Working Capacity of Deaf, and Visually and Mentally Handicapped Children

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From The Children's Hospital of Winnipeg and The University of Manitoba

Cumming, G. R., Goulding, D., and Baggley, G. (1971). Archives of Disease in Childhood, 46, 490. Working capacity of deaf, visually and mentally handicapped children. Using bicycle ergometers, physical working capacity was determined in 61 deaf, 22 visually handicapped, and 67 mentally retarded children 8 to 17 years of age. Compared to the normal population, the working capacities per kilogram body weight of the deaf children, particularly the girls, were superior to the other groups and to the normal population. The visually handicapped had lower working capacities, while those of the retarded children were similar to the normals.

The work efficiency was similar in both groups. For the boys and younger girls, the maximum oxygen uptakes per kilogram body weight were similar in the deaf and visually handicapped, results that were contrary to the working capacity studies. The difference could be explained by postulating that the deaf children did not work to maximal values though lactic acid and respiratory quotient data suggested that they did. The maximum heart rates of the deaf children were lower than the visually handicapped.

The working capacities of handicapped children may be related to the degree to which their disability changes their habitual physical activity. Children who have serious visual handicaps are likely to be sedentary and should theoretically have reduced working capacities. Children with severe mental retardation theoretically might be apathetic and inactive and have low working capacities, or be hyperactive and have high capacities. Deaf children may compensate for their lack of oral communication with an increase in physical activity. To test these hypotheses, the physical working capacity and maximum oxygen uptake have been determined in children aged 7 to 17 years with mental retardation and visual and hearing handicaps.

Methods

Tests were performed using Von Dõbeln friction type ergometers and an electrically braked ergometer. The ergometers were externally calibrated so that comparable loads were obtained (Cumming and Alexander, 1968). All subjects were exercised at two loads of 6

Received 12 March 1971.

*Supported by Fitness and Amateur Sport Directorate, Ottawa, Canada.
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Subjects

Mentally retarded.—Subjects with mental retardation with intelligence quotients ranging from 40–60 were obtained from special classes at the Winnipeg school system. Their ages ranged from 7 to 17 years. None of the subjects had cardiac lesions, or orthopedic or constitutional illnesses. None was on any medication other than occasional bedtime sedation. 12 of the subjects had Down's syndrome and none of these had clinical evidence of heart disease. The subjects were tested in their schools in 1970. Of those asked to participate, 3 were not sufficiently co-operative to perform the test, and one was too small for the ergometer.

Visually handicapped.—None of these children was totally blind but all had sufficient visual problems that a special class was required for schooling. Visual problems had been present from infancy. All were capable of navigating on their own. Cardiopulmonary disease was excluded on the basis of physical examination. Children with Marfan's disease were excluded, and none of the children tested had any systemic disorder. These children were tested in the laboratory in 1968, and all available children in two city school classes were tested.

Deaf children.—These children were selected at random from the class list of the special school for the deaf. Hearing problems had been present from infancy; in 40%, the primary lesion was nerve deafness, in 60% chronic middle-ear disease. All had electrocardiographic studies and no patient with a long QT interval was discovered. Subjects with known rubella syndrome on the basis of history, or with other stigmata of the rubella syndrome, were excluded. 30 subjects were tested in the school in 1967, and 26 subjects in the laboratory in 1968.

Physical education.—The retarded children had physical education classes twice weekly. This involved mostly calisthenics, and motor learning with some light games such as baseball. The visually handicapped had physical education classes twice weekly, mostly involving calisthenics, dancing, and games not requiring visual acuity. The deaf children had a large physical education facility, and the children received two classes weekly. For those boarding at the school, extra games periods were held each evening.

Results

Results for the three groups were compared using the student t test and linear regression analyses were carried out by computer using standard statistical techniques (Steel and Torrie, 1960).

Boys.—The PWC 170/kg body weight of the individual boys and girls are plotted on a centile chart of normal subjects obtained in a large national survey conducted in 1967 (Canadian Association for Health, Physical Education and Recreation, 1968). Disposition of the three groups in relation to the normal values is summarized in Table 1. For the boys, two-thirds of the deaf children were above 50 centile, and only 1 out of 15 was below the 15 centile line. For the retarded, almost a half were above 50 centile, and one-fourth were below 15 centile. For the visually handicapped, none were above the 50 centile, and over one-third were below the 15 centile. If we may define fitness as having a high physical working capacity, the deaf had an increased PWC 170, with very few unfit; the retarded had an average number of fit subjects but more than the expected in the very low fitness category; none of the visually handicapped boys was above average in fitness, and over twice as many as expected were in the below 15 centile group.

