Longitudinal reductions in biological age were observed in participants in the Transcendental Meditation and TM-Sidhi programme. Over an eighteen-month period, average biological age decreased from 7.5 years younger than chronological age to 10.6 years younger. Duration of practice of the Transcendental Meditation and TM-Sidhi programme was correlated with the degree to which both biological and functional ages were younger than chronological age.

Systolic blood pressure, near point of vision, and auditory threshold at 6 kHz were measured at the beginning and end of a 1.5-year period in 73 subjects with an initial average age of 31.1 years, who were practising the Transcendental Meditation and TM-Sidhi programme. Biological age was calculated from these three variables using the methods of Morgan's Adult Growth Examination.

Systolic blood pressure and auditory threshold were found to have decreased significantly during the 1.5 years ($p < .01$ and $p < .001$, respectively), while near point of vision remained unchanged. The average biological age of the group decreased from 23.6 years at the first assessment to 22.0 years at the second assessment ($p < .05$). The difference between average biological age and average chronological age increased from 7.5 years younger at the first assessment to 10.6 years younger at the second assessment ($p < .001$).

These results indicate a continuing trend of reversal of the physiological ageing process through the practice of the Transcendental Meditation and TM-Sidhi programme.

The degree to which biological age was younger than chronological age was significantly correlated with duration of practice of the Transcendental Meditation and TM-Sidhi programme ($r = - .36$, $N = 73$, $p < .005$ for the first assessment; $r = - .45$, $N = 73$, $p < .001$ for the second assessment).

Functional age, as defined by Webster and Logie, was also calculated and the difference between functional age and chronological age was found to be correlated with duration of practice of the Transcendental Meditation and TM-Sidhi programme ($r = - .363$, $N = 73$, $p < .005$ for the first assessment; $r = - .311$, $N = 73$, $p < .01$ for the second assessment).

INTRODUCTION

In a previous cross-sectional study it was found that the mean biological age of subjects practising the Transcendental Meditation and TM-Sidhi programme was substantially younger than their chronological age. Furthermore the duration of participation in the Transcendental Meditation and TM-Sidhi programme was significantly correlated with the reduction in physiological age (Toomey et al., in press). These findings were highly consistent with the earlier work of Wallace et al. (1982) whose
subjects were, however, taken from an older age group.

The results of these studies strongly suggest that the practice of the Transcendental Meditation and TM-Sidhi programme has the effect of reversing the deterioration in physiological functioning commonly associated with the ageing process.

In order to ascertain whether a continuing longitudinal trend of improvement was occurring as a result of the Transcendental Meditation and TM-Sidhi programme, measurements of physiological variables that are influenced by ageing were repeated in subjects who had been similarly examined in our cross-sectional study.

METHODS

SUBJECTS—Seventy-three individuals (54 men and 19 ladies), who had been tested in the original cross-sectional study were re-evaluated. Details of mean values for age, duration of practice of Transcendental Meditation, duration of practice of the TM-Sidhi programme, and the sum of the latter two variables (TMSD) are given in table 1.

TESTING PROCEDURE—As in the previous cross-sectional study, measurements were made of systolic blood pressure, near point of vision, and auditory threshold at 6 kHz, according to the method of the Adult Growth Examination (AGE), (Morgan and Fevens, 1972).

Systolic blood pressure was measured with a random zero sphygmomanometer (Gelman Hawksley, England), the appearance of the first sound being taken as the systolic pressure. The value of systolic blood pressure used for calculations was the average of three readings taken at rest in the sitting position separated by the intervening activity of the other two tests.

Near point of vision was taken as the closest distance for uncorrected binocular vision at which a sentence in 12-point characters could be read without blurring.

The auditory threshold was measured at 6 kHz for the better ear after a rehearsal at 1 kHz (1702 recording audiometer, Grayson Stadler, U.S.A.). The only difference in method from the previous assessment was that subjects signalled the appearance or disappearance of the tone by pressing a button, as opposed to raising their hand (the latter being the method described by Morgan).

ANALYSIS—The results of the three subtests of the AGE were compared for each subject and the significance of the differences between the first and the second assessments were calculated using the paired t-test. The subtest results were also used to derive each subject’s biological age, according to the AGE method using norms as previously described (Toomey et al., in press). Biological age and the dif-

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>DETAILS OF SAMPLE: AGE AND DURATION OF PRACTICE OF THE TRANSCENDENTAL MEDITATION AND TM-SIDHI PROGRAMME</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>MEN (N=54)</th>
<th>LADIES (N=19)</th>
<th>ALL SUBJECTS (N=73)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Assessment</td>
<td>Second Assessment</td>
<td>Difference</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>30.2</td>
<td>31.7</td>
<td>1.5</td>
</tr>
<tr>
<td>S.D.</td>
<td>5.8</td>
<td>5.8</td>
<td>0.1</td>
</tr>
<tr>
<td>Transcendental Meditation (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>6.7</td>
<td>8.2</td>
<td>1.5</td>
</tr>
<tr>
<td>S.D.</td>
<td>2.5</td>
<td>2.5</td>
<td>0.1</td>
</tr>
<tr>
<td>TM-Sidhi programme (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.4</td>
<td>3.9</td>
<td>1.5</td>
</tr>
<tr>
<td>S.D.</td>
<td>1.0</td>
<td>1.0</td>
<td>0.1</td>
</tr>
<tr>
<td>TMSD* (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>9.2</td>
<td>12.1</td>
<td>2.9</td>
</tr>
<tr>
<td>S.D.</td>
<td>3.1</td>
<td>3.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

* TMSD = years of practice of Transcendental Meditation added to years of practice of the TM-Sidhi programme.
ference between biological age and chronological age were then compared from the first to the second assessments using the paired $t$-test.

