation,³ and that it is confined mainly to whites. The results of the surveys are summarized in Figure 1, which indicate that among whites the relative risk was 1.4 for total disorders and 1.7 for hospitalized mental illness. These findings raised the question of whether the irradiated cases would also show a significantly higher incidence of milder forms of mental illness which had not received medical attention. This question was examined in the study reported here involving direct psychiatric and psychologic evaluation of a subsample of the previously studied irradiated and control cases.

Materials and Methods

Of the subjects who had already been included in the follow-up study and who lived in the New York metropolitan area at the time of this evaluation, a random sample was selected from the irradiated and control groups for clinic recruitment. The same procedures of contact and recruitment were used with the irradiated and the control groups. These consisted of mailed invitations and direct telephone contacts with the individual. Each individual was asked to attend a clinic session where he received a physical examination, a psychiatric interview, and psychological testing with the Minnesota Multiphasic Personality Inventory (MMPI). As far as possible, the person making the contact did not know whether the contacted individual was irradiated or not.

Psychiatric Interview: One psychiatrist (R.A.M.) interviewed all the patients utilizing a standard, semi-structured interview schedule which required about 30 minutes to complete. The psychiatrist did not know whether the subject had been irradiated, and the subjects were not aware that the study pertained to radiation treatment.

The areas covered in the interview protocol were: school history and scholastic achievement; work history; marital history; social, peer and authority relationships; personality characteristics and patterns of interaction; psychiatric symptoms; history of medical and psychiatric illness; family structure; and family psychiatric history. Afterwards the psychiatrist completed an assessment of mental status. This included a check list of observations, a brief narrative impression, and a psychiatric diagnosis.

Disorders were designated in broad categories: psychosis, neurosis, or personality disorder. Psychophysiological symptoms were considered secondary to the other categories of disorder. Disorders were also rated for severity on a descriptive rating scale for which scores were assigned as follows: 1 = no psychiatric disorder, 2 = possible, 3 = possible-to-mild, 4 = mild, 5 = mild-to-moderate, 6 = moderate, 7 = moderate-to-severe, 8 = severe disorder.

Psychologic Testing: The MMPI was chosen for this study mainly because of its clinical relevance. Because of limitations in the testing time available, the short form of the MMPI was given to about one-half of the subjects in both groups. The short form included items for all the basic validity scales and the ten clinical scales, so that full, K-corrected profiles (i.e., adjusted for defensiveness) could be generated for all subjects.

Each profile was also rated by three independent judges on the MMPI rating scale of severity of maladjustment devised by Cooke.⁷ The judges did not know which group any profile belonged to, and two of the three judges were not even aware of the purpose of the study. The scale-points are defined in detail by Cooke⁷ but may be stated briefly as: 1 = severe maladjustment, 2 = considerable maladjustment, 3 = moderate maladjustment, 4 = mild maladjustment, 5 = average adjustment, 6 = better than average adjustment, 7 = superior adjustment. The scale combines both the notion of severity of personal suffering and the concept of interpersonal difficulties, so that the traditional neurotic and psychotic maladjustments and the problems generated

by personality disorders are all represented on one dimension. The judges also independently sorted all profiles into categories of psychotic, neurotic, personality disorder, or no disorder.

Results

The sample consisted of 109 irradiated and 68 control males*, of whom 25 irradiated and 24 control cases were black and the remainder white. The mean intervals between tinea treatment and clinical evaluation for the white, male irradiated and control groups were 18.8 ± 4.4 and 21.1 ± 3.7 years respectively, while the intervals for the respective black groups were 15.6 ± 4.4 and 16.6 ± 6.0 . The groups were compared for age, education, occupation, marital status, and religion. Among blacks the irradiated and control groups did not differ, but among whites the irradiated cases were younger (30 per cent vs. 58 per cent over the age of 30), more often single (51 per cent vs. 31 per cent), and better educated (45 per cent vs. 29 per cent with some college education) than the control group.