![Fig. 1.—Centile chart of working capacity per kg body weight for normal boys aged 8 to 17, and individual values for handicapped boys.](http://adc.bmj.com/)
Girls.—Over 80% of the deaf girls were above the 50 centile category and none was below the 15 centile level. The distribution for the retarded girls was the same as for the retarded boys. There was a difference in the fitness levels between the visually handicapped girls as opposed to the visually handicapped boys with half of the girls above the 50 centile line. There were, however, twice the expected number of visually handicapped girls below the 15 centile line. The results indicate that the deaf girls were well above average in working capacity values while the retarded and visually handicapped girls had an average number of fit children, but a greater number of unfit than expected.

The patients with Down’s syndrome had the same mean working capacity values and distribution on the centile chart as those with mental retardation not due to Down’s syndrome.

Table II gives the mean values and standard deviations for body build and fitness tests. For the boys, the deaf children were taller and slightly heavier with the exception that the older retarded children were the heaviest group. The deaf children seemed to be the leanest in terms of percentage fat. For the girls, the deaf children were taller than the other groups, while the retarded older girls were heavier and had a higher percentage of body fat as measured by skinfolds.

The mean PWC 170/kg body weight was greater in the deaf boys and girls compared to their counterparts. The mean values for the retarded children were significantly greater than the mean values for the visually handicapped in the case of the boys but not for the girls.

The maximum studies showed that the maximum heart rate was significantly greater in the visually handicapped than in the deaf children. The mean maximum oxygen uptake (VO₂ max) in ml/min per kg body weight was similar in the deaf and visually handicapped boys. The mean VO₂ max of the younger girls were the same in both groups, while the deaf girls tended to have higher VO₂ max values than the visually handicapped (P < 0.05) (t test).

The correlation coefficient between PWC 170 and VO₂ max per kg body weight for the girls was 0.49, with a standard error of the estimate of 13%. The correlation coefficient between PWC 170 and VO₂ max per kg body weight for the boys was 0.57 with a standard error of prediction of 12-6%. The exercise efficiency of the children was similar, i.e. there was no difference between the oxygen requirement for performing similar work loads. For the four groups, deaf and visually handicapped boys and girls, there was a high correlation between submaximal heart rate and oxygen uptake expressed as a percentage of the maximum (correlation coefficients ranged from 0.88 to 0.94). Fig.

**Fig. 2.—Centile chart of working capacity per kg body weight for normal girls age 8 to 17, and individual values for handicapped girls.**

### Table II

<table>
<thead>
<tr>
<th>Group</th>
<th>Deaf</th>
<th>Visually Handicapped</th>
<th>Retarded</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group</td>
<td>8–12</td>
<td>13–17</td>
<td>8–12</td>
<td>13–17</td>
</tr>
<tr>
<td>Number</td>
<td>14</td>
<td>18</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Mean age (yr)</td>
<td>11 ± 1</td>
<td>15 ± 2</td>
<td>10 ± 2</td>
<td>14 ± 1</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>144 ± 10</td>
<td>164 ± 9</td>
<td>139 ± 17</td>
<td>159 ± 2</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>37–3 ± 6–7</td>
<td>57–2 ± 11–8</td>
<td>37–7 ± 14–8</td>
<td>52–6 ± 18–2</td>
</tr>
<tr>
<td>Fat—% body weight</td>
<td>16–0 ± 3–5</td>
<td>18–0 ± 4–9</td>
<td>21–2 ± 5–3</td>
<td>21–1 ± 8–8</td>
</tr>
<tr>
<td>PWC 170 kpm/kg per min</td>
<td>14–3 ± 2–6</td>
<td>15–0 ± 3–0</td>
<td>9–6 ± 2–2</td>
<td>10–4 ± 3–3</td>
</tr>
<tr>
<td>Max heart rate</td>
<td>195 ± 8</td>
<td>185 ± 8</td>
<td>205 ± 3</td>
<td>201 ± 4</td>
</tr>
<tr>
<td>VO₂ max ml/kg per min</td>
<td>43–8 ± 4–6</td>
<td>45–2 ± 7–0</td>
<td>44–6 ± 11–8</td>
<td>44–6 ± 11–8</td>
</tr>
</tbody>
</table>

± = standard deviation.
3 shows that there was a difference, however, between the groups in that for a given heart rate the deaf children were working at a greater percentage of their maximum. This is because the maximum heart rate in the deaf was lower than in the visually handicapped.