In addition to examining longitudinal changes, the difference between biological age and chronological age was correlated with years of practice of the Transcendental Meditation and TM-Sidhi programme, using the data from the two assessments separately.

Functional age, a sample-derived measure of physiological age (Webster and Logie, 1976), was calculated for each subject in order to overcome possible problems with norm-derived biological age. The difference between functional age and chronological age was then correlated with the duration of practice of the Transcendental Meditation and TM-Sidhi programme, using the data from each assessment separately.

Since duration of practice of Transcendental Meditation and duration of practice of the TM-Sidhi programme were highly intercorrelated ($r = .625$, $N=73$, $p<.001$), they were added together to form a composite variable, termed TMSD, which accounts for daily time invested in the programme. This was used for the correlation analyses described above.

**RESULTS**

Significant reductions in systolic blood pressure ($p<.01$) and auditory threshold at 6 kHz ($p<.001$), were found after 1.5 years. The reduction in blood pressure for ladies was not statistically significant. Near point of vision remained unchanged.

Mean biological age decreased by 1.7 years during the interval of study ($p<.05$). There was therefore a significant increase in the degree to which biological age was younger than chronological age, the difference being 7.5 years at the first assessment and 10.6 years at the second assessment ($p<.001$). The change in biological age is illustrated in figure 1.

The results of the AGE subtests, biological age, and the difference between biological age and chronological age are summarized in table 2.

At both assessments, the difference between biological age and chronological age was significantly correlated with years of practice of the Transcendental Meditation and TM-Sidhi programme ($r = -.36$, $N=73$, $p<.005$ for the first assessment; $r = -.451$, $N=73$, $p<.001$ for the second assessment).

The difference between functional age and chronological age was also significantly correlated with years of practice of the Transcendental Meditation and TM-Sidhi programme at both assessments ($r = -.363$, $N=73$, $p<.005$ for the first assessment; $r = -.311$, $N=73$, $p<.01$ for the second assessment).

**DISCUSSION**

In this paper we have reported the findings of the first two assessments in an on-going longitudinal study. The results show that systolic blood pressure, auditory threshold at 6 kHz, and biological age decreased significantly over a 1.5-year period in individuals practising the Transcendental Meditation and TM-Sidhi programme. Thus, the ageing process is apparently not only halted but actually reversed.
TABLE 2

RESULTS OF ADULT GROWTH EXAMINATION SUBTESTS AND BIOLOGICAL AGE CALCULATIONS

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>MEN (N=54)</th>
<th>LADIES (N=19)</th>
<th>ALL SUBJECTS (N=73)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Assessment</td>
<td>Second Assessment</td>
<td>Difference</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>Mean</td>
<td>120.7</td>
<td>116.5</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>9.4</td>
<td>9.3</td>
</tr>
<tr>
<td>Near point of vision (inches)</td>
<td>Mean</td>
<td>4.155</td>
<td>4.122</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>1.574</td>
<td>1.833</td>
</tr>
<tr>
<td>Auditory threshold (decibels)</td>
<td>Mean</td>
<td>8.648</td>
<td>3.648</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>12.181</td>
<td>12.263</td>
</tr>
<tr>
<td>Biological age (years)</td>
<td>Mean</td>
<td>22.7</td>
<td>21.3</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>5.9</td>
<td>4.2</td>
</tr>
<tr>
<td>Difference between biological age and chronological age (years)</td>
<td>Mean</td>
<td>-7.5</td>
<td>-10.4</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>7.1</td>
<td>5.8</td>
</tr>
</tbody>
</table>

*p < .05; **p < .01; ***p < .001; NS = not significant; (paired t-test).

These findings are of particular interest since the subjects had been practising the Transcendental Meditation and TM-Sidhi programme for several years, and had already exhibited a marked difference between biological age and chronological age at the time of the first assessment. It appears that a plateau in the improvement in systolic blood pressure and auditory thresholds has yet to be reached. Also worthy of note is the fact that near point of vision did not deteriorate over the eighteen-month period.

The correlations between length of time practising the Transcendental Meditation and TM-Sidhi programme and the degree to which both biological and functional ages were younger than chronological age confirm the findings of our first cross-sectional assessment. This lends further support to the hypothesis that the difference between physiological age and chronological age increases as the individual continues to participate in the Transcendental Meditation and TM-Sidhi programme.