The rate of cooperation in the study was rather low. Of those contacted and potentially available 48 per cent attended the clinic (50 per cent of the irradiated and 45 per cent of the control with no difference in response by color). Twenty per cent failed to show up for one or more appointments, and 32 per cent could not participate for various reasons, usually because of the time and travel involved. Therefore, a comparison of this clinic sample with the remainder of the tinea survey population was performed to determine if there was significant self-selection bias. Comparisons were made separately for whites and blacks on age, marital status, education, occupation, and history of treated mental illness. The clinic samples were comparable to the tinea population, except that the clinic sample was more often single and was of slightly higher socioeconomic status. However, the trends were small and were significant only because of the large sample size of the tinea populations; in no case did the sample differences account for more than 2 per cent of the variation in the characteristic. Nevertheless, self selection in this sample cannot be eliminated.

Since group differences were not parallel for whites and blacks, the data were analyzed separately for the two racial groups and were adjusted, using the Mantel-Haenszel summary Chi square⁸ and adjusted relative risk (RR), by stratifying on attained education and whether or not there was a history of mental disorders among parents and siblings. Preliminary analyses showed that adjustment for age and marital status had no discernible effect on the results, so they were dropped from the analyses.

Psychiatric Interview: Summary results of the psychiatric and psychologic evaluations are shown in Table 1. Among whites the summary variables showed more signs of mental disorders in the irradiated group, but there were no

such regular differences among blacks. Among white subjects, 21 per cent of the irradiated group and 7 per cent of controls had a history of psychiatric treatment (RR = 3.5). Family history of psychiatric disorders was correlated with a personal history of disorders. When there was family psychopathology, 47 per cent of the subjects had received psychiatric treatment, whereas in the absence of family psychopathology only 12 per cent had been treated. Since family psychopathology had such a strong relationship to the subjects' psychiatric disorders, it might either mask the association of radiation with psychiatric disorders or cause a spurious association. Therefore the relationship was examined more closely. The RR (adjusted for educational level) among subjects for whom there was no family history of psychopathology was 3.5, identical with the overall adjusted risk. The "pure" relative risk of radiation calculated by removing the component attributable to family psychopathology⁹ was 3.4 again indicating that the association was not spurious.

The cumulative ratings of severity of current psychiatric disorder by the psychiatrist are shown in Table 2 for whites. The white irradiated group had a higher prevalence of disorders of at least moderate severity (ratings of 6 to 8). This included 39 per cent of the irradiated and 27 per cent of the control group (RR = 1.7, $p = .14$). Again family psychiatric disorder was a potential confounding variable, with ratings of 6 to 8 on the psychiatric rating scale given to 73 per cent of those with and 30 per cent of those without a family history of psychopathology. Calculation of a "pure" relative risk, as above, again showed no confounding (RR = 1.7). Tables 1 and 2 indicate no association between psychiatric disorders and irradiation among blacks.

An inspection of the psychiatrist's categorization of types of disorders in whites (Table 3) revealed no differential patterns between the irradiated and control groups. There was no concentration of psychopathology in any single category (psychosis, neurosis, or personality disorder) in the irradiated group, so irradiation does not appear to precipitate any particular type of mental disorder.

Several interview questions were oriented toward problems with a probable psychiatric basis. As shown in Table 1, work problems among whites tended to be more frequent in the irradiated group (21 per cent vs. 9 per cent, $p = .09$). These consisted mainly of friction with other employees, or job dissatisfaction at several jobs. There were no differences between the irradiated and control groups in the frequency of either marital problems or criminal infractions.

For each subject the psychiatrist completed a checklist of ten psychiatric symptoms which could be observed or elicited during the interview. These included: chronic anxiety, fears and phobias, obsessive-compulsive symptoms, emotional instability, antisocial behavior, depression, somatization, drug abuse, alcohol abuse, and psychotic symptoms. A summary score was formed by the number of symptoms checked. Table 1 indicates that among whites there were significantly more irradiated than control subjects with four or more psychiatric symptoms (18 per cent vs. 4 per cent, RR = 4.8). The difference between the two groups was accounted for mainly by the first five of the

*Because of the small number of females evaluated, they were excluded from these analyses.

TABLE 1—Summary Results of the Psychiatric and MMPI Evaluation in the Irradiated (I) and Control (C) Groups.