Because of the lower maximum heart rates in the deaf children, the question arises as to whether these children were worked to true maximum values. We believe that they were because the majority of subjects worked close to exhaustion and lactic acid values obtained in 5 children ranged from 9·8 to 12·4 mmol/l. (warmed fingertip blood 5 min after exercise). Respiratory quotient values during maximal exercise ranged from 1·10 to 1·32, another index that near maximum values for VO₂ were being achieved.

**Discussion**

Submaximal tests may show a larger difference compared to direct measurement of VO₂ max between the fit and unfit. At a heart rate of 170 beats per minute, the visually handicapped were worked at 70% of their maximum, whereas the deaf children were working at 80% of their maximum (Fig. 3). This confirms the results of previous studies (Cumming and Danzinger, 1963). This finding could also be explained on the basis of the deaf children not having achieved true maximal VO₂ values. In trying to communicate with the deaf children, it became obvious how much we relied on the spoken word for encouraging and urging a young subject to go all out and to put up with the leg fatigue necessary for a maximum test on the bicycle ergometer. However, with the use of sign language, large printed cards, and having an official from the Deaf School, knowledgeable in sign language, present at the time of the testing, we believe that the majority gave maximal efforts. Treadmill testing might present some advantages over the bicycle ergometer in testing these subjects.

There is a large range in the normal values for exercise working capacity in the average population. Because of this, the centile method has some advantages for looking at the range of fitness in different groups. A previous report has indicated that the physical education classes in the City of Winnipeg did not improve PWC 170 or VO₂ max over the course of the school year. Even schools with superior physical education programmes, while having students with above average levels of fitness, were also unsuccessful in improving these parameters (Cumming, Goulding, and Baggley,

<table>
<thead>
<tr>
<th>Girls</th>
<th>Visually Handicapped</th>
<th>Retarded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-12</td>
<td>13-17</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>19</td>
<td>12-17</td>
</tr>
<tr>
<td>11 ± 1</td>
<td>15 ± 1</td>
<td>18 ± 1</td>
</tr>
<tr>
<td>149 ± 7</td>
<td>161 ± 5</td>
<td>142 ± 8</td>
</tr>
<tr>
<td>87 ± 3</td>
<td>11-0</td>
<td>113 ± 7</td>
</tr>
<tr>
<td>26-5 ± 4</td>
<td>9 ± 3</td>
<td>30-0 ± 2</td>
</tr>
<tr>
<td>11-4 ± 2</td>
<td>5 ± 1</td>
<td>30-0 ± 2</td>
</tr>
<tr>
<td>193 ± 6</td>
<td>193 ± 6</td>
<td>7-9 ± 2</td>
</tr>
<tr>
<td>37-0 ± 6</td>
<td>37-6 ± 1</td>
<td>13-17</td>
</tr>
</tbody>
</table>

**Fig. 3.—** Heart rate vs oxygen uptake (VO₂) expressed as a percentage of maximum VO₂. \( r = \) correlation coefficient. Least square lines drawn.
1969). Thus, while the deaf children tend to have better physical education programmes which might account for their higher working capacities, our previous experience tends to discount this as a major factor. Such a limited time is devoted to physical education, and so much of the physical education is of an instructional nature, that there is little in the way of training accomplished unless a special effort is made to do so.

It is, therefore, suggested that in the three groups studied the differences in their fitness as measured by PWC 170 may be related to differences in habitual physical activity which started at an early age. The deaf had higher working capacities compared to the normal population or to the other groups, while the visually handicapped had low working capacities. The mentally retarded had some high and some low values, but the average value was similar to that of the general population. The low working capacities of the visually handicapped may be because the lack of visual acuity tends to steer them away from physically active pursuits. The working capacities of deaf children are above the average population, possibly because they do not sit around with idle chatter and spend as much time with television. The average working capacities of the normal population are equal to those of the child with severe mental retardation, possibly because neither group has the urge or need for intense physical activity. In both groups, there are found some children with relatively high and some with very low levels of fitness.

Technical assistance was provided by Misses Kerry McCarthy and Cecile Dufresne. We are grateful to Mr. D. M. Plummer and officials at the Manitoba School for the Deaf, and the officials of Winnipeg School Division 1 for their co-operation and assistance.

REFERENCES


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Arch Dis Child 1971 46: 490-494
doi: 10.1136/adc.46.248.490

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