This conclusion is also confirmed by the work of Wallace et al. (1982). In another study on systolic blood pressure among middle-aged practitioners of the Transcendental Meditation and TM-Sidhi programme, Wallace and his colleagues (in press, b) found that average values were substantially lower than population norms, with a greater difference apparent in the older age groups. Duration of practice of the Transcendental Meditation programme was correlated with the degree to which blood pressure was lower than expected from normative data.

Apart from their importance as indicators of reversal of ageing, these effects on blood pressure are of great significance in the context of the prevention of cardiovascular diseases, particularly now that the risks of even mild hypertension and high "normal" blood pressure are apparent. Normalization of high blood pressure (Wallace et al., 1972a; Blackwell et al., 1975), reduced use of tobacco (Wallace et al., 1972b; Lazar et al., 1976; Monahan, 1977), and decreased serum cholesterol (Cooper and Aygen, 1978 and 1979) have also been found to result from the Transcendental Meditation and TM-Sidhi programme, which therefore appears...
to have comprehensive benefits in the prevention of ischaemic heart disease, the largest single cause of mortality in developed nations.

In a review of research, Clements and Clements (1980) found that changes in thirty-four physiological and psychological variables brought about by the Transcendental Meditation and TM-Sidhi programme were in the opposite direction to the usual deteriorations associated with the ageing process. Furthermore, the Transcendental Meditation and TM-Sidhi programme was noted to have multiple beneficial effects on eight factors most closely associated with longevity and good mental and physical health in later life.

More recent studies have shown a significant relationship between years of practice of the Transcendental Meditation and TM-Sidhi programme and high performance on tests of psychological abilities which are known to deteriorate with ageing (Jedrczak, in press).

Thus, there is now powerful evidence that the Transcendental Meditation and TM-Sidhi programme produces an holistic improvement in psychological and physiological functioning which is consistent with reversal of the ageing process. The probable physiological mechanisms for this effect are discussed by Clements and Clements (1980) and include such factors as the occurrence of markedly reduced metabolic rate (e.g. Wallace et al., 1971; Farrow and Hebert, 1981) and increased cerebral blood flow during Transcendental Meditation (Jevning and Wilson, 1978), increased neuro-physiological integration (Levine et al., 1976; Orme-Johnson and Haynes, 1981; Appelle and Oswald, 1974; Warshal, 1980; Wallace et al., in press, a); improved homeostatic functioning (McDonagh and Egenes, 1976; Miskiman, 1976; Reddy, in press; Yee and Dissanayake, in press), faster recovery from stress as indicated by skin resistance recovery time (Orme-Johnson, 1973; Daniels, in press), and persistent reductions in stress levels as indicated by fewer spontaneous skin resistance responses (Orme-Johnson, 1973), lower urinary free cortisol excretion (Bevain et al., 1976), and lower basal heart and breath rate (Routt, 1976).

The recent study of Werner et al. (in press) shows particularly interesting effects of the TM-Sidhi programme on the neuro-endocrine system with evidence of increased stability, and greater sensitivity of endocrine control. The efficiency of the neuro-endocrine system may be particularly important in determining the rate of ageing (Everitt, 1980).

Vedic Science, as brought to light by His Holiness Maharishi Mahesh Yogi, provides a more fundamental perspective in terms of the growth of the ability to live spontaneously in accordance with natural law as higher states of consciousness are developed through the Transcendental Meditation and TM-Sidhi programme. Vedic Science locates the cause of disease and ageing in the violation of the laws of nature which are responsible for the maintenance and evolution of every aspect of life. Conversely, perfect health is seen as the result of life lived in accordance with natural law. From this standpoint, reversal of the ageing process, as shown in the present study, is a clear indication that the Transcendental Meditation and TM-Sidhi programme establishes life in accordance with natural law.

The deterioration in mental, physical, and social functioning associated with the ageing process is a world-wide problem of immense proportions, both in terms of human suffering and economic consequences. In developed nations, where the elderly form a large segment of the total population, illnesses related to ageing constitute the bulk of the workload of health services.

Furthermore, there can be no doubt that the measures taken so far to tackle the problems caused by ageing have been inadequate. Most importantly, no means have previously been available to prevent or reverse the basic cause of these problems, which is the biological ageing process. While mental, physical and social factors all contribute to the problems of old age, attempts to improve the life of the elderly by social manipulation or increased availability of medical care must meet with only limited success if overall mental and physical functioning is impaired by ageing.

The results of the present study demonstrate that the Transcendental Meditation and TM-Sidhi programme reverses the physiological ageing process at its inception in early adult life, while the same influence is apparent in older individuals in the study of Wallace et al. (1982).

The availability of such a simple, safe and reliable technology to eliminate the root cause of the problems of old age promises great benefits for the promotion of longevity, and for the quality of life of older individuals. The presence in society of
healthy, productive senior citizens whose creative capabilities continue to grow with age, and whose wisdom and experience are available to all, can be expected to lead to profound benefits for society as a whole.

It is therefore suggested that widespread application of the Transcendental Meditation and TM-Sidhi programme in all age groups should be a priority for health services in order to avert the crisis presented by ageing today, and to achieve the highest standards of health and longevity.

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