Variable	Whites			Blacks			Total		
	I	C	RR§	I	C	RR	I	C	RR
	%	%		%	%		%	%	
Psychiatric Rating of at least Moderate Disorder	39	28	1.7	29	25	1.3	37	26	1.6
History of Psychiatric Treatment	21	7	3.5†	4	4	1.0	17	6	3.2†
Psychiatric Symptoms									
A. 2 or more	52	36	1.9*	28	42	0.5	46	39	1.4
B. 4 or more	18	4	4.8†	12	8	1.5	17	6	3.6†
Paranoid Score ≥ 2	35	18	2.4†	17	25	0.5	31	20	1.6
Job Difficulties	21	9	2.4*	27	13	2.3	22	10	2.3*
MMPI: Judged Disorder	33	14	3.2†	38	42	0.8	34	24	1.9*
2 or more MMPI Scales ≥ 70	30	12	3.1†	40	33	1.3	32	20	2.1†
Rated Psychiatric Disorder by Both Psychiatrist and MMPI Judges	21	7	3.5†	20	13	2.3	21	9	3.0†

§ RR = Relative risk (odds ratio) adjusted for education and family psychiatric disorders. For the total group, RR is also adjusted for race.
 * p < .10
 † p < .05

above symptoms. Among blacks there was no significant association of symptom prevalence with irradiation.

In the 12 items of the interview dealing with social behavior and personality characteristics, a cluster of paranoid characteristics tended to differentiate the groups. This paranoid profile consisted of six items: has few or no friends, doesn't trust others, experiences others as critical, is easily affronted, doesn't like others, and prefers his own company. Each person's score was the number of positive responses to these items. Table 1 shows that among whites roughly twice as great a proportion of the irradiated subjects reported two or more of the characteristics in the paranoid profile.

MMPI Test: In the irradiated group four subjects—two with a history of psychiatric disorders and one with borderline mental retardation—failed to complete the MMPI. In the

control group two subjects also failed to complete it due to time limitations or uncooperativeness; neither of these individuals had evidence of mental disorders.

On the four validity scales, the irradiated and control groups of both races had mean values which indicated acceptable levels of comprehension and cooperation with the test instructions. The L (lie) and K (defensiveness) scales indicated normal honesty and frankness. On the clinical scales, all groups averaged well within the normal range, and the patterns of their mean profiles resembled those of other random samples of white and black adults. For example, the relatively higher scores on scale 8 (schizophrenia) among blacks than among whites were consistent with other findings in the MMPI literature.^{10, 11} Hence, the evidence suggests that the tests were completed validly.

Comparison of means among the white males indicated that the irradiated group scored significantly higher on the scales of femininity (scale 5), obsessive-compulsive personality (scale 7), schizoid personality (scale 8), and introversion (scale 0). Although these differences were significant, they were not large enough to make much difference in their adjustment or effectiveness. It was noted, however, that the irradiated males were more variable than the control group on nine of the ten clinical scales, which suggested there were deviant subgroups.

Therefore, the MMPI data were examined by considering a T-score ≥ 70 (i.e., two standard deviations above the normative mean) on a scale as indicative of maladjustment. Table 1 shows that among whites 34 per cent of the irradiated cases and 14 per cent of the controls (RR = 3.2) had two or more scale scores ≥ 70. The difference among blacks was small and insignificant. Comparisons for individual scales

TABLE 2—Cumulative Rated Severity of Psychiatric Disorders in the Irradiated and Control Groups.

Severity of Disorder	Cumulative Per Cent			
	Whites		Blacks	
	Irradiated	Control	Irradiated	Control
8 (Severe)	10	7	8	8
7	18	14	24	17
6 (Moderate)	39	27	28	25
5	44	36	46	38
4 (Mild)	50	48	50	46
3	56	52	58	54
2 (Possible)	61	55	58	58
1 (None)	100	100	100	100

TABLE 3—Frequency of Types of Mental Disorders Based on the Psychiatric Evaluation and the MMPI Judges.

Mental Disorder	Whites		Blacks	
	Irradiated %	Control %	Irradiated %	Control %
			<i>Psychiatric judgments</i>	
Psychosis	5	0	4	4
Neurosis	26	20	8	21
Personality Disorder	7	7	16	0
No Disorder	62	73	72	75
Number of Disorders/ Total Subjects	32/84	12/44	7/25	6/24
			<i>MMPI Judgments</i>	
Psychosis	12	7	13	42
Neurosis	12	5	4	0
Personality Disorder	9	2	21	0
No Disorder	67	86	63	58
Number of Disorders/ Total Subjects	27/81	6/42	9/24	10/24

showed that the white irradiated group had a significantly greater proportion of scores ≥ 70 than did the white control group on two scales: femininity and hypomania.

The three judges' independent ratings of the MMPI profiles for severity of maladjustment showed good agreement, with an alpha reliability coefficient of .93 for the average of the three judgments. There were no differences in the means of the composite judges' ratings between the black irradiated (3.7 ± 1.0) and control (3.4 ± 1.4) groups, but the white irradiated group had a lower mean score (3.9 ± 1.5) indicating more maladjustment, than the controls (4.4 ± 1.2 , $p < .05$).

On the basis of the composite of the three judges' ratings and categorizations, each group was separated into four diagnostic categories: no pathology (average severity rating > 3), and psychotic, neurotic, or personality disorder pattern (average severity rating ≤ 3 and agreement between at least two judges on category assignment). The agreement among judges in categorization was satisfactory, with a median interjudge agreement of 82 per cent among whites and 75 per cent among blacks.

The composite frequencies and per cent of these various categorizations of judgment are presented in Table 3 for white and black samples separately. The white irradiated group was significantly more often given a pathological designation by the judges than the white controls were (RR = 3.1; see Table 1).

Comparisons of Psychiatric and MMPI Judgments: The psychiatric classification given each case by the psychiatrist was compared with the composite test-based judgments, using the same four psychiatric groupings. The tabulations shown in Table 4 indicate that agreement between MMPI and psychiatric judgments was 65 per cent among whites and 56 per cent among blacks on specific diagnostic classification. Agreement on a dichotomy of no disorder vs. disorder was 75 per cent and 66 per cent respectively, which yielded judge-psychiatrist tetrachoric correlations of .59 among whites and .44 among blacks, indicating a moderate degree

of consensus between the psychiatric and MMPI assessments of mental disorder.

To provide a stringent test of the effect of radiation on psychiatric disorders the proportions who were rated as disorders by both the psychiatrist and MMPI judges were examined. Table 1 shows that among whites three times as many irradiated cases as controls were rated as disorders by both methods.

Discussion

While the methods of contact and motivation were equivalent for the irradiated and control cases, the low cooperation rate raises questions of selection bias. Although the irradiated and control clinic groups were comparable on most of the demographic characteristics and were similar to the tinea population, some self-selection bias could not be eliminated. However, several possible sources of bias were controlled by the statistical analysis.

The psychiatric evaluation had to be kept brief and within one visit by the patient. Despite this limitation, the psychiatric interview detected several conditions among whites which had occurred more frequently in the irradiated group. There was an excess of psychiatric symptoms, paranoid orientation, work problems, and treated psychiatric illnesses in the irradiated group. The MMPI likewise showed that among whites the irradiated group more frequently had multiple scale-scores in the maladjusted range. Using the ratings by expert judges of the total MMPI profile, the irradiated whites showed a significantly higher frequency of maladjustment than the controls.

The results of this evaluation are very similar to those of the latest survey of these two populations from which the clinic samples were drawn.³ In the survey an insignificant difference on the order of 10 per cent in the cumulative incidence of treated psychiatric disorders was found among blacks, but among whites there was a 40 per cent excess in

TABLE 4—Comparison of Psychiatric Categorizations by the Psychiatrist and the MMPI Judges for Whites and Blacks.

MMPI Judge Categories	Psychiatrist Categories			
	No Disorder %*	Neurosis %	Pers. Disorder %	Psychosis %
	<i>Whites</i>			
No Disorder	57	13	2	1
Neurosis	3	5	1	1
Pers. Disorder	2	2	2	0
Psychosis	4	5	1	1
	<i>Blacks</i>			
No Disorder	50	6	4	0
Neurosis	2	0	0	0
Pers. Disorder	2	2	4	2
Psychosis	19	6	0	2

* % of white subjects (N = 122) or black subjects (N = 48).

the irradiated group. The yearly incidence of diagnosed psychiatric disorders for whites was 3.9 per 1,000 in the irradiated group and 2.8 in the control group. The excess was found consistently in both sexes and in all three major psychiatric categories: psychosis, neurosis, and personality disorders. Life-table analyses among whites showed that the excess of psychiatric disorders in the irradiated group increased in a regular fashion up to 30 years since the tinea treatment (the maximum length of observation). This indicates a long-term effect of radiation, and not just a brief spurt of psychiatric crises provoked by the trauma of the tinea treatment.

Yamazaki,¹² in a comprehensive review of radiation and CNS disturbances, reported human data on CNS effects following *in utero* irradiation (atomic bomb and therapeutic radiation studies), which showed several abnormalities, most notably microcephaly. However, human studies of the psychiatric effects of postnatal radiation, which could confirm or disconfirm the present results, have apparently not been done. One study showed personality deviations in 52 Japanese children exposed to the atomic bomb,¹³ but the economic deprivation and malnutrition of the survivors plus the lack of a control group make the findings difficult to evaluate. Potential study populations might be those given therapeutic radiation to the head or neck for acne, hypertrophied tonsils or other conditions.

Why there was an association between radiation and mental disorders among whites but not blacks is unclear. Yamazaki¹² reported great individual variation in susceptibility to CNS damage by radiation, and it is possible that ethnic or other group variation may exist as well. Certain parallel findings of group differences have been reported. Diamond¹⁴ in a large and well-controlled study, found tumorigenic radiation effects among whites only. Pasamanick has suggested that brain insults at birth have relatively less impact among blacks on the risk of subsequent neuropsychiatric disorders than among whites.¹⁵ However, another explanation of the ethnic differences which must be considered is that the MMPI and the interview ratings by a white psychiatrist have less validity for measuring psycho-

pathology in blacks than in whites. Some studies have suggested that the MMPI discriminates between psychiatric groups more poorly in black samples than in white ones.¹⁶ Others have shown that a psychiatric rater's frame of reference is not directly applicable to persons from other cultures.¹⁷ The MMPI judgments of the control cases showed 14 per cent disorders among whites and 42 per cent among blacks. The psychiatric ratings did not show a similar interracial pattern, which suggests that the MMPI and/or the psychiatric interview had subculture-based biases, leading to discrepancies. Future evaluations should undoubtedly use a psychiatric interviewer of similar ethnic background and psychometric instruments validated for blacks.

The rates of judged mental illness proved to be considerable in this population. The question arises whether they were abnormally so, thereby indicating a self-selection bias in which those with disorders were more likely to participate in the clinic. In the control group, 27 per cent of whites and 25 per cent of blacks were classified as having mental disorders from psychiatric ratings. Of the epidemiological studies of mental disorders, the midtown Manhattan study population¹⁸ is most directly comparable to our population. In that study, psychiatric interviews revealed mental disorders severe enough to be classified as "impaired" in 15 per cent of the 20–29 age group, and in 23 per cent of the 30–39 age group, the latter figure being very close to the present results. They also estimated lesser degrees of mental disorders in another 60 per cent of the sample. Hence, the present rates do not appear to be seriously out of line.

It may be concluded that the higher prevalence of (primarily subclinical) mental disorders found in this white irradiated subsample as compared to the white controls lends support to the epidemiologic survey finding of a higher frequency of treated mental illness among white irradiated tinea capitis cases. The fact that both the psychiatric and MMPI findings showed relationships, albeit weak ones, between radiation and a broad range of mental symptoms and disorders suggests that radiation does not trigger a specific form of psychopathology. It may produce some form of damage or stress which inches subjects closer to the threshold of that

type of mental illness toward which they were already predisposed. Further studies are needed to cross-validate and clarify the effects of radiation on mental health.